

BEEF + LAMB NEW ZEALAND

GUIDE TO NEW ZEALAND CATTLE FARMING



BY FARMERS.
FOR FARMERS



GUIDE TO NEW ZEALAND **CATTLE FARMING**

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BEEF INDUSTRY OVERVIEW

- World meat production is increasing with beef making up 22% of the total.
- Beef production contributes significantly to the New Zealand economy with total beef exports worth around \$2.8 billion per year.
- New Zealand's pasture-based farming systems and largely disease-free status gives this country a marketing advantage internationally.
- Since 2000 New Zealand beef cattle and sheep numbers have declined 13% and 30% respectively while dairy cattle numbers have increased 41%.
- Consumer demand for New Zealand beef is strong due to healthy eating and convenience food attributes.
- The dairy industry contributes significantly to beef production supplying 24% of farm gate receipts from cull cattle slaughtered including bobby calves.
- Dairy-beef bull beef calves kept and reared for beef production on sheep and beef farms make up 19% of the adult cattle slaughter.
- Innovation has allowed beef productivity to increase between 1978 and 2011 contributing to a growth in agricultural productivity of 2.8% per year.
- The main beef cow breeds comprise 47% Angus, 14% Hereford and 14% Angus x Hereford crosses, with the balance other breeds and crosses.
- About 71% of New Zealand's beef cattle are in the North Island with 34% in the Auckland region and 25% on the East Coast while Canterbury and Westland have 18%.
- Sheep and beef cattle production are complementary for pasture management.
- Reducing beef's environmental footprint is becoming increasingly important through reducing nitrogen contamination and greenhouse gas emissions.

Introduction

The world has a large and increasing appetite for meat. Global meat production and consumption over the last 50 years has trebled to 312 million tonnes with beef having a 22% share. Both pork and chicken have shown slightly greater growth than beef in recent years with sheep meat remaining relatively constant as shown in Table 1.

Table 1: World meat market at a glance (Food & Agriculture Organisation, Food Outlook October 2014).

	2012	2013	2014	CHANGE	2012	2013	2014
	<i>estimate</i>		<i>forecast</i>	<i>2014 over 2013</i>			
WORLD BALANCE							
	million tonnes				%		
Production	304.2	308.3	311.6	1.1	100.0%	100.0%	100.0%
Bovine meat	67.0	67.8	68.3	0.8	22.0%	22.0%	21.9%
Poultry meat	105.4	106.4	107.6	1.1	34.6%	34.5%	34.5%
Pigmeat	112.4	114.5	116.1	1.4	36.9%	37.1%	37.3%
Ovine meat	13.7	13.9	14.0	0.6	4.5%	4.5%	4.5%



Beef production contributes significantly to the New Zealand economy earning about \$2.8b each year and being 42% of total meat exports

New Zealand beef is from cattle with extremely low levels of disease, allowing ready international market access

Around 13% of global beef production is traded internationally and even though New Zealand produces only 0.9% of the total we account for about 6% of the traded volume. The beef industry plays a significant role in the New Zealand primary sector with beef and veal exports worth about \$2.3 billion a year. There is another \$0.5 billion in related co-products including hides, tallow, meat meal, pet food and animal oils and fats from beef.

Larger countries rely more on crop or forage to raise cattle whereas New Zealand relies predominantly on pasture. India has the world's largest national cattle herd with over 301 million head. Brazil and China have 213m and 103m respectively, while the US is fourth having declined in recent decades to 88 m. The New Zealand cattle population at 10.4m, comprising 3.64m beef and 6.75m dairy cattle, ranks the 12th largest cattle herd by country. Australia ranks 7th in the world with 27.6m cattle.

An important non-land factor that affects a country's position in world beef trade is the disease status of its cattle. The most serious of the animal diseases are foot and mouth disease (FMD), and bovine spongiform encephalopathy (BSE). New Zealand is internationally recognised as being a negligible BSE risk and is FMD free. New Zealand has never had a case of either disease. This allows exports of fresh, chilled and frozen beef to a greater number of markets. Possibly the greatest threat to our beef exports is TB. New Zealand has an active programme to control TB and ensure there is a very low incidence rate. Our international animal health status was further bolstered in 2012 with the introduction of a compulsory individual electronic individual animal identification (EID) programme. With the introduction of compulsory EID and tracking of cattle this has not only enabled high level disease surveillance but also greatly enhances our biosecurity integrity and therefore the confidence of our international customers.

International beef trade is comprised of several sub-markets. Countries that have not developed cattle feed-lot industries can supply grass-fed and short-fed, or limited feeding of grain, beef. Nearly all of New Zealand's beef exports are directed to markets for grass-fed beef, including the US and Asian markets. Australian grass-fed beef is also exported to the US, as well as Asia. The EU produces limited amounts of grass fed beef, and exports grass-fed dairy beef to low income markets in Eastern Europe, Russia, and Africa. South American countries have long been prohibited from sending fresh chilled and frozen beef to the high-valued Asian and North American markets because of their FMD status. South America's major market has historically been the EU, which allowed imports of such product from FMD countries subject to specific standards. Potentially one of the biggest threats for the export of our pasture-fed beef could come from South American countries if they were able to raise their animal health status and compete with us on some of our more lucrative beef markets such as North America.

In New Zealand the annual per capita consumption of beef meat on a carcass weight equivalent basis is 24 kg while in Argentina it is 63 kg, Australia 32 kg, USA 35 kg and China 4.6 kg.

Unique features of the New Zealand beef industry are that about 95% is pasture fed and there is a great diversity of breeds with the dairy industry contributing a significant proportion of production. Most beef cattle are run on hill country having given ground to dairying and intensive sheep systems on the easier more highly productive rolling and flat areas. The number of New Zealand beef cattle has declined from a peak of 6.3m in 1975-76 to 3.6 m in 2014-15. Over the same period sheep numbers increased from 55.3 m to a peak of 70.3 m in 1982-83 and then decreased to 29.6 m by 2014-15. In contrast, dairy cattle have increased from 3.0m in 1975-76 to 6.7 m in 2014. These trends in stock numbers are illustrated in Figure 1 below.

Livestock trend (000s)

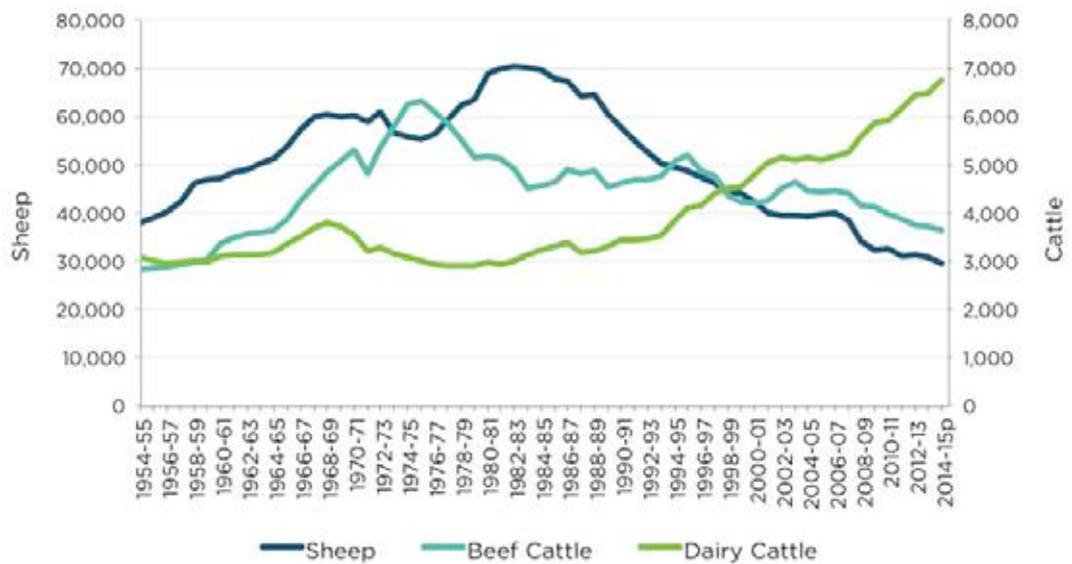


Figure 1: Trends in New Zealand sheep and cattle numbers over the past 60 years. Note scales show same relative rates of change for sheep and cattle. Source: Beef + Lamb New Zealand Economic Service.



New Zealand beef is predominantly pasture fed in contrast to other major overseas producers

Trends in New Zealand in recent decades have seen beef and sheep numbers decline and dairying numbers increase

There is little scope for increased pastoral livestock numbers as land development has been largely completed in New Zealand. Therefore relative areas of land use for beef, sheep or dairy livestock is determined largely by potential production and profit.

Trends in beef and dairy cow numbers have been similar to trends in overall numbers as shown in Figure 2.

The continued upsurge in dairy cow numbers has resulted in an increased tonnage of cow beef with declining steer, heifer and bull beef as shown in Figure 3.

These above trends have seen cow beef increase from 21% of total beef production in 2000-01 to 31% in 2013-14. This increase has been due to expansion of the national cow herd.

Cow numbers and beef production

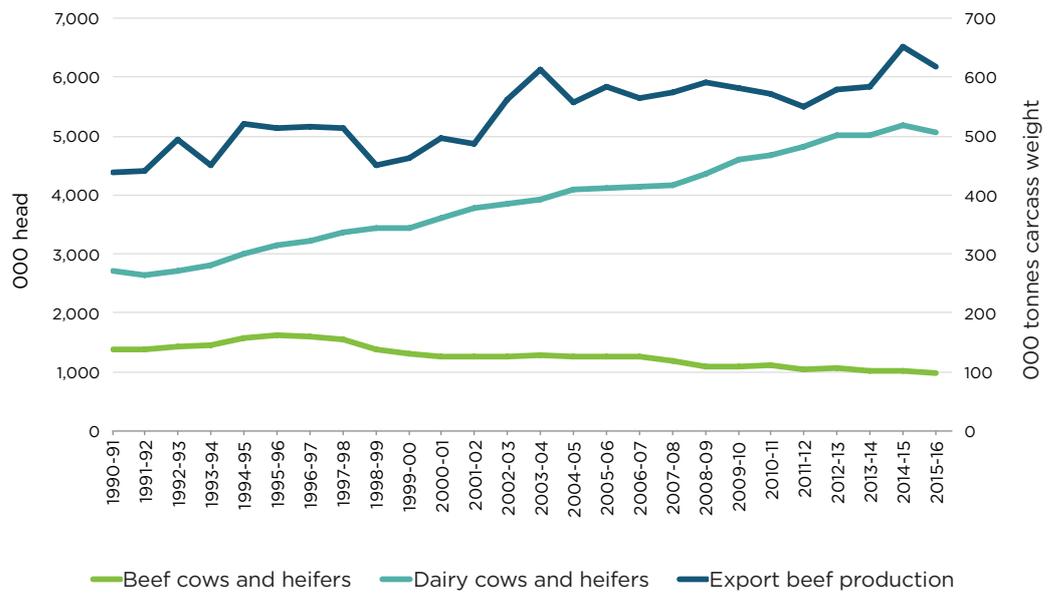


Figure 2: Trends in beef and dairy cow numbers over the last 25 years. Source: Beef + Lamb New Zealand Economic Service.

Total beef production carcass weight

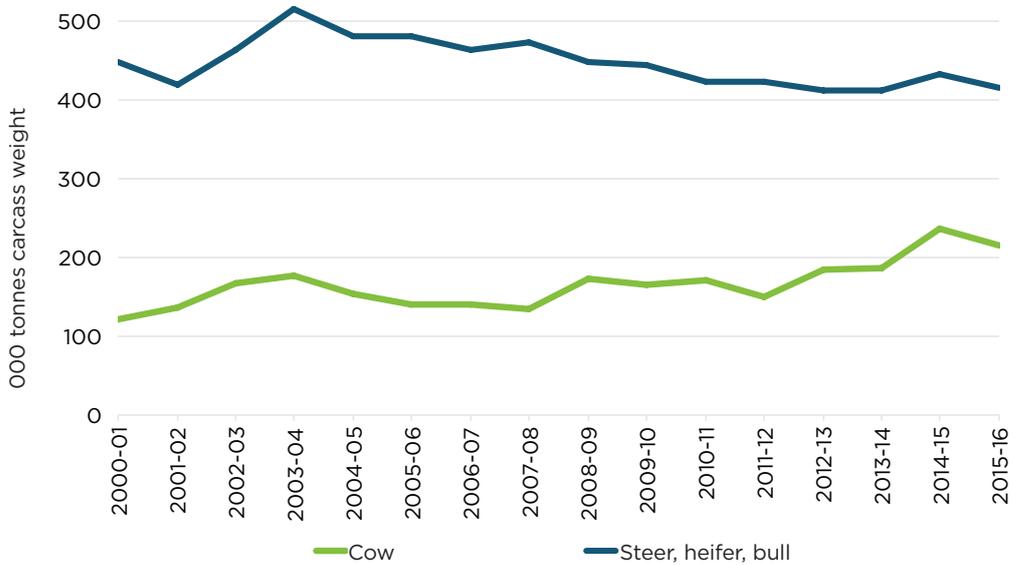


Figure 3: Trends in cow beef and steer, heifer and bull beef over the past decade. Source: Beef + Lamb New Zealand Economic Service.

Major factors driving beef consumption

Major factors that drive changes in beef consumption in food markets include the following:

- People all over the world are recognising that diet is important to their health
- Consumers are looking for foods to counter poor health caused by busy lifestyles, insufficient exercise and fast food
- In wealthy and developed countries, functional foods are meeting specific health needs such as bone health, and there is an increasing desire for foods with specific attributes such as good iron content, good ratios of Omega 3:6 and low glycemic index (GI) or organically and sustainably produced
- With the pace of life continuing to accelerate, consumers are looking for convenience, so the consumption of fresh and frozen easy-to-prepare meals has increased in recent decades
- Households with children are seeking healthier foods and beverages
- Demand for clean, pure, and unprocessed foods is accelerating. Foods that are closer to the farm, often referred to as organic and natural, sustainably grown, free-range and grass-fed will appeal to premium food markets worldwide
- Animal disease, chemical use and food-borne illnesses are drivers of consumer food safety concerns
- Consumers want to know that their food is safe, where and how it was produced and who handled it
- Recent dietary discussions in the US and elsewhere have associated obesity with carbohydrates and are promoting the inclusion of meat in a healthy diet.



Beef exports

The New Zealand Government has a “Growth Agenda” to improve the income and wealth of New Zealanders. This is to be achieved by increasing the ratio of exports to Gross Domestic Product (GDP) from the current 30% to 40% by 2025. For the agricultural sector economic growth is linked to export markets. A significant proportion of export growth in the last decade has been from agriculture which continues to be the key to enhancing economic growth. Research indicates considerably higher levels of animal production are possible such as 1000 kg beef carcass weight per hectare from Friesian bulls, although the average may be closer to 280 to 335 kg carcass weight of beef per ha. Beef + Lamb New Zealand’s Economic Service Sheep and Beef Farm Survey shows eight per cent of sheep and beef farms are achieving this level of production on intensive farms.

The sheep and beef sectors have a strong export focus with 80% of beef, 95% of sheep meat, and 90% of wool exported. In the year ending 30 September 2014 New Zealand produced 633,000 tonnes of beef and veal, 486,000 tonnes of sheep meat and 164,000 tonnes of wool. Trends in total production over the last five years are shown in Figure 4.

North America is the dominant export market for beef accounting for 52% of beef exports by volume while North Asia, mainly China and including Japan, South Korea and Taiwan, accounts for 29% of exports. Exports to other countries are summarised in Table 2.



Consumer demand for New Zealand beef is strong for convenience and healthy eating reasons

New Zealand beef production is an important part of agricultural led economic growth

Total production

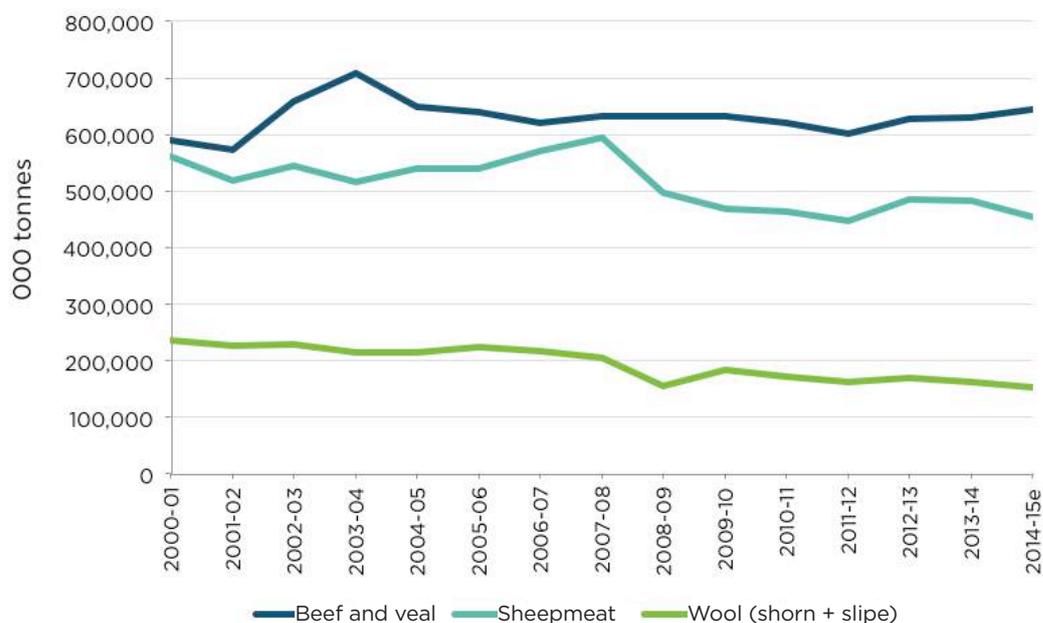


Figure 4: Trends in total production of beef, sheepmeat and wool over 15 years.
Source: Beef + Lamb New Zealand Economic Service.

Table 2: Beef and bobby veal tonnes exported, shipped weight year ended 30 September, 2014.
Source: Beef + Lamb New Zealand Economic Service.

World region	Total shipped (tonnes)	Tonnes %
North America	204,872	52%
North Asia	113,239	29%
South Asia	32,915	8%
Middle East	13,954	4%
European Union	11,524	3%
Pacific	10,198	3%
Other	4,031	1%
	390,733	100%



The dairy industry accounts for 24% of farm gate receipts from beef and bobby veal production

The dairy industry contributes significantly to beef production with an estimated 35% of calves entering the beef industry each year born on dairy farms. It is also estimated that 750,000 dairy cows are the major contributor to the 900,000 adult cows processed for beef each year. With cull dairy heifers it is estimated that dairy cattle make up 38 per cent of the adult cattle slaughter and 24% of farm gate receipts bobby calves included.

Agriculture contributed strongly to productivity in the New Zealand economy during the period 1978 to 2011 where labour productivity increased 3.4% per annum and capital productivity, or ratio of output to capital input, increased by 2.2% per annum. Put anotherway, multi-factorial productivity, or the ratio of output to inputs, reflecting growth attributed to technological change and not capital and labour alone, increased 2.8% annually over this period.

Examples of change in practices on New Zealand beef farms that has helped drive these gains include increased investment in fertiliser, improved pasture production and management, implementation of pregnancy scanning, body condition scoring, use of terminal sires, use of crossbreeding including development of composite breeds, genetic selection for improved production, improved whole-herd health plans, once-bred heifers that have calved and are then processed for prime beef along with their progeny for finishing.

Unlike many countries, the New Zealand beef industry has not fully utilised reproductive technologies such as artificial insemination (AI) and embryo transfer (ET) due to the extensive nature of beef cattle farming and the logistics and cost of these technologies.

Changes have also occurred in the genetic makeup of herds through importation of breeds to meet demand for improved growth and meat production. These imported cattle breeds have then been crossed with the established breeds to obtain the desired traits and animals that are productive in the New Zealand environment. Some composite breeds have been developed and stabilised (see Chapter six).

The beef cattle industry is considered a seasonal industry, principally because most beef is produced from pasture. This marked

seasonality in supply of cattle with 85% of slaughtering occurring during the months November to June inclusive, is seen as a limitation for marketers to meet the demand of some markets. Therefore limits to some of our supply chains become fixed by the low availability of suitable cattle in the period July to October.

Annual slaughter patterns for steers, heifers, bulls and cows for the 2013-14 season are shown in Figure 5 below.

This slaughter pattern in export processing plants is most marked for cull cows with increased levels in March and April building to a peak in May each year. Bull beef production reaches a summer peak in January-February from bulls grown to weight on spring grass. There is a second, smaller autumn bull beef production peak in May-June before winter. The steer production pattern follows a similar but less pronounced trend to bull beef. Heifer slaughter is steady throughout the year showing a small peak in May and is linked to culls from the dairy herd. The seasonal surge in slaughtering follows the spring pasture flush with a lag of about two to three months. New Zealand's 12 meat processing companies process export beef across a total of 33 plants that over the year operate at around 48% of maximum potential. However, the capacity is fully utilised at peak periods and in drought years where there can be waiting lists to get stock slaughtered.



Practice change, mainly improved pasture management, pregnancy scanning, body condition scoring, crossbreeding and improved animal health, has contributed to productivity increasing by 2.8% per year in recent decades in the agricultural sector

Most beef cattle slaughter is between November and June each year

Cattle slaughter pattern by month

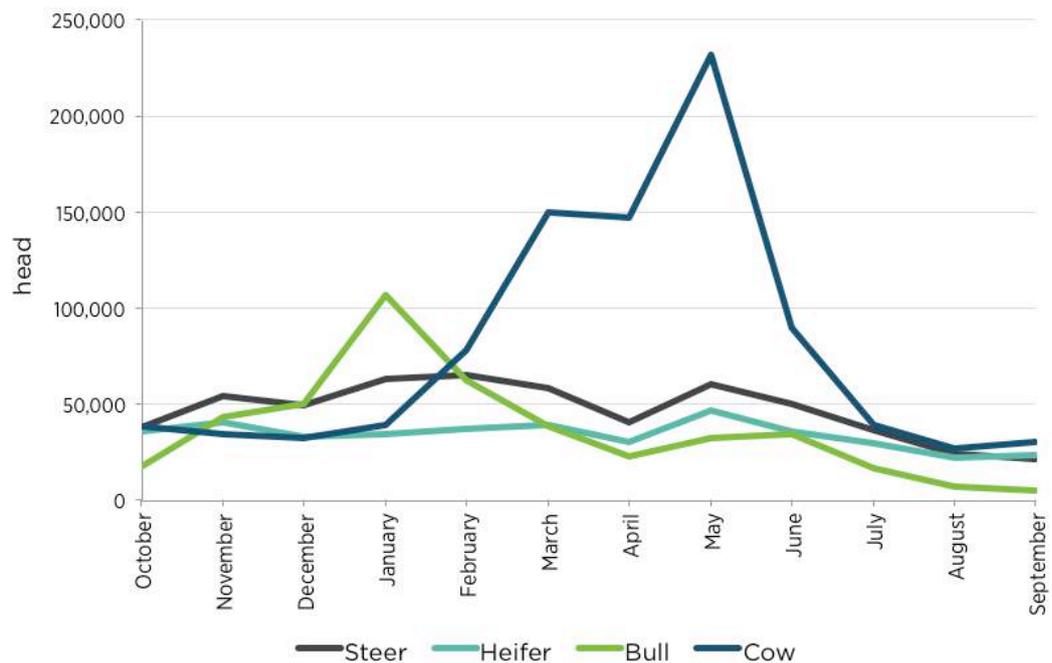


Figure 5: Annual slaughter patterns for numbers of steers, heifers, bulls and cows slaughtered each month for the 2013-14 season. Source: Beef + Lamb New Zealand Economic Service.

Beef cattle breeds

Of the one million beef breeding cows and heifers in New Zealand it is estimated that 47% are Angus, 14% Hereford and 14% Angus x Hereford. Angus and Hereford crosses also contribute to a specific group of 15% classified as mixed crosses. Friesian crossbreds make up 4% of the beef cow herd, “mixed” make up a further 15% and 6% of other breeds make up the rest. Presumably farmers prefer Angus, Hereford and their crosses for their adaptability to hill country conditions.

In terms of total beef cattle including cows the breakdown is: Angus 34%; Angus crosses 12%; Hereford 10%; dairy-beef Friesian 14%; Friesian Hereford 3%; mixed 21% and other breeds 6%.

The expanding New Zealand dairy cattle industry represents a huge opportunity to produce surplus calves for the beef industry using both male and female. Surplus capacity in the dairy industry could be increasingly utilised to produce more efficient beef suckler cows such as Hereford cross Friesian or Angus

cross Jersey. The Angus cross Jersey is an example of a smaller beef cow with high milk levels to produce a large calf at weaning and get back in calf. The larger Hereford cross Friesian heifer would be suitable for improved pastures in a once-bred heifer beef production system. Research has indicated the once-bred heifer system is quite productive and profitable under New Zealand pastoral systems.

These crossbred dairy-beef cows are often mated to Simmental, Charolais, South Devon and Limousin as terminal sires since replacements are no longer required to be bred on-farm.

Recent research has shown there is little difference in that meat eating quality between breed types. Contrary to popular opinion, beef with dairy cattle content are not inferior in eating quality to traditional beef breeds. However, there is some evidence to show the fat from some cattle of dairy origin may be more yellow in colour.



Main beef cow breeds include 47% Angus, 14% Hereford and 14% Angus x Hereford, 15% beef crossbreds and 4% Friesian crosses

Beef herd sizes and distribution

Beef herd sizes are highly skewed because of the many small holdings such as lifestyle blocks which run few beef cattle. Figure 6 shows that small holdings make up the majority of farms with beef cattle. However, these small holdings have a relatively small proportion of the total beef herd. For example, 55% of the beef holdings have

less than 50 beef cattle. In aggregate, these holdings have just 7% of the total beef cattle. This group of farms are likely to be less responsive to industry conditions than the larger more commercial farms. At the other extreme, 7% of farms have over 500 beef cattle. In aggregate, these farms have 45% of the total beef cattle as shown in Figure 7.

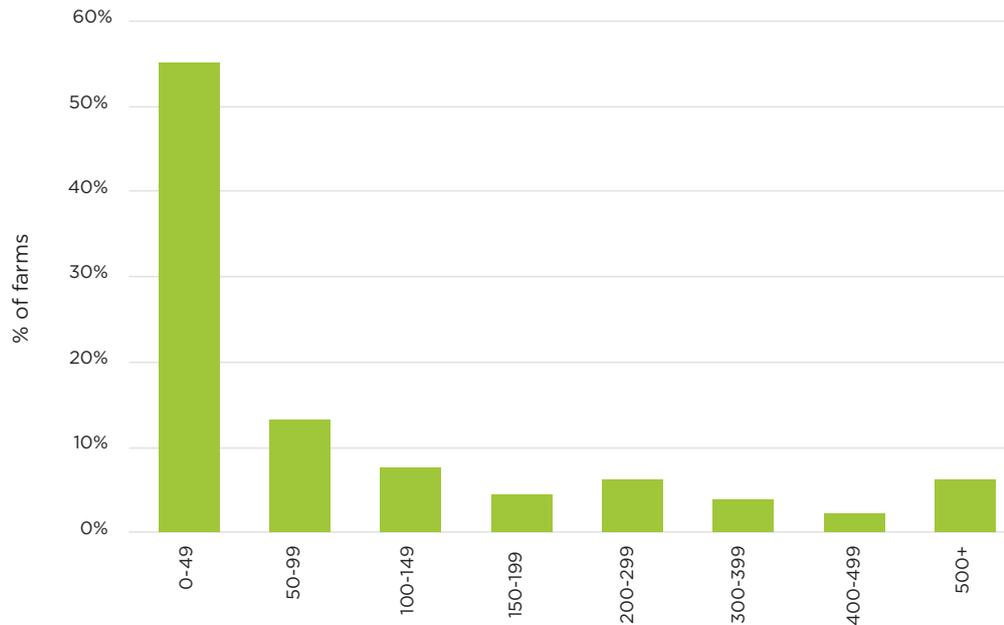


Figure 6: Beef cattle herd size distribution. June 2013. Source: Beef + Lamb New Zealand Economic Service.

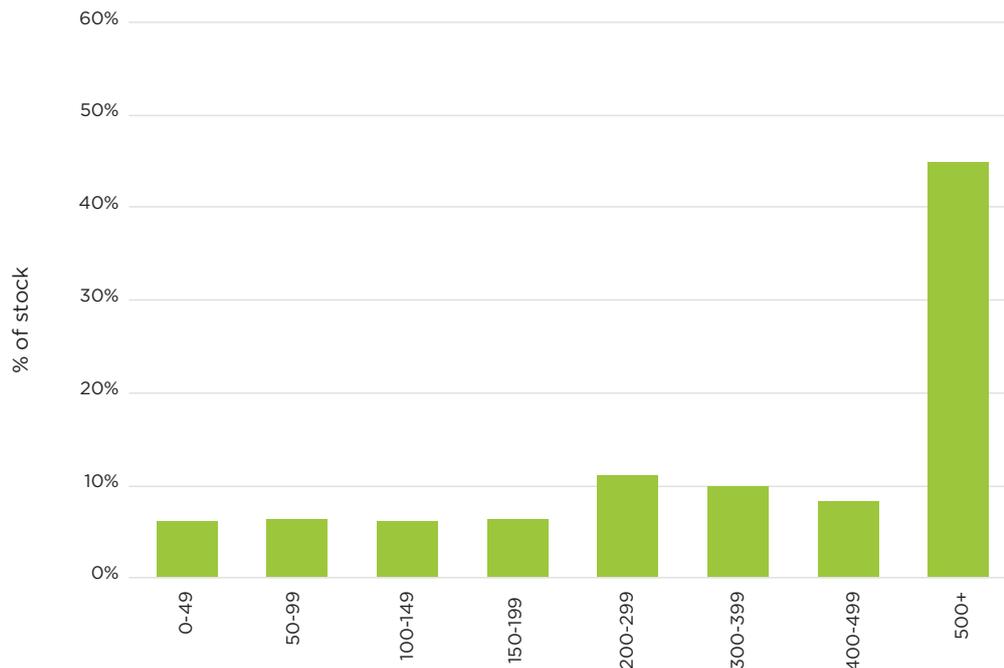


Figure 7: Beef cattle herd size distribution. Source: Beef + Lamb New Zealand Economic Service.



Most beef cattle are run in larger herds with 45% in herds of over 500

Table 3: Beef cattle numbers by local region (as at 30 June 2013).
Source: Beef + Lamb New Zealand Economic Service.

Region	N° Beef Cattle (000)	% of Total Cattle
Northland/ Waikato/BOP	1,240	34
East Coast	936	25
Taranaki/ Manawatu	445	12
North Island	2621	71
South Island	1,077	29
New Zealand	3,699	100

About 71% of New Zealand's beef herd is located in the North Island. While relatively evenly distributed throughout the North Island, the Northland/Waikato/Bay of Plenty region has 34% of the total herd. Table 3 lists the major beef cattle producing regions. A recent change in cattle numbers is occurring in the lower part of the South Island where substantial numbers of dairy beef calves are now being sourced from the increasing number of dairy farms in the region.

Sheep and beef complementarity

In New Zealand beef cattle and sheep are usually farmed together as they are complementary to one another with respect to pasture management and animal health, especially under hill country conditions.

It is relatively easy for producers to alter their mix of sheep and cattle to suit current economic conditions and preferences. The main driving force behind this substitution is the relative profitability between cattle and sheep. There is often debate as to how this profitability is calculated as the cattle typically provide a pasture grooming role in hill country to the benefit of sheep production.

The expansion of the sheep flock and the decline in cattle numbers through the late 1970s was driven by market prices favouring sheep. Today beef cattle numbers are relatively static at around 3.7 million.

Pasture based systems

(see Chapter five for more detail)

The New Zealand climate favours year round pasture growth and this is the key to sheep and beef cattle production with over 95% of the diet being grazed pasture or whole crop. Exports are the focus of the industry with 95% of sheep meat and wool, and 80% of beef exported.

It is the efficient, sustainable and relatively low cost system of pasture production that allows New Zealand to compete globally as a major exporter of food and fibre. Today sheep and beef cattle production are the dominant land uses in terms of land area, utilising 76% or 8.3 million ha of New Zealand's grazing land. These form the basis of the traditional visual and social landscape of New Zealand.

Sheep and beef cattle are usually farmed together in New Zealand and increasingly tend to be located in the steeper hill country, often of lower soil fertility and in summer dry regions. From a management viewpoint sheep and beef cattle farms are relatively complex with the same pastures having to meet several different feed requirements, including feeding ewes and beef cows, finishing lambs and growing cattle for slaughter.

Sheep generally graze pasture to a shorter residual height than cattle and hence grazing policies are not consistent throughout the year but rather vary between seasons. For example, the same paddock may be set-stocked or continuously grazed during spring then rotationally or shuffle grazed at other times of the year. Many pastures are permanent, especially those in less cultivable hill country, which is a significant proportion of the total area farmed. It is presently uneconomic to renew pasture. Of the total area farmed with sheep and beef cattle, the annual rate of pasture renewal has been reported to be just 2.3% compared with 8% on dairy cattle farms which are generally on flatter more fertile land.

More detail on pastures and pasture feeding is given in Chapters four and five.



Sheep and beef production are complimentary due mainly to improved pasture quality

Beef production is pasture based allowing a competitive advantage for the 80% exported

Pasture management is complex with different classes of sheep and cattle competing

Environmental considerations

The environmental issues faced by the sheep and beef cattle industries revolve around water quality and supply, climate change and greenhouse gas (GHG) emissions and managing soil resources.

Sheep and beef cattle farming contributes significantly to the economic wellbeing of New Zealand. Continually improving environmental management alongside animal performance and economic returns is a major opportunity for the sector and for New Zealand. Farming to reduce the environmental footprint is still a key feature of the operating environment for the sheep and beef cattle in New Zealand.

Leaching of nitrogen (N) and loss of phosphorous (P) are potential undesirable effects of agricultural intensification as N and P are pollutants in waterways.

The average nitrogen discharge for the sheep and beef sector is relatively low in comparison to other land uses. The sheep and beef sector is primarily focused on addressing contaminants which flow over land such as phosphorous, sediment and pathogens. These contaminants can be managed through critical source identification and tailored farm specific plans. Evidence¹ indicates that 25-50% of these contaminants can be reduced while maintaining on-farm profit with significant environmental benefits.

The sector is also supportive of excluding cattle from waterways; especially in intensively farmed situations. Hill country farmers can reduce environmental impacts by looking at riparian management and exclusion of critical and sensitive habitats using tailored farm environment planning.

N can be leached at any time of year but is particularly vulnerable when soil concentrations exceed plant demand and when rainfall exceeds evapotranspiration and soil moisture status is high. Current research into mitigation to reduce N leaching is focused on a number of factors including plant species mix, time on crops and pasture when soils are vulnerable to leaching, minimising bare soil time following cropping, smart use of fertiliser, managing hot spots at a paddock, farm and sub catchment scale as well as understanding the potential to breed for within animal differences and nutrient conversion efficiency.

New Zealand's extensive low cost sheep and beef farming systems simply mean that housing to control the potential environmental effects is not an option. There are some advances to be gained from the precision application of fertiliser from aeroplanes and this is an active area of research in New Zealand. Many of these technologies are on the verge of mainstream use and this approach to nutrient balancing in hill country has the potential to transform both pasture and animal production and nutrient loss.

Ways to reduce potential pollutants entering waterways on sheep and beef cattle farms, especially in hill country properties, pose significant challenges to the industry. Nevertheless, all farm types in the future are likely to be evaluated for contaminant losses. There is still huge potential to continue to develop and optimise sheep and cattle farming throughout New Zealand—through the adoption of whole farm planning, focusing targeted actions, and management and adoption of technology to continue to reduce contaminant loss and soil damage.

See more on environmental considerations in Chapter ten.



Farming beef to reduce the environmental footprint is critically important

Cattle can be farmed in harmony with the environment using whole farm planning to optimise land use and minimise contaminant loss and soil damage



References and further reading

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BEEF BREEDING COWS

Recommendations

- High production efficiency is needed for beef breeding cows to be competitive with other livestock enterprises.
- Aim for a production efficiency index of 0.48 kg of calf weaned per kg of cow liveweight at weaning or 48% of cow liveweight at body condition score 6-7.
- Prioritise adequate feeding of cows rearing calves for both high weaning weights and good re-breeding.
- Cow body condition score of 6-7 at mating will ensure high conception rate/calf survival which are major contributors to productivity.
- Cow body condition score of 6-7 at weaning will mean up to two condition scores can be mobilised during winter.
- Wean calves earlier and priority feed if pasture is in short supply.
- Consider ways in which beef cattle can complement sheep or other enterprises on the farm.
- Breeding cow numbers for pasture control will likely be 80 mixed-age cows per 1000 ewes on hill country farms.

Introduction

Traditionally, New Zealand beef production has been based on beef breeding cows producing calves. Normally bull calves are castrated and raised as steers for slaughter either on breeding or finishing farms on a better class of country. Heifer calves replace the old and cull cows within the breeding herd and those that fail to get pregnant.

While this management system is practiced mainly on hill country an alternative system using replacement calves from the dairy herd is a good option. There are well established systems for purchasing four-day-old calves from the dairy herd and raised as bulls, steers or heifers for slaughter. Beef breed x dairy heifers are sometimes raised for replacements in the beef breeding herd. The advantages for the purchased in option are three-fold. Firstly, there is less capital tied up in a beef-breeding herd, so more capital can be used for direct income generation. Secondly, relatively more feed goes into production than maintenance, making this system more efficient. Thirdly, the crossbred dairy breed cows have been shown to be more productive.

The national calving percentage, calculated as the number of calves weaned as a percentage of cows mated, has been 81% over the last five years. Based on cows wintered this figure is 89%. Age at first calving has historically been three years of age in traditional beef cattle farming systems although a survey of farmers found that 65% of heifers calved for

the first time at two years of age. Statistics New Zealand Agricultural Production census data suggests only 30% are bred at 15 months of age to calve at two years. However, the census data makes no distinction between non-pregnant rising two-year old heifers that were kept as finishing cattle or for breeding at 27 months of age. Also, up to 16% of cast for age cows rearing calves in cow mating mobs are often not accounted for. In-calf heifers over one year and under two years at 1 July 2013 made up 13% of the total beef breeding herd. Often there is little scope to cull cows or heifers after emptys have been culled following pregnancy testing.

The distribution of beef cow calving percentage for the 2012-13 season is shown in Figure 1. The top third of herds averaged 90% calving or better. There is considerable potential for increased reproductive performance of the national beef herd and in the growth of calves from birth to weaning. A commonly accepted live weight gain over this period is approximately 1.0 kg day while a calf suckles its dam.



Beef production based on beef breeding cows has been supplemented by dairy beef production

National calving percentage is 81% with around 65% of the beef breeding herd mated to calve as two year olds. This figure is 89% when based on cows wintered

Beef calving %

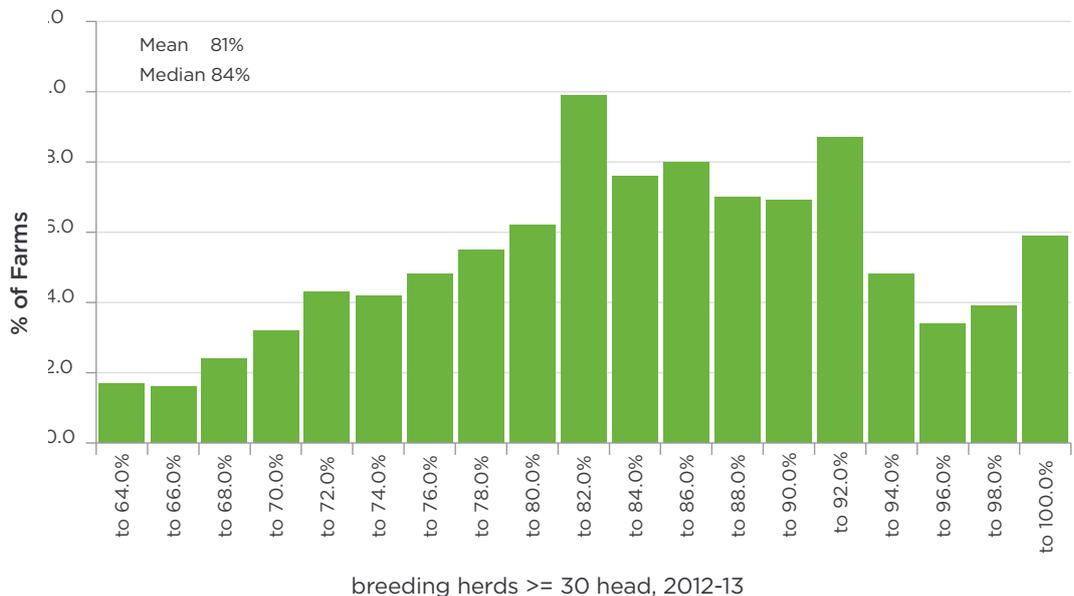


Figure 1: Distribution of beef cow calving% for 2012-13 based on calves weaned/cows mated. Source: Beef + Lamb New Zealand Economic Service.

An indication of beef cow calving % trend over time is given in Figure 2. In this graph the columns represent calving % based on calves weaned to cows mated as above. Note that reproduction efficiency, referred to in reproduction chapter seven, is a combination

of cows pregnant/cows mated multiplied by calves weaned/over cows wintered (and usually diagnosed pregnant). This usually gives reproductive efficiency estimate of 90% x 90% = 81%.

Beef calving % trend

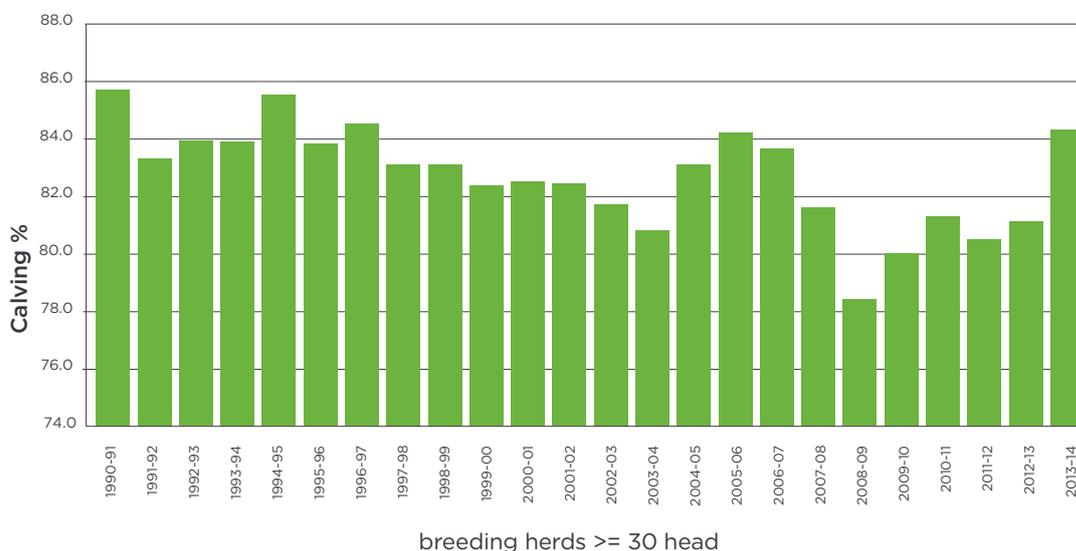


Figure 2: Trend in beef calving % based on calves weaned/cows mated. Source: Beef + Lamb New Zealand Economic Service.

With an increasing percentage of the New Zealand beef herd being derived from the dairy herd, the ratio of beef breeding cows and heifers in the national herd has declined from 36% in 1973 to 27% in 2013 with a resultant increase in “trading” or finishing stock. See Table 1 where they are classified as “other cattle”. Unless retention of female beef stock numbers increases, future growth and annual fluctuations in beef cattle numbers will primarily be due to the number of dairy calves originating from the dairy industry that are reared for beef production. What these figures do not show however, is the increase in dairy support by sheep and beef cattle farmers. Dairy replacement heifers over a complete year and/or dairy cows over the winter months are off-grazed as part of the cattle policy on these sheep and beef farms.

Another likely reason for the decline in breeding cow numbers is due to their perceived poorer profitability. On a gross margin / kg DM basis, they are less

profitable than other livestock enterprises, but this excludes the effects of the beef cow in maintaining pasture quality. In fact, the breeding cow will usually be more profitable than other stock classes on poor quality feed. The cow needs to play a complementary rather than competitive role to maximise these extra benefits.

Table 1: Composition of the New Zealand beef herd (000) (as at 30 June).

Year	1973	1993	2013
Total Beef Cattle	5,343	4,676	3,699
Breeding Cows	1,907	1,419	1,019
Other Cattle	3,436	3,257	2,680
Breeding cows as % of total	36	30	27

Source: Beef + Lamb New Zealand Economic Service.



Significant numbers of dairy heifers or cows are off-grazed on sheep and beef farms

The place of breeding cows

In New Zealand beef cattle and sheep are usually farmed together, and are complementary to one another especially under hill country conditions. It is relatively easy for producers to alter their mix of sheep and cattle to suit current economic conditions and preferences. The main driving force behind this substitution is the relative profitability between cattle and sheep although there is often debate as to how this profitability is calculated as the cattle typically provide a pasture grooming role on hill country to the benefit of sheep.



Sheep and beef production are complimentary due mainly to improved pasture quality

The New Zealand climate favours pasture growth and this is the key to sheep and beef cattle production with over 95% of the diet being grazed pasture or crop. Exports are the focus of the industry with 95% of sheep meat and wool, and 80% of beef exported.

It is the efficient, sustainable and relatively low cost system of pasture production that allows New Zealand to compete globally as a major exporter of food and fibre. Today sheep and beef cattle production are the dominant land uses in terms of land area, utilising 76% or 8.3 million ha of New Zealand's grazing land and forms the basis of the traditional visual and social landscape of New Zealand.

Sheep and beef cattle are increasingly tending to be located on the steeper hill country often of lower fertility and in many cases in summer dry regions. From a management viewpoint sheep and beef

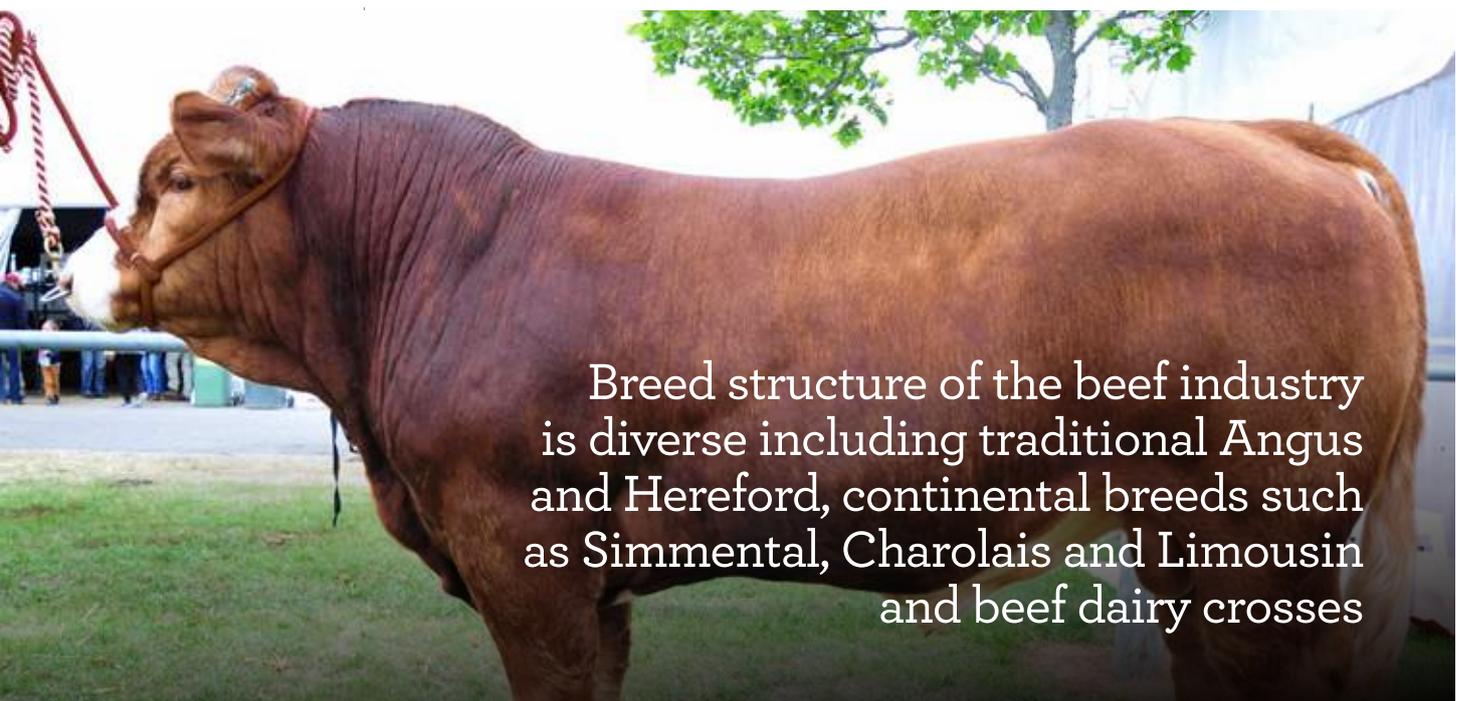
cattle farms are relatively complex with the same pastures having to meet several different feed requirements, including feeding ewes and beef cows, finishing lambs and growing cattle for slaughter.

Sheep generally graze pasture to a shorter residual height than cattle and hence grazing policies are not consistent throughout the year but rather vary between seasons. For example the same paddock may be set stocked or continuously grazed during spring then rotationally or shuffle grazed at other times of the year. Many pastures are permanent especially those in less cultivable hill country which is a significant proportion of the total area farmed, as it is presently uneconomic to renew pasture. Of the total area farmed with sheep and beef cattle the annual rate of pasture renewal has been reported to be just 2.3% compared with 8% on dairy cattle farms which are generally on flatter more fertile land.

The breeding cow herd is dominated by two breeds, the Angus and Hereford. The heavier European breeds began to be imported in the late 1960s and some, especially Simmental, Charolais, South Devon and Limousin have made an impact as terminal sires, where, with rare exceptions all progeny (both male and female) are sold for slaughter or to finishing farms. There has also been an increased use of beef x dairy breeding cows to take advantage of Friesian genes for higher milk and beef production.

Beef production is pasture based allowing a competitive advantage for the 80% exported

Pasture management is complex with different classes of sheep and cattle competing



Breed structure of the beef industry is diverse including traditional Angus and Hereford, continental breeds such as Simmental, Charolais and Limousin and beef dairy crosses

Because the overall output of a breeding cow herd is dependent on both weaning percentage and weaning weight of the calf, these are often combined into a term called cow productivity as follows:

$$\text{PRODUCTIVITY} = \frac{\text{No. of calves weaned} \times \text{Av. weaning weight}}{\text{No. of cows joined with bull}}$$

However, the total feed consumed by large cows is greater than that of small cows. To take account of this the term weight of calf weaned per cow joined, or productivity, is divided by the cow liveweight to give an indication of efficiency:

$$\text{EFFICIENCY} = \frac{\text{Productivity}}{\text{Cow liveweight}}$$

Usually autumn or cow weaning weight is used, but some farmers prefer to use winter liveweight, to measure biological efficiency as above in the beef breeding cow herd. Some consideration should also be given to BCS which should be 6-8 at weaning.

As a general rule, smaller cows that wean heavy calves in excess of 50% of their dam autumn liveweight are more efficient. This is probably easier to achieve with some form of crossbreeding where a larger terminal sire breed is crossed with a smaller dam breed.

The difference in annual feed consumption (kg DM/head/year) for small, medium and large cow liveweight types shows small cows rearing small calves can be just as efficient and profitable as large cows rearing large calves. Table 2 illustrates that there are a range of cow types that can give similar productivity and returns. If each of the cows in Table 2 rears 50% of their own autumn liveweight to sale as weaner calves they are all equal in terms of dollar return per kg of feed eaten or per stock unit. It is high productivity irrespective of cow size that makes a beef cow herd profitable.

Table 2: Seasonal liveweights and production data for three different beef breeding cow types and calculations of efficiency and profitability (note liveweights exclude the weight of conceptus). The calculations assume that small vs. large weaners are worth the same per kg liveweight.

	Small	Medium	Large
Weaning (kg)	430	470	550
Mid-winter (kg)	380	420	500
Pre-calving (kg)	380	420	500
Mating (kg)	410	450	530
Calf wean weight (kg)	215	235	275
Feed eaten per cow (kg DM/year)	2880	3131	3657
Number of cows	100	92	79
Number of calves (at 80% CW/CM*)	80	73.6	63.2
Kg DM/kg calf weaned	16.7	16.8	16.6
Return/kg feed (\$)	0.186	0.187	0.187
Gross margin (\$/SU)	105	107	108

* Calves weaned per cows mated



Efficiency of beef cow production is indicated by weight of calf weaned divided by cow liveweight at weaning

Productive and economic efficiency of small, medium and large cows can be similar

The total weight of calves weaned by the herd is the key production output of the breeding cow herd. It is a reflection of:

- Reproductive success; clearly, empty cows do not wean a calf
- Feeding levels of cow and suckled calf
- Cow and calf genetics, hybrid vigour
- Cow and calf health
- Age at weaning—for comparisons often standardised at 200 days of age.

The weaning weight of an individual calf from a cow is dependent on the above factors and also more specifically:

- Cow milk production
- Age of dam
- Age of calf at weaning, in turn affected by calving date.

All the above are discussed in more detail in the various chapters of this book. The material below discusses management aspects integrating these factors.

Setting and achieving calving date and calf weaning weight targets

The ability to wean heavy calves has become progressively more important in conventional single-suckled breeding herds because of the trend towards selling cattle for slaughter at a younger age. This means that growth to weaning represents a higher proportion of total growth to slaughter.

Calf weaning weight targets will be specific to the farm in question but a minimum liveweight gain target for a suckled calf on hill country should be 1.0 kg/calf/day. Typically in New Zealand it is less than this, particularly if the cow is expected to do a lot of pasture quality management work. Most beef calves are weaned at 5-7 months of age resulting in calf weaning weights in the range of 180 kg to 240 kg, assuming a 35 kg birth weight. Higher achieving farmers get weights of up to 280 kg/calf weaned at 200 days. The importance of a condensed calving with 65% of cows calving in the first 21 days of calving within an appropriate calving period, corresponding with pasture supply is important. This has a positive effect on calf weaning weight and cow re-breeding performance.

Many commercial beef herds calve too early in the spring. The usual sign for this is a slow start to calving with less than 50% calved in the first 21 days, accordingly compromising calf weaning weights and cow re-breeding performance.

The rate of growth of the suckling calf largely depends on the cow's milk supply, which in turn depends on the feed available to the cow. Some research suggests that about 70% of the variation in weaning weight of calves is due to differences in milk production of the dam. A calf can consume 10-15% of its

liveweight as milk each day. A 50 kg calf drinking 7-8 kg milk per day will grow at 1.0 kg liveweight/day. As the calf grows, its capacity to drink milk increases and there are obvious advantages if the cow can increase her milk production to match this demand. A calf at 120 days weighing 150 kg could consume around 15 kg of milk. It is highly unlikely a cow would produce that much milk at that stage and so the calf gets its extra nutrients by consuming pasture.

To achieve high calf weaning weights, cows must be well fed before and after calving. A high level of feeding after calving is also necessary for a high conception rate at re-breeding. Experience suggests that a feed budget should allow for a cow to eat in excess of 12 kg DM/day from the day of calving. How this will be achieved depends on the date of calving, and may require feed saved from late winter. Cows will often buffer their calves against underfeeding in early lactation by losing liveweight to maintain calf growth. However, this cannot happen in poor conditioned cows with BCS 4 or less, so it is therefore desirable to have cows in a body condition score of 5 or better at calving.

Date of weaning should depend on feed supply but it often depends on labour availability and sale date. If there is ample feed, there is little to be gained from early weaning unless there is an opportunity to use the cows in a mob for pasture control or preparation for other classes of stock. However, if hill country pastures dry out badly in summer, calves could be weaned and put onto what fresh pasture is available and the cows fed hard rations to relieve grazing competition.



Cow milk supply largely determines calf growth which should be at 1 kg/day when consuming 10-15% of calf liveweight as milk

Liberal post calving feeding of cows promotes good re-breeding and calf weaning weights



Optimum cow liveweight and cow efficiency

The best cow for hill country is a medium sized cow that weans a high proportion of its liveweight in calf weaning weight. The cow needs to be in good condition at weaning so she can mobilise her excess body condition as “supplementary feed” over the winter months. In fact, cows should be near their maximum liveweight and condition at weaning indicating they have eaten as much as possible of the excess spring-summer feed that usually occurs on hill country properties.

It is possible for cows to wean calves at 200 days age that weigh 50% of the cow's liveweight at weaning. However in reality this is generally closer to 35% to 45% on average, especially from straight-bred traditional breeding cows.

Cow productivity is extremely sensitive to:

- Cow liveweight relative to calf weaning weight
- Pregnancy rate
- Cow survival over winter and at calving
- Calf survival, mostly around the calving period.

Traditionally, beef producers improve their herds by selecting for growth EBVs of progeny growth and visual size. Growth is an easy and economical trait to measure and is moderately heritable. Selection for growth traits has resulted in faster growing cattle, however it has also resulted in the introduction of some correlated undesirable traits such as increased birth weights leading to calving difficulties, delayed sexual maturity and increased herd maintenance requirements associated with greater feed costs of larger animals.

In most cow-calf beef cattle production systems with cows producing calves to finish 300 kg steer carcasses, researchers have established that 65% to 85% of total feed intake is required by the breeding cow herd. Half of the total feed intake is required just to maintain cow liveweight. The costs of maintaining the breeding cow herd is clearly an important factor determining the efficiency of beef production.



Ideally breeding cows should wean calves at 200 days equivalent to 50% of cow liveweight

For beef cow systems producing calves to finish at 300 kg carcass weight approximately 75% of total feed is required by the breeding cow including 50% for maintenance.

Despite its economic importance, farmers in New Zealand do not usually assess the cost of feed for their farming operation. The complementary roles of beef cattle on sheep farms complicate the economic assessment of feed efficiency in mixed livestock farming systems. However, as profitability is a function of both inputs and outputs, there is a need to consider avenues for reducing inputs in order to improve efficiency of production and increase profits. Farmers need to ensure they are not running cows too heavy for the country. As most beef cows are now run on hill country it is suggested a moderate-sized cow of 500–530 kg with a BCS of 7 at weaning is the best option. This cow needs to rear a 240 kg calf at 200 day weaning given the feed proportion requirements above. It is important that the cow goes into autumn with a BCS of 7 as she needs to have this condition as fat reserves to be able to winter effectively on hill country.

Weaning date and calf age at weaning

The main advantage of early weaning is to retain cow body condition. If the previous management has been correct, this should not be an important issue. However in case of droughts, and a requirement to graze cows off the farm as part of the drought management strategy, early weaning is good practice.

Weaning time is often determined by managerial convenience and timing of weaner sales in the district. Farmers often like to wean on the day of these sales so calves are trucked to the sale straight off their mothers looking in their best condition. However, if calves are not being sold at weaning, then weaning date can be related to feed supplies.

Comparison with other enterprises

In single enterprise analyses comparing profitability of breeding cows, finishing cattle and breeding ewes, breeding cows usually appear less profitable. However, this analysis does not take into account the other benefits cows may provide within the farm system. Cows can play a valuable complementary role in maintaining pasture quality on sheep and beef farms but this is difficult to value. Results from a Beef + Lamb New Zealand Beef Focus Farm project have shown that for much of

the year, many breeding cows consume poor quality herbage which is of little or no value to other stock classes. On this poor quality feed, cows are likely to be more profitable than other livestock classes. What farmers need to calculate is how many cows they need to clean up or groom pastures for sheep. Experience suggests it should only be mixed age cows and not first and second calvers that do this type of pasture control.

Simplistic calculation of enterprise biological and gross margin performance

When various sheep and beef systems are compared on a single enterprise basis, results such as shown in Table 3 can be derived.

Table 3: Relative profitability of four single enterprise systems modelled using FARMAX, each with the same pasture growth curve.

			Compare Gross Margin			
			Jul 15 - Jun 16			
			GM	GM	GM	GM
			Breed Cows Ave Perf	Breed Cows Hi Perf	High Performance Ewes	Bulls R1
Revenue	Sheep	Sales - Purchases	0	0	123,535	0
		Wool	0	0	18,857	0
		Capital Value Change	0	0	56	0
		Total Sheep	0	0	142,448	0
	Beef	Sales - Purchases	86,299	102,252	0	142,713
		Capital Value Change	-171	-365	0	0
Total Beef		86,128	101,887	0	142,713	
Total Revenue			86,128	101,887	142,448	142,713
Expenses	Crop & Feed	Conservation	2,744	2,352	0	0
		Nitrogen	0	0	15,408	15,408
		Total Crop & Feed	2,744	2,352	15,408	15,408
	Stock Costs	Animal Health	2,037	2,322	4,687	3,062
		Shearing	0	0	12,973	0
		Total Stock Costs	2,037	2,322	17,660	3,062
	Interest on Capital (livestock & feed)		8,976	9,179	8,635	11,762
Total Variable Expenses			13,758	13,853	41,703	30,232
Gross Margin			72,370	88,034	100,745	112,481
Gross Margin per ha			724	880	1,007	1,125

- Gross margin based on 2015-16 values but with beef prices benchmarked to \$4.50/ kg CW
- Average performance cows weigh 520 kg LW, weaning 87% and calves growing at 0.9 kg LW/day
- High performing cows weigh 470 kg LW, weaning 93% and calves growing at 1.2 kg LW/day
- High performing ewes weigh 64 kg LW, weaning 150% and lambs wean at 30 kg LW at 90 days of age.



Pasture quality benefits of beef breeding cows are hard to quantify



Table 4: Comparison of production, profit and feed efficiency.

Policy	Production	Gross margin (\$)	FCE
Breeding cow average performance	171	724	39.4
Breeding cow high performance	229	887	31.2
Breeding ewe high performance	334	1,007	29.1
R1 bulls	453	1,225	18
Local trade prime	385	770	20.7

Average performing beef cows are less productive and profitable than some other enterprises, largely because of their high maintenance requirement and the apparently non productive period from weaning to just before calving in terms of product gain/kg DM eaten or feed conversion efficiency (FCE). If cows could rear and wean two calves via twin pregnancy that would cause a quantum leap in productivity and probably profit, but that is mostly outside current technology. Table 4 demonstrates that finishing systems, such as the bull system shown, are more efficient biologically, and also currently more profitable. High performance ewes are also relatively efficient, and are often competitive financially.

However, the above gross margin analysis can be misleading because:

- Takes no account of the complementary role that one stock class provides for another within a full farm system e.g. breeding cows 'grooming' pasture for breeding ewes
- Some policies require high quality feed to sustain high animal growth rates which in turn requires high quality pasture e.g. dairy heifer grazers and finishing cattle compared to breeding ewes or breeding cows
- Some policies have a relatively poor match of feed demand compared to feed supply e.g. finishing cattle and dairy grazers compared to bulls.



Generally high performance cows show similar returns to finishing cattle but high performance sheep and bull systems are usually more profitable



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POST WEANING SYSTEMS

Recommendations

- To achieve liveweight production targets prioritise your best finishing land.
- For high growth rates, plan feed supply and consider ways of maximising feed conversion.
- Spend time researching market outlets for your prime or processing beef products.
- Choose the best beef finishing system that fits in with your other farming activities.
- For calf rearing ensure you get the basics right; starting with colostrum and good hygiene.
- Before transitioning reared calves onto a pasture-only diet, ensure they have access to high quality solid food until they weigh a minimum of 100 kg.
- For young growing beef animals, aim for pasture covers of at least 2,200 kg DM/ha and don't graze it down too hard.



Introduction

The aim of beef cattle finishing is to match available pasture to animal feed requirements in a way that achieves levels of beef production for high profits. The beef cattle finishing manager can make decisions on age, sex, breed, liveweight, and the number of animals carried to match feed requirements and achieve production targets. The manager can also, to some degree, affect the selling price and cost of replacements.

Growing and finishing farms for beef cattle are mainly located on lowland or easier country on hill country farms. For almost all of the beef cattle raised for slaughter in New Zealand, pasture makes-up over 95% of their diet. Forage crops are used sparingly, usually only in winter while other supplements including hay, silage, and possibly concentrates may be used during periods of feed shortage in winter and/or during particularly dry summers. Dairy-beef rearing systems sometimes use concentrates in the period to weaning at 12 weeks and some farmers continue to feed part of the ration as concentrates after weaning to ensure high liveweight gains in these young dairy-bred weaners.

Finishing systems

Breeding and finishing systems are often combined on one farm where a farmer may breed their own calves and then finish the steers for slaughter. This will occur if the property has some flat land or improved pasture that can be run as an intensive beef operation. However most beef cattle finishing enterprises in New Zealand are on farms where the highest proportion of income is derived from another enterprise, usually sheep. The exception is specialist bull beef finishing systems, usually based on Friesian dairy-bred bulls. Where finishing cattle are run with sheep and beef breeding stock then policies for finishing cattle need to be evaluated in terms of the other stock requirements. For example the additional needs of lactating ewes or during ewe mating in the autumn. The evaluation of beef policies and profitability should not be done in isolation and must always consider the impact on other classes of livestock.



The two main products from finishing systems are prime and processing beef

We can divide finishing systems on the basis of the type of beef and market they supply. The two main types of beef produced are:

- Prime beef—usually from steers or heifers but some prime cuts are taken from bulls
- Processing beef—from bulls and cull cows and the fore quarters of steers and heifers.

Prime beef is sometimes called table beef and is also known as “primal cuts”. When exported in the chilled form, this beef fetches the highest price in our export markets. It can also be exported as frozen cuts and a small quantity is exported as frozen quarter carcass beef.

Processing beef is sometimes also known as manufacturing or ingredient beef. This beef is usually exported in a frozen undifferentiated form after it is boned-out and boxed. Processing beef is the major form of export beef from New Zealand and it is usually destined for the USA. Some farmers refer to processing beef as “dairy beef” but we should note that processing beef can also come from prime steers and some prime cuts can be taken from Friesian bulls. See Table 1.

Table 1: Source of processing and prime beef.

	Prime beef (table beef)	Processing beef breeds
Steer (Beef breeds or beef x dairy cross)	54%	46%
Heifer (beef or beef x dairy cross)	54%	46%
Bull (usually Friesian and Friesian cross with some beef breeds)	0-32%	68-100%
Cow (dairy and beef (manufacturing beef))	-	100%

Table 1 shows that from a steer carcass, around 54% enters the prime beef trade while 46% is destined for processing. Likewise from a bull carcass, up to 32% can be marketed as prime cuts with the actual amount depending on the processing company and their market access. Marketing efforts in South East Asia, particularly Singapore, have included a push to market "young lean beef" taken from primal cuts of bull carcasses where the bull has been slaughtered before two permanent incisor teeth have erupted and they reach two years of age.

Specialist beef finishing systems exist and these include feedlot beef, organic beef or veal or milk fed animals less than 1 year of age. There is only a small number of these specialist producers and they often need to establish their own marketing outlets.

There are difficulties associated with finishing beef cattle on hill country. These mainly arise from management of pasture quality, which is more difficult where topping and intensive subdivision is impracticable or impossible. Low fertility pasture species may dominate because of restrictions on cultivation impeding any pasture improvement. Infrastructure development in hill country, such as water, subdivision and access lane ways, is more expensive. Labour requirements may be higher due to time taken to access and move cattle. It should also be noted that on steeper hill country, heavier cattle or high stocking rates can damage the environment, resulting in erosion and weed infestations.

The principles of finishing beef cattle however are common on all classes of land and they involve four main components:

- Feed conversion efficiency of the individual animal and the production system
- Growing an appropriate forage supply
- Utilisation of the forage by the cattle, (the main influence on output per hectare)
- Buying and selling price of the cattle.

There are many different systems of finishing beef cattle. All have their merits and can be profitable, but not in all situations. Farmers can make choices about the age and time of the year when cattle are purchased, the age and time of the year cattle are sold, the breed and sex of finishing cattle. Each system has inherent advantages and disadvantages.

Calves enter the New Zealand beef herd from two sources (Table 2)—those born on beef and sheep farms where their dams are beef breeding cows and those born on dairy farms and reared on these farms or in specialist calf rearing units.



The main principles of beef finishing are good feed supply, conversion efficiency and astute buying and selling

About 65% of calves for finishing are from beef cows and 35% from dairy

Table 2: Source and number of calves entering the National Beef Herd (Numbers in 000s at June 2013).

	Number	Percentage
Number of beef cows	1,019	
Calving percentage (%)	80	
Number of beef calves	812	65%
Dairy beef retentions	440	35%
Total Calf Input	1,252	100%

Source: Beef + Lamb New Zealand Economic Service.

Beef bred steer weaners

Steers are the traditional form of beef cattle finished on sheep farms. Unless they are home-bred, beef steers are usually purchased as weaners around 6–7 months of age in the autumn. They are usually finished to supply the prime beef export market and taken to carcass weights in excess of 300 kg. Increasingly farmers are planning to finish steers before their second winter so they are 18–22 months of age at slaughter carcass weights of 300 kg. If steers need to be wintered past their second birthday then target slaughter carcass weights are often well in excess of 300 kg and average age at slaughter will be 27–30 months of age. Eighteen-month steer systems are quite profitable if high quality feed is supplied to achieve target growth rates. This class of animal is not suitable for cleaning up pastures. The system relies on better than average weaners entering the system, typically above 250 kg at weaning at 6–7 months of age. This requires calves to grow in excess of 1 kg per day while suckling their dams. Steers lighter than 220 kg at weaning are often destined for two-year systems or much lighter target carcass weights. Steers have an advantage over bulls in that they can be run in larger mobs and are more suited to extensive farming systems. Mobs can be mixed together easily and steers have fewer behavioural problems than bulls. Some disadvantages of steers are that they often cost more to purchase on a cents/kg basis, have slower growth rates than bulls, and can have grading problems with too little or too much fat cover and hence discounts on sale price.



Steers are easier to run than bulls but are often less profitable because they cost more and are slower growing

Steers are often wintered on crops and a new practice is emerging where weaner steers are wintered on fodder beet. Here finishers are running steers from May to September on fodder beet at stocking rates of 20 steers / hectare and growth rates around 0.8 kg/day are being recorded. This system fits into the pasture growth curve as high numbers are wintered on reduced land area over winter and then finished on pasture once the spring grass is available. Fodder beet is a high energy feed and steers need to be carefully transitioned from grass onto the crop.

In summary, steers have advantages over bulls in that they:

- Can be run in larger mobs
- Can be mixed together
- Have less behaviour problems, mishaps and inflict less damage to fences, races, and paddock surfaces.

The major disadvantages of farming steers are:

- They often cost more to purchase on a cents/kg liveweight basis
- Have lower growth rate than bulls
- Can have carcass grading problems—and therefore discounts on sale price.



Beef bred heifer weaners

Heifers are usually finished for the local trade. They are typically traditional breeds including Angus, and Hereford and are slaughtered at carcass weights of 220–250 kg. The local trade prefers a small carcass as individual cuts are smaller and more suited to the New Zealand consumer.

Some advantages of farming heifers for beef are:

- Cheaper to buy on a cents per kg liveweight basis
- Can run bigger mobs than bulls
- Can mix mobs easily
- Can sell to local trade at a premium in certain months due to short supply
- Can run more to the hectare than bulls or steers
- They can reach desired finishing weights earlier.

Disadvantages include:

- They grow slower than steers and bulls
- Can have carcass grading problems, with too much or too little fat cover.

Some of the heifers that end up in the local trade are beef bred heifers that fail to get in calf at first mating at either at 15 months or 27 months of age. It is common practice for commercial beef breeders to mate more heifers than they require as replacements and then finish those that fail to get in calf for the local trade market.



Heifers for beef finishing are cheaper to buy and provide management flexibility

Once bred heifers

A variation on heifer finishing is a once-bred beef heifer finishing system which involves producing a calf from a heifer prior to her slaughter for beef production. The system can be operated in a variety of ways ranging from the most simple, where heifers have a calf and are then slaughtered at, or soon after calving and the calf is artificially reared, to more complex operations involving suckling periods of up to six months. In all systems, the once-bred heifer must be slaughtered before no more than six permanent incisor teeth have erupted usually by 34–38 months of age. They will then grade as heifer beef on both the export and local grading systems. Once eight teeth have erupted, female cattle are then graded as cow manufacturing grade which is usually \$1 per kg of carcass weight below the heifer beef grade price. Hereford x Friesian or other beef x dairy heifers, mated to easy calving sire breed bulls to avoid calving difficulties, are well suited to this type of production. They can provide a quick response method of increasing the cattle slaughter numbers. A particular feature of the once-bred heifer system is that it provides an opportunity to make better use of beef crossbred heifer calves from the dairy industry.

Once-bred heifers can theoretically be taken to heavier carcass weights compared to maiden heifers without becoming excessively fat. The demands of pregnancy and lactation require mobilisation of fat tissue, which may promote leaner carcasses. It is important to remember that a once-bred heifer beef production system is a finishing system, not a breeding system. Heifers need to be grown at maximum rates throughout the year, with only a small period of slow liveweight gain over the last two months of pregnancy.



Once bred heifers provide management and slaughter age flexibility to 34–38 months

Dairy beef

The New Zealand dairy herd contributes to beef production directly through slaughter of cull cows and 4-day old bobby calves and indirectly through the supply of Friesian and crossbred bull calves to beef cattle finishers. In addition dairy bull calves reared on sheep and beef farms slaughtered as bull beef contribute 20% to beef and veal production and 21% to farm gate receipts from beef and veal. The main beef production system utilizing dairy-bred calves is the Friesian bull beef finishing system.

Calf rearing is a significant activity in the New Zealand dairy and beef industries with approximately one million dairy heifers and around 450,000 bull calves reared artificially every year. Calves are reared 'artificially' on whole or reconstituted milk and meal from 4 days of age and weaned at approximately 8-10 weeks of age. These calves are sourced almost entirely from the dairy industry and are typically, Friesian or Friesian cross bull calves weighing about 100 kg. Much of the information presented on the management of these animals through to weaning has been derived from research and extension material based on work carried out by Paul Muir at the On-Farm Poukawa Research Station, Hawkes Bay, New Zealand. See references at end of chapter for more information.



The dairy herd supplies bobby calves and cull cows to the beef export industry

Around 450,000 bull calves are artificially reared each year for the beef industry

The newborn calf must drink colostrum from a cow within 48 hours of birth

Rumen development in the young calf is important with good quality solid concentrates and roughage from an early age

The calf's requirements for liquid feed after these first one to two days of life can be satisfied by various other feeds including fresh whole-milk, stored colostrum, acidified milk or milk substitutes, or reconstituted milk powders.

The rumen of the new calf

The newborn calf has only a very small rumen of approximately 1-2 litres capacity compared to the 25-30 litres capacity that it will have in later life. Effectively at this early stage, it is a monogastric much the same as a pig or human. However, the calf's rumen can enlarge very rapidly in the first few weeks of its life given the correct feeding regime. The sooner the calf is able to graze forage rather than needing expensive milk and meal, the cheaper it will be to rear.

Rumen development, therefore, is the key to successful calf rearing. There are two critical factors governing rumen development. Firstly, the calf must start using and developing its rumen as young as possible and secondly, what the calf eats when it is starting to use its rumen must be easily digested. Roughage is the key to establishing a large rumen as quickly as possible. It should be offered along with high quality, readily digestible concentrates, which should have a protein content of at least 20% and have an available energy density of more than 12-13MJ ME kg DM. Straw and stinky hay are the best roughages for rumen development because these physically stimulate the developing rumen wall. Spring pasture is acceptable, but is not the ideal roughage source for calves, as it has too little fibre, is high in water content and on a wet weight basis, has a low energy density. Calves need *ad libitum* access to high protein, high energy concentrates or meal. Roughages stimulate rumen development, while concentrates, usually grain derived, supply the feed nutrients for growth.

The newly born calf and colostrum

The newborn calf must drink at least two litres of colostrum from its dam, or from another freshly calved cow, within 48 hours of birth and preferably within 24 hours. This is because it has a "naive" immune system. This period of immune naivety lasts for the first 6-7 weeks of the calf's life. In the natural situation, protein antibodies delivered from the cow to the calf via colostrum cover this period of naivety. For the first 48 hours of a calf's life, its digestive tract is able to absorb these large protein molecules undigested. This provides passive immunity for the calf until the calf's own immune system becomes fully functional. Calves which do not drink enough colostrum at this stage, will be much more susceptible to infectious diseases, such as scours and pneumonia, and are less likely to survive, or grow rapidly, than normal calves.

Never assume that purchased newborn dairy calves will have had adequate colostrum. A recent meat company survey of slaughtered bobby calves found that 40% of calves had inadequate colostrum. If in doubt, calves can be blood tested for immuno-gamma-globulin levels.

Calf rearing systems

Calves for beef production may be successfully reared artificially in a number of different ways using a variety of feeds and feeding levels. The particular system used is usually governed by factors such as the cost of feeds and the availability of labour. Milk and milk substitutes are expensive and so are often fed at restricted levels. This also encourages the calf to eat solid feeds thereby developing its rumen

The use of liquid feeds can be labour intensive. This provides an incentive to wean early onto pasture, sometimes with the aid of a transitional period on concentrates. Calves fed restricted milk at between 4 and 5 litres per day, but with good access to good quality pasture, will wean slightly lighter than those calves which are fully-fed milk right from the start. However, the intake of pasture will be inversely related to milk intake. While calves on restricted levels of milk grow a little more slowly, they are also less likely to show a check in growth rate at weaning, than those that are fed milk to appetite. The reason for the weaning check is usually related to rumen development. The aim is to provide enough milk energy to sustain growth, aided by high-energy concentrates, and yet keep the calf hungry enough to encourage the intake of roughages in sufficient quantity to adequately develop the rumen prior to weaning.

Restricted milk feeding programmes are designed to encourage the young calf to eat solid feed and develop its rumen. Every time milk is fed to a calf, the calf lies down and sleeps while it digests the milk. The more often or the greater the amount of milk fed to the calf, the longer the calf is left feeling full and therefore less likely to be interested in consuming dry feed. The once-a-day milk feeding system is the greatest asset available to assist the early consumption of dry feed. The amount of nutrients supplied in a single feed of milk can be calculated so that it supplies enough nutrients for maintenance and modest growth, but leaves the calf feeling hungry later in the day. This is the time when calves will seek out solid feed to satisfy their appetites. The use of a smaller amount of milk at a greater concentration also encourages intake of solid feed. This is the basis of restricted-milk calf rearing systems including the "Poukawa Research Centre Milk Feeding System" described in Table 3.

Additional features of the programme include:

- High protein calf pellets fed to appetite up to a maximum of 1.5 kg per calf per day at 12 weeks of age. Calves should not be weaned off milk until they are consuming at least 1 kg DM/day of calf pellets
- Calves must be allowed access to pasture from a minimum of four weeks of age
- Calves should have access to clean water and barley straw or similar roughage at all times.

Table 3: A recommended programme for feeding milk replacer (litres) to calves based on results from Poukawa Research Centre. Note: 2 x 1 = 2 feeds per day each of 1 litre; 1.5 = 1 feed per day of 1.5 litres.

Age (days after arrival)	Calf size weight range at four days old		
	Small (<37 kg)	Medium (37 - 43 kg)	Large (>43 kg)
1 - 2	2 x 1	2 x 1	2 x 1
3 - 5	2 x 1	1.5	2.0
6 - 9	2 x 1	1.75	2.25
10 - 12	1.5	2.0	2.5
13 - 16	1.75	2.25	2.5
17 - 20	2.0	2.5	2.5
21 - 24	2.25	2.5	2.5
25 - 35	2.5	2.5	2.5
36 - 42	2.5	2.5	Weaned
43 - 49	2.5	Weaned	Weaned
Total milk replacer per calf (kg)	21.8	19.1	16.8



Milk substitutes should be fed in minimal quantities with an early transition to solids important

Calf health

The most common cause of calf deaths and ill health is scouring and subsequent dehydration. The biggest cause of scours is stress and or lack of colostrum in the first 48 hours after birth. Scouring causes depletion of critical vitamins and important electrolytes and stress scours will often occur in the first ten days of a calf's life. Damage done to the intestinal walls of the calf mean that it is unable to utilise the food it consumes and the results are a poor calf. An essential feature of a successful calf rearing programme, which minimises disease, is close observation. A sick calf is inactive, and often lies down for long periods of time with its head extended. Its eyes may be sunken, the calf otherwise looks dehydrated with a dull coat and it is generally unresponsive. People responsible for looking after calves should be trained to recognise these symptoms, especially when calves are moved away from their place of birth on to other farms.

Calves suffer from two major forms of scours, viral diarrhoea, which compromises the ability of the intestine to absorb nutrients, and bacterial *E. coli* or white scours, which does not. Scours can also result from incorrect feeding of milk powder, either too much or inadequate quality, particularly of protein. The risk of scours is increased if calves are subject to stress, for example by movement or following a sudden change of diet.

Calf scours occurs at anytime up to four weeks of life, by which time the rumen is sufficiently inoculated with benign bacteria to prevent it being colonised by bacterial pathogens. Calves can be protected via dam vaccination pre-calving against certain forms of *E. coli* scours, but the most important means of protection is ensuring that the calf has adequate intake of colostrum in the first 24 hours of its life.

The major viral pathogens are rotavirus and corona virus. Calves with viral diarrhoea are not able to re-absorb water in the gut because of damage to the gut wall so dehydration is the major problem.

Dehydration can be averted by recognising the symptoms early and providing oral re-hydration therapy. Scouring calves will lose up to 20 times more fluid than healthy calves. The first step in the treatment of moderate or severe scours is to stop feeding milk on which scour bacteria live and provide a complete balanced fluid replacer, which contains both electrolytes as mineral salts and energy as glucose. This is a form of energy that the bacteria cannot survive on, but which the calf can utilise.



Good hygiene and constant observation are essential to prevent scouring and dehydration

General comments about artificially rearing calves:

- Accommodation—the best bedding for young calves is bark, wood chips, post peelings or sawdust shavings. Preferably all of these should be non-tanalised. The minimum area per calf is 1.5m²
- Calves should be housed for the first 2–4 weeks and then put out onto fresh pasture, weather permitting, preferably with shelter available or away from the prevailing weather direction
- Do not overcrowd the calf-rearing shed. Use an “all-in, all-out” rearing system with stringent cleaning between batches of reared calves
- Spray the pen surrounding the calves with disinfectant before the calves go into the rearing sheds, or alternatively, apply a mix of 100gms of washing soda per litre of water
- The calf's navel should be sprayed with iodine within 24 hours of birth if possible. Check navels at three days of age. If bigger than your little finger, infection has probably occurred and the calf should be checked by a vet
- Always provide fresh, clean water to calves in their pens. Always feed young calves before older calves if using the same feeders for both calves.
- If calves do not feed, or look sick, take them off milk immediately and feed electrolytes
- If calves are not eating sufficient amounts of dry feed and are not scouring, reduce their daily milk volume and if necessary increase the milk concentration
- On average, medium calves around 37–42 kg at four days of age consume around 19 kg of milk replacement powder, and 22 kg of high protein calf pellets up to weaning at 63 kg. From weaning until 10–12 weeks of age, they will consume a further 53 kg of low protein calf pellets.

Target weaning liveweights for artificially reared bull calves

Calf live weight appears to be a better indicator than age or meal consumption as to when to wean a calf off milk. Calves can be weaned from milk at 63 kg, irrespective of age, and will then be able to achieve a target liveweight of 100 kg at 12 weeks of age.

Table 4 summarises target weight information provided in the sections above. These targets relate to Friesian bulls.

Table 4: Target weights for artificially reared bull calves

Age (weeks)	Target weight (kg)
0	Approx. 40
6	63 (wean off milk replacer)
12	100 (wean off meal)

Requirements of artificially reared weaner calves up to six months of age

It should not be assumed that young weaner calves purchased from a rearing property will be totally independent by the time they arrive on the next property. Some rearers encourage high liveweight gain in their calves, by continuing to feed high energy and protein supplements or high milk content diets right up until the day they are sold, or transferred, to the next grower. Their rumens may still not be fully developed as a result. In this case, a weaning check, stress and a pre-disposition to disease could be a feature of the newly arrived weaners. If there is a suspicion that this is the case, then continued feeding on a high nutritional supplement such as calf meal and slowly reduce the quantity to fully wean them on to pasture over the next few weeks may be required. This extra meal feeding is likely to be more important for calves below 100–110 kg liveweight.

For social and management stress, the issues include handling the animals, mob size and their management. Nutritional stress relates to feeding—both quantity and quality, especially in the summer. Young animals are more susceptible to problems than older animals because their immune system is still developing and the survival aspects of their behaviour are still not properly learnt.

Optimum mob size for young Friesian bulls has not been clearly defined although farmer experience suggests 70–100 is an acceptable figure. Before the animals reach puberty, mob size may not directly contribute to social stress. The reason may be that in a bigger mob, individual animals are less likely to be noticed.

Access to good, clean trough water is required. Dams and streams can pose problems. It should be remembered that weaner calves are young, inexperienced animals. They may not be able to determine how to get to water in isolated streams or

swamps. They become stressed easily and in desperation, can become bogged or have some other mishap. If the water source is a stream or a dam rather than a trough, ensure that animals are able to get in and out from the drinking source without spoiling it for other animals. For environmental reasons, troughed water is preferable to a natural water supply.

For these weaner calves to grow at 1 kg/day they require pre-grazing pasture covers in excess of 2200 kg DM/ha and the energy content in the pasture must be greater than 11.4 MJ ME. Managing feed quality (Chapter five) must be a vital part of a farming system to keep these animals growing to target weights

Often in the first summer period, when 100 kg live weight calves enter sheep and beef farms, they graze pastures that are entering a period of lower growth. This is due to lack of moisture, and a decline in feed value. Calf live weight gains are therefore seldom above 0.6–0.7 kg/head/day and short of the desired target of 1.0 plus kg/head/day. If these weaned calves could be grown faster during this period, then the system would be more efficient through earlier slaughter at 16–18 months of age or slaughter at the same time at a heavier carcass weight.

A recent unpublished experiment has compared three month-old Friesian bulls on a herb mix of chicory, plantain, red and white clovers or a ryegrass-white clover pasture with or without added concentrates from November to March. Bulls on the herb mix grew at 1.33 kg/head/day versus 1.02 kg/head/day on pasture plus concentrate and 0.62 kg/head/day when fed pasture alone. This is a large increase in performance over the summer and ensures these bulls are on target for slaughter at 300 kg carcass weight at 16–18 months of age. Further research is required to determine the potential of this herb-clover mix and its optimal management for beef production.



Calves can be weaned from milk at 63 kg with a target liveweight of 100 kg at 12 weeks of age

Newly weaned calves should have continued feeding calf meal until 100–110 kg liveweight

Optimum mob size for young Friesian bulls is 70–100 to minimise competition and social stress

Good quality pasture covers of over 2200 kg DM/ha are needed for growth rates of 1 kg/day

The rules for these young animals are simple:

- Do not expect them to clean up pastures
- Move them onto new pasture as soon as feed quality drops
- Provide supplements to the animals if they are below target weights on arrival at the property or if pasture quality or quantity are below target feeding levels
- Remove animal health issues by working to a strict animal health programme.

Bull beef systems

Finishing dairy-bred bulls is a popular and profitable form of beef production. Typically, spring born Friesian male calves are purchased as weaned calves in October and November at three to four months of age at around 100 kg liveweight. Approximately half of these bulls are farmed through to the following year and sold for slaughter from December to April when they are 16–20 months of age at 550–580 kg liveweight. To achieve this weight an average liveweight gain of excess of 1 kg/head/day is required for the entire period. Like other livestock systems the key to success is the use of an appropriate stocking rate. The other 50% of these bulls are finished at 27–30 months of age in excess of 600 kg liveweight.

Because of the schedule premium for bulls, some farmers leave their beef-bred weaner males entire, including Angus or Angus x continental males, and market them on to bull finishers as weaners. The extent that this occurs depends on the difference between the meat schedule for bull or steer.

The seasonal match of feed demand and pasture growth rate in these systems is achieved by an increase in livestock numbers in November when weaner bulls are purchased and the sale of older bulls through the summer and autumn. Alternatively, the rate of liveweight gain achieved per bull per day can be varied according to the seasonal patterns of pasture production or whether other classes of stock are added to the finishing area.



Bulls have potential for higher liveweight gains, have greater growth rates and mature later than steers

Autumn born bulls provide an opportunity to slaughter at 15-18 months at a premium

Bulls offer the following advantages over steers or heifers:

- Potential for high liveweight gains
- Later maturing therefore leaner at a given age
- Can slaughter at any weight irrespective of fatness level
- Suited to processing, as they have a high water holding capacity and low fat content
- More profitable than most other beef cattle enterprises
- Often they can be purchased cheaper than steers on price per kg liveweight basis.

There are some disadvantages namely they:

- Fight when mobs are mixed which results in a short-term liveweight cost
- Are better run in small mobs of 15-30 bulls
- Can damage pastures, fences and cause soil erosion when digging holes.

Different bull systems based on age at purchase or sale

Three different systems developed for bull finishing are described below. Each is defined by age of purchase and sale of the bulls. Similar systems can also be applied to steers and heifers, the major differences being that they grow a little slower and mature at a lower liveweight.

Weaned at three months and finished at 15–18 months age

This system has been developed around the autumn born or early spring born bull, either of Friesian or European x Friesian cross breed. The calf will have been artificially reared since birth either by the finisher or more usually, purchased at 100 kg liveweight from specialist calf rearers. These calves or weaners are then placed into a high performance finishing system where the objective is to maximise liveweight gain and hence feed conversion efficiency. A premium price has normally been paid for the earlier born weaners, as their growth pattern allows the bulls to be finished in 12–15 months and sold when the schedule price is generally at its highest level, and before dry summer conditions. This is why autumn born bulls are so sought after. This system does require intensive, skilled management, good animal health planning, water reticulation and subdivision, and high quality pastures.

Weaner to age 18-22 months

The weaner bull in this system, in contrast to the above, is carried through the second summer with the aim of finishing in the second autumn. The later finishing date, compared to the 15-18 month bull system, usually occurs because these bulls are born later and/or are of lesser genetic merit for growth rate, e.g. Friesian x Jersey. They are usually obtained at a discounted price in relation to those purchased for the first system. The critical factor for this system to be successful is that, the bulls must attain their final target live weight and be sold before the second winter. Failure to achieve this will jeopardise the feed supply of their young replacements.

Both systems require disciplined, planned selling strategies or programmes to ensure stock are marketed on time. This is to ensure they do not impact negatively on the feed requirements of other stock classes on the farm.

18 month to two year old bulls

These bulls are generally purchased at an older age as “store” animals often from farmers who were unable to finish them. They have not achieved, or are not expected to achieve, the performance targets of the above systems, and so will be farmed through a second winter. These bulls will have under-performed for a number of reasons. They are farmed on sheep and beef cattle properties and integrated with sheep, often on steep land. The bulls are purposely held on maintenance rations during periods when feed supply is limited as they are not a priority stock class. They can be used as a pasture management tool, a role traditionally filled by the breeding cow. Alternatively farmers establish a specific finishing system with an intensively subdivided area of the farm that incorporates these older bulls. Intensive grazing systems are often set up to farm these bulls. They can be the technosystem or cell grazing where the farmer subdivides a land area into a set number of paddocks to carry the required number of bulls through the winter months.

Compensatory growth

This refers to the situation where animals, following a period of feed deprivation and when given the opportunity, grow at a faster rate than unrestricted animals. The system works on the principle of having a high number of bulls or any class of cattle being break-fed at only maintenance levels during the winter period and relying on compensatory growth rates in the following spring.

During the compensatory period they appear to utilise feed more efficiently. However, complete liveweight recovery is frequently not attained before maturity, depending to some extent on the age at which restriction occurred, its severity, and the period of recovery. Generally, the younger the animal and the more severe the restriction, the poorer the compensation. If nutrition is very good following restriction, greater compensatory growth can be expected.

Compensatory growth is common in pastoral beef farming. The incorporation of a period of lower growth in the winter followed by compensatory growth in the spring is consistent with a seasonal pattern of pasture production. The importance of setting and achieving planned target liveweights and pasture levels, by key dates, cannot be over emphasised. It is crucial that a monitoring programme is developed to check on progress so that remedial action can be initiated in time to avoid or correct problems.

Cull “boner” dairy cows or carry-over cows

These animals become available as culls from the dairy industry usually in the late autumn or earlier in drought conditions. Around half of them are pregnant. Their numbers available for slaughter vary depending on demand by the dairy industry for replacements to build herd numbers.



Compensatory growth follows a period of feed deprivation and normally occurs in the spring

Typically, the animals are in lean condition having just completed a season of lactation. If sent direct to the meat companies for slaughter, they are processed for manufacturing beef. A few farmers buy these cows and winter them. Those that are pregnant calve, and may have a second or third calf fostered onto them. Animals multiple suckled in this way are very efficient.

All these cows can be wintered at maintenance feeding levels and well fed on surplus spring pasture. Because of their initial lean body condition they always, unless sick, gain weight very readily. They can then be sold finished in late spring or early summer coinciding with favourable schedule prices. If they are pregnant and calve, they may also be sold back to dairy farmers. At present, these animals, managed in this way, are a relatively small component of the beef industry but represent a huge potential opportunity.

Getting the best value from your beef

In order to extract the full value from an animal, carcasses must comply with industry standard specifications. If carcasses fail to comply they will receive price deductions.

Standard market specifications

Hot standard carcass weight

The weight of the carcass with head, hide and organs removed to a standard fat trim (at the end of the slaughter chain).

Carcasses that weigh outside of the given processors market weight ranges will be deducted in price. This varies between companies and between carcass types.

Heavier carcasses that lie within the market weight range will earn more money:

- 290 kg x \$5.00(/kg) = \$1450
- 360 kg x \$5.00(/kg) = \$1800

(Difference of \$350/carcass)

- Typical Domestic CW ranges: 145-290 kg
- Typical Export CW range: 290-360 kg

Dressing percentage

Carcass Weight/Liveweight (%)

Carcasses that are heavier relative to their Liveweight return more money to the producer.

Two steers of equal LW (600 kg) but of differing CW:

- Steer a) 330 kg CW/600 kg LW= 55% yield
330 kg x \$5.00/kg = \$1650
- Steer b) 300kg CW/600 kg = 50% yield
300 kg x \$5.00/kg = \$1500
(Differences in 5% Dressing percentage
(at same LW) = \$150/carcass)

Typical Dressing Percentage range: 45-70%.

Fat depth

Depth of subcutaneous (external) fat measured at the 13th rib site (in the chiller room).

Carcasses require a minimum subcutaneous fat cover of 3 mm to ensure carcasses are not deducted on price (A or L Grade). This allows the carcass adequate protection for the appropriate rate of cooling and prevention of dehydration and toughening of muscle—called “cold-shortening”. Excessive fat (<11 mm T/F Grade) requires trimming and is a cost to the processor that will result in price deductions to carcasses.

Typical Prime (P) range: 3-11 mm.

Table 5. Steer and heifer fat descriptions.

Fat cover description	Fat class	Fat depth
Devoid	A	Nil
Light, patchy	L	<3 mm
*Light to medium	P	3-10 mm
Heavy	T	11-16 mm
Excessive	F	17 mm +

Ultimate pH

The point following slaughter where the muscle can no longer turn glycogen into lactic acid.

Carcasses must reach a point below 5.8 pH in order to avoid the eating quality issue of 'dark cutting' – where the meat becomes dark, firm and dry. Dark cutting meat will result in price deductions to carcasses.

Optimal range 5.8 < 5.3.

Health

Cattle must be healthy. If there is carcass damage from things like wounds, bruising, abscesses and damage from disease, then the carcass will have to be handled to remove these defects. This results in weight reduction and sometimes price deductions.

Muscle confirmation

Carcasses are categorised into 3 classes based on the degree of muscling. Class 1 carcasses have bulge at the hock and hind quarter (more desirable); and Class 3 carcasses have reduced muscle shape (less desirable). Typically, producers will not receive price deductions for carcasses of poor muscling.

Additional quality measurements

There are also markets available to New Zealand cattle farmers that grade their carcasses for eating quality measurements. These premium markets offer price incentives for carcasses that achieve the standard market specifications and excel in the following eating quality measurements:

- Ossification
- Marbling
- Fat colour
- Meat colour
- Eye muscle area.

Beef meat is classified by four factors:

1. Gender
2. Maturity (age determined by dentition)
3. Fat (finish)
4. Muscling (conformation).

Types of carcasses include:

- Bobby calf: Milk-fed, generally under two weeks old
- Steer: Male cattle castrated when young.
- Heifer: Female cattle having no more than six permanent incisors
- Cow: Female cattle having more than six permanent incisors
- Bull: Entire cattle with masculine characteristics.



Cull or boner cows provide flexibility and use as a pasture management tool



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Beef + Lamb New Zealand Reference Guide—available via www.beeflambnz.com



FEEDING AND EFFICIENCY

Recommendations

- Because energy is the most limiting dietary component for ruminants, the metabolisable energy (ME) system should be used to determine feed requirements.
- Production targets are the most important factor influencing beef cattle feed requirements.
- Precise ME requirements for maintenance, pregnancy, lactation and growth are difficult to determine and there should be a balance according to farm variables.
- Dietary minerals are normally present in the right quantities in pasture, but farmers should monitor copper, cobalt and selenium as deficiencies can be production-limiting.

Introduction

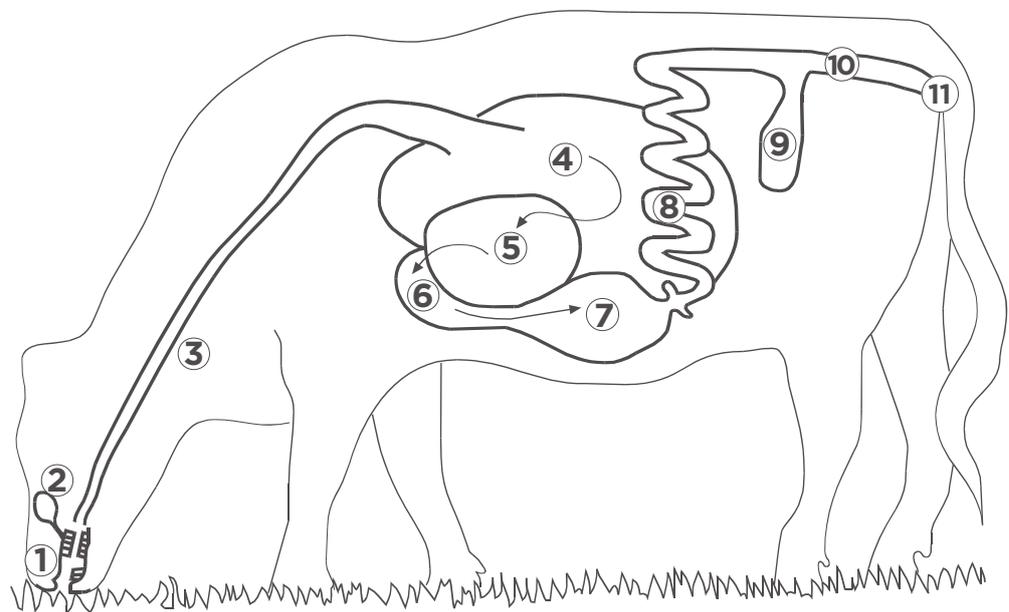
Beef cattle are ruminants with the ability to digest a wide variety of plant based feeds by fermentation using microbial organisms in their rumen. The most common feeds are grass and clover pastures, accounting for about 90% of their feed, while alternatives range from high energy cereal grains to lower quality roughages such as cereal straw.

To achieve good reproductive rates in breeding cows and high growth rates in weaners and finishing cattle, well-planned feeding is essential. This includes adequate levels of energy and protein with the essential minerals. Supplements are often required to balance diets and correct deficiencies. Supplements are often used in areas with copper, selenium or cobalt deficiencies.

This chapter covers the process of ruminant digestion, the metabolisable energy system, determination of feed requirements, animal performance, feed conversion efficiency and dietary mineral requirements. Pasture feeding of beef cattle will be covered in Chapter five.

Feed digestion

Main features of the digestive tract of beef cattle are shown in Figure 1.



Beef cattle obtain about 95% of their feed from grass and clover dominant pastures

Beef cattle are ruminants and are able to digest a wide variety of plant products

- | | | | | | |
|---|------------|---|-----------------|----|-----------------|
| 1 | Teeth | 5 | Reticulum | 9 | Caecum |
| 2 | Saliva | 6 | Omasum | 10 | Large intestine |
| 3 | Oesophagus | 7 | Abomasum | 11 | Rectum |
| 4 | Rumen | 8 | Small intestine | | |

Figure 1: Diagram of the digestive tract of cattle (Waghorn and Barry, 1987).

The rumen

The rumen is the first and largest of four stomachs with its contents making up 10–20% of the animal's liveweight. Here microbial fermentation breaks down plant constituents providing about 60% of the animal's total energy requirements. Plant material entering the rumen must be reduced to fine particles by biting and tearing during eating and extensive chewing and grinding with teeth. This is by re-gurgitating and chewing their feed, commonly known as "chewing their cud". It may last for up to eighteen hours per day, particularly with coarse mature and highly fibrous feed.

Feed particles need to be less than 2mm in size to leave the rumen and carry on through the digestive tract. The more difficult it is to reduce plant material to small particle size, the longer it will take to leave the rumen. So mature fibrous feeds leave less room for incoming feed and reduces intake. This is one of the ways in which pasture quality affects animal performance.

About 80–100 litres of saliva are produced each day. This makes swallowing the feed easier. Saliva also helps buffer the contents of the rumen in a slightly acid state (pH 6–7) with production of volatile fatty acids. Maintaining pH in this slightly acid state is essential for optimum microbial fermentation.

The rumen has a massive population of some 80 million microbial organisms per litre, comprising mainly bacteria with some protozoa and fungi. Bacteria is by far the most important.

Digestion

Material leaving the rumen includes undigested plant material, microbes and water. Volatile fatty acids and some water are absorbed from the omasum before further acid digestion in the abomasum which has no live microbes and a pH of around 2.5. From here digestion becomes similar to monogastrics like humans and pigs. There is a small amount of microbial fermentation with further water absorption in the caecum and colon.

Total apparent digestion is about 55–65% in the rumen, 25–30% in the small intestine with the large intestine and caecum accounting for 5–15% depending on feed type. The term "apparent digestion" is used because microbes produced in the rumen are subsequently used providing up 20–40% of carbohydrates digested.

Typically cattle digest 70–90% of structural plant cellulose in pasture and all water soluble sugars and organic acids. About 80% of plant proteins are digested with addition of microbial protein and urea from saliva. These non-pasture sources of nitrogen are important with low quality forages such as straw with low crude protein of less than 9%. Most New Zealand pastures contain 12–25% crude protein which is more than adequate. Hence energy is considered the main limiting factor for production in beef cattle.

About 70% of crude protein from pastures is digested in the rumen. A high proportion is absorbed as ammonia and excreted as urea in urine. Rumen microbes break down protein, some of which is lost as ammonia, then provide it as microbial protein for digestion. Reducing protein degradation and loss in the rumen has been a major area of research in New Zealand.

Digestion of lipids, or fats, is not well understood in ruminants. These chemicals comprise 4–8% of pasture dry matter and apparent digestibility is 60–80% occurring in the small intestine.

Metabolisable energy

Metabolisable energy (ME) is the amount of energy available to the animal for production and is one of the main indicators of feed quality. Energy is likely to be the main factor limiting cattle production.

Not all total energy or gross energy (GE) in feeds is available to cattle. A proportion is digested (digestible energy, DE) and some is voided as faecal (FE) and urinary energy (UE).

Digestible energy is quite a good indicator of feed quality but metabolisable energy (ME) is an even better indicator. This is the amount of digested energy available for productivity after losses in faeces, urine and fermentation gases (FG), mainly methane. The latter is regarded as an undesirable greenhouse gas and with more detail in Chapter ten.

ME is thus represented by the following formula:

$$ME = GE - FE - UE - FG$$

ME is expressed as megajoules (MJ) ME/kg DM. This describes the amount of available ME/kg DM for the animal for maintenance and production.



The rumen is large containing microbes for fermentation and is 10-20% of the animals liveweight

There are four stomachs with fermentation in the rumen, reticulum and omasum and gastric digestion in the abomasum

Energy is the main limiting diet component as there are enough protein and minerals in most pastures

Metabolisable energy (ME) is the best way of expressing feed requirements

The pathway between gross energy and metabolisable energy is represented in the following figure.

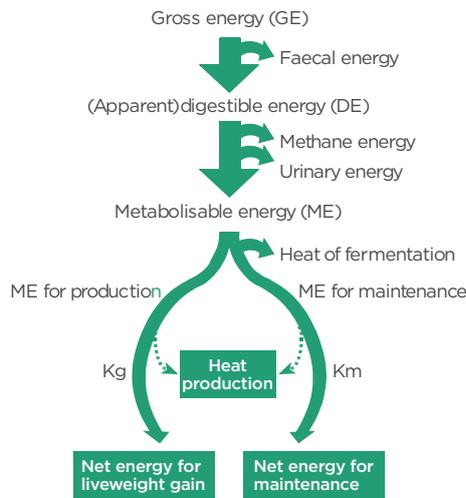


Figure 2: Gross energy and metabolised energy.

ME used for maintenance includes that used for essential body functions such as heart and kidney function, muscle and brain activity, tissue replacement, body temperature maintenance etc. ME for production is used for pregnancy, lactation and growth. Efficiency of ME utilisation for these functions varies depending on type of feed and age of the animal. Newly weaned calves use ME inefficiently mainly because their digestive systems are not fully developed and a high proportion of energy is retained as protein. On recovery from the weaning check efficiency increases with mainly protein deposition. In comparison energy is retained less efficiently as fat in mature animals.

The efficiency with which ME is used is described by K values such as Km for maintenance, and kg for growth (see Figure 2). For example ME for maintenance has an efficiency of 60-70% while that for growth is 30-55% depending on the weight and level of maturity of the animal. K values also vary depending on the quality of the feed. Values are generally higher with better quality feeds.



ME is used for maintenance, pregnancy, lactation and growth with varying efficiency

Precision feeding of beef cattle to meet production targets is difficult due to the many farming variables

Feeding beef cattle

Beef cattle should be fed according to production targets and sustainability of the whole farm enterprise. However feeding precisely to meet requirements is difficult due to variable seasonal conditions and pasture growth and meeting requirements of other classes of livestock. Some balance can be provided by use of forage crops or supplements such as hay silage or concentrates, particularly during winter or dry summers.

Management on sheep and beef cattle farms ranges from extensive, with conservative stocking rates and where liveweight changes buffer variations in feed supply and demand, through to intensively planned systems where farmers make daily decisions to achieve the right balance. With intensive systems, management to improve production is focused on lambing and calving liveweight targets, weaning date, flushing, and the timing of sale of store lambs, weaners, cull ewes, cull cows and finishing lambs, steers or bulls.

This highlights that most beef production is combined with other classes of livestock. Therefore in beef operations consideration must always be given to what other livestock classes cattle are complementing or competing with at different times of the year. And importantly how feed resources are balanced among the different enterprises for optimum farm production.

Energy requirements of cattle

Feed requirements represent the amount of feed which needs to be consumed for a defined level of production. For maintenance, pregnancy, milk production and liveweight gain sufficient nutrients and energy must be supplied to the animal tissues to meet metabolic demands. Requirements are conveniently expressed as metabolic energy (ME) as in most pastures energy is the main limiting factor for a given level of production.

In high quality pastures most other nutrients including protein and minerals are present in adequate levels. Exceptions are where there are known mineral deficiencies or on some low digestible mature pastures where protein may be limiting, particularly for young growing animals with higher protein requirements.

The main determinants of energy requirements in grazing beef cattle are:

- Liveweight and body condition
- Stage of pregnancy
- Level of milk production
- Rate and composition of liveweight gain or loss
- Level of grazing activity in eating and movement
- Topographical environment
- Possible effects of climate
- Sex of animal
- Age.

It is difficult to include all these factors in tables of ME requirements. For cattle the requirements for maintenance, liveweight gain, pregnancy and milk production are estimated separately then added for total requirements. See example on p41 under “calculating feed requirements”.

Requirements for maintenance

The ME requirements for maintenance are for essential body functions. If this energy is not supplied in the diet it must come from mobilising body tissue, mainly fat. This is generally associated with liveweight loss.

As liveweight increases, so does maintenance energy requirement as shown in Table 1.

Table 1: The metabolisable energy requirement (MJ ME/cow/day) for maintenance of beef cows. Source: Nicol and Brookes (2007).

Land class	Liveweight (kg)			
	300	400	500	600
Easy hill	-	55	66	77
Hard hill	50	65	75	-

Notes:

- Add/subtract 7% per MJ ME for diets below/above 10.5 MJ ME/kg DM
- Add 15% for adult bulls
- A guideline requirement for maintenance can be given as:
 - 0.62 MJ ME/kg liveweight^{0.75} for cows on easy hill country
 - 0.70 MJ ME/kg liveweight^{0.75} for cows on hard hill country.

For example:

A 450 kg cow on hard hill country has a maintenance requirement of $0.7 \text{ MJME} \times 450^{0.75}$

This is $0.7 \times 97.7 = 68 \text{ MJME}$.

Requirements for pregnancy

Energy required for both maintenance and growth of the foetus and conceptus depends on:

- Days from conception. Greatest requirements are in the last third of pregnancy
- Number of foetuses. Twins rarely exceed 1% of births in beef cattle
- Size of foetus.

Weight of the gravid uterus (foetus plus membranes and fluids) for a single calf in beef cows is around 8 kg at day 125 of pregnancy and increases to 20 kg at day 200 then to 55 kg at day 265. Full gestation is 278-285 days.

Pregnancy energy requirements for pregnancy with calves of varying birth weights are shown in Table 2. These requirements are additional to maintenance energy requirements of the cow.

Table 2: The metabolisable energy requirement of beef cows (MJ ME/cow/day) for pregnancy (in addition to maintenance requirement). Source: Nicol and Brookes (2007).

Calf birth weight (kg)	Weeks before calving				Total for Pregnancy MJ ME
	-12	-8	-4	0	
	MJ ME/cow/day				
30	6	11	20	34	1700
40	9	15	26	45	2300
50	11	18	32	55	2800

Notes:

- Add these to the maintenance requirement of the cow
- Adjust proportionately for pregnancy rate of the herd, for example:

Pregnancy rate = 95%, ME for 40 kg birthweight, four weeks pre-calving
 $= 0.95 \times 26 = 25 \text{ MJ ME/cow/day}$.



There are many things determining feed requirements but production targets are the most important

Maintenance feeding holds liveweight and increases as animals get heavier

ME requirements during pregnancy vary with stage of gestation and weight of the calf

Requirements for lactation

The ME requirements for milk production depend on:

- Milk yield (litres/day)
- Milk composition—as concentration of fat, lactose and protein varies so does ME requirement.

It is difficult to know the milk production of beef cows but it will generally range from 5–10 kg/day for single suckled cows. As a guideline this will mean additional consumption of 5.8 MJ ME/kg milk. The ME requirement of lactating cows will decline by about 30 MJ ME for each kg of liveweight loss and increase by around 55 MJ ME for each kg of liveweight gain. Thus the net cost of losing then regaining liveweight is 25 MJ ME/kg liveweight.

Energy costs of lactation and calf growth (Table 3) are estimated as 60 MJ ME/kg calf weaning weight. This includes assumed quantities of milk and pasture consumed by the calf.

Table 3: The metabolisable energy requirements of beef cows and their calves during lactation (in addition to cow maintenance requirements). Source: Nicol and Brookes (2007).

Calf weaning weight (kg)	Months after calving				Total for lactation MJ ME
	+1	+3	+5	+7	
	MJ ME/cow/day + calf/day				
150	35	45	55	55	8700
200	40	55	65	75	12000
250	50	70	85	95	15000
300	60	80	100	115	18000

Notes:

- Add these figures to cow maintenance requirement (see Table 1)
- Adjust proportionately for weaning %, for example
- 85% weaning, 200 kg calves, five months = 0.85 x 65 = 55 MJ ME/cow/day.
- Add/subtract 8% MJ ME for diets below/above 11.0 MJ ME/kg DM.

Requirements for liveweight gain

Feed requirements of growing beef cattle, from weaning normally at around six months of age, depends mainly on their liveweight and growth rate.

ME requirements of growing beef cattle depend on:

- liveweight and growth rate
- composition of gain.

Young animals mainly lay down protein with greater levels of fat as they reach maturity. As the proportion of fat in liveweight gain increases, efficiency of gain decreases as fat requires more energy than protein.

The ME requirements of growing cattle are shown in Table 4. The ME requirements vary according to sex, mature size of cattle, contour of country and feed quality. Generally males have up to 15% higher requirements than females, larger breeds like Charolais and Friesian have 10–15% lower requirements per kg liveweight. High ME feeds tend to result in lower requirements than poor quality feeds.

Table 4: The ME requirements of growing cattle (MJ ME/head/day).

Liveweight (kg)	Liveweight gain (kg/hd/day)						
	0	0.25	0.50	0.75	1.0	1.25	1.50
100	19	23	28	32	37	41	46
150	25	31	37	43	49	55	61
200	32	39	47	54	62	69	77
250	37	46	55	64	72	81	90
300	43	53	63	73	84	94	104
350	48	59	71	82	94	105	116
400	53	66	78	81	103	116	129
450	58	72	86	99	113	127	141
500	63	78	93	108	123	138	152
550	67	83	99	116	132	148	164
600	72	89	106	123	140	157	175

Formula = MEI = LW^{0.75} (0.594 + 0.564 LWG).



Lactation ME requirements vary with level of milk production and extent of cow liveweight change

ME requirements for growth vary mainly due to sex, composition of gain and growth rate

Calculating feed requirements

Once a value for the ME content of feeds is available the feed requirements as kg DM can be calculated from the ME tables above. Concentration of ME in feeds is expressed as M/D (MJ ME/kg DM) and most pastures contain 8-12 MJ ME/kg DM. Note that some feeding tables use DM values which should be treated with caution if there is variation in feed quality.

Table 5 provides an example of how the previous information can be used to calculate annual ME and DM requirements of breeding cows with different levels of productivity on good or hard hill country.

Table 5: The annual ME requirements of beef cows in hard and easy hill country. Source: Nicol and Brookes (2007).

Specifications	Hard hill	Easy hill
Liveweight (kg)	400	550
Weight loss/gain (kg total)	30	30
Calves born/cow joined	92	97
Calf birth weight (kg)	30	40
Calves weaned/cow joined	86	90
Calf weaning weight (kg)	175	250
ME requirements (MJ ME)		
Maintenance	365 x 65 = 23725	365 x 72 = 26280
Weight loss/gain	30 x 25 = 750	30 x 25 = 750
Pregnancy	0.92 x 1700 = 1565	0.97 x 2300 = 2230
Lactation and calf growth	0.86 x 10350 = 8900	0.90 x 15000 = 13500
Total annual (MJ ME/year)	35000	42750
Total annual DM (kg)	4,375	4,275

Notes:

- Maintenance requirement from Table 1
- Net cost of loss and regain of weight is 25 MJ ME/kg
- Total requirement for pregnancy from Table 3 and number of calves born (NCB)
- Total requirement for lactation and calf growth from Table 3 and number of calves weaned
- ME of pasture on hard hill = 8 MJ ME/kg/Dm; on easy hill = 10 MJ ME/kg DM

Note the 23% greater ME requirement of cows in the better environment but producing 9% greater weight of calf weaned per kg liveweight. When converted to DM consumption cows on the easy hill country with better feed quality needed 100 kg DM less annually than cows on the harder country.



Pasture dry matter (DM) requirements can be calculated from ME content of pasture



FeedSmart

The FeedSmart app was developed by the Red Meat Profit Partnership and Beef + Lamb New Zealand to make it easier for farmers to plan stock feeding.

It takes the feed tables published in books such as “A guide to feed planning for sheep farmers” and makes them available at the click of the mouse, or the tap of your finger. FeedSmart works on any computer, tablet or Smartphone. It can be saved so that it works offline—anywhere, anytime.

To download the app, go to www.feedsmart.co.nz and check out the UserGuide on the Beef + Lamb New Zealand website www.beeflambnz.com

There are also instructional videos on the Beef + Lamb New Zealand YouTube channel [youtube.com/beeflambnz](https://www.youtube.com/beeflambnz).

Feed conversion efficiency

This measure of efficiency, or FCE, is the ratio of the amount of feed eaten per unit of liveweight gain. Since feed is the numerator, the lower the value the greater the efficiency. FCE values for fast growing grazing cattle are in the range 7-10 whereas high performance cattle on concentrate diets on feedlots are

in the range of 5-7 for FCE. Pig and poultry producers aim for a FCE of below 2.

The liveweight gain of a beef animal at any given weight dramatically affects the FCE of that animal. Table 6 shows how the FCE of a 300 kg steer increases dramatically at higher liveweight gain.

Table 6: The impact of liveweight gain (LWG) on the FCE of a 300 kg steer.

LWG (kg/hd/day)	0.25	0.5	0.75	1.0	1.25	1.5
FCE (kg DM/kg LWG)	19	11.4	8.8	7.6	6.4	6.3

From the above table a steer growing at 0.75 kg/day eats about 40% more DM per kg liveweight gain than one growing at 1.5 kg/day. This suggests maximum liveweight gain should be achieved for better FCE, however there can be detrimental impacts on pasture utilisation which will be discussed in Chapter five. Other factors such as different feeding costs during the year, seasonal pasture growth rates, managing pasture quality, competing needs of other livestock etc. also need consideration.

Another method of expressing genetic differences in feed conversion efficiency is through use of Net Feed Intake (NFI). Progeny of different bulls are measured for feed intake, normally on a feedlot, allowing bulls to be ranked for NFI which takes into account intake in relation to liveweight and liveweight change. A high NFI bull's progeny will consume less feed than expected over the test period and have a lower or negative NFI. A low NFI bull will leave progeny that consume more feed than expected and will have a higher or positive NFI.

Another approach is to put a relative value on DM month by month. It should reflect the opportunity cost of pasture DM through the year. The relative value shown in Table 7 is obtained by dividing the average annual pasture growth rate (PGR) of 23.8 kg/DM/day by the monthly pasture growth rate. This procedure attaches more value to the DM being consumed over the winter at 5.29, as PGR is low. In contrast, the spring surplus in November/December is when the pasture consumed has a lower value of 0.6 in comparison with the rest of the year.

This difference in value is the equivalent of charging \$13/cow/week for grazing dairy cows in the winter versus charging \$1.50/cow/week in the summer. Therefore, the enterprise, beef or sheep, with greater demand over the winter period for example will "pay" more for the dry matter consumed so should be generating higher returns per kg DM.

Table 7: Calculation of the relative value of DM per month. The relative value equals annual average daily growth divided by average daily growth in each month.

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Ave.
Kg/DM/day*	4.5	7.2	17	31	43.4	40	35	24.6	21.3	28	24.4	9.3	23.8
Relative value	5.3	3.3	1.4	0.8	0.6	0.6	0.7	1.0	1.1	0.9	1.0	2.6	

*See "Further reading" on page 47 for data source.



Feed conversion efficiency (FCE) is poorer with ruminants than monogastrics such as pigs and poultry

Dietary minerals

Most high quality New Zealand pastures contain the essential minerals required by grazing beef cattle. The major and trace minerals required for a balanced diet are listed in the Table 8.

Most common deficiencies are the trace elements copper, cobalt and selenium. Particular areas are known for these deficiencies such as the Central Plateau of the North Island where cobalt deficiency, a

pre-cursor to vitamin B12, led to widespread “bush sickness” around the middle of last century. Supplementation with cobalt quickly rectified this problem.

Routine monitoring is recommended for these three essential trace minerals as deficiencies can severely hinder production. Also, monitoring will ensure effectiveness of any supplementation program and detect changes in trace mineral status caused by fertilisers, seasons and time.

Table 8: Major and trace minerals required in pasture by beef cattle.

Major	g/kg DM	Trace	mg/kg DM
Sodium (Na)	1.2	Copper (Cu)	7-10
Potassium (K)	5.8	Cobalt (Co)	0.09
Magnesium (Mg)	1.9	Selenium (Se)	0.03
Calcium (Ca)	4.4	Iodine (I)	0.5
Phosphorus (P)	3.2	Zinc (Zn)	25
Sulphur (S)	1.8	Manganese (Mn)	25
Chlorine (Cl)	2.4	Iron (Fe)	40

Copper

Cattle in New Zealand are commonly deficient in copper which causes depressed growth rate, fertility and calf survival. Farmers are encouraged to consult their veterinarian and possibly develop response trials.

The best way to assess copper status is to measure levels in the liver using samples from slaughtered animals or from live animal biopsies. Most meat companies or animal health laboratories will provide this service.

Recommended times to monitor copper status in cattle are:

- Cull cows in the autumn
- Pregnant cows in late winter by live biopsy
- Cull growing cattle at any time
- Rising one year cattle in mid-winter by biopsy.

Liver Cu < 45 $\mu\text{mol/kg}$ fresh weight of liver indicates copper deficiency. Blood can also be tested for copper levels but is less accurate and does not reflect long term copper intake.

Breeding cows need large amounts of copper to support pregnancy and lactation and if levels are adequate calves will be born with good copper status. Monitoring is essential before embarking on a supplementation program as copper toxicity and deaths are possible with over-dosing.

Drenching with copper supplements is not advised as it provides only brief benefit. Other supplementation options include:

1. Subcutaneous injection of copper salts (eg calcium Cu edenate) at a rate of 0.4-1.0 mg/kg liveweight is effective for one 1-2 months.
2. Copper can be added to drinking water using an inline dispenser (3-6 mg Cu/l) to provide up to 90-180 mg/cow/day.
3. Intraruminal boluses containing copper oxide (CuO) particles are effective for 6-9 months.
4. Topdressing with copper added can increase pasture levels rapidly. Annual application of 6-12 kg copper sulphate/ha (1.5-3 kg Cu/ha) in autumn or spring is best. However, effectiveness can be reduced if molybdenum levels are high. Note that pastures should not be grazed after application until rain has washed fertiliser off the plants.



Most pastures contain the right balance of minerals, but should be monitored for the most common deficiencies being copper, cobalt and selenium

Copper is important for growth rate, fertility and calf survival and if deficient can be supplemented by vaccination, rumen boluses, in drinking water or applied with fertiliser

Selenium

Selenium deficiency can depress conception rate, calf survival and growth. Selenium status is measured by the level of a selenium containing enzyme in the blood called glutathione peroxidase (GsPx). Monitoring selenium status should be:

- Just before calving, and
- At any time in growing cattle, but at least two months after any selenised drench or vaccination has been applied.

From this test supplementation levels can be predicted by a veterinarian or animal health laboratory.

If selenium deficiency is suspected a vet should collect tissue samples, preferably blood. Cattle will be deficient when the selenium concentration in blood is < 130 nmol/l. Concentration of selenium in pasture is another good indicator and this should be >0.03 mg Se/kg DM.

The type and frequency of supplementation is determined by the level of deficiency, time of year, accessibility of stock and ease of administration. Be certain stock are deficient in selenium before treatment as excessive selenium is toxic and accumulates in the liver and kidneys.

Many drenches and vaccines contain selenium as sodium selenate or sodium selenite. Administration by either means should be at 0.1mg Se/kg liveweight. A rapid increase in blood selenium will gradually decline over 6–8 weeks.

Longer lasting supplements are available including vaccination with barium selenate at 0.5-1 mg Se/kg liveweight (500 mg for cows), or boluses containing metallic selenium and Iron, lasting 10-12 months.

Selenium can be dispensed in-line to the water supply to provide 1.5–3 mg Se/cow/day.

Pastures can be top dressed with 1 kg selenium prills/ha (10g Se/ha) in spring or autumn every one or two years. This should only be done if pasture levels of selenium are below 0.03 mg Se/kg DM.



Conception rate, calf survival and growth can be lowered with selenium deficiency which can be remedied by vaccination, drenching, adding to drinking water or applying with fertiliser

Cobalt deficiency is uncommon and can be overcome by administering vitamin B12 or applying to pastures with fertiliser

Cobalt

Cobalt deficiencies are uncommon in cattle but if present will cause vitamin B12 deficiency which depresses growth rate.

If cobalt deficiency is suspected, a vet should take blood or liver samples to determine vitamin B12 levels. Testing is most effective in late spring.

Cobalt deficiency can be prevented by supplementation with cobalt or vitamin B12 or topdressing pastures with cobalt. Vitamin B12 must be given by monthly injection of 2–3 mg of water soluble solution. A long acting vitamin B12 formulation is effective for three months in calves. Another option is a single injection of 0.12 mg/kg liveweight (i.e. 6 mg for a 50 kg calf). Controlled release cobalt intra-ruminal boluses can last up to 12 months. Topdressing of pastures with 350 g/ha of cobalt sulphate (70 g Co/ha) with fertiliser will increase pasture levels > 0.05 mg/kg DM within four weeks. Levels will then decline over the following 9–12 weeks.





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PASTURE MANAGEMENT

Recommendations

- Obtain a clear picture of seasonal pasture supply and year to year variation for your farm.
- Develop skills in feed budgeting either using spreadsheets or professional packages such as FARMAX™.
- Consider the many options for better matching seasonal pasture supply with animal requirements including:
 - Increased sub-division for better management
 - Manage pastures to avoid wasteful surpluses by:
 - Feed conservation
 - Flexible stocking rates through buying and selling
 - Mixed grazing with different classes of stock
 - Manipulating liveweight gain and stocking rate
 - Use of nitrogen and fertiliser.
- Prioritise stock:
 - Consider optimum stocking rates with finishing cattle for a balance between biological efficiency and maximum profit
 - Use better paddocks for finishing beef with low grazing pressure to achieve liveweight targets
 - Use lower priority stock such as dry cows or sheep to clean up after finishing cattle and to control surpluses in late spring-summer-autumn
 - With breeding cows and sheep, match calving and lambing dates with the start of spring pasture growth.
- Manage winter grazing of mixed-age cows to leave residuals of 800-1000 kg DM/ha for good early spring growth.
- Manage winter grazing of finishing cattle to leave residuals of >1200 kg DM/ha for good early spring growth.
- Winter rotation lengths need to be related to pasture growth rates, this will likely mean long winter rotations of 60-120 days.
- Reduce grazing pressure during drought by reducing stock numbers and/or use of feed supplements.
- Carefully examine the cost effectiveness of using feed supplements.

Introduction

A major competitive advantage of the beef industry in New Zealand is the relatively low cost of pasture as a feed. However, the challenge for beef farmers is to meet animal feed requirements with seasonally available pasture for animal performance and marketing requirements. These production variables do not always complement each other.

The feed demand of growing animals does not match the seasonal pasture growth curve very well. In fact, the most profitable beef production system may not be the most biologically efficient or one that utilises the most pasture. There are various ways by which farmers can match feed supply and demand, and some cost more than others.

Variations in pasture production depends on many factors. Maintaining high animal growth rates and high pasture quality at the same time is very difficult. Many farmers use other stock classes, such as breeding cows or sheep to achieve this. However, this can be a cost in its own right as grazing affects pasture growth and quality. Hard grazing will reduce pasture growth in the short term, while lax grazing will lead to surpluses and quality losses through plant death and decay.

Because 60-70% of pasture growth occurs during the spring—early summer, a substantial proportion may not be consumed. Management of the quality of this surplus feed is one of the greatest challenges of livestock farming.

There are various “tools” for maintaining a supply of high nutritive value feed to cattle. These include:

- Manipulation of liveweight gain to match feed demand with feed supply
- Manipulation of winter and spring rotation lengths
- Maintaining pastures at the appropriate grazing height
- Topping and conservation of surplus pasture
- Subdivision for improved grazing management
- Flexible stocking rates through buying and selling stock
- Forage cropping or specialist pastures for feed deficit periods
- Use of feed supplements
- Fertiliser, and nitrogen application.



Matching seasonal pasture feed supply with animal requirements is challenging

There are many management options to better match seasonal feed variation with animal needs

Matching feed supply and demand with market requirements is challenging

Use of low cost pasture gives New Zealand a key competitive advantage internationally

Pasture based beef production

A key competitive advantage in the pastoral industry in New Zealand, compared to many overseas beef production systems, is the relatively low cost of pasture as a feed. Generally supplementary feed is two to three times more expensive than grazed pasture.

Key issues in coping with seasonal pasture supply have been:

- Stocking rates that have been a compromise between efficient feed usage and adequate animal performance
- Timing of calving, lambing, purchasing and disposal to fit best with variations in seasonal feed supply

- Mixes of stock classes that complement each other
- Winter grazing rotations that have been too short, relative to pasture growth rate.

High value markets, with their requirements for continuous production, result in more demanding systems that are generally poorly matched to seasonal pasture production and therefore biologically less efficient. Although meat schedule prices reflect some of the out of season cost, they do not currently adequately reward out-of-season production.

Seasonal pasture growth

The dominating effect of climate on pasture productivity and growth is reflected in Figures 1 and 2. This can vary greatly with different land contour and between regions and years. This variation in seasonal pasture growth precludes the use of recipes. Rather, managers need to be flexible with principles and practices they apply to their particular circumstances.

It should be noted that differences in pasture growth between years are greatest during summer and autumn as a consequence of varying rainfall. That is the reason why breeding systems involving sheep or cows with stable capital stock numbers over winter, and flexible disposable stock policies over summer and autumn, have been biologically very successful.

Pasture production is dependent not only on climate, but also soil fertility as shown in Figure 2. More fertile, developed pastures produce relatively better growth rates going into dry conditions and during winter and early spring, the two main crisis periods in beef production systems.

Beef finishing systems demand higher levels of productivity over winter-early spring and are therefore much less suited to low fertility farms, as shown in the comparison in Figure 2. Soil fertility not only influences pasture growth rate but also pasture quality. High fertility soils result in a change in pasture composition in favour of ryegrass and white clover, both of which are highly nutritious.

The feed demand of beef animals does not generally match the seasonal pasture production growth-curve very well as shown in Figure 1.

The most biologically efficient farming system is one in which the maximum amount of pasture grown is utilised by the animals. However, the most profitable farming system may be less efficient than the ewe system shown in Figure 1, but it achieves animal production targets that are closely aligned with market requirements.

Figure 1 implies that a lot of feed grown is wasted. While this may apply on some farms, many operators achieve a much closer match between supply and demand by:

- Buying and selling stock at key times
- Manipulating stock performance to match pasture growth
- Conserving surplus feed as supplements for times of feed deficit
- Using animal body condition as a buffer
- Purchasing feed supplements if deemed cost effective
- Manipulating calving dates and stocking rate
- Saving some paddocks for forage crops
- Using nitrogen.

The above factors alter feed demand more in line with seasonal pasture growth. Pasture growth rate can also be manipulated by changing soil fertility. Fertiliser has a long term effect on pasture growth (see Figure 2).



Seasonal variation in pasture supply is influenced mainly by climate and soil fertility

Beef cattle finishing systems are not suited to low fertility soils which are better for breeding cows

Beef cattle production is a trade-off between optimum biological efficiency and financial productivity

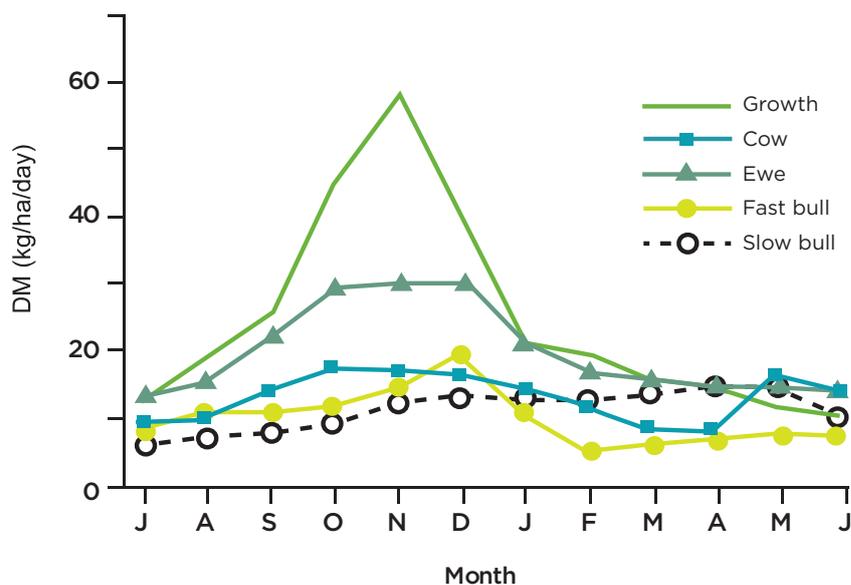


Figure 1: Pasture growth on North Island easy hill-country and feed demand of various stock classes/hectare/day, derived from FARMAX. This figure will vary depending on the pasture growth curve, for example, Figure 2 on page 52.

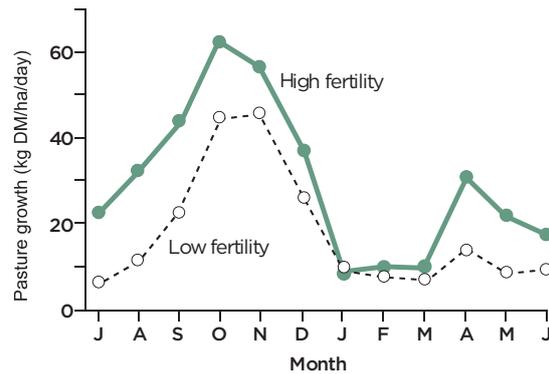


Figure 2: Example pasture growth rate curve for a low fertility (soil Olsen P level less than 12) and a high fertility farm (soil Olsen P level greater than 20). The growth curve will vary depending on climate and location.

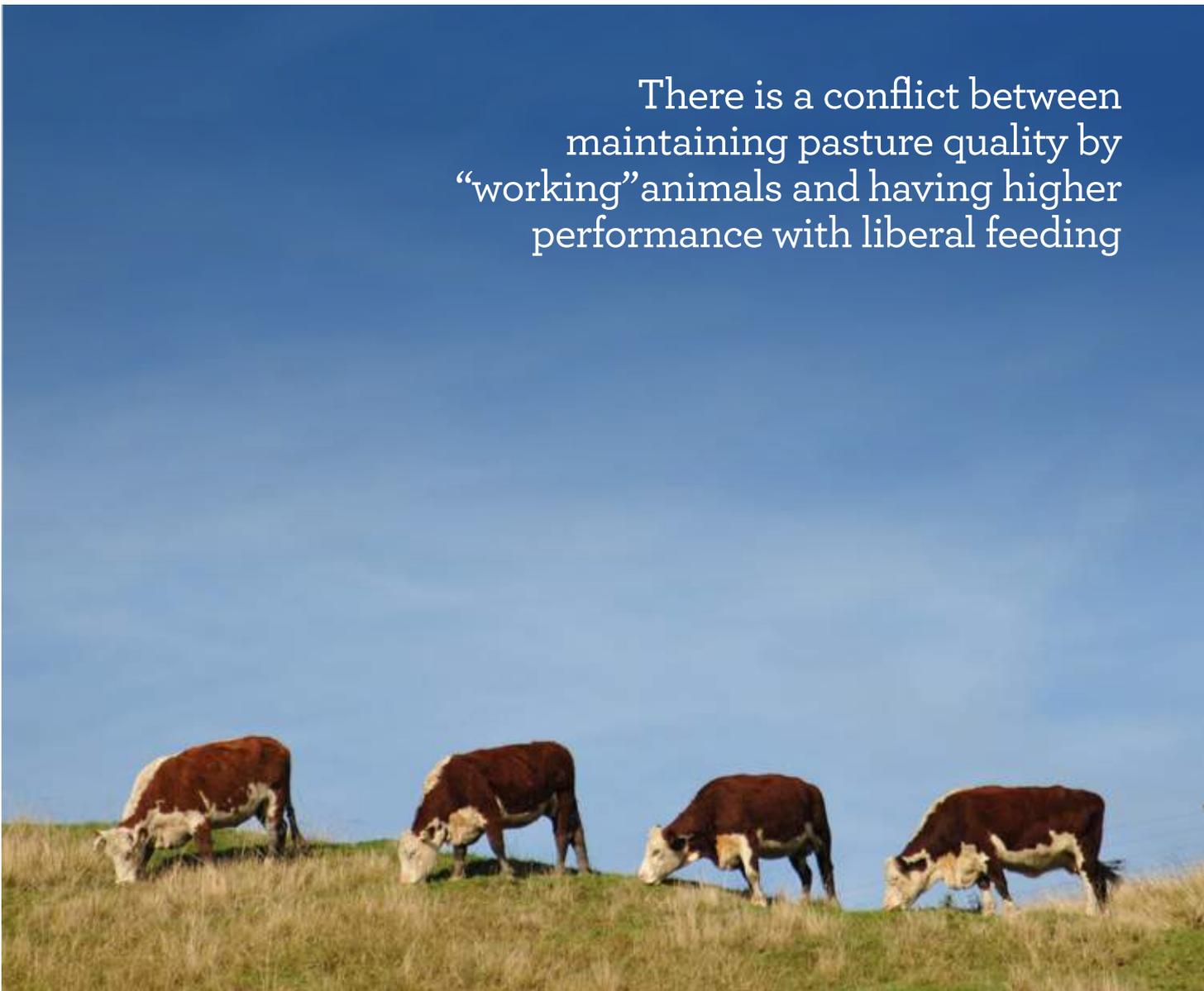
With bulls, you can “bend” feed demand to match feed supply—this is not the case with finishing animals or dairy grazers.

The feed demand for R1 bulls and breeding cows had a good match with feed supply.

For prime finishing and dairy grazers one-third of the farm had to be conserved for silage (or hay) to maintain pasture quality. The conserved feed then needed to be fed-out in autumn and winter.

Successful management means knowing which of the above options are profitable and which are not. Sometimes the most profitable option is to accept poorer performance, or more wasted pasture. Lateral thinking is often required to obtain the best solution and to utilise as much of the pasture grown as possible.

There is a conflict between maintaining pasture quality by “working” animals and having higher performance with liberal feeding



Performance targets on sheep and beef properties have lifted in recent times. On many farms the proportion of “working animals” that can be used for pasture clean-up and maintenance of pasture quality has decreased because of the low profitability of these animals, relative to other stock classes—see Chapter two for calculations.

The move towards more fecund sheep, heavier lamb weaning weights, and the perception that breeding cows are less profitable than other stock classes, means there is reduced opportunity to underfeed ewes and/or cows and their replacements. There are fewer cows on sheep and beef farms than in previous years and those that remain are often expected to produce heavy weaner calves. This is a big ask for cows that are also expected to eat poor quality feed to maintain pasture quality for growing animals.

Replacement of some or all breeding cows with finishing cattle, on the grounds of increased profitability, has compounded the pasture management problem. Finishing cattle must grow rapidly for biological efficiency, which requires high feed intakes and lax grazing of pasture. Unfortunately this causes production of rank, low quality feed especially in the late spring and early summer.

As producers strive to improve the performance of their livestock, the way they are fed becomes more critical. Management of feed quality on sheep and beef properties is now acknowledged as one of the key factors in achieving high production targets. Improving pasture quality and quantity are the greatest opportunities farmers have to improve livestock performance, if they can successfully tread the narrow line between maintenance of feed quality and high cattle performance.

An example of altering calving date to better match pasture supply with animal demand is given in Figure 3.

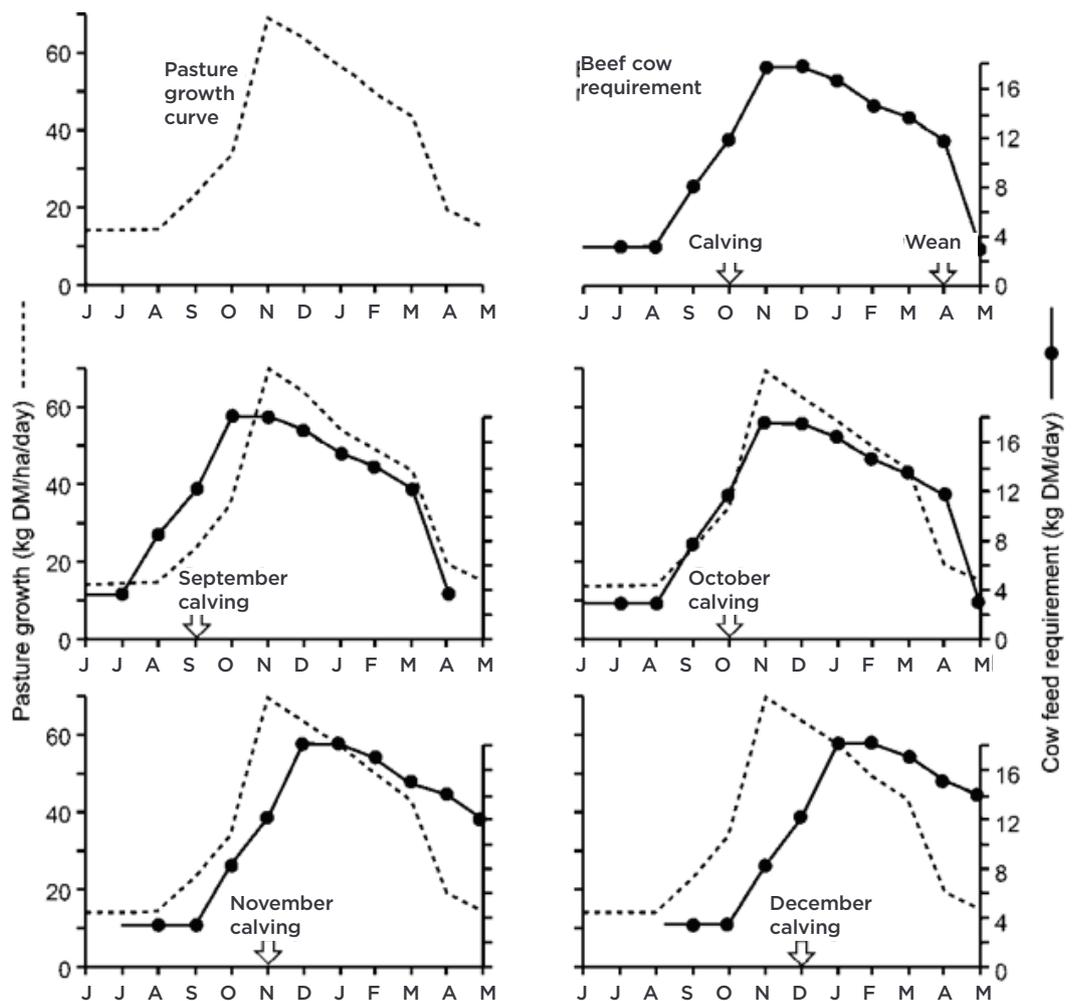


Figure 3. Matching beef cow nutritional requirements to Taihape hill country pasture growth. The pasture growth curve is the average of three years of data. Source: Hughes and Morris (1998).

Demand is made up of maintenance, growth, pregnancy and lactation (see Figure 4). The maintenance requirement is lower during the spring months of September–November due to improved feed supply, therefore animals expend less energy to obtain their nutrition. All other components of their demand are exactly the same between the four calving scenarios in Figure 3. Therefore as maintenance increases following the spring months and is summed with the growth and lactation requirements, the peak demand increases when calving is shifted back—another reason spring calving is better suited to pasture supply.

The potential (grey shaded area in Figure 4) illustrates theoretical maximum intake per head. This potential is not contributing to the cow demand, it is confining intake. Therefore, if the demands for pregnancy, lactation or growth were exceptionally high, the model will restrict their intake based on this potential. This is affected by conceptus growth during pregnancy.

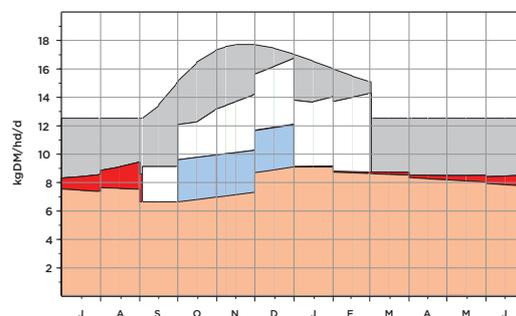
There are major benefits from running beef cows on hill country farms because of their flexible feed demand which can be aligned with the seasonal pasture growth curve. An additional benefit is their ability to assist in the management of pasture quality. In this respect, they play an important role on kikuyu pasture in Northland and brown-top dominant swards elsewhere.

Hill country farmers marketing weaners in the autumn will often put in place a strategy to cope with calving ahead of the spring pasture growth, in order to supply the market with older, and therefore larger, weaners. Farmers marketing progeny in the following spring or autumn, or finishing the weaner steers themselves, have the flexibility of being able to calve at a more appropriate time in relation to their pasture growth curve. Furthermore by calving later feed is released to more profitable enterprises and this is often overlooked.

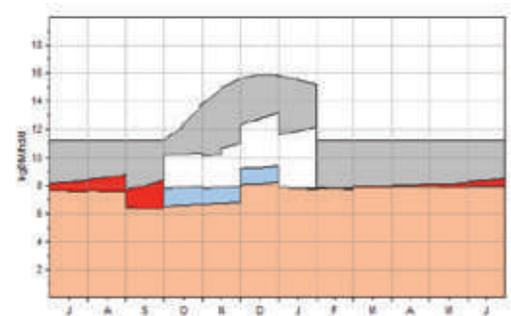
An appreciation of the pasture growth curve of a farm is fundamental to the management of any pasture based production system. When calving before the spring pasture growth flush, the cow is placed in a more competitive rather than a complementary position with other livestock classes that might also be able to utilise that same scarce feed.

Demand per head for GM: Breeding cows: Cows

Jul 15–Jun 16



September calving cows



October calving cows

Potential
 Lactation
 Pregnancy
 Growth
 Maintenance

Figure 4: Components of beef cow requirements for October and September calving cows as in Figure 3. Sourced from FARMAX™.



Altering calving date can better match breeding cow feed requirements with seasonal pasture supply



Effects of animal management on pasture

The type of grazing animal has a significant impact on pasture composition. Grazing predominantly with cattle reduces pasture density, especially with ryegrass, and may cause soil pugging damage which can take months to recover, causing up to 10-25% lost pasture production. Some soil types such as clay are affected more than others. It is important therefore, that sheep, because of their different grazing behaviour, are occasionally grazed in cattle paddocks. It is important to avoid heavy cattle pugging soils and reducing pasture growth. It may not be sustainable to winter cattle over 400 kg on some pug-prone soils.

Variations in grazing pressure have the most influence on pasture quality and clover content during October to March. Clover

responds well to light and so is encouraged by close grazing during its maximum growth period of October to December. Low quality grasses such as browntop, Yorkshire fog, danthonia and weeds are also discouraged by avoiding rank pastures during the December to March period. Maintaining pasture control also benefits pasture quality, and hence animal performance, during the summer and autumn period. It also encourages pasture density for maximum winter growth. This is particularly so for steeper hill country, which suffers most from mismanagement.

Unfortunately, beef-finishing systems are in conflict with the above pasture needs. Any restrictions through increased grazing pressure will reduce growth performance and achievement of liveweight targets.

Impacts of grazing on pasture growth

Pasture growth is determined mainly by climate and soil fertility, as described earlier in Figures 1 and 2. Pasture growth is also determined by leaf cover or pasture mass as shown in Figure 5. At low pasture mass levels, leaf cover is less than that required for the optimum interception of sunlight energy with reduced pasture growth rate. At pasture mass levels greater than 2500 kg DM/ha, pasture decay, equivalent to negative growth, increases significantly due to shading in the lower zone of the sward. New growth rates do not increase further than the maximum level

shown in Figure 6. The result is that the rate of net pasture accumulation or growth actually declines beyond an optimum pasture mass level of approximately 2500 kg DM/ha.

Late winter-early spring and following droughts are the most likely times to have insufficient leaf cover for maximum potential pasture growth. Winter saved pasture and that grown in late spring to early summer can produce high pasture mass swards most likely to detrimentally affect net growth. A minimum pasture cover of 1500 kg DM/ha is required for optimum growth.



Continuous grazing with beef cattle reduces pasture density and often causes pugging which can be countered with occasional grazing by sheep

A more balanced grazing management using sheep and cattle avoids rank growth and encourages dominance by higher quality ryegrasses and clovers

Pasture growth is optimum when pasture mass levels are maintained between 1500-2500 kg DM/ha

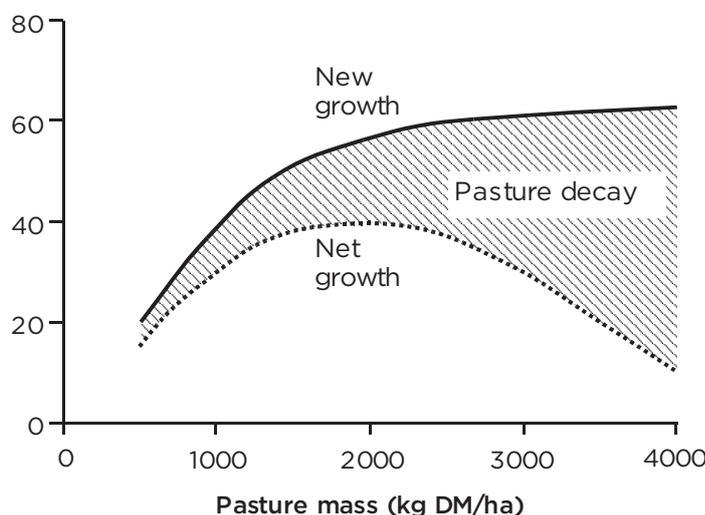


Figure 5. A diagrammatic representation of the components that determine the rate of pasture accumulation or growth across a range of pasture mass levels. The vertical difference between the new growth and the net growth lines is due to pasture decay, which is equivalent to negative growth.

Clearly, a disciplined approach to rationing feed over the winter period is important for maintaining early spring pasture covers and to ensure maximum pasture growth rates. A compromise is required with rationing pasture in winter using long rotation lengths with electric fences and breaks grazed to low residual pasture levels of less than 1200 kg DM/ha. These breaks will then have a period of less than optimum pasture growth. However, this is the price paid to ensure average farm or block cover is maintained at an optimum level.

Disciplined pasture rationing is often more likely to be successful if the number of mobs is reduced. Integrated grazing of sheep and cattle during winter such as cows with or before ewes, steers, heifers before hoggets can reduce mob numbers and achieve priority feeding. Advancing calving or lambing dates does not achieve this objective of minimum cover at the beginning of spring. For example, earlier lambing in late July versus late August can increase lamb weaning weights but overall farm income will be lower.



Use of pasture over winter should be managed to leave sufficient cover of >1200 kg DM/ha for good spring growth

Having fewer mobs and integrated grazing of sheep and cattle over winter will help maintain cover >1200 kg DM/ha

Reduced grazing pressure during drought, possibly through stock disposal, will help recovery along with use of hay or silage supplements

Because 60-70% of pasture grows during spring resulting surpluses if not controlled mean lower feed quality, pasture wastage and reduced animal performance

Pasture growth and utilisation

Because 60-70% of pasture growth occurs during the spring—early summer period and with limitations to animal consumption under ad lib feeding a substantial amount of pasture produced over this period may not be consumed. The consequences of this are a reduction in the accumulation of pasture as shown in Figure 6 above and a subsequent decline in feed quality due to accumulation of dead matter. Options to avoid this are to harvest surplus feed as hay or silage or put paddocks into a summer crop, or to buy in extra stock to eat the surplus pasture. All these options have a cost which is difficult to quantify.

The accumulation of dead pasture results in a decline in quality. For every 1% of extra dead material in the diet, feed digestibility declines by 0.5%. The significance of this

As an alternative to reducing numbers of mobs, many finishing beef farmers run their cattle in specially dedicated and intensively subdivided areas to ensure accurate rationing and to avoid conflict with the feed requirements of other stock classes. High pasture quality and high cattle growth rates in the early spring are a positive feature of these systems. However this can create animal health complications, especially with internal parasites (see Chapter eight). Some farmers attempt to minimise this by periodically running other stock through the area to eliminate the parasite load in the pasture. Ewes are effective in that they can often graze beneath intensive single electric-wire fences, thereby cleaning up large areas quickly.

Grazing management can alter pasture performance during, and coming out of drought conditions. Reduced grazing pressure during the dry spell is the key to success under these circumstances, along with timely stock disposal. Recovery from drought can be aided by feeding hay or silage to breeding ewes and/or cows to increase pasture cover once soils have become wet again. This increase in pasture cover can be critical in achieving adequate weight gains of greater than 0.5 kg per day for finishing cattle, during the subsequent winter and early spring.

is that with 40% dead matter which is quite common during summer/autumn, digestibility will decline to 60-65%. This compares with leafy late-winter or early-spring pasture with a digestibility of 80%. As pasture digestibility declines, daily intake will also decline by one third. This reduces the animal's intake to maintenance levels causing growth rates of young cattle over the summer/autumn period often falling to 0.2-0.3 kg liveweight gain/day.

The significance of the above is that stock carrying policy has a major effect on the size of the November to January feed surplus, the extent of seed head and dead drymatter accumulating in the sward and subsequent impacts on animal performance. From a grazing point of view, the key objective is to achieve a balance between high pasture intake and maintenance of pasture quality.

Feed budgeting and pasture quality

Matching pasture supply with animal requirements to ensure target performance requires knowledge of pasture availability and quality. Also prediction of future surplus and deficit periods can only be achieved, with accuracy, if future feed supplies and requirements are budgeted. Feed budgeting enables the farm manager to predict the size of feed deficit periods and their timing. This then allows determination what type of reaction, such as the use of supplements, stock sales or even doing nothing, as the best option. Feed budgeting allows a planned response to feed deficits and helps avoid emergency responses which are almost always more costly. Hence feed budgets need to be updated on a regular basis.

They can be on a daily basis and averaged monthly, although other periods may be perfectly acceptable.



Feed budgeting allows prediction of deficits/surpluses enabling better matching of animal feed demand with pasture supply

Feed budgeting programs are available commercially or can be set up on a computer spreadsheet

As fertility increases low fertility grasses like browntop and sweet vernal decrease and higher quality ryegrass based pastures dominate

When pasture levels exceed 3000 kg DM/ha in summer-autumn easier contoured paddocks should be used for hay/silage conservation and the surplus controlled by careful grazing management on the hills

Information required includes:

- Knowledge of feed on-hand from assessed pasture mass
- Assessment of pasture quality as described above which is important over the summer-autumn period for animal performance
- Knowledge of local pasture growth rates
- Farm or block area, available supplementary feeds
- Stock numbers and their target performance levels translated into daily feed intake requirements (Chapter five).

Importantly calculating feed demand and feed supply, determining the size of any deficits and considering what actions need to be taken are the key issues.

Computerised feed budgeting programmes such as FARMAX™ can be helpful. Alternatively, it is quite possible to set up a feed budget on a computer spreadsheet.

Maintaining high nutritive value feed for growing cattle

There is a wide range of means for maintaining or increasing the supply of high quality pasture to cattle. Options include:

Soil fertility

Soil fertility has only small direct effects on nutritive value. Most noticeable is the increase in protein content with nitrogen application and the correction of trace element deficiencies. However, the indirect effects of fertiliser are substantial. Increased clover content and ryegrass content, faster nutrient cycling and quicker breakdown of dead material are all important.

As soil fertility increases the content of low fertility species such as browntop, and sweet vernal declines. Although feed quality of these grasses are similar, ryegrass dominant pastures are easier to manage and there is less accumulation of stem and dead material in the summer. In addition the stem and seed head of ryegrass is more digestible than that of the lower fertility grasses. The growth pattern of ryegrass is more even and shows less of a peak than the lower fertility species. See Figure 2 on page 49.

Grazing management

Maintenance of pasture quality over the summer-autumn period is best achieved by keeping pastures below 3000 kg DM/ha within a 20–25 day grazing rotation. When pre-grazing pasture levels start to exceed 3000 kgDM/ha, easier contoured paddocks should be dropped out of the rotation and harvested for hay or silage or grazed by cows or other low priority stock in the January–February period. This ensures the steeper land on the farm is controlled. This is important because pasture and stock performance suffers most, if pasture control is lost on the steep land. Pasture quality is not easily or quickly regained on steep country. In addition, repeated loss of control on steep land encourages reversion to scrubby, woody weeds.

Set stocking during periods of rapid pasture growth is one method of maintaining better pasture control because it maximises the opportunity for the animals to eat all the pasture in front of them. The key to successful set stocking is to choose the appropriate stocking rate for that stock class. Mixing of stock classes can be useful such as rotating older cattle or cows through set stocked ewes and lambs.

Subdivision

Subdivision is a very effective tool for maintaining pasture quality and grazing control. Intensive subdivision reduces the opportunity for animals to only graze favoured areas of a paddock and allows better establishment of controlled rotations.

Recent advances in electric fencing technology have enabled high levels of subdivision to be achieved at relatively low cost. In addition the advent of 'virtual fencing' involving electronic exclusion may be utilised in some extensive farming situations.

Good subdivision, albeit with temporary electric fencing, provides the farm manager the opportunity to make more management decisions thereby allowing them to apply their pasture and animal management skills.

Adjusting liveweight gain and feed demand

All-pasture farming is usually the most cost effective however this requires the farm manager to 'bend' the animal feed demand to match feed supply. When pasture growth rates are at their lowest in winter, animal growth rates should be adjusted accordingly. The net result is that higher stocking rates can be wintered which in turn means more of the spring pasture surplus will be utilised, reducing the need to 'top' pastures or conserve feed.

Another advantage of adjusting animal liveweight gain and feed demand is to maintain pasture covers in the optimum pasture growth range—this is often termed 'grass grows grass'. By maintaining pasture in the optimum cover range more pasture will be grown in total (see Figure 5).

Rotation length (interval between grazing) is another related way farm managers can manipulate both animal liveweight gain, pasture cover and therefore pasture growth rate. Rotation length is one of the main ways of maintaining optimum pasture cover and associated pasture growth rate.

Animal liveweight gain, feed demand, pasture cover and pasture growth rate are all interrelated. Experienced farm managers fully understand and apply their knowledge and skills in balancing these factors to achieve the optimum result.

Nitrogen

Nitrogen fertiliser almost always rapidly provides high quality pasture although its effects are often short term. Applied at the wrong time of the year, such as mid-spring, can actually reduce pasture quality by increasing the pasture surplus on the farm. However, it is a most effective fertiliser and one of the cheapest available provided growing conditions are favourable. Its need has to be anticipated and planned several weeks in advance of use.

Nitrogen application, usually in the form of urea, is a grossly under-utilised, profitable and effective fertiliser for many beef finishing systems, particularly over the late autumn, winter and early spring periods. Lack of significant nitrogen use on many beef finishing properties remains one of the great mysteries of modern beef-farming.

Strategic use of nitrogen fertiliser gives a quick short term boost to growth. Any fertiliser applications should be based on sound technical advice supported with tools such as overseer and is compliant with Beef + Lamb New Zealand land and environment plan.



Strategic use of nitrogen fertiliser gives a quick short term boost to growth



Increased subdivision and more paddocks allows better control with grazing management

Integration of stock classes

This is an effective way of maintaining pasture quality in the spring-summer period. Lax grazing high quality pasture with growing cattle, which allows them to select the best quality feed to maintain high liveweight gain, means that residual feed quality can be lower, particularly later in the season if not removed. A lower priority stock class, such as breeding cows or older growing cattle, therefore, complements a beef finishing system, especially where removal of pasture surpluses as hay or silage is not practical. However, in recent years, an increase in the proportion of high-profit finishing cattle has placed restrictions on availability of low priority stock classes like breeding cows for “cleaning up” pasture.

Most gross margin budgeting systems fail to take into account the value pasture management from animals such as breeding cows, mainly because of the difficulty in ascertaining the value of these animals for pasture management.

Topping and conservation

Mechanical topping is an effective, though inefficient way of reducing the development of stem in pastures in the spring. It results in the total loss through decay of topped pasture. Conservation of surplus pasture early in the season around November can be a potent and effective tool for maintaining pasture quality. The objective is to increase stocking rates in spring, on paddocks that cannot be harvested mechanically, by shutting up easy contour areas for silage or hay. If well timed these paddocks come back into the grazing round as growth rates slow down a little from the spring flush. Many farmers find this timing difficult to manage, with paddocks not coming back into the grazing round soon enough. Chemical topping, using low rates of glyphosate herbicide at 200ml/ha was potentially another way of reducing reproductive growth of grasses.

Without doubt cows can play an extremely valuable role in removing poor quality feed and can maintain good calf growth rates while removing feed other animals will not eat.

Adjusting seasonal stocking rates

This is critical for successfully managing pasture quality and feed quantity. Adjustments, especially in spring can be achieved by buying, selling, taking on grazers, or grazing stock off, manipulating lambing, calving and weaning dates and increasing the proportion of high fecundity ewes.

A flexible slaughter policy allows target liveweights of replacement younger calves to be met through the summer-autumn period by reducing the total feed demand. The flexibility to slaughter older animals when required, depends in turn on earlier target liveweights being met. For example, if 16 month old cattle are grown so that a significant percentage weigh 440 kg or greater in early summer, flexibility exists in timing to slaughter these animals, or to retain them to higher weights, should summer pasture production be high.

A carefully planned slaughter pattern over the summer-autumn is important to ensure the required pasture cover on the farm is achieved at the start of winter. Strict decisions for stock disposal timing need to be in place. This is to ensure that only animals to be wintered are on the property, with no carryover animals remaining to be finished over the winter period, when pasture is in short supply and costly.

Regrassing

Regrassing and use of forage crops on cultivable areas can be a way of ensuring availability of high quality feed for young stock in the summer, autumn or winter periods. New pastures generally have less dead material than the pastures replaced, and are also often lower in levels of fungal toxins and parasite larvae. The most important factors governing the effectiveness of these crops and new pastures are the success with which they are established, and the cost relative to their benefits.

Cropping removes pasture from the grazing rotation in the spring and is a good strategy for weed control. This can assist in pasture control on the remaining areas of the farm, by effectively increasing farm stocking rate.



With intensive beef finishing lax grazing for high performance is best with use of lower priority stock like breeding cows to clean up

Conservation or mechanical topping can control of surplus pasture

Adjusting seasonal stock numbers through buying and selling or using high fecundity ewes will help to better match pasture supply and demand

Use of re-grassing and forage crops can cost effectively help with feed deficits in summer, autumn or winter



High-energy supplements or concentrates

These are an option when it is apparent that feed quality or quantity is insufficient to achieve target liveweight gains. The increase in liveweight gained from a supplement will be related to the quality of the supplement, for example:

- Cereal grain supplementation and/or Palm Kernel Expeller (PKE) is a reliable means of improving cattle growth rates during summer and winter with a response rate of about 5 kg grain/kg liveweight gain
- Grass silage will improve cattle growth only if it is of higher quality than the pasture that is offered, or if the animals would otherwise have been severely restricted. Much silage and hay has an ME content of less than 10 MJ/kg DM sometimes less than 8.5 MJ ME. However, it is possible to make high quality grass silage in the right conditions with an ME content greater than 10.7. This silage can give a response rate of 7 kg DM/kg liveweight gain
- Cost effectiveness of supplementation can often be poor due to wastage.



Exploitation of compensatory growth in spring can effectively help match pasture supply and demand

With supplementation substitution for pasture can have both positive sparing effects and negative quality influences

Longer winter rotations of 60-90 days increase pasture covers and subsequent early spring pasture growth

Use of high carbohydrate supplements, unless carefully introduced, can cause serious metabolic disorders such as acidosis or grain poisoning.

Use of cereal grains or grass silage can be cost effective for finishing cattle to target weights.

Use of nitrogen-stimulated pasture as above during winter has provided a response of 6 kg DM/kg liveweight gain and is almost as effective in terms of animal performance as grain.

One beneficial use of supplements is in young weaned dairy-beef calves during their first summer.

Grain and many other supplements are most effective when used as tactical finishing tools. In all cases cost:benefit must be analysed. Unless animals are slaughtered when feeding stops, some of the advantages will be lost, compared to animals that were not supplemented, due to the effects of compensatory gain described next.

Compensatory gain

Compensatory gain can be a means of helping to align animal requirements with seasonal pasture growth patterns. For example, cattle on restricted feeding during the winter will have higher growth rates during the spring, than cattle that were fed well during the winter. However, for cattle to show this compensation, pasture-feeding levels need to be high during the spring, to enable them to eat the feed necessary to make the extra gain.

Low liveweight gains over winter may not meet some meat processors beef quality standards.

Winter rotation lengths

The decision about rotation speed during winter will depend on the balance of pasture supply and demand, and the element of risk in maintaining late winter-early spring pasture covers. The use of a slow rotation during winter reduces this risk. The extent of this feed restriction depends on the need to maintain positive growth over the winter period to achieve targeted marketing times and weights. The choice of winter rotation speed allows management of risk and achieving market targets rather than affecting total system production. Many farmers operate a winter rotation length of 60-90 days.

Optimum stocking rate

Biological efficiency of beef production can be improved by using high stocking rates to improve pasture utilisation. However, as described earlier, increased liveweight gain also increases efficiency because it shortens the production cycle and therefore reduces the total energy cost of animal maintenance. High liveweight gain requires high pasture DM intake, which in turn is associated with reduced pasture utilisation and the negative impacts on pasture quality for subsequent grazings. The combination of these competing or conflicting forces is that neither very low, nor very high stocking rates can optimise biological efficiency.

Data from long-term bull beef production projects does provide much assistance in determining optimum stocking rate. Figure 6 shows that optimum liveweight gain/ha/year occurred at about 1300 kg bull liveweight/ha although 875 kg bull liveweight/ha was also near the optimum. At both 875 kg and 1300 kg of bull live weight/ha, pasture utilisation/year was 95%, whereas at the lowest stocking rate it was only 67%. Note also, that liveweight gain/head/year declined steadily as stocking rate increased. This was on pastures which produced 15,000 kg DM/ha/year—more than on many hill country pastures.

The important question of course, is what is the most profitable stocking rate? Gross margin analyses on the data in Figure 7 showed optimum stocking rate to be about 3.75 bulls/ha to maximise gross margin \$/ha. The difference between the optimum stocking rate for biological and economic efficiency was because the per kg purchase price of the calf is much greater than the selling price, and also the heavier carcasses generated at lower stocking rates were worth more per unit weight.

Therefore optimum stocking rate for economic efficiency will vary from year to year and between farms depending on:

- Pastures producing less than the 15,000 kg DM/ha/year will have to be stocked lower according to their production
- Calf purchase price
- Beef schedule price and the level of premiums for heavier carcasses.

The latter two items are critical determinants of optimum gross margin/ha.

Decisions on which precise stocking rate to use may depend on factors such as:

- Attitude to risk
- Labour availability
- Size of operation
- Interaction with other enterprises.

At high stocking rates, financial risk is a major factor because quite small changes in the ratio of calf price to bull schedule price 12 months later can substantially alter profitability.

At low stocking rates, financial risks are reduced, but high liveweight gains are required throughout the year, to maximise profitability. Poor pasture quality will place the enterprise at risk. The incomplete utilisation of pasture is a very important factor at low stocking rates and must be carefully managed.



Stocking rates of 5-7 bulls/ha are best for optimum liveweight gain/ha

Lower stocking rates of <4 bulls/ha optimise economic \$ returns/ha

Pasture surpluses at low stocking rates need to be carefully managed to maintain pasture quality

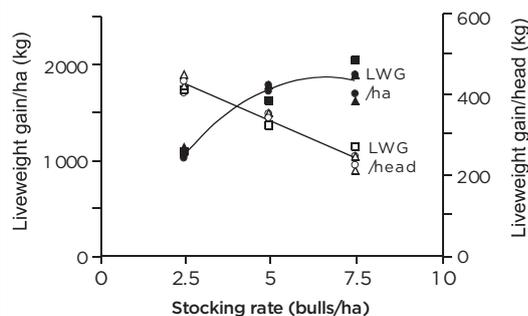


Figure 6: The observed relationships of net liveweight gain/ha/year, and liveweight gain/head/year, to stocking rate (bulls/ha) in the bull production trial of Clark (1992).

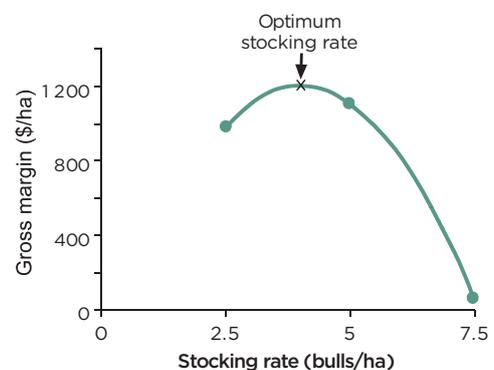


Figure 7: The predicted relationship of gross margin (\$/ha) to stocking rate (bulls/ha) from the bull production trial of Clark (1992).



Further reading

Pasture Growth forecaster, Beef + Lamb New Zealand.
www.beeflambnz.com/information/interactive-tools

Hughes, P.L., Morris, S.T. 1998. *Management solutions for beef cows*. New Zealand Beef Council Southern Regional Field day, Gore, 8 May 1998, Alexandra

Matthew, C., Hodgson, J., Matthews, P.N.P., Bluett, S. 1995. *Growth of pasture—Principles and their application*. Massey Dairy Farming Annual 47:122-129

Beef + Lamb New Zealand, Land and Environment Plans. www.beeflambnz.com



GENETIC IMPROVEMENT

Recommendations

- Bull selection is important for genetic improvement as each sire passes on his genes to 50–150 calves compared with 5–10 calves for each cow.
- Commercial beef producers should have clear breeding objectives based on productive and economic goals which are compatible with those of their bull breeder.
- Choice of a progressive bull breeder is essential. Commercial producers will follow a similar genetic trend with a lag of two to three generations. Group BREEDPLAN illustrates how well the bull breeder is progressing year on year relative to the breed average.
- Usually selection accuracy is low for the EBVs of yearling and 2-year old bulls. This further emphasises the need to place the majority of effort in selecting a good bull breeder rather than the bull itself.
- Consider use of index selection such as the Self Replacing Index for commercial breeding cow herds where traits are grouped according to economic value and in line with your breeding objectives.
- Establish clear selection criteria giving a balance between objectively measured and economically important traits and subjective traits such as conformation and structural soundness. The more traits being selected the less progress in each trait.
- Breeds and crosses show characteristic performance differences and no one breed excels for both maternal and growth traits. There are considerable differences in performance between individuals within a breed.
- Crossbreds and composites have advantages with expression of hybrid vigour, however high genetic merit sires should still be selected as there are large differences within breeds.
- Choose a breed or crossbreeding system which is compatible with your farming system and breeding objectives.

Introduction

Most beef cattle in New Zealand are managed in commercial herds with bulls purchased from outside the herd. Little or no individual recording is undertaken in commercial herds. A small proportion of cattle are located in registered herds where pedigree recording with breed societies has been mandatory. These seedstock or nucleus breeder herds produce almost all breeding bulls used in commercial herds. Industry genetic change is dictated by the direction and rate of progress achieved in the nucleus of breeder herds. Most of these herds are registered and performance recorded with a beef cattle breed society.

The number of new bulls required each year by the beef industry can be estimated by considering the total beef cow and heifers in-calf (1,195,000 in 2008/09 and 990,000 in 2013/14), the number of cows or heifers mated by each bull, at say 1 bull to 50 cows, and the average working life of a bull is 3 years. These figures suggest a total requirement of around 24,750 bulls and an annual requirement of 8,250 bulls.

When a commercial farmer consistently buys bulls from a bull breeder, the commercial farmer's herd will be improving genetically at the same rate as the bull breeder's herd but will be two to three generations or 10-15 years behind. This two to three generation delay is called 'genetic lag'. This highlights the importance of choosing the right bull breeder to buy bulls from. The most important single factor in making that choice is that the breeder's herd must have higher genetic merit than the commercial herd. EBV's generated through Group BREEDPLAN provide the basis on which a bull buyer can determine the genetic merit of the bull breeder's herd.

Consider the process of selection and mating that will occur in bull breeding herds in spring 2015. The resultant offspring will be born in spring 2016. In the case of bull calves, these will be typically sold as rising two-year olds, in winter 2018. The farmer that buys such a bull, will join it with the commercial cows in spring 2018 giving rise to the calf crop in spring 2019. If the farmer sells weaners, the first impact his bull has on income will be

at the weaner fairs in autumn 2020. If the farmer finishes the male and surplus female offspring, this crop will be typically harvested in late 2020 or in 2021. Bulls used for four breeding seasons will continue producing terminal offspring until 2025. In the situation where daughters are retained for breeding, these daughters from the first crop will have their first calves, if mated as yearlings, in 2021. Cows may remain in the herd for seven or eight calvings, or until 2031 if the bull is used as a sire for four years. It should be apparent that the impact of selection decisions in bull-breeding herds in 2015 will affect the bull-buyers or commercial farmer's income from 2020 at the earliest until 2031. It is therefore the future circumstances that are important, not today's.

The graph in Figure 1 on the following page illustrates genetic progress in four separate herds compared to the breed average based on Group BREEDPLAN. These are real herds selling appreciable numbers of bulls to the industry each year. The Self Replacing Index combines the maternal traits important for commercial beef herds and is based on the relative economic value of each trait. In effect the Self Replacing Index is an economic index to bring about the most profitable outcome in the commercial farmers herd. Clearly Herd B is genetically superior to all other herds compared and would provide a bull buyer with good bull buying choices even if an individual bull within the herd was below the Herd B average. This emphasises the point that selecting the bull breeder is as important as selecting the bull itself.



Bulls for industry herds come from breed society registered seedstock or nucleus breeders

The commercial herd's rate of genetics will be the same as the bull breeder's herd but there will be a genetic lag of two-three generations

Self Replacing Index

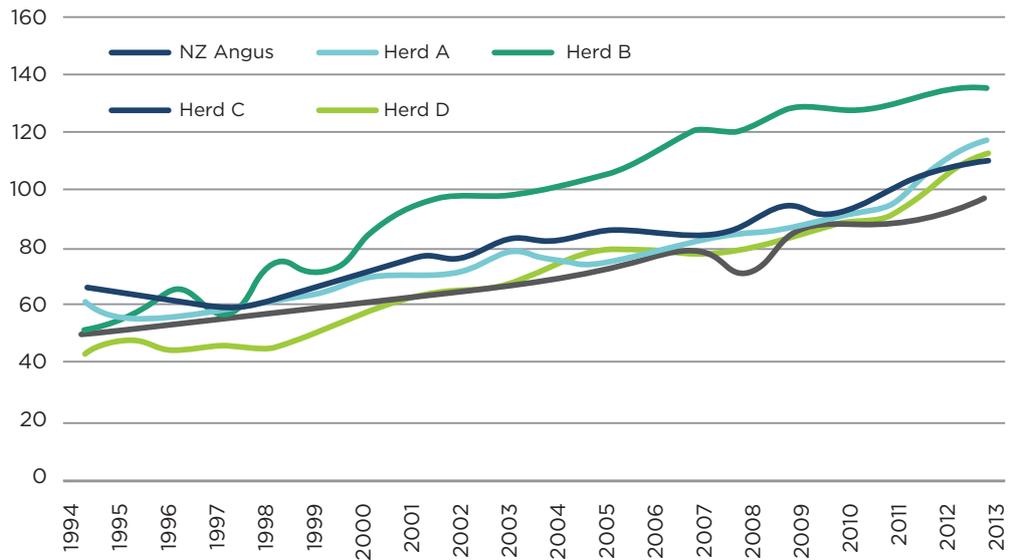


Figure 1: Rate of genetic progress in four separate herds in comparison with the breed average.

Selection decisions

Bull breeder herds need to:

1. Establish selection objectives, and
2. Be able to demonstrate high levels of genetic gains based on objectively measured traits.

Commercial herds need to:

1. Establish selection objectives.
2. Choose a breed mix to generate good levels of hybrid vigour.
3. Choose a breeder with similar objectives and high levels of genetic gain.
4. Choose bulls based on traits consistent with objectives, and
5. Choose heifer replacements consistent with objectives.

To be included in a genetic improvement programme a selection trait must meet four basic criteria: (1) be economically important, (2) measurable, (3) heritable and (4) characterised by variability in the population. Economic importance can mean different things to different producers. For example a farmer selling weaners at seven months of age will have slightly different economic criteria to a farmer who breeds cattle and carries all progeny through to slaughter. Objective measurement of beef cattle performance traits enables the breeder to compare the traits irrespective



Both breeder and commercial herds need to establish selection objectives based on objectively recorded production traits

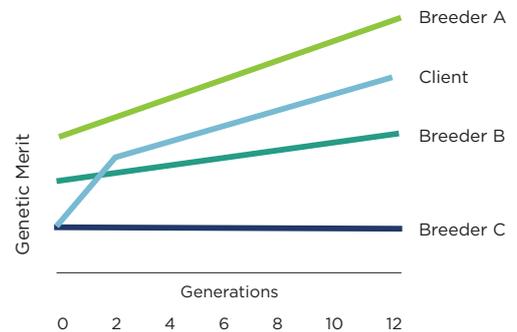


Figure 2. Generation lag theory—the rate of genetic gain as determined by your breeder.

of season, bias, year or environmental effects, and allows the calculation of estimates of genetic merit. Liveweight is easy to measure and is a logical first choice for most genetic improvement programmes. Maternal traits such as reproductive rate, calving ease and mature cow weight are important for the commercial beef cow operator and these are usually represented in an Index, e.g. Angus Self Replacing Index.

Figure 2 above shows the “lag” between bull breeder and bull buyer in genetic trend over time. The buyer remains two generations behind the bull breeder in genetic trend. The bulls a buyer purchases are the easiest way to represent this trend. The two-generation lag can be reduced by purchasing bulls annually, at a level above the average of the breeder’s bulls.

Heritability is an important term. It is defined as the difference in the level of performance of individuals that on average is passed on to their offspring. So if the heritability of a trait is high much of the level of performance of parents will be passed on to their offspring. Conversely if the heritability is low only a small percentage of this performance will be transferred to the next generation. Heritability's are expressed as proportions (from 0 to 1) or percentages (from 0 to 100).

The higher the heritability of a trait, the greater the proportion of the parental genetic merit passed on to offspring. Most of the growth traits in beef cattle have a heritability of between 30% and 50%. This means that of the measured levels of growth rate between animals in a group, 30-50% is due to genetic factors and 50-70% to non-genetic or environmental factors. Carcass traits generally have heritability's between 30% and

55%. Female fertility traits tend to have much lower heritability's of between 5% and 20%. This means that a smaller proportion of the measured fertility is due to genetic differences, and so the rate of improvement in fertility traits in a genetic improvement programme will be slower than for other traits. Heritability estimates for some of the important traits of beef cattle are shown in Table 1.

Traits that have greater variation in performance among individuals in a group have more scope for change. Some traits vary more than others and even if a trait has a low heritability, a large variation will mean that significant changes can be made by selecting the best animals (see Table 1). Additionally, although some traits have low heritability, they may have a high relative economic value. This is where Index Selection is useful as it balances and combines traits according to their contribution to farm profit. See the following section on Economic weights and values.



Heritability is the difference in level of performance of individuals which is passed on to their progeny

Growth and carcass traits have high heritability of 30-50% while reproductive traits have lower heritability of 5-20%

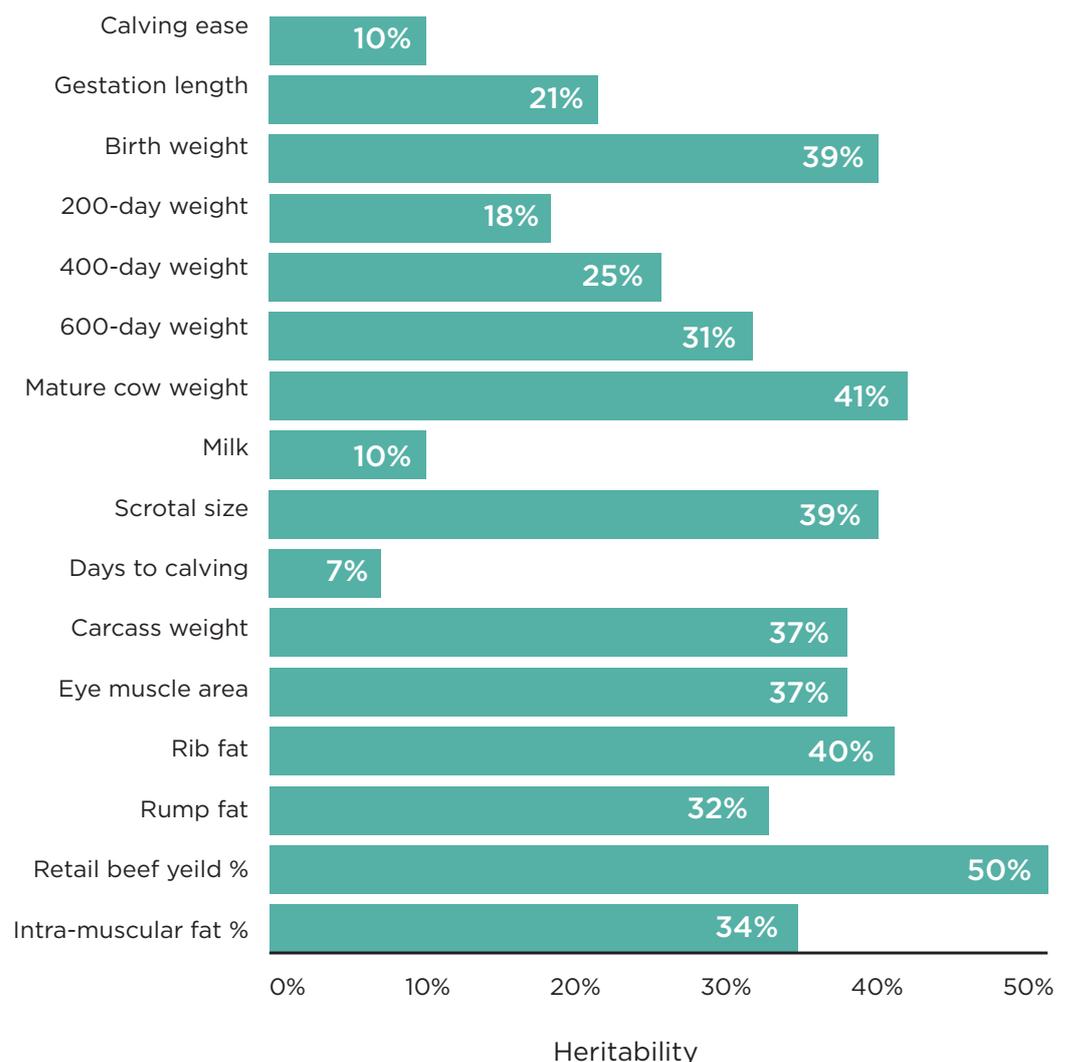


Figure 3. Angus heritability estimates by trait.
Source: angusnz.com/cattle/technical/ebvs/heritability.

Table 1: Heritability estimates for traits across breeds.

Trait	Heritability description	Heritability estimate (%)
Reproduction		
Conception	Low	0-5
Days-to-calving	Low	0-10
Calving ease (heifers)	Low-medium	15-50
Semen quality	Low-medium	25-40
Scrotal circumference (18 months)	Medium-high	20-50
Serving capacity (18 months)	Low-high	15-60
Maternal ability	Medium	20-40
Gestation length	Medium	15-25
Conformation and growth		
Birthweight	Medium	35-45
Milk yield	Medium	20-25
Weaning weight	Medium	20-30
200-Day weight	Medium	18
400-Day weight	Medium	25
600-Day weight	Medium	31
Mature cow weight	High	50-70
Carcass		
Carcass weight/day of age	Medium	25-45
Rib fat (12/13th rib)	Medium	27
P8 rump fat	Medium-high	29
Intramuscular fat (imf%)	Medium-high	15
Eye muscle area (EMA)	Medium	20-25
Dressing %	Medium-high	15
Tenderness	High	4-25
Retail beef yield (RBY%)	High	29
Yield % carcass weight	High	49
Other traits		
Temperament	Medium-high	25-50
Worm resistance	Medium	na

Breeding objectives

The first step in the development of a breeding objective is to identify the goal, e.g. superior maternal ability. A breeding objective will reflect the production and economic objectives of the individual breeder. The exception could be the bull breeder who may have a number of objectives reflecting their own and their various clients' objectives. This is not an ideal situation because the bull breeder is likely to have too many objectives which will limit genetic progress in each of the traits being selected.

Given a clearly defined goal, the next step in the development of a breeding objective is to identify traits that influence the goal and to which economic values are important. A diagram of some possible economically-relevant traits is shown in Figure 4. For a given situation, there may be alternative objective trait lists with different traits and different definitions. Clear and precise definition of traits is very important. Correlations between traits also need to be considered. For example, selection for yearling weight can increase birth weight and in some cases increased calving difficulty. Selection on birth weight can be used to limit correlated increases in calving difficulty. Highly sought after bulls, often have low birth weight and high yearling weight breeding values.

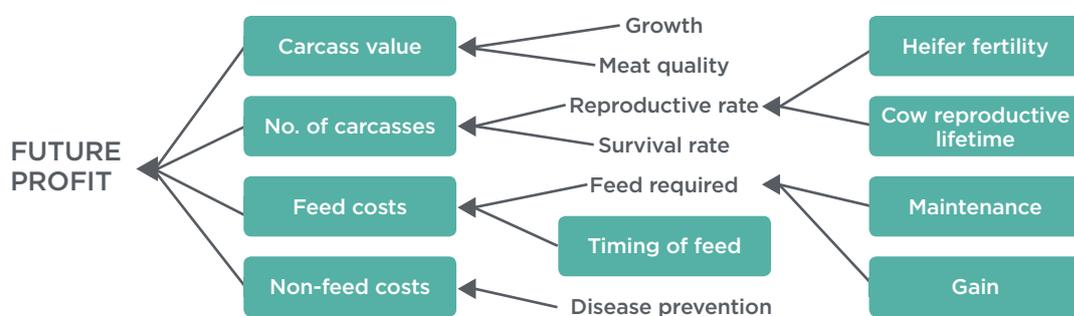


Figure 4: Some factors influencing profitability in beef cattle.



Breeding objectives have traits that reflect the production and economic goals of the breeder or commercial producer

$$\text{Profit}/\$ = \# \text{ calves} \\ \times \text{weight (kg)} \times \text{cents}/ \\ \text{kg} - \text{cost of input}$$

A single selection index comprises a group of relevant traits with known economic values

Economic weights and values

In order to construct a single index value encompassing several selection traits, economic values are needed for each relevant trait. Economic values should be defined as the net benefit from improvement in an individual breeding trait in \$ value terms. This value is expressed per unit change and holding all other breeding objective traits constant. This helps avoid the potential for double counting of benefits.

In many instances, “economic value” and “economic weight” are terms used interchangeably. However, it is helpful to give economic weight a different definition. We define here the economic weight as the benefit of improvement in an individual breeding objective trait, expressed relative to some other trait of interest.

The construction of indexes is complicated and best left to a geneticist to construct. From a commercial farmers perspective the things to check relate to the relevance of the traits included in the Index compared to your own objectives. Questions that may be asked by a commercial beef cow operator are—does the Index include traits that reflect my objectives? For example:

- Higher reproduction rate
- Better calving ease
- Lower mature cow weight for better efficiency higher calf weaning weight.

If the Index includes these traits then the commercial bull buyer can be satisfied that the Index represents the breeding objectives for their herd.

Selection methods

As was mentioned in the section on selection objectives, it is common for breeders to be interested in improving several traits simultaneously. There are three methods of selecting for multiple traits.

Tandem selection

This involves ranking animals for the most important trait and culling on that trait. At some point in time, selection is relaxed on the first trait and imposed on a second trait instead. Over time, selection proceeds through the list of traits in tandem. This form of selection is the least effective as it is difficult to decide when to change from one trait to the next, and if there are several traits, which are common in beef cattle production, it will take considerable time before selection can be imposed on all traits. Another difficulty is when two or more traits are unfavourably genetically correlated. In this case selection for an increase in one trait will result in a correlated decrease in a second trait. On changing selection from the first to second trait, there could be a related decrease in the first trait, undoing some of the selection response achieved.

Independent culling levels

Selection using independent culling levels involves ranking the animals for each trait in the selection objective. For each trait, some of the inferior animals are culled. The relative importance of each trait will determine the extent to which selection is imposed on that trait. Independent culling is widely used for culling animals on conformation traits. For example, heifers which have unacceptable feet or black Angus cattle with white markings are likely to be culled regardless of their genetic merit for other traits of interest.

Selection index

The selection index method combines information from a number of traits with known economic values and weighted accordingly so animals can be compared. The selection index method has not been used widely in the New Zealand beef industry, but is common in the sheep and dairy industry. A tool available through BREEDPLAN called BreedObject is a selection index for New Zealand breeders. An example of this is the Self Replacing Index which is utilised by the Angus breed.



Methods of improving several traits simultaneously include tandem selection, independent culling levels and selection index

Estimated Breeding Values (EBVs)

For more guidance on EBVs see Beef + Lamb New Zealand publication *Bull Buying for the commercial beef breeder*.

BREEDPLAN is a widely used breeding programme which estimates the genetic merit, or breeding value of an animal using a number of measurements made on the animal and its relatives. BREEDPLAN reports estimates of genetic merit as Estimated Breeding Values (EBVs) for each trait. EBVs are predictions of relative genetic merit animals will pass on to their progeny. EBVs are expressed as positive or negative deviations from a base which is set at zero on a fixed date.

EBVs are estimated using the measured deviation in the trait from the herd average for a particular animal, heritability of the trait, information on the trait from the animal's relatives and correlations with other important and related traits.

EBVs are reported in the unit of original measurement, for example growth traits in kilograms (kg), scrotal size in centimetres (cm) and days-to-calving (days); they are expressed as deviations from a base average, which is set from a particular year for each EBV.

Group BREEDPLAN allows across-herd genetic evaluation of cattle from herds which are linked genetically by related sires and have been recorded with BREEDPLAN. EBVs are available for growth, carcass, reproduction and other traits. When selecting a bull breeder it is important that they are recording on Group Breedplan so that you can compare the relative genetic merit of each herd you are considering.

The real advantage of gaining knowledge of between-herd genetic differences is that the genetic trendlines between the bull breeder and the breed average provide evidence that the bull breeder is conforming to best practice.

One of the traps when selecting a bull breeder is that some bull breeders are better at feeding and presenting their bulls. These are environmental factors and therefore will not necessarily contribute improved genetic merit to the bull buyer's herd.

Estimated breeding values or EBVs give the genetic merit of a trait based on the deviation of the individual animal, trait heritability and correlations, and information from relatives

EBVs are provided by BREEDPLAN and Group BREEDPLAN provides across herd genetic evaluation from herds genetically linked by related sires

Growth EBVs

Birth weight EBV

Birth weight should ideally be taken at birth or within a few days of birth. Birth weight is associated with an animal's weight at later ages: in general, calves which are heavier at birth tend to be heavier later in their life. An EBV for birth weight is not available unless the calf's birth weight or that of a number of its relatives has been measured, although it may be estimated with reduced accuracy from later weights such as weaning weight. Buyers looking for easy calving bulls can use birth weight EBV as a guide, but should look carefully at the accuracy of the EBV. Calving Ease Direct is recommended as the best individual EBV to use when looking to improve ease of calving.

200-day growth and 200-day milk EBVs

These EBVs are derived from the records of calves weighed between 81 and 300 days of age. The 200-day weight, the measure of pre-weaning gain, is derived or influenced from three sources:

- The calf's inherent growth potential
- The dam's merit for milk production and milk quality
- Performance of all known relatives e.g. sire, dam, brothers and sisters.

The 200-day growth and milk EBVs are calculated for the "growth" and "milk" genes. Note that the milk estimate in kilograms is not the yield of milk of the dam, but the growth rate in the calf attributable to the dam's milking ability. It is an indirect measure of the milk production of the dam expressed in kilograms of calf weight at 200 days. It should be used in the selection process, if the contribution of the dam through her milking ability, is important in a particular production system.

Each time a 200-day weight is recorded it increases the reliability of the EBVs for growth and milk of all relatives of the particular calf. An EBV for milk in a calf is simply a calculation of the average of its sire and dam's EBV for milk and is called a mid-parent value or average. It is not until females have progeny, and males have daughters that have weaned calves, that the EBVs for milk will change from the average of their parents' EBVs.

The heritability of 200-day milk is about 8%, which means that genetic progress in this trait will be slow. Conversely, the heritability for 200-day growth is about 20%, which enables greater opportunities in improved growth following selection using this trait. Since EBVs for milk are less heritable than growth EBVs, they are more likely to fluctuate as new information is added relative to growth.

400-day yearling weight EBV

This EBV covers records of calves weighed between 301 and 500 days of age. This EBV is most useful for selection in yearling production systems in which cattle are sold some months after weaning.

600-day final weight EBV

Final weight EBVs are computed for growth and recorded between 501 and 900 days of age. It is an estimation of an animal's ability to continue to grow to an older age.

Mature cow weight

This is defined as the cow's weight recorded at the same time as her calf is weaned. The mature cow weight EBVs are estimates of the genetic differences in weights between cows at weaning during production of their first four calves. Mature cow weight EBVs for sires are based on weights recorded from their daughters following weaning of their calves plus correlations between cow weight and earlier growth performance. Mature cow weight EBV values can be used to influence the mature size of cows in the herd.



Liveweight (WT) EBVs include birthweight, 200 day WT, 400 day WT, 600 day WT and mature cow WT



Reproductive EBVs

Scrotal size EBV

Adjusted to 400 days of age. An animal with a greater scrotal size EBV will produce male progeny with relatively larger scrotal circumferences and daughters that reach puberty at an earlier age. The sons of bulls with larger scrotal size will on average have greater daily and total sperm production, which can be associated with increased fertility.

Days to calving

An estimate of the genetic differences between cows in fertility, expressed as the number of days for the period from when the bull is placed with the females to calving. A female with a shorter days-to-calving EBV tends to reach puberty earlier as a heifer, return to oestrus earlier after calving and conceive early in the joining period. A lower days-to-calving EBV value indicates greater opportunity for the cow to conceive within any one mating period. Cows that do not calve are given a 'penalty' figure. These EBV values for bulls are based on the performance of their daughters and female relatives.

Carcass EBVs

Five carcass EBVs are available based on live animal ultrasound scan measurements taken by accredited scanners and information collected from actual carcass data. The measures are eye muscle area, rump fat depth, rib fat depth, intramuscular fat % (IMF%) and retail beef yield % (RBY%). Extra data collected at abattoirs, including hot carcass weight, marble score, meat colour, fat colour and meat pH, can be stored in the database. The quality EBVs are expressed in terms of a 400 kg dressed steer carcass weight and measured between 300 and 800 days of age but preferably less than two years old.

Carcass weight

Estimates of the genetic differences between animals' untrimmed hot carcass weight at 650 days of age and are based on slaughter carcass weight records.

Fat depth

Measured at the 12/13th rib site and the P8 rump site on a standard 400 kg carcass. The measurement at the 12/13th rib has a genetic correlation of 0.9 with P8 fat and is preferably used in the multi-trait model. Fat depth has a negative relationship with retail beef yield.

Gestation length EBVs

Estimates of genetic differences between animals in the number of days from the date of conception to the calf birth date. Gestation length EBVs are expressed in days. Gestation length is available only when the conception date is known, that is, as with artificial insemination. Gestation length is one component of days-to-calving. An animal with a more negative EBV will have progeny with a shorter pregnancy, more time to get back in calf relative to females with a larger EBV, and potentially a smaller calf.

Calving ease

There are two calving ease EBVs:

1. Calving ease maternal (daughter) is the bull's EBV associated with his daughter's ability to calve
2. Calving ease direct EBV is an indication of the bull's progeny's ease of calving i.e. influenced by size and shape etc of the calf.

Components include calving ease score, gestation length and birth weight. A larger positive value for both maternal and direct is a desirable selection option. Birth weight EBV is a commonly used as a proxy for calving ease because it is easier to measure. However, it does not predict calving ease as accurately as calving ease direct EBV.

Eye muscle area (EMA)

Measured in cm² at the 12/13th rib on a standard 300 kg carcass. Eye muscle area and fat measurement are used in the prediction of retail beef yield % from a live animal or carcass. Larger eye muscle area EBVs are associated with higher carcass yield and generally leaner carcasses.

Retail beef yield (RBY %)

The major reason for measuring either fat depth or eye muscle area is to predict the yield of meat from the live animal or carcass. Equations have been developed for the within-breed calculations of retail beef yield percentage. These include age, liveweight, fat depth and eye muscle area with fat depth having a greater influence than eye muscle area. Retail beef yield % EBVs can be used to select for yield of retail cuts from carcasses.

Intra-muscular fat (IMF %)

Measurement of the percentage of fat within the 'eye muscle' and is similar to 'marbling score' as reported at slaughter. 'Marbling score' is a subjective assessment of intramuscular fat. IMF% is based on a 400 kg standard carcass. IMF% EBVs are important in the selection of sires to produce progeny for markets such as Japan that require increased amounts of marbling in carcasses.



Reproductive EBVs include scrotal size, days to calving, gestation length and calving ease

Carcass EBVs include carcass weight, fat depth, eye muscle area, retail beef yield and intramuscular fat

Additional EBVs available

Feed efficiency

Net feed intake EBVs can be used to predict the differences in feed consumption among progeny of different sires adjusted for differences in their live weight and growth performance. Net feed intake is sometimes referred to as residual feed intake (RFI), net feed efficiency (NFE) or net feed conversion efficiency (NFCE). A negative NFE EBV is preferred. Recording for this EBV is expensive and is available in Australia but not yet in New Zealand.

Other traits

A number of traits are being assessed according to demand by the breed societies that use BREEDPLAN. New traits may include: animal linear measures (e.g. hip height), conformation score (e.g. leg score), temperament (e.g. docility), body condition score and heifer fertility. Beef + Lamb New Zealand Genetics are currently consulting with breeders and commercial producers on industry requirements.

Accuracy of EBVs

There are benefits in knowing the reliability of EBV estimates and the likelihood they will change with the addition of more performance information about the animal or its relatives. Accuracy is expressed as a % and is calculated from the number of performance records that are available for each trait on the animal itself, as well as its progeny and relations (refer to Table 6.2). The higher the accuracy, the greater the confidence that the EBV is an accurate estimate of the animals' true breeding value, and with less likelihood of it changing as more information becomes available.

An accuracy of less than 55% indicates that no direct information is available about the animal. Information may come from relatives rather than direct observation or from a correlated trait. An EBV with this level of accuracy should be considered

a preliminary estimate only and could change considerably up or down as more substantial information becomes available.

EBVs for yearling bulls without progeny recorded are calculated from the record of the bull and/or its relatives. The accuracy of these EBVs will be in the range of 40% to 75%, with the higher accuracy EBVs reflecting greater information from relatives. The EBVs of sires with recorded progeny are more accurate and more stable than the EBVs of bulls without progeny. Progeny information is a better estimate of a bull's breeding value than the individual's performance. These EBVs will range in accuracy from 75% to 99%, with the higher accuracy EBVs reflecting a greater number of progeny and/or the availability of daughters' progeny records.



Additional EBVs include feed efficiency and newly assessed traits including animal linear measures, conformation, temperament, body condition score and heifer fertility

Accuracy of EBVs depends on the amount of information from an animal and its relatives and ranges from 55% for an individual to 90% for an individual plus 45 progeny

Performance measured on:	Accuracy (%)
Individual	55
Individual + 10 PHS* + 2 MHS	61
Individual + 20 PHS + 4 MHS	64
10 progeny	67
32 progeny	85
55 progeny	90
Individual + 10 progeny	74
Individual + 20 progeny	82
Individual + 45 progeny	90

*PHS: paternal half sibs or other calves by the same sire, MHS: maternal half sibs or other calves by the same dam.

Table 2: Accuracy values for a trait (assumed heritability 30%) when additional performance records are added to an EBV.

Source: Beef + Lamb New Zealand publication Better Beef Breeding 14 May 2014.

Genomics

Genomics is a useful technology to enhance accuracy of EBVs. It uses many DNA markers to derive 'molecular' breeding values. These values help to predict performance in the various traits we are concerned about. Molecular breeding values are similar to estimated breeding values generated from a traditional genetic evaluation system.

Except they are derived using an animal's DNA profile rather than from collecting its phenotype. The resulting EBV mixes the new genomic information with phenotype information to allow the breeder to make a more informed selection decision using both genotype and phenotype.

Profitable use of EBVs

EBVs are a very powerful tool in selecting animals to improve profitability for both breeders and commercial buyers. For example, the progeny of bulls in the top 1% of the Angus breed for carcass weight generate 17.5 kg more carcass weight at 22 months of age than bulls in the bottom 1% (1999 NZ Angus Genetic Evaluation Report). This demonstrates an important aspect of EBVs. That is, the more highly ranked the animal is in the breed, the greater the genetic progress and the more profit the bull will generate. Therefore a buyer can afford to pay more for highly ranked bulls. Percentile bands show where a particular animal ranks within a breed for a specific trait.

EBV validation

Beef + Lamb New Zealand Genetics Beef Progeny Test

Bull EBVs predict weaning weight of calves. In the calf, half the genes come from the cow and half come from the bull. That means we would expect that half the benefit of a sire's EBV to be passed on to the calf.

It was found that for every 1 kg more in 200 day weight EBV, 0.41 kg was gained in average weaning weight. Effectively 80% of the expected weaning weight advantage predicted by EBVs is being realised in NZ commercial farms. This was achieved across the country on five large scale commercial farms, five breeds and with high and low accuracy sires.



Use of EBVs can improve profitability from up to 17.5 kg more carcass weight from progeny of top bulls

Selection of a sire will depend on the production system and importance of traits such as ease of calving, weaning weight, yearling weight or two year weight

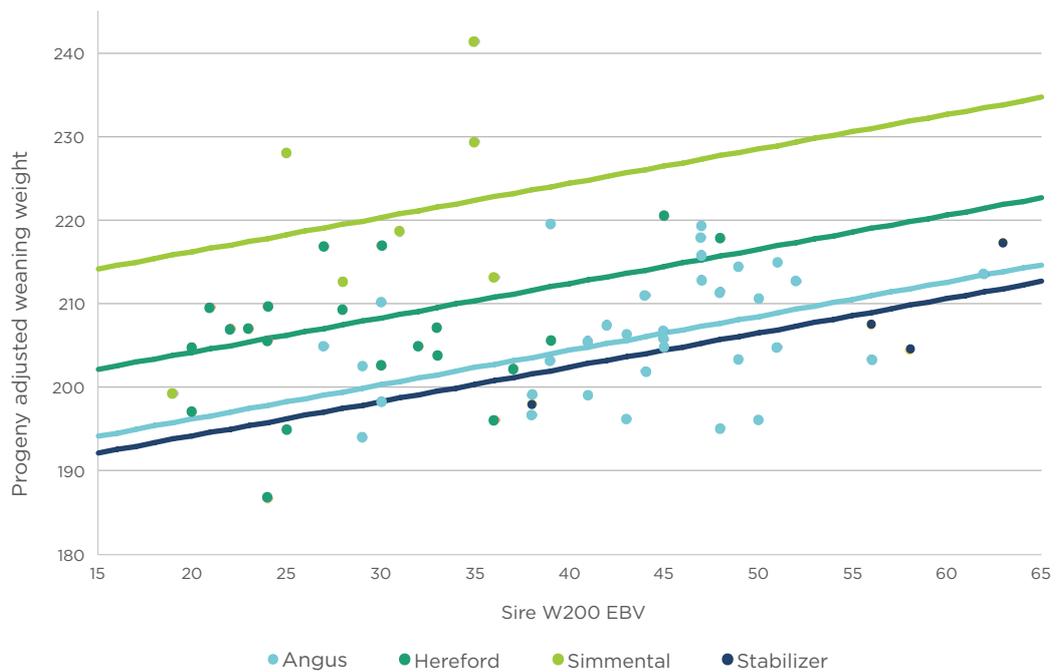


Figure 5. Correlation between Sire 200 day weight (weaning) EBV and how it has matched up to on farm weaning weight in their calves. As you can see when EBV goes up, so does average weaning weight. Source: Beef + Lamb New Zealand Genetics, Beef Progeny Test 2016.

Index selection

BreedObject®

BreedObject the Index System is also administered by BREEDPLAN and has a number of advantages over EBVs. BreedObject allows the breeder to use and/or provide a custom designed index to a bull

buyer based on the traits deemed important. Before embarking on the customisation of an Index through BreedObject breeders are encouraged to consider those already on offer through their respective Breed Society.

Angus selection indices

The Angus breed for example has two indices: the Self-Replacing Index and the AngusPure Index.

The New Zealand Angus Self Replacing Index

Self-Replacing Index ranks bulls on their progeny's ability to generate profit per cow mated in a self-replacing herd in which some females are retained for breeding and surplus females, along with all males, are slaughtered. The main drivers of profit included in the Index in order of economic importance are:

- Direct and maternal calving ease
- Growth
- Meat yield
- Cow survival
- Finishing ability
- Fertility
- Cow efficiency.

Selection on this Index is expected to favour production in a cow herd with excellent reproductive efficiency, rearing progeny with moderate-to-high growth rates and high yielding carcasses.

The Self Replacing Index estimates the genetic differences between animals in net profitability per cow joined for a self-replacing commercial herd, targeting the production of grass finished steers. Steers are assumed to be marketed at 525 kg live weight, or 280 kg carcass weight and 10 mm fat depth, at 16 months of age.

The following bar graph shows the key economic traits that are important in this selection index. The different trait emphases reflect the underlying profit drivers in a typical self-replacing commercial operation.

Considering the genetic relationship between the key profit drivers and the EBVs that are available, this transposes to the following EBV emphases (refer Figure 7). The sign indicates the direction of the emphasis. For example, greater 400 Day Weight EBVs and shorter Days to Calving EBVs are favoured.

While these graphs show the different profit drivers and emphases that have been placed on each EBV within the Self Replacing Index, they do not illustrate the likely change that will occur to each individual trait if producers select animals using this selection index. The response to selection will also be influenced by such factors as the genetic relationship between traits and the animals that are available for selection. For example, while there is only a slight weighting on 200 Day Weight in this selection index, it would be expected that growth to 200 days would increase as there is a large weighting on 400 Day Weight.

The AngusPure Index

The beef production system this index targets is the same as for the self-replacing index but has a greater emphasis on higher marbling sires with progeny sale at around 16-17 months of age.



BreedObject is an index based system which allows use of a customised group of traits deemed important

Angus BreedObject has the self-replacing index, ease of calving index and AngusPure index

Self Replacing Index—Profit Drivers

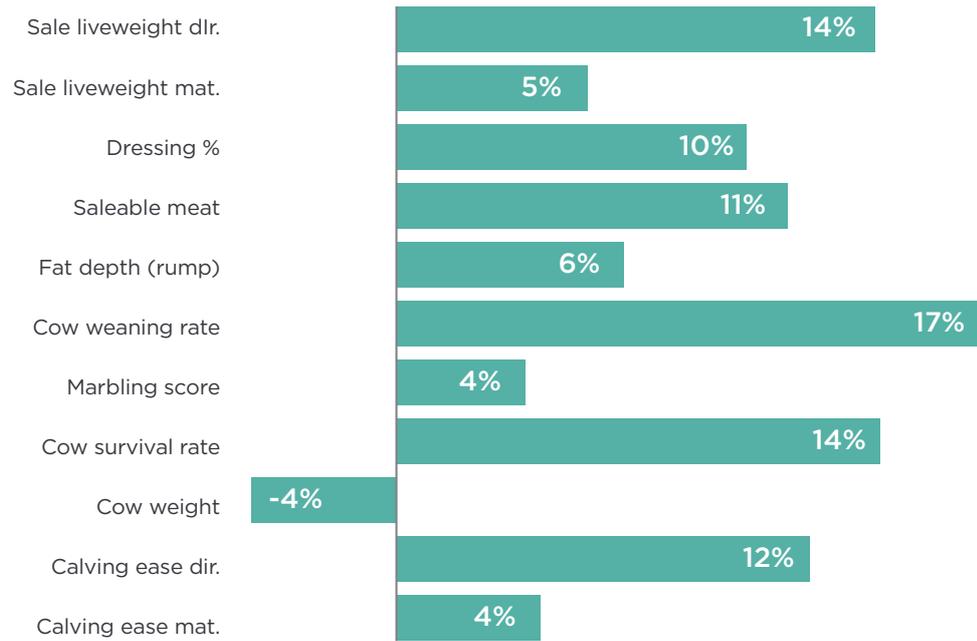


Figure 6. Source: www.angusnz.com/cattle/technical/indexes-2.

Self Replacing Index—EBV Weightings

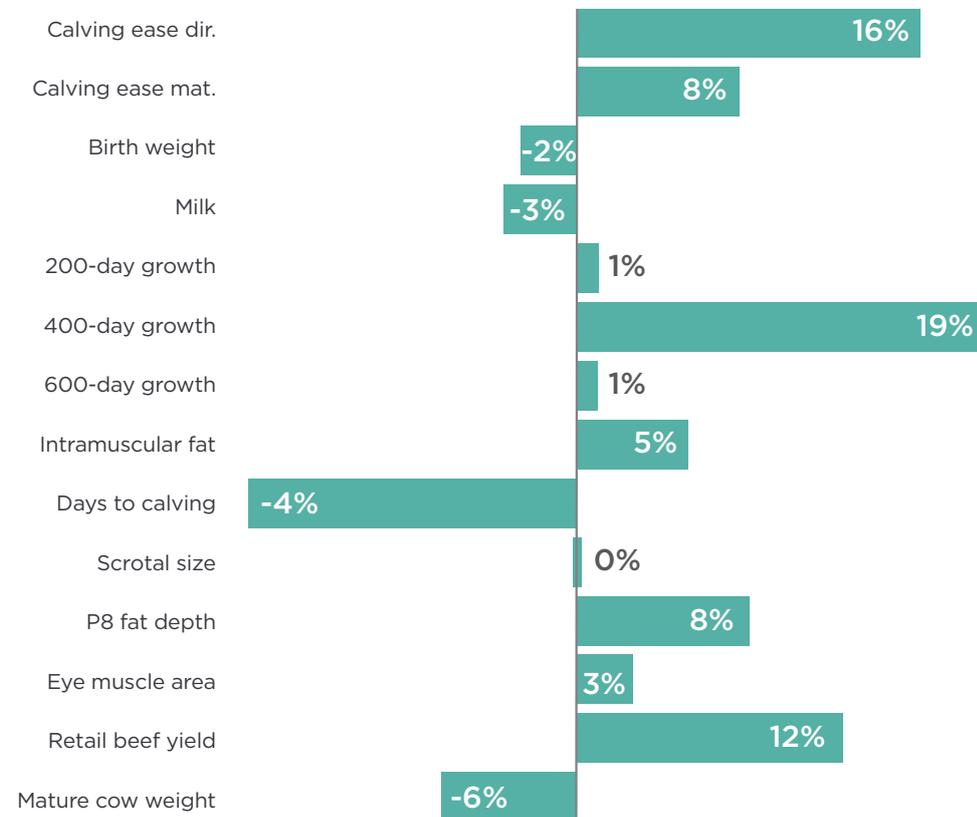


Figure 7. Source: www.angusnz.com/cattle/technical/indexes-2.



Choice of selection index is influenced by production systems such as weaner production, yearlings or heavy weight carcasses for export

Selecting breeding females

The most rapid progress in genetic improvement of a beef herd is achieved through accurate and effective bull selection. On average, each sire passes his genes onto about 50–150 calves during his working life, while each female passes on her genetic merit to only 5–10 progeny in her lifetime. However, although commercial breeders should be concerned mostly with bull selection they still need to make good decisions on heifer replacements in their herd.

Selection of breeding females can increase the level of desirable traits in the herd. Through female selection, producers can improve fertility, weight of calf weaned, the subsequent growth of weaned animals and the ultimate value of the sale animals through carcass quality etc. Improvements in fertility and survival will increase sale numbers. Selection for environmental adaptation, growth rate, temperament, structural soundness and carcass traits will affect the price achieved or the relative value of sold animals. Factors such as environmental adaptation, including resistance to diseases and parasites, and higher growth rates will affect the cost to produce each animal to sale weight. There are three opportunities to select females—pre- and post-mating and at first weaning. Pre-mating selection removes poor performers and their potential progeny from the herd. Selection either allows culls to be replaced by more productive females, or allows the remaining productive animals access to more feed.

Pre-mating selection

The number of replacements required for a beef cow herd is determined by:

- Current herd reproductive performance
- Herd policy for culling and selection
 - Culling for age
 - Culling for reproductive failure
 - Culling for non, or poor performance in other production traits
- Maximum cow age
- Annual culling and mortality rates.

Higher reproductive rates allow increased culling for performance and/or a lower heifer retention rate. Some farmers mate excessive numbers of heifers and treat surplus animals as meat producing “once-bred-heifers”.

At this stage only those heifers with obvious bad temperament, structural faults or low growth rates that will severely impede their survival or their ability to reproduce and grow should be culled. The remainder of the heifers should be mated for a sufficient period and the required number of pregnant replacements retained.

Post-mating selection

Post-mating selection is primarily concerned with identifying productive females based mainly on pregnancy test.



Opportunities to select breeding females are pre- and post-mating and at first weaning



On average each sire passes on his genes to 50–150 calves while each cow passes on her genetics to 5–10 progeny contributing 80% of genetic gain in a commercial herd



Selection at first weaning

There are a limited number of times during the year that cows can be evaluated for productivity such as kg calves weaned/kg cows mated. The best times are at weaning and during pregnancy testing. Culling criteria might include:

- *Fertility:* Failure to become pregnant, particularly if not lactating, and failure to produce a live weaner are most critical. In some intensively managed herds with a short-period of calving, cows that produce lighter or lower quality calves may also be culled.
- *Temperament and structural soundness:* Culling for unacceptable temperament and structural faults such as malformed teats should be on-going during the life of the female.
- *Mothering ability:* Mothering ability is the female's ability to feed and look after her calf. Some females will abandon a calf after birth or become separated from the calf later on. The ability to protect the calf from predators is also a factor in mothering ability. Culling cows that fail to wean a calf generally removes poor mothers.
- *Cow efficiency:* This is based on calf weaning weight relative to cow weight. This requires calves to be identified with their dams, therefore, most farmers do not select for cow efficiency because of the practical difficulties of doing this. See Chapter four for more details.

In most commercial herds the majority of selection for replacements is applied pre-mating and is largely based on heifer liveweight and appearance. In addition to this initial selection the first mating is usually restricted to two cycles or 42–45 days which will result in around 85% in-calf. Empty heifers are usually slaughtered. A common challenge in beef herds is that there are insufficient heifers entering the herd each year to allow for selection and culling once empty cows and cast-for-age (cfa) cows are sold. Typically a commercial herd will allow for 20% of the herd being first calving heifers and this is the minimum when based on average performance levels around deaths of 1–3%, calving percentage based on 89–92% scanned in-calf and empty rates of 5–10%.

One option to improve the performance of the herd through heifer selection is to “over mate” heifers whereby 30% of the herd are joined as first calving heifers. At calving the calf is tagged and recorded along with the dam's number and date of birth. At weaning the calves and heifers are weighed and the calf weight adjusted to a common age e.g. 200 days. The heifer's weight at weaning is divided into her calf's age-adjusted weight thereby creating a measure of the heifer's efficiency in producing a weaner. This measure is a reasonable indicator of lifetime weaner production with a repeatability of ~40%. Using this method of selection the culled heifers can be sold onto the prime market thus creating a partial once-bred-heifer policy. Alternatively, if such a heifer selection process was not utilised, the 30% of heifers entering the herd could provide the opportunity to displace an increased number of older and less productive mixed-age cows.

Evidence of genetic progress

Growth rate has been and remains the primary selection criterion for most beef cattle breeders because it is easy to measure and is related to efficiency of production. Research at several locations around the world has shown that selection for high growth rate produces heavier animals than random-bred controls.

One of the best New Zealand examples comes from an experiment established in 1971 on hill country at Waikite near Rotorua. This experiment had three closed Angus and Hereford herds with no outside genetics introduced and selected for (1) adjusted 13 month weight, (2) 18 month weight and (3) random selection. Annual responses in liveweight in the selected herds were 0.48% to 0.96% greater than in the randomly selected control herds. This is an actual difference of up to 1.06 to 2.12 kg/year over the 14 year period of calvings.

One of the frequently asked questions is what were the associated or correlated responses in other traits while this single selection for growth rate was occurring? Six correlated responses were observed in the Waikete trial:

1. Cow weight—selection for yearling or 18 month weight resulted in mature cows that were 7.5% and 8.2% heavier respectively than the randomly selected control herd.
2. Calf birth weight—selection for growth rate increased birth weight
3. Scrotal circumference—selection for yearling weight or 18 month weight increased scrotal circumference
4. The selected herds were taller as measured by height at withers
5. Intake was measured in a sample of bulls after 11 years of selection and the 13 month and 18 month selected bulls had silage intakes 10.4% and 11.7% greater than the randomly selected bulls.
6. In a separate experiment, sires from the selected herds after six years of selection were mated to balanced samples of test cows. Weaning weights from the herds created by using sires from the 13 month weight and 18 month weight selected herds were superior by 8.6 kg (5.7%) and 2.2 kg (1.5%) than weaning weights from cows sired by randomly selected bulls.

Breeders that select solely for growth rate need to be aware of correlated responses in cow traits such as increased mature cow weight resulting increased feed intakes, increased birth weight and calving difficulty. Selection for growth rate resulted in females reaching puberty earlier. Reproductive rate was similar between the lines.

A subsequent trial recorded a difference of 70 days \pm 6 days or a difference of 17% in age at puberty between “early” vs. “late” puberty selection lines. Genetic correlations between age at puberty in heifers and cow reproductive traits were favourable so selecting heifers for earlier pubertal age would improve cow reproduction. In reality, selecting heifers for puberty is not practical. The correlated response in age at puberty for heifers and scrotal size in half-brothers was high. Selecting on scrotal size would be a more practical way to decrease age at puberty.

In summary, the evidence suggests selection for growth will result in good live weight progress but gains in reproductive traits, while positive will be less spectacular.

Evidence of benefits from selection for carcass and meat traits has not been demonstrated in New Zealand. Examples are available from other countries to suggest the practice is worthwhile if producers are paid for the improvement. Presently farmers in New Zealand are mainly rewarded for carcass weight and as final weight is the main determinant of carcass weight, selection for growth remains the primary objective in most breeding programmes.



Selection for improved liveweight can increase weight by up to 2.12 kg/year in progeny

With sole selection for liveweight care should be taken with correlated responses in traits such as calf birth weight, feed requirements and mature cow size

Breeding systems

There are two basic breeding systems. If the source of replacement females is heifers produced in the herd this is a **self-replacing** system. If heifers are not used as replacements this is a **terminal** system.

A **self-replacing** system produces its own replacement females but requires externally selected sires. Since replacement females are retained in this system, the cow herd has genetics from both herd sires and herd dams. Therefore, if herd sires have traits that are undesirable in cows, they will continue

to be exhibited. They cannot be hidden in a self-replacing system. Both sires and dams in these systems should be similar in important traits, without any undesirable characteristics.

In a **terminal** system, both replacement females and sires come from external sources. However, since heifers produced in terminal herds are not retained for breeding, there is more flexibility in choice of genetic types. Specialised maternal and sire types can be used in terminals.

Crossbreeding

Crossbreeding is an established breeding method used in sheep and beef cattle breeding to increase overall productivity through hybrid vigour. However, not all crossbreeding systems are able to maximise these potential gains, because some are too difficult to implement under commercial hill country conditions, especially in small herds. The challenge is to identify crossbreeding systems that are simple and easy to operate in commercial beef breeding cow herds. Crossbreeding does not replace the need for continued selection on performance. Rather, it adds to these benefits.

Crossbreeding by commercial beef cattle farmers may be practised for the following reasons:

- To introduce a new breed
- To take advantage of the superior qualities of two or more breeds

- To combine the qualities of the different breeds
- To take advantage of hybrid vigour
- To make maximum progress in the traits of low heritability.

The benefits from crossbreeding are best achieved through increased fertility of crossbred cows and growth rate of calves. In Figure 8 straightbred cows that reared crossbred calves rather than straightbred calves, on average, had an extra 8.5% increase in weight of calf weaned per cow mated. For a 200 kg weaner this would equate to 17 kg of extra calf weaning weight. If crossbred dams reared the crossbred calves, a further 14.8% increase was a result of the better fertility and milk production by the crossbred dams. Using crossbred dams to rear crossbred calves, the expected extra calf weight weaned/cow would be 23.3% compared to straightbred cows rearing straightbred calves.

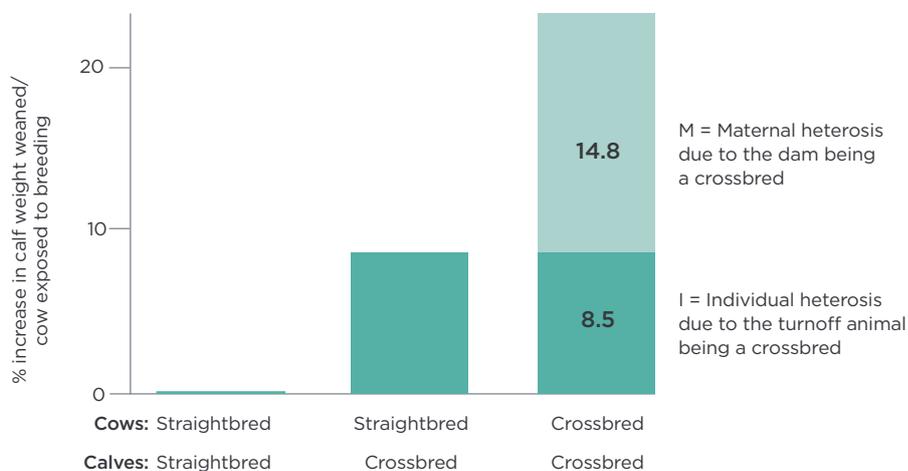


Figure 8: A comparison of percentage increase in calf weight weaned/cow exposed to breeding, as a result of mating either straightbred cows to bulls of a different breed (centre), or mating first cross cows to bulls of a third breed (right). The results were obtained from an experiment involving all relevant crosses among Hereford, Angus and Shorthorn cattle. Source: Taylor and Field (1999).



The two basic breeding systems are self-replacing and terminal

Crossbreeding provides hybrid vigor or heterosis benefits which add to benefits from continued selection on performance

Alternative crossbreeding systems

As stated earlier, the maximum benefits from crossbreeding are when using a crossbred cow mated to a terminal sire.

The following three main crossbreeding systems suitable for New Zealand beef cattle producers are **purchasing crossbred heifers, three breed crosses** and **rotational crossing**.

Purchasing crossbred heifer replacements

By buying-in all heifer replacements, all of the cows in the herd can be mated to a terminal sire. This results in maximum heterosis of about 23%. A common system used by farmers is the purchase of Beef x Dairy cross heifers (Hereford x Friesian or Angus x Friesian) as weaned calves. These are mated at 15 months to an easy calving sire breed (e.g. Angus, Hereford, Murray Grey, Shorthorn) and from then on to a larger terminal sire breed (e.g. Simmental, Charolais, Limousin or South Devon). The main disadvantage of this system is the need to organise a reliable source of replacement heifers. However, if it can be managed, it is the simplest and most effective system. The risk of introducing new diseases onto the farm, by purchasing replacements off-farm, has to be managed.

Rating for ease of Implementation = easy

Three breed specific cross

This system uses three breeds which should all complement each other. For example, the first two breeds (the breeding cow) can be chosen to achieve maternal heterosis and adaptation to an environment (e.g. Hereford x Angus) whilst the third or terminal sire breed such as Charolais or Simmental can produce the most acceptable sale animals using growth and carcass characteristics.

For example, in a 300 cow herd:

- 105 of the Angus heifers, three year and possibly four year old cows (35%) are bred to Angus bulls to generate replacement Angus heifers
- 75 of the Angus four, five and six year and older cows (25%) are bred to Hereford bulls to generate Hereford x Angus heifers
- 120 of the Hereford x Angus heifers and cows, and aged Angus cows (40%) are bred to a terminal sire (Simmental) and all progeny are slaughtered. Heifers may go to an easy calving sire (Shorthorn, Salers).

This system utilises pure-bred and crossbred heifers on the same farm. It is more complex, requiring a large herd with at least three mating and calving groups.

Rating for ease of Implementation = moderate

Rotational crossing

(sometimes referred to as criss-crossing)

In this system two, three, or more breeds of bulls are utilised in a rotational mating system. In a two breed rotation (Figure 9), heifers sired by breed A are mated to breed B bulls, and heifers sired by breed B bull are mated to breed A bulls for the rest of their lives. Hereford and Angus breeds have traditionally been utilised in this method and can stabilise at around 67% of maximum heterosis.

In the three breed rotation (Figure 10), females sired by breed A bulls are bred to breed bull breed B and heifers sired by that mating are bred to bull breed C. Heifers sired by breed C are then bred to breed A bulls, and so on.

Note that Friesian cross cows produce high calf weaning weights, but in an intensively farmed system the feed required to restore cow liveweight lost during lactation has to be diverted from some other enterprise or, preferably from surplus feed that is not required by other stock classes. The opportunity cost of this needs to be considered.

Rating for ease of Implementation = difficult

Alternating breeds over time

With small herds using only one or two bulls, the choice of crossbreeding systems is restricted. A normal rotational system cannot be used although buying in replacements heifers, as in system one above, is an option. By purchasing a different breed of bull every two or three years, the two and three breed rotations may be possible.

Rating for ease of Implementation = easy

Benefits of crossbreeding

The relationship between the various mating systems, maximum heterosis retained and the increase in weight of calf weaned per cow is shown in Table 3.

The prices noted have not included a premium for the growth potential of crossbred cattle which in the past have resulted in premiums of 10-20 cents/kg for Simmental and Charolais cross cattle.



Crossbreds often out-perform purebreds due to heterosis and desirable combinations of productive traits

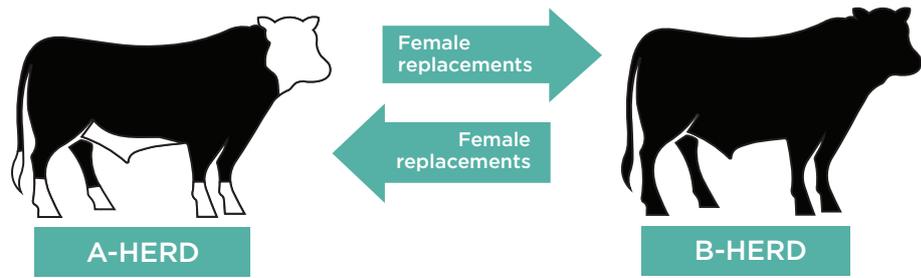


Figure 9: Two-breed rotational crossing.

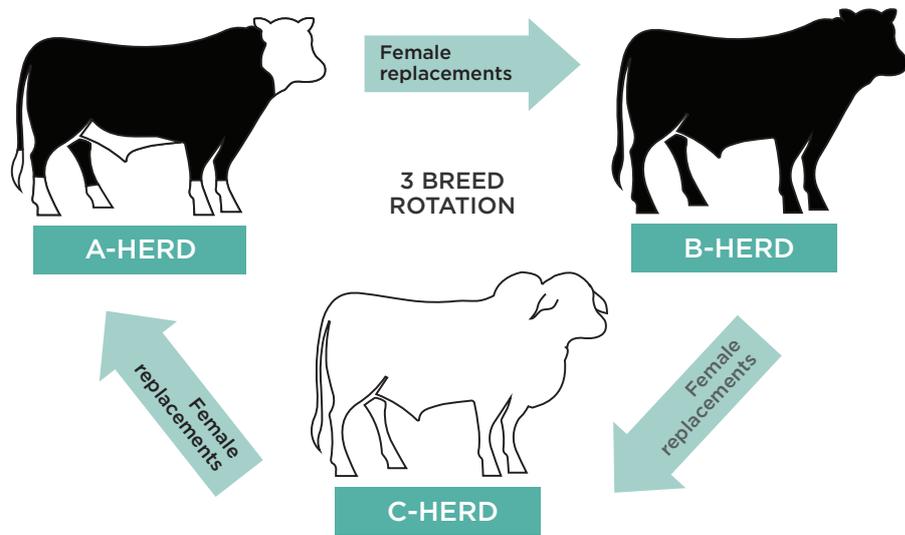


Figure 10: Three breed rotational crossbreeding system.

Table 3: Maximum heterosis expected in progeny (%) for various mating systems.

Mating system	Heterosis retained		Superiority over parent breeds	
	Individual (%)	Maternal (%)	Weight of calf	
			Weaned (%)	Cow mated (kg)
Straightbred A x A	0	0	0	200
2 breed cross (A x B)	100	0	8.5	217
3 breed cross (A x B) x C*	100	100	23.3	246
Rotational crosses				
2 breed	33	67	12.7	226
3 breed	86	86	20.0	240
4 breed	93	93	21.7	243
Composite				
3 breed	67	67	15.6	230
8 breed	87	87	20.4	241

*For example (Hereford x Friesian) x Simmental, Charolais etc.

Disadvantages of crossbreeding

Despite all the above benefits there are several disadvantages with crossbreeding:

- Extra management: Crossbreeding systems within a single farm can be complicated because of the need to maintain crossbred and purebred cows in separate mating groups
- More precise recording of breeds and breed groups is required
- Bulls are likely to be sourced from more than one breeder
- Different cattle coat colours may make marketing of store cattle more challenging.

Advantages of crossbreeding

- Provides the opportunity to maximise the benefits of maternal attributes in the cow herd and growth and carcass attributes in the offspring
- Hybrid vigour is a bonus in addition to exploiting breed complementarity e.g. 23.3% advantage with breeding cow production.

To maximise the benefits from crossbreeding, producers need to:

- Identify the performance characteristics of beef breeding cows and their offspring that will best suit their farming system
- Recognise that breeds differ in their performance attributes for maternal, growth and carcass traits
- Choose a breeding system which involves a compromise between breeding and growth characteristics
- Take into account their management skill levels and their ability to plan, implement and monitor a cross-breeding program
- Adopt the most simple system within the constraints of crossbreeding and their objectives.



Further reading

Beef + Lamb New Zealand Genetics resources (including Bull Buying) available at www.beeflambnz.com

Beef + Lamb New Zealand, Better Beef Breeding workshop—please contact your local Extension Manager www.beeflambnz.com

Morris, S.T., Chan, F.Y., Lopez-Villalobos, N., Kenyon, P.R., Garrick, D.J., Blair, H.T., 2014. *Growth, feed intake and maternal performance of Angus heifers from high and low feed efficiency selection lines*. *Animal Production Science* 54: 1428-1431.

Schreurs, N. M., Hickson, RE, Coleman, L. W., Kenyon, P.R., Martin, N.P., Morris, S.T. 2014. *Quality of meat from steers born to beef-cross-dairy cows and sired by Hereford bulls*. *Proceedings of the New Zealand Society of Animal Production* 74: 229-233.

REPRODUCTION

Recommendations

- Aim for a calving percentage of 90% (if cast for age cows are ignored).
- A compact calving of around 63 days will give better calf weaning weights and improved re-breeding.
- Yearling heifers should be mated over a shorter period of two cycles or 42 days.
- Minimum liveweight for mating heifers should be 300 kg for Angus and 320 kg for later maturing breeds.
- At least 60% of cows should calve in the first 21 days.
- To avoid calving difficulties and mortality select sires with low calf birth weight EBVs.
- Post partum oestrus interval should be less than 83 days.
- Check bulls for breeding soundness before mating.
- Use ultrasound pregnancy diagnosis and foetal age if possible.



Introduction

A major factor determining the productivity and profitability of beef cow herds is their reproductive performance. The efficiency of beef cows depends on total lifetime liveweight of calves weaned per cow. This is a complex trait affected by many factors as shown in Figure 1.

A live calf born and weaned to each breeding female each year is the primary objective for successful reproduction. However, cows are not managed as individuals but as a herd, so the economic evaluation of the total herd reproductive performance is critical. Reproductive efficiency in cattle, as measured by the number of calves born and weaned each year per 100 females joined in the breeding herd, is considered the most important economic factor in cattle production. Reproduction is at least twice as important as growth or carcass characteristics for cow-calf producers who sell their calves at weaning.

A high lifetime output of a beef breeding cow depends on a high reproductive rate where the target is as close as possible to one calf per year per cow joined. The production cost of failing to rear a calf is high and is difficult to make up. For example a cow that rears seven calves each weighing 220 kg has a total lifetime output of 1540 kg of calf weaned. To produce the same total lifetime output in five calvings would require an annual calf weaning weight of 308 kg.

Useful definitions of reproductive efficiency that can be measured in beef cow herds are:

- Pregnancy %—the number of cows pregnant per 100 cows joined with the bull
- Calving %—the number of calves born per 100 cows retained or wintered
- Reproductive efficiency %—pregnancy % x calving %.

Other definitions:

- Calving rate—the number cows calving per number of cows joined with the bull
- Calf survival—number of calves weaned per 100 calves born
- Calf weaning % or rate—number of calves weaned per 100 cows joined with the bull or calves weaned per 100 cows diagnosed pregnant.

Each of these reproductive indices are useful in determining the reproductive efficiency of a beef cow herd as they allow conception rate, abortion rates, postnatal calf mortality rate and calf losses to weaning to be calculated. These indices or ratios have the limitation that they take no account of the duration of joining or the interval between calving. Furthermore it takes no account of the fact that some females with the potential to produce calves, such as yearling heifers, are not given the opportunity. The indicators also assume a natural mating system with bulls, as probably 98% of beef cows are mated in this manner. They also take no account of age and number of bulls used or the liveweight of cows in the herd, all of which can contribute to overall herd reproductive efficiency.



Reproductive performance is a major factor in determining productivity and profit of beef cattle

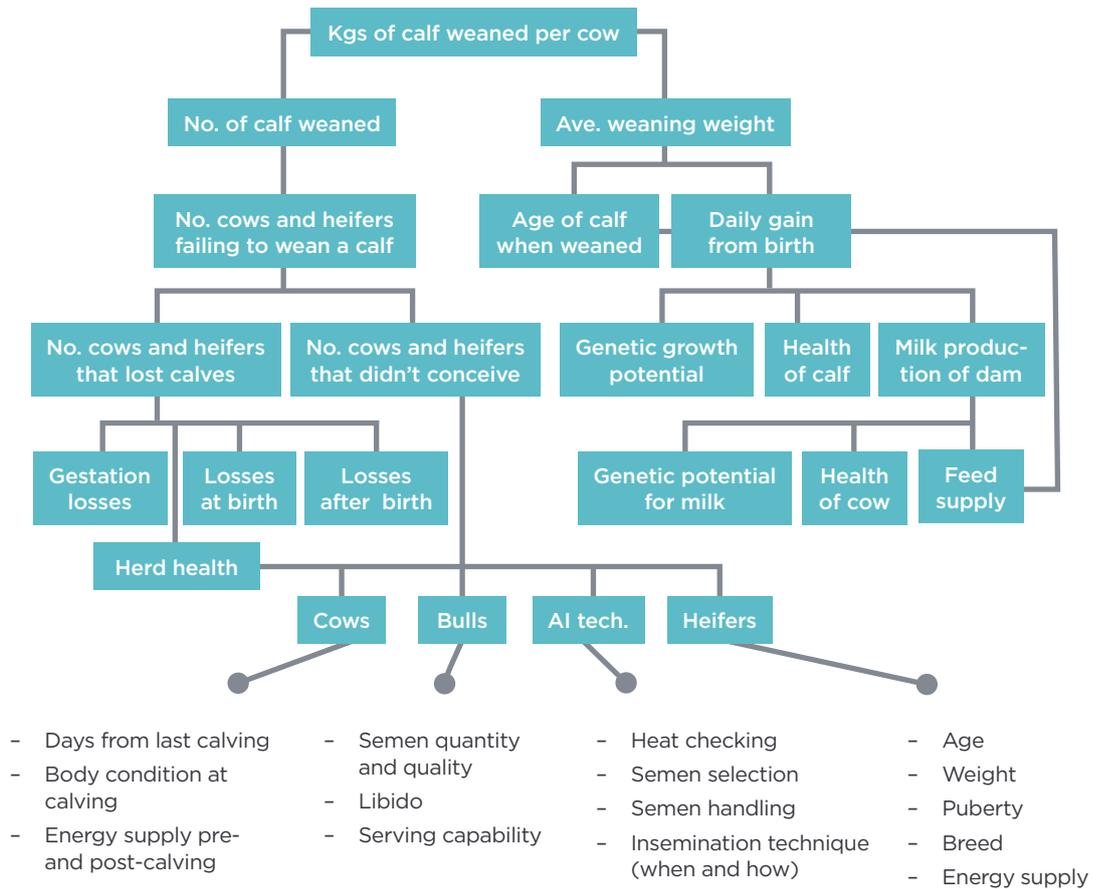


Figure 1: The major factors influencing weight of calf weaned per cow joined. Source: Adapted from Taylor and Field (1999).

Reproductive management

The reproductive rate of beef herds has been documented by the Beef + Lamb New Zealand Economic Service which records the number of calves marked per 100 cows joined with the bull, described as calving percentage. Note there are few calf deaths between calf marking at around 60–90 days of age, and calf weaning. The survey data indicate that the percentage of calves weaned is static at 80 to 84%. This is in spite of the fact that considerable variation exists in calf marking percentage among herds and there is often variation in pregnancy rate from year to year in the same herd. We can conclude from this data that there is considerable potential to improve reproductive efficiency in our beef cow herds but it has proven very difficult to achieve change. Many farmers record reproductive performance on calves weaned per 100 cows wintered for the reason that cast for age (CFA) and cull cows are normally mated, simply because they have calves at foot and it is difficult or not practical to remove them from the overall mob. Typically 16% of cows are culled or CFA each year so on that basis or definition calving % ranges from 88–92%.

In New Zealand where pasture production is seasonal, most beef cow farmers have a compact calving season, usually in spring. The biological timetable must be worked to a tight schedule if a 365 day calving interval is to be maintained because:

- Pregnancy or gestation length is about 282 days with a range of 270–290 days
- To maintain a calving interval of one calendar year there are only 83 “non pregnant” days available to the cow to get pregnant.

An excessive calving spread reflects reduced efficiency and reduces the likelihood of cows, particularly those calving later, to conceive.

The advantages of a compact calving include:

- Easier allocation of feed and metabolic supplements to meet the cow’s feed requirements
- Easier allocation of calving paddocks
- Ease of supervision at calving
- An even line of weaners for sale
- An even line of replacement heifers
- A higher proportion of cows likely to be cycling when the bull goes out
- Heavier average weaning weights.



Calf weaning percent is the number of calves weaned per 100 cows mated

Calving % from farm surveys averages 80-84% but generally cull cows are included so the true calving % is closer to 88-92%

It is relatively easy to place a monetary value on a condensed calving pattern compared to a longer period. Consider two herds:

Herd A—assumptions; spread out calving:

- 105 day calving period 15 August to 30 November
- Equates to bulls out 1 November and in on 20 February (i.e. 5 cycles of mating)
- Calving spread as in Figure 2 below
- Calf birth weight of 35 kg
- Weaning 1 March i.e. 200 days from start of calving
- Average LWG birth to weaning = 1.0 kg/calf/day
- Calves in each 21 day spread are taken on average to be born at the mid-point
- Weaning weight calculated as:
 - 1st period average age = 190 days (mid way 180–200 days)
 - liveweight = (190 x 1.0) + birthweight (=35 kg) = **225 kg.**

However, actual calf weaning weights for each 21 day spread were:

1-21	=	225 kg
22-42	=	203 kg
43-63	=	183 kg
64-84	=	161 kg
85-105	=	140 kg.

The average weaning weight for this cow herd with a spread out calving was 187 kg.

Herd B—assumptions; condensed calving:

- 63 days calving period 15 August to 18 October
- Bulls out 20 November and in 20 January or three cycles
- Calving spread as in Figure 3 below.

The average calf weaning weight for Herd B would be 215 kg—using the same assumptions as for Herd A.

The advantage of Herd B over Herd A is 28 kg. For a 200 cow herd with a 90% weaning rate the advantage is 5,040 kg of calf weaned which represents a substantial increase in income.

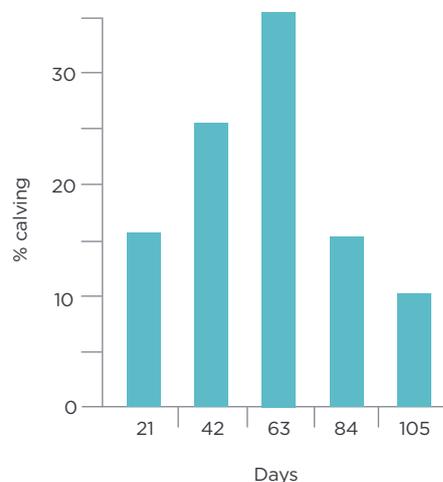


Figure 2: Typical hill county calving spread (Herd A).

This calving pattern coincides with 1 November–mid February mating.

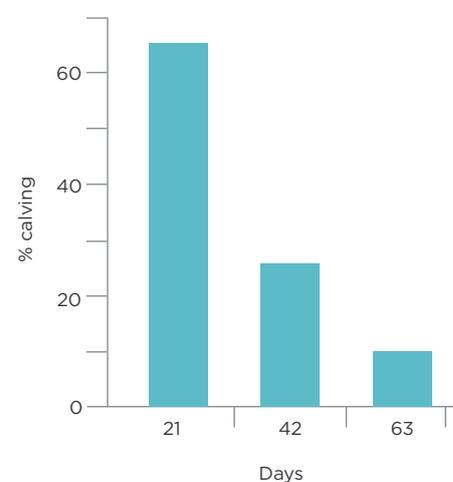


Figure 3: Preferred calving spread for hill country herd (Herd B).

This calving pattern coincides with a 20 November–20 January mating period.



A shorter mating period and calving spread of around 63 days gives better calf weaning weights

In practice there is often a compromise between acceptable duration and timing of calving, and potential reproductive performance. It is the successful management of this compromise that is the key to successful reproduction in beef breeding cow herds.

We can therefore identify some useful reproductive targets for an adult beef cow herd:

- 12 month or 365 day mean calving interval
- A 63 day or three cycles mating period for cows
- A pregnancy rate of at least 95% for adult cows
- A calf weaning percentage of at least 90% in adult cows—some do better than this
- Less than 3% abortion rate
- At least 60% of cows calving in the first 21 days of calving
- Less than 5% incidence of difficult births.

To achieve 90% calves weaned to cows mated a herd would need to achieve a 95% pregnancy rate and 95% of those pregnant cows would need to rear a calf to weaning. To the above list we can add targets for replacement heifers, discussed in more detail later.

- Mate heifers for only 42-45 days, or two cycles, with a target of 85% in calf
- 70% calve in first 21 days of mating
- Less than 10% incidence of calving difficulty.

Note—An oestrous cycle is about 21 days and two cycles about 42 days. Some farmers also mate cows for 2½ cycles i.e. 7½ weeks = 52 days to ensure a cow that cycles on day 22 which is not mated and cycles 22 or 23 days later has an equal chance of being mated twice. If a 42 day mating was used this would not be the case and the cow would have only one opportunity to be mated.

Another reason for restricting mating to 2½ to three cycles, or 53-63 days, is shown in Table 1. In this example the herd that was mated for 105 days, or five cycles. The entire herd was cycling when the bull was introduced, and a 60% conception rate was assumed, which is normal for natural mating, usually ranging from 50% to 75%. After 63 days of mating 94% of cows would be pregnant, but it would take another 42 days on average for the remaining cows to get pregnant.



Mate heifers over a shorter period of two cycles or 42-45 days compared with 63 days for older cows

It is more profitable to mate heifers at 15 months to calve at two years of age

Heifer mating and age of cow

A recent Beef + Lamb New Zealand survey suggests about 55% of beef heifers are first mated at 15 months of age. It is usually more profitable to calve heifers first at two years of age than three years.

The main reasons for this are because:

- Lifetime output is increased by about 10% with an extra 0.7 calves or 150 kg of calf weaned
- Land use for heifer rearing is reduced by nearly 50%
- Information for selecting replacements is available much earlier in a female's life. This information is particularly useful if more heifers are mated than are required as replacements
- Increased rate of genetic gain, especially for bull breeding herds.

The main reasons for farmers failing to adopt the practice of two year-old calving in New Zealand beef cow herds are:

- Poor performance at the next mating, often because with two year-old calving there is a 5-10% lower pregnancy rate in the next breeding period
- Fear of increased incidence of calving difficulty or dystocia and associated increase in calf mortality and possibly heifer mortality
- A failure to achieve target liveweights during rearing and at mating, thereby jeopardising subsequent reproduction performance
- Concern that the heifer's mature size and productivity will be reduced
- Stage of farm development—on harder hill country or less developed country, in terms of pasture production and quality, heifers may fail to reach the required mating liveweights
- Reduced management flexibility as pregnant heifers require extra feed and there is an extra mob to manage
- Overall increased management skills are required.

Table 1: Pattern of mating and conception during a 105 day mating period—assuming a 60% conception rate (Morris 1998).

Days since start of joining	Number on heat each 21 days	Number pregnant each 21 day period
21	100	60
42	40	24
63	16	10
84	6	4
105	2	2
0-105	164	100

While the evidence consistently favours mating heifers at 15 months of age to increase production and profit per animal or per herd, the evidence is less convincing when accounting for feed costs required to achieve this increase.

A prerequisite to mating heifers at 15 months to calve at two years of age is that the heifer has attained puberty. Puberty in the heifer is marked by the start of regular oestrous activity, associated with ovulation. All heifers should reach puberty well before the planned start of mating, so each has exhibited at least one "heat" before the start of mating. This will ensure there is a high probability that all will be mated and conceive during the first six weeks of mating.

Critical minimum weight

Heifers mated as yearlings have a requirement for high quality feed if they are to reach a critical minimum weight, at which 85% or more heifers get pregnant in a 42 day mating period, and rebreed successfully. Under harder hill country this condition might not be met. Target live weights for mating British breed heifers at yearling age are shown in Table 2. From New Zealand breed comparisons, Continental x British breed heifers were on average 30 days older and 30 kg heavier at puberty than straightbred British breed heifers, suggesting higher target live weights for these later maturing breeds.

There are additional feed costs, when mating yearling heifers. If yearling heifer in-calf rates are less than 70% there may be no benefits compared with calving first at three years. Every farm needs to be evaluated separately to ensure benefits are realised. Table 2 indicates that heifers should be growing all through pregnancy to achieve the target calving liveweights that ensures ease of calving. In areas where winter heifer growth rates are challenging, target liveweights need to be met earlier.



Target minimum liveweight for mating heifers at 15 months is 270 kg for Angus and 300 kg for later maturing breeds

	Age (months)	Weight (kg)
Weaning	6	200-220
1st winter	10	220-240
1st mating	15	300-320
2nd winter	22	400-450
Pre-calving	24	440-480
2nd mating	27	420-450

Checklist for successfully mating heifers at 15 months

- Set a growth pathway from weaning to a minimum joining live weight at 15 months (Table 2). An appropriate minimum target might be 270 kg for Angus and 300 kg for later maturing breeds
- Mate heifers for 42 days—aim for a target pregnancy rate of 85%
- Mate heifers at the same time as older cows as earlier mating can result in below target pregnancy rates at the next mating due to delayed returns to oestrus—discussed later
- Mate more heifers than are required as replacements and cull empty heifers following pregnancy testing. Non pregnant at yearling breeding is highly repeatable
- Cull late calvers to ensure that 70% calve in the first 21 days
- Understand the concept of Expected Breeding Values (EBVs) and select service sires from easy calving breeds/herds and with a high direct calving ease EBV. If these EBVs are not available select sires with below breed average birth weight EBVs, below breed average gestation length EBVs but with above breed average 200 or 400 day weight EBVs - 'curve bender bulls'
- Use sires from the same or smaller breeds
- Provide assistance at calving where necessary
- Run as separate group until second calving
- Strive for 90% calf survival to weaning
- At least 90% of heifers should be pregnant again as R-3 year olds.

Table 2: Target minimum live weights for mating Angus or Friesian x Hereford/Angus cross heifers first at 15 months of age.

Age of cow and reproductive performance

Young cows often have a lower average reproductive performance than older cows, although the extent of the difference can depend on breed type. Pregnancy rate increases up to at least six years of age, then remains stable until about 9–10 years of age, after which it starts to decline.

The most comprehensive New Zealand study on age of cow and reproductive performance from 7500 matings is summarised in Table 3. Results suggest that beef cows in a mixed age herd should not be culled on age until they are over 10 years.

Table 3: Effects of cow age at mating on pregnancy rate, ease of calving and calf weaning %. Source: Morris (1998).

Age at mating	No. of records	% cows pregnant	% calved without difficulty	% calves weaned per female/mated
15 months	2711	77	84	63
27 months	2022	74	92	63
3 years	1803	82	95	74
4 years	1639	89	96	83

Calving dates and management

It is important to distinguish between mating date, or the day the cow is mated, and joining date, the day the bull is put in with the cows. There are risks associated with an early mating date and likewise a late mating date.

Risks associated with an early mating date are:

- Cows calve before spring flush
- There is greater requirement for saved winter pasture pre-calving
- Cows are usually in a lower condition score at joining
- Cows exhibit longer post-partum anoestrus intervals
- Cows often calve later in the following year.

Risks associated with a late calving:

- Waste of surplus spring pasture
- Smaller calves at weaning
- Peak lactation is reached too late in the summer-dry risk period
- Reduced opportunities for re-mating
- Reduced lifetime calf output.

Generally, except for South Island high country, beef cows are typically planned to calve at the same time as, or before lambing. Many farmers are now questioning this as being too early and in terms of profitable use of winter feed and efficient reproduction. Time of mating for heifers is important and if they are mated too early in spring they will have less time to reach puberty and the required "critical minimum mating weight". In reality, most beef cows are run with sheep and the optimum time to mate depends on individual property features.

Calving pattern is an excellent guide to the suitability of mating date. If less than 50% are calving in the first 21 days of calving then mating date is probably too early. The target is 60% of cows and heifers mated in first 21 days of mating—so that at least 60% should calve in the first 21 days of calving. It is a relatively simple procedure to collect this information. Simply count the number of calves born per week and then plot them over 21 day periods throughout the calving period. This will give a detailed picture of how the previous year's mating went.

Calving difficulty or dystocia

Calving difficulty or dystocia has a major effect on the subsequent production and reproductive performance of the affected cow. The incidence of calving difficulty varies and is probably responsible for up to two thirds of calf deaths in beef cow herds. Average calf mortality in herds is 0–15%. The incidence can be much higher in first calving heifers but can be quite low at <2% in adult cows. When mating heifers at 15 months to calf first at two years of age, managing for a low incidence of calving difficulty is important.

Factors that influence the incidence of calving difficulty:

- Calf size—calf birth weight is the most important factor affecting calving difficulty. Most of the other factors influencing calving difficulty levels are mediated through calf birth weight so that controlling calf birth weight will eliminate calving difficulty from the herd



Calving % increases with cow age to six years then stays stable until around 10 years of age

If less than 50% of cows are calving in the first 21 days calving date is probably too early

- Breed of sire of calf—Continental breeds have high incidences of calving difficulty as shown in Table 4. Jersey sires have low to negligible calving difficulty
 - Sire within breed—selecting the correct bull will also reduce calving difficulty. Choose bulls with below average estimated breeding value (EBV) for birth weight
 - Sex of calf—male calves are about 1-2 kg heavier than female calves and tend to have a 1-2 day longer gestation than heifers (see Table 4)
 - Plane of nutrition—excessive growth or liveweight gain in late pregnancy can affect the size of the calf and the amount of fat laid down in the pelvis region. This is important in heifers, since their birth canal is small—but remember heifers need to be well grown to have developed a sufficiently large birth canal to be able to deliver a calf. Feeding levels have to be extreme to manipulate birth weight as a heifer buffers against low nutrition feeding levels by mobilising her energy to maintain the nutrient supply to calf
 - Breed of dam—the British beef breeds including Angus and Hereford tend to have less incidence of calving difficulty than dairy or continental beef crosses
 - Gestation length—an extended gestation length will increase calf birth weight
 - Season of birth—late season calvers tend to have higher birth weights than animals that calve in late winter early spring.
- Table 4 gives some comparative data on birth weight, gestation length, incidence of calving difficulty and calf mortality from the only comprehensive breed evaluation carried out in New Zealand. Note the relationship between birth weight, gestation length and incidence of calving difficulty and calf death. One of the reasons that calving difficulty is high when European continental breeds are used is the increased gestation length of their calves.
- The most practical way to control or minimise calving difficulty is via bull breed and birth weight EBV. It is also crucial that EBV accuracy is taken into account.

Table 4: The effects of breed of sire mated to both Angus and Hereford dams, sex of calf and age of dam on calf birthweight, gestation length, incidence of dystocia and calf deaths. (NZ data: Baker and others 1990).

Sire	Birthweight (kg)	Gestation (days)	% Calving difficulty	% Calf deaths to 48 days age
Jersey	27.4	283	0.9	1.8
Angus	29.6	281	3.6	4.1
Hereford	31.6	282	2.3	3.6
Friesian	31.9	280	4.6	2.9
Limousin	32.7	287	5.5	3.8
Blond d'Aquitaine	33.8	288	10.4	4.8
Simmental:				
- German	33.5	285	7.3	5.2
- Austrian	34.4	286	9.6	10.5
- French	35.0	287	10.9	4.7
- Swiss	35.0	286	10.8	6.4
South Devon	34.4	286	7.1	5.0
Charolais	35.7	285	17.7	11.2
Chianina	36.8	288	15.1	6.1
Maine Anjou	35.7	285	13.7	8.4
Sex of calf				
Male	34.5	286	12.1	7.4
Female	32.3	284	5.0	3.9
Age of cow at calving				
3 years	32.0	285	13.8	8.6
4 years	33.5	284	6.8	4.5
Older than 4 years	34.7	285	5.0	3.8



Calf mortality from calving difficulty is higher in young cows and ranges from 0-15% in herds

Calving difficulty is influenced by calf size, sire or dam breed, sire selection and nutrition

Post-partum anoestrus interval

The post-partum anoestrus interval (PPAI) is the time between calving and the first oestrus after calving. Post-partum intervals are of prime importance in cattle where gestation takes up to 282, days thereby leaving only 83 days to re-commence oestrous cycles and to establish pregnancy if calving date is to be maintained.

The duration of the post-partum interval in beef cows is determined by:

1. **Date of calving:** Cows which calve earlier in the late winter/spring calving season tend to take longer to experience their first post-calving oestrus than cows that calve later in the calving season. See Figure 3 below. Heifers can take about seven days longer to cycle for every 10 days earlier calving.
2. **Age of cow:** In one study for example, PPAI for two year old cows was 90 days vs. 63 days for older cows. The practical significance of this is that the benefits of mating heifers three weeks ahead of the mixed aged cow herd are often negated by their longer PPAI. Research indicates that the range in PPAI is as shown:
 - a. Two-year old heifers 72-111 days
 - b. Mixed aged cows 57-71 days.

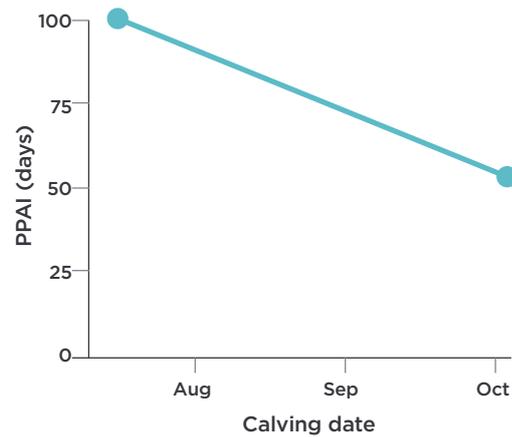


Figure 3: The effect of spring calving date on post-partum anoestrus interval (PPAI).



Post partum oestrus interval is influenced by nutrition, calving date, cow age and breed. It ranges from 57-111 days but needs to be less than 83 days

3. **Breed of cow:** In another study, Friesian cross heifers had an average PPAI of 90 days vs. 81 days for Angus heifers. This breed difference is likely to be related to increased milk production and lighter condition from nutritional stress in beef x dairy animals.
4. **Nutrition:** Table 5 below provides an example of the relationships between calving date and feeding level during the post-partum period. A high level of feeding after calving does not fully compensate for an early calving date. In contrast a medium-nutrition regime is adequate for later calving cows. Photoperiod has some influence on PPAI with increasing day length tending to reduce PPAI. However, this is difficult to quantify in its own right because increasing day length is closely linked to increasing pasture growth rates.

Season of birth can determine PPAI. In spring-calving herds the interval ranges from 65-90 days while for autumn calving herds it is 31-51 days.

Cow condition, liveweight and liveweight gain post-calving are major determinants of the post-calving interval in beef cows. In one trial an extra 20 kg post-calving liveweight was associated with a seven day shorter interval in heifers, compared with only two days in adult cows.

Table 5: The effect of calving date and post-calving nutrition levels on PPAI (days).

	Early calving	Late calving
Calving Period	July 21 - Sept 15	Sept 9 - Oct 10
High nutrition	67	57
Medium nutrition	83	62

Bull management

Most New Zealand beef cows are mated using natural mating with artificial insemination being confined mainly to the bull breeding industry. Factors that contribute to the outcome of natural mating include bull age, bull soundness and fertility, breed of bull and bull to cow ratio.

Age: Puberty is dependant on nutrition, age and breed. This occurs in males for New Zealand breeds at around one year of age, or older in some continental breeds. Yearling bulls make satisfactory herd sires if they are adequately grown (>350 kg) and run with no more than 25-30 cows each. Scrotal circumference is a good indicator of puberty and bulls with a scrotal circumference less than 30 cm should not be used.

Bull-to-cow ratio: Little New Zealand data exist as to the effects of bull to cow ratio on herd pregnancy rate. It is normal practice for one bull to be joined with to 30-50 cows. If farmers wish to use fewer bulls of higher genetic merit, a higher ratio can be used provided the bull is physically fit enough.

Soundness and fertility: Mating cow herds on undulating to steep hill country poses extra problems for bulls. They must be able to seek out, find and mate oestrus cows on broken terrain. Unstable footing during mounting can potentially lead to damage to limbs, joints and genitals. Every bull used needs to have a yearly breeding soundness evaluation 30-60 days before the start of the breeding season.

Currently attempts are being made by the beef cattle stud industry in consultation with the Sheep and Beef Society of the New Zealand Veterinary Association to standardise a presale or pre-season bull soundness examination which could include the following items:

- Inspection for structural and inheritable faults
- Examination/palpation of reproductive organs
- Temperament, locomotory system assessment
- Serving capability test
- Diagnostic tests for BVD, EBL, Campylobacter, Trichomonas
- Semen evaluation from gross and morphology.



Success of natural mating depends on bull age, soundness and fertility, breed and bull:cow ratio

Bulls should be checked for breeding soundness prior to mating, particularly with single bull mobs

information on fail rates for the tests. If tests are carried out for the first time in several years, anecdotal evidence suggests at least 25% of a bull team could fail but with much lower fail rates in subsequent years.

There is variation in the assessment of the true level of risk associated with the prevalence of semen faults in young bulls. One study found 0.6% of 175 sale bulls surveyed were unsound on semen morphology with a further 10.5% temporarily unsound and requiring repeat semen testing. It was also found 21% of mixed age bulls failed this test versus 5% of two-year old bulls. There is variation within populations of bulls. Younger bulls tend to have fewer semen quality issues than older bulls. It is impossible to state categorically that a bull is fertile but it is possible to minimise the risk. Semen testing is not common in commercial herds. Clearly, where mixed age bulls are to be single sire mated there are advantages of including semen evaluation to mitigate risk.

As a bull ages, the risk of failure, for the service test in particular, also increases. Procedures for assessing the mating potential of bulls have also been developed in Australia. The “serving capacity test” provides an indication of the ability of a bull to successfully mate a given number of cows over a three week period. Serving capacity testing is not recommended by Beef + Lamb New Zealand for welfare reasons; a modified form called serving capability testing has been developed by the New Zealand Veterinary profession. This test simply determines if the bull is capable of mating an oestrus cow and does not rank bulls. It is a less stressful test and is valuable in detecting arthritis and joint problems with older bulls.

In practice, most bulls are used in syndicate matings with more than one bull per mating mob, usually 2-3 bulls per 100 cows. While this is an acceptable practice it uses a higher proportion of bulls than is needed to achieve a high pregnancy rate. The extra bulls are an insurance policy against any one bull failing during the mating period.

Bulls need to be in good condition score (CS) of 6-7, but not over-fat prior to the mating season. Check bulls at least twice a week during mating to observe them walking and to check for anything unusual. If possible, watch bulls actually mating. It is a good idea to have a spare bull available to replace any bull that breaks down over the mating period. Some farmers rotate bulls after one cycle, or one week, of mating. This is especially important in single sire mated groups and acts as insurance against bull infertility.

The degree to which these tests are used in the industry will depend on the level of risk associated with using unsound bulls and animal welfare issues associated with some of the testing procedures. There is little hard

When a new bull is purchased remember it needs time to adjust to its new surroundings. The bull should be run with a steer or old cow once it arrives at its new home, never run with older bulls. Sometimes bulls purchased have not cut their second teeth—so feed should be plentiful as this is a stressful time and they can lose condition.

Pregnancy diagnosis

Determining pregnancy in cattle is an important management tool. The advantages of knowing the pregnancy status of a beef cow herd are:

- Timely allocation of feed
- Saving feed by culling non-pregnant animals before the winter.

An experienced veterinarian can determine the age of the foetus if pregnancy diagnosis is done at the right time when 8-12 weeks pregnant. This allows for prediction of calving dates and prediction of a calving pattern and more precise allocation of feed in late pregnancy and early lactation. It can also assist in more efficient use of labour during calving especially if calves are tagged and weighed at birth.

Methods of pregnancy diagnosis

1. Palpation of the uterus and its contents: this involves inserting a gloved and lubricated arm into the rectum and feeling the reproductive tract. This was the most common method used in New Zealand and is performed at six weeks for heifers and eight weeks for cows after the bull is removed from the herd.
2. Ultrasonic detection of the foetus and its membranes using a portable scanner is now the most common technique for determining pregnancy in cattle. Scanning is faster and less demanding physically than rectal palpation and is becoming the preferred technique. Scanning is done with a rectal probe. The technique is often performed between 6 to 8 weeks after mating and allows for manual checking of cows where either a foetus or an empty uterus cannot be visualised. Pregnancies can be detected as early as 35 days. However accuracy and speed of detection increases as pregnancies develop. At the other extreme, the later that testing is left after bull removal, the more manual checking may be required as pregnancies drop down over the pelvic rim beyond the reach of the probe.



Ultrasound detection is the most common method of pregnancy testing and can include foetal ageing

Foetal aging can also be performed but requires training and practice. The most practical time for foetal aging is when pregnancies are between 6–12 weeks. Depending on the length of the mating season, pregnancies can be split into mating cycles, allowing better feed allocation pre-calving. Scanning needs to occur 6–8 weeks after bull removal. A complicating factor is cows often are not weaned at this time requiring drafting of calves. Less desirably, they can run up the race with the cows as they are usually large enough by then to handle this.

Foetal sexing is possible using ultrasound but is technical and specialised. It is best performed at 60–80 days after conception and requires a high resolution scanner. Sequential testing may be required due to foetal orientation and accurate mating records are necessary. It is more time consuming and laborious and requires more experience.

Under good conditions with a long race holding up to 10 cows and when pregnant/non pregnant diagnosis only is required, up to 200 cows an hour can be scanned. As the dry rate increases this slows down the speed of operation. Foetal aging also reduces speed to 80 to 100 cows an hour. However speed of scanning is very variable under field conditions as many factors can influence operator speed e.g. light, cow temperament, faecal composition, stage of pregnancy, race length, race width, cat walk height, number of staff present.

In long races it is preferable to work from front to back to avoid having cows piling on top of each other. A dividing gate half way along can help alleviate this problem as does race width of 650–700 mm. Right handed operators prefer the cat walk on the right hand side of the race when looking forward. The top rail should not be too high above the cows, usually level or 200 mm above the cow's back. The most common height for cat walks is 600 mm with the top rail 900 mm to 1 meter above this. A generous cat-walk width of 750 mm to one metre allows for operator safety and so people can pass each other comfortably.



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ANIMAL HEALTH



Recommendations

- Monitor for diseases and take preventive action where possible.
- Feeding and management are the most effective ways of avoiding disease.
- Develop an informed and integrated parasite control programme.
- Construct an animal health plan, initially in consultation with your veterinarian and revise it each year.
- Look to meat company slaughter reporting sheets for valuable disease information.

Introduction

Beef cattle generally have few health problems when well fed under intensive conditions or extensively managed under optimum grazing conditions. However there are a few animal health problems to be aware of, with the more common issues dealt with in this chapter.

Animal Health Plans

Animal Health Plans (AHP) are valuable tools for increasing farm production and profitability. An AHP allows all stock classes to be considered cohesively and an integrated plan can be put in place. Important diseases of cattle which should be considered include:

- Internal parasites (worms)
- Liver fluke
- Facial eczema
- Trace element deficiencies such as copper, selenium and cobalt
- Hypomagnesaemia
- Other diseases such as TB, Bovine Viral Diarrhoea (BVD), Theileria, Clostridia, Leptospirosis and Bloat.

Meat Processing Companies usually only provide animal health information on their killing sheets if there is a problem. If requested, most companies will collect liver samples for animal health testing.

An Animal Health Plan has three parts:

1. Identify likely animal health challenges
2. Determine timing and choice of prevention or treatment
3. Develop a monitoring programme that will allow early identification of disease and assessment of treatment success.

The AHP should be revised yearly, or if any significant changes are made to the farming system.

Monitoring

Monitoring animal health in cattle primarily involves the following:

- Planned nutrition and feeding—discussed in Chapters four and five
- Measurement of animal condition score (BCS), liveweights, and gain can be determined and compared to target values
- Internal parasite status—usually via faecal egg counts, which need to be interpreted with care
- Sampling pastures and/or faeces for facial eczema spore counts at the appropriate time of the year
- Sampling animals for trace element deficiencies. This involves both blood and liver sampling to cover the range of possible deficiencies
- Monitoring Meat Company slaughter sheets
- Appropriate post mortem of animals found dead.
- Recording reproductive performance indicators e.g. scanning and weaning %.

Internal parasites (worms)

Gastrointestinal parasites or roundworms are common in New Zealand pastoral based farming systems. Parasitism is most commonly a problem in young and growing cattle, with immunity developing in older cows. Parasite burdens can cause reduced growth rates, weight loss, scouring, a dull coat and hollow gut.

It is essential to develop a comprehensive cattle parasite management plan, ideally with a local veterinarian. Things to consider are cattle classes most at risk, usually young and growing cattle, risk periods such as warm and wet weather and grazing management in combination with appropriate anthelmintic drench use.



Beef cattle generally have few health problems when well fed and managed under optimum grazing conditions

Animal Health Plans are valuable tools for increasing farm production and profitability

Monitoring animal health in cattle is an essential part of an animal health plan

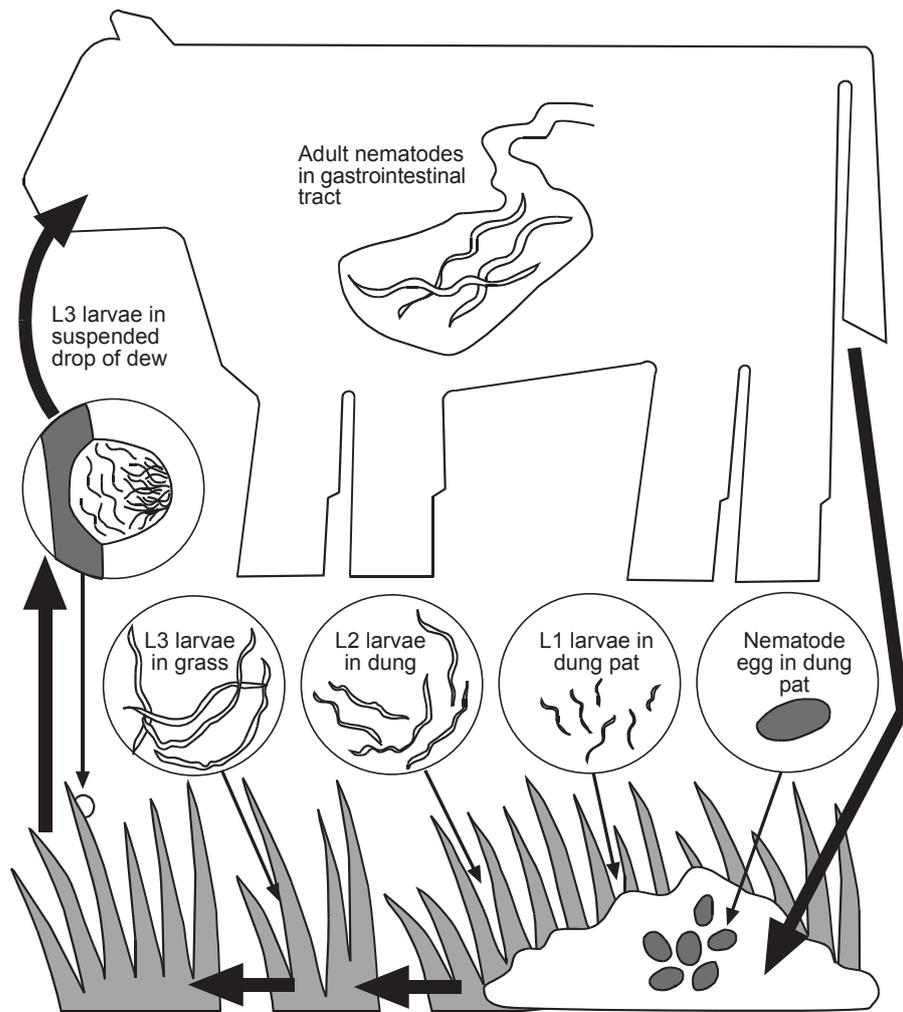


Figure 1: Lifecycle of typical gut roundworms. Note that generally 5-10% of the total parasite population is in the animal and 90-95% occurs outside the animal as pasture larval contamination or in dung pats.



Parasite burdens can cause reduced growth rates, weight loss, scouring, a dull coat and hollow gut

The control of internal parasites is specific to each farm

Ostertagia is by far the most damaging parasite in cattle in New Zealand

Significant reductions in liveweight performance can occur purely through exposure to high levels of worm larvae on the pasture. Immature or infective “L3” worm larvae ingested by an animal are foreign infectious agents and the body responds by repelling with an immune response. This response costs energy and protein. When the challenge by L3 larvae is very high, the exposure can significantly depress performance. Such costs can often occur with no visible symptoms. Figure 1 indicates the general life cycle of the commonly found gut parasites affecting New Zealand beef cattle.

Control of internal parasites is specific to each farm. Creating and using an internal parasite management plan is the best way to reduce production losses due to parasitism. Grazing management, stock and age group ratios, monitoring data and historic experiences must all come together in making the plan. The plan should schedule grazing changes, monitoring, anthelmintic treatments (drenches), and include timing and type of ongoing monitoring.

The overall aim must be to identify procedures and opportunities to create grazing areas for cattle less than 9-12 months of age, which are not heavily contaminated with worm larvae. Options for creating these areas are:

- Identify areas not predominantly grazed by cattle or areas grazed only by mature cattle such as cows
- Identify areas not predominantly grazed by young cattle in the previous autumn.
- Use of crops which are almost completely free of internal parasites
- Use of new pasture swards which are also parasite-free.

Internal parasite monitoring based on faecal egg counts (FEC) can be used to help identify problems in young cattle. A local veterinary service can be used for this procedure. Professional advice is recommended to assist with the interpretation of the counts obtained. The frequency of the monitoring will depend on the assessed risk of the grazing areas.

A wide range of drenches are available and they can be described according to their action or drench family (Table 1).

Their descriptions relate to the mechanism by which the drench kills worms. The action families (drench families) are the benzimidazole (BZ or white drench), the levamisole (clear drench family), or the avermectin/milbemycin or endectocide family. Combination drench products are also available (Table 1 lists descriptions and examples of these drenches).

Drench resistance is an emerging problem throughout New Zealand, and is a problem with both sheep and cattle parasites. Oral combination products are recommended as they are more likely to be effective. There is also less risk of drench resistance developing when compared to single actives. Faecal egg count reduction tests (FECRT) can be done by a veterinarian to assess the efficacy of specific drenches on your property.

To avoid bringing resistant worms onto the property, cattle coming on to the farm should be quarantine drenched. Discuss which drench to use with your advisor, but this will commonly involve the use of a triple combination product.

Table 1: Drench Action Families plus a Combination Group for internal parasite control.

Benzimidazole Action Family (BZ or White Drenches)	1st Generation Thiabendazole
	2nd Generation Mebendazole
	3rd Generation Fenbendazole Oxfendazole Albendazole
Levamisole Action Family (Clear Drench)	Levamisole, Morantel
Avermectin/Milbemycin Action Family (Endectocide Drenches)	Ivermectin, Abamectin, Moxidectin, Doramectin, Eprinomectin
Combination Drench Group (double or triple combinations)	Levamisole plus Benzimidazole
	Abamectin plus Levamisole
	Triple combinations (abamectin, oxfendazole, levamisole)



Maximum growth rates can only be achieved in young cattle provided they are not exposed to high levels of pasture worm larvae

Good nutrition reduces the impact worms have on young stock

Table 2: Monitoring and risk assessment tools for internal parasites and treatment options.

Monitoring tools	Faecal egg counts
	Blood samples
	Monitor live weight gains
Risk assessment tools	Age of animal
	Time of year
	Property history
	Herd history
	Environmental factors—feed, weather, grazing history
	Monitoring of drench resistance
Treatment/control options	Anthelmintics (drenches)
	Feeding levels
	Integrated grazing
	Stocking policy
	Planning

Worm challenge and pasture quality

Nutrition directly effects the impact worms have on young stock. Young cattle for example, suffer much more from a worm challenge, when they are grazing low quality pasture, than from the same challenge, when grazing good quality pasture. This may impact on growth rates and drenching requirements. This could be a reflection of the level of worm larval uptake, the susceptibility of the animals to the worms, the level of worm larvae in the pasture, or the quality of the pasture. The recommendation is to maintain high quality pasture for young stock, while providing adequate parasite control.

Intensive beef systems, based around weaners, can cause extremely high levels of larval contamination on pasture, leading to poor liveweight gains. Regular drenching will reduce the effect of this larval challenge, but it will never completely remove it. Therefore, young stock grazing systems that encourage the accumulation of larval contamination on the pastures are likely to have a production ceiling imposed by that larval challenge.

There are various ways of avoiding or minimising pasture larval accumulation. Cropping and or pasture renewal is extremely effective and has allowed for the sustainable grazing of many bull blocks.

Mixed animal species or age grazing

Inter-grazing with other animal species is a very effective tool, because most parasites do not readily cross-infect between different animal species e.g. between sheep and cattle. Organising grazing plans, so that grazing areas are shared, or interchanging species within a season or between years, are practical and effective measures that can be taken. Mixed grazing with mature cattle that have a low worm output can also be used. The aim is to expose stock to lower levels of pasture larval challenge.

Liver fluke

Liver fluke is also an internal parasite, but is a different type altogether from the commonly described “worms” above. As the name implies, the adults of this parasite are found in the liver where they suck blood from the host animal. This also results in a loss of protein from the infected host. Liver fluke burdens cause reduced growth rates, weight loss, poor coat condition, scouring and bottle jaw.

The liver fluke lifecycle is very different from that of the common gut worms in that it spends part of its lifecycle in either of two snail species. Both the snails, and liver fluke larvae, are dependent on marshy habitats or swamps for their survival. This means areas that are swampy pose a risk for fluke infection. Cattle and sheep of all ages are susceptible to liver fluke infections.

The monitoring requirements and management of live fluke are somewhat different from internal worm parasites as summarised below.

Monitoring tools	Works reports, faecal and blood samples
Risk assessment tools	Time of year Age of an animal History Grazing management
Environmental conditions (e.g. drought)	History Control options Flukicide drenches Grazing plan Environment manipulation

Triclabendazole and albendazole are commonly used drenches to treat liver fluke infections.

Hypomagnesaemia (grass staggers)

Hypomagnesaemia is a nutritional disorder associated with low levels of magnesium in the blood. It is most commonly seen in pregnant and/or lactating cows, with clinical cases showing various gradations of behaviour from a slightly disjointed gait, aggression and fine muscle tremors to violent convulsions and sudden death. While surveys have shown that the incidence is relatively low, fluctuating between 1% and 2% of beef cows annually, major outbreaks can occur in individual herds with between 10-30% of the animals showing clinical signs or are found dead.

Risk factors for the development of hypomagnesaemia include: under-feeding, grazing lush spring herbage, abrupt changes in diet, content of supplementary feedstuff, fertilising practices, age and body condition of cow, pregnancy, lactation and a variety of stresses such as rough weather, handling, yarding and trucking.



Mixed animal species grazing is a very effective tool for decreasing the impact of worm larval challenge

Liver fluke causes loss of protein from the host animal with ill health and lost production

Feeding and management systems have been developed to reduce the risk of hypomagnesaemia. The essential elements of such systems are:

- A timed mating period of 7–9 weeks to enable calving to coincide with the onset of the spring flush of growth
- Feeding cows at consistent levels over late autumn–winter to avoid sudden changes in energy supply from day to day
- Avoiding sudden dietary changes
- Feeding cows to appetite on saved pasture from 2–3 weeks prior to the onset of calving. This can be difficult to achieve if calving is not compact
- Blood testing to assess cow magnesium levels as necessary; particularly after summer and autumn droughts and during times of feed shortage
- Supplementation with magnesium as required.

Magnesium supplementation

Oral magnesium supplementation can be very effective in preventing grass staggers in beef cattle. If hypomagnesaemia is a problem in your herd or if the risk of development is high, a veterinarian will be able to discuss the most appropriate options.



Magnesium deficiency or grass staggers causes behavioural problems and sometimes death

Options for magnesium supplementation include Causmag, magnesium in drinking water, magnesium bullets or mineral licks

Facial eczema is caused by a fungal mycotoxin in the pasture usually after warm humid weather, mainly in the North Island

Magnesium Oxide (Causmag)—Can be a very useful and cost-effective method of magnesium supplementation. This can be administered to beef cows via addition to hay or silage or by pasture dusting prior to grazing.

Water trough treatment—Treatment of drinking water with soluble magnesium salts such as magnesium chloride at the rate of 60 g/cow/day can also be used. Cows must be introduced slowly as treated water is not very palatable, and alternative water sources must not be available.

Magnesium licks—Are not a very reliable method of supplementation due to variable intake by cows and should be used with caution.

Magnesium bullets—Probably the most costly method of supplementation, the use of intra-ruminal slow release bullets can be very effective in extensively grazed herds. Depending on the severity of magnesium deficiency in the diet, the bullets may only need to be given to older cows which are more prone to staggers. The bullet remains effective for about four weeks.

Facial eczema

Facial eczema is caused by a fungal mycotoxin in the pasture. The main risk period is after warm humid weather, usually late summer and autumn, in the North Island. It results in liver damage in the animal. Affected animals may show signs of photosensitivity ranging from swelling and drooping of the ears to extensive peeling of light coloured hairless areas such as the ears, muzzle and udder. The consequences of facial eczema range from poor reproductive and growth performance through to death, depending on severity of the liver damage.

Sheep are more susceptible than cattle primarily because they graze closer to the base of the sward and hence ingest more of the fungal spores. Many local vet clinics or consultants report counts weekly during periods of high risk. Counts above 100,000 spores per gram of grass are considered dangerous, although constant exposure to lower spore counts can also be a problem.

Control and treatment is achieved by:

- Monitoring spore counts and predicting danger periods
- Not grazing at-risk paddocks and ensuring cattle do not graze pastures too hard
- Spraying pastures with fungicides to prevent fungal growth
- Zinc supplementation via intra-ruminal capsules or water treatment.

Control programs should be developed jointly with a veterinarian.



Control of facial eczema is by monitoring, spraying pastures or zinc supplementation

Bovine Viral Diarrhoea (BVD)

BVD is a viral disease that affects cattle. Recent New Zealand studies have shown around 65% of New Zealand beef cattle herds have active BVD infection, and about 80-90% of herds have had exposure to BVD virus. The studies have also found that between mating and pregnancy testing, active BVD infection in a herd can reduce pregnancy rates by an average of 5%, with losses in some herds of up to 15%.

In mature cattle the main consequence of BVD infection is reproductive wastage. In young stock infection can also result in reduced weight gains, diarrhoea and loss of body condition.

Reproductive wastage occurs when a heifer or cow becomes exposed to BVD virus while pregnant. The outcome depends on when the pregnant cow is infected after conception:

- 0-45 days—cow fails to conceive or loses embryo and returns to service. These are known as long returns and are often not detected. Later repeat pregnancy scanning may help detect these
- 18-125 days—virus causes an abortion and return to service, or results in the birth of a persistently infected calf
- 90-180 days—virus enters the unborn calf, producing a variety of effects including abortion and congenital deformities
- 150-280 days—calves infected in the last trimester of pregnancy are often born “stunted”. They fail to grow as well as their cohorts. Heifer calves infected during this period also have poorer “first season mating” fertility. These calves are often born weak and die at birth.

When dealing with BVD infection there are two types to be aware of:

- Transient infection
- Persistent infection.

Transient infections are not usually a significant problem unless infection occurs during pregnancy. Transiently infected animals may show mild illness for a couple of weeks before infection clears. However persistently infected (PI) animals continually shed BVD virus throughout their lives. PI animals are often “poor doers” with reduced growth rates, although some may appear normal.

Progeny from PI animals are always PI, further perpetuating the disease in the herd. In beef herds, cows and calves are kept together allowing a much more dynamic spread of the disease between younger and older animals during the breeding season. This means that PI animals can be in constant contact with new calves, replacements, bulls and the breeding herd.

Route of BVD infection. Infection commonly occurs either through direct contact, such as nose to nose, or contact with saliva or faeces. Other possible routes of transmission are semen, milk, saliva, urine, placental and birth fluid. It is also possible for the BVD virus to be spread through cattle yards, stock trucks and to be carried around on footwear. The virus can survive in typical conditions in the environment for up to seven days.

BVD is often characterised clinically but with low death rates. BVD in young stock is frequently not diagnosed or mis-diagnosed because symptoms can be similar to parasitism. Some farmers therefore mistakenly drench without getting a diagnosis. Since most stock recover after a transient BVD infection, farmers often get the false impression that their stock have responded to the parasite drench.

Control of BVD. Any new cattle beast entering the property has the potential to act as a source of BVD infection for a herd. Contact with neighboring cattle can also act as a potential source of infection.

There are a number of factors to consider when managing BVD. These are best discussed with a veterinarian, allowing a comprehensive control plan to be developed.

Consideration should be given to the following:

- Test and vaccinate all bulls prior to arrival on farm—certification from breeder required
- Yearly booster vaccination of bulls prior to breeding
- Whole herd vaccination
- Testing, initially to identify exposure levels and if required to identify PI animals. If the antibody levels indicate exposure to the virus is high then identifying and culling PI cattle is important.
- Effective biosecurity.



Around 65% of New Zealand beef cattle herds have active BVD infection

BVD can cause ill health in cattle of all ages and abortions in pregnant cows

Control of BVD is through monitoring and vaccinating with veterinary consultation

Nitrate poisoning

High levels of nitrate and nitrite in plants and water sources are the primary cause of acute nitrate poisoning in cattle. Plants which are the main source of nitrates for cattle, sometimes causing poisoning, include regrowth rape, choumollier, turnips, immature green oats, Italian rye grass and young maize. Nitrate poisoning is rare on permanent pasture but can occur. Rapidly growing plants, grown in nitrogen-rich soils after a period of drought, are most dangerous.

Nitrate poisoning results in sudden death of affected animals, and unfortunately cases usually involve large numbers of cattle as all have been exposed to the high levels of nitrate. Affected herds must be immediately removed from the pasture or crop and offered hay, while severely affected animals require rapid treatment with intravenous methylene blue administered by a veterinarian. If affected animals are pregnant at the time of poisoning it is not uncommon for them to abort in the following weeks.

Plants can be tested by your veterinarian prior to grazing to ensure safety. A good handful of plant materials, including the stalk, should be sent for testing.

Bloat

Bloat is not a common problem for beef cattle but, when it occurs, it can be very difficult to manage. Its occurrence can be sporadic and hard to predict. Animals vary genetically in their susceptibility to the problem and resistance is quite highly inherited. Bloat occurs when stable protein foam develops in the animal's rumen and cannot be belched out like the normal rumen gases, which are produced constantly. The end result can be fatal, because of physical pressure on internal organs such as the heart, which eventually stops. Bloat is most prevalent in early spring and where soil fertility and pasture quality are high. It is more common, but not exclusively so, on pastures with high clover content. Bloat can also occur on brassica crops and the new fast-growing grasses. Low fibre content appears to be a causative factor.

Adding fibre such as hay to the diet decreases the risk of bloat. When the risk is very high, adding anti-bloating agents to water either in the water supply or as a drench can be very effective, but the latter process is very tedious and impracticable in run cattle. Avoid introducing hungry cattle to high risk pasture. Slow-release, Rumensin rumen "bullets" are effective and are also reported to give a liveweight gain response.

Theileria

A new strain of *Theileria orientalis* known as ikeda was first identified in Northland in late 2012. Theileria has been present in New Zealand for some time, but unlike the ikeda strain, it did not cause clinical disease. This new ikeda strain is associated with anaemia or reduced red blood cells and death in cattle, and has been of particular importance within the dairy industry.

Theileria orientalis is a blood borne parasite and is transmitted via ticks. This means cattle in areas where there are high tick burdens are at increased risk of becoming infected. Infection with Theileria causes anaemia in cattle, so signs to look for are:

- Lack of energy, lagging behind when moving paddocks
- Increased breathing and heart rate
- Low growth rates in young cattle or weight loss
- Increased "sick animals" or reduced response to treatment for other conditions
- Pale or yellow tinged mucous membranes including gums, vulva, around the eye
- Sudden death.

The risk of developing severe clinical signs appears to increase during times of stress. This means cattle are most likely to show signs around calving, post-weaning or if they are under significant stress with a high parasite burden or in poor body condition.

Treatment. A presumptive diagnosis can be made based on clinical signs and confirmed by a blood test. The test identifies the severity of the anaemia and also checks for the presence of Theileria in the red blood cells.

There are a range of treatment options available depending on the individual case. These include:

- Blood transfusions to replace the destroyed red blood cells
- Symptomatic care—minimise stress, handle only when necessary, and ensure access to high quality feed and water, flatter paddocks with access to shelter
- Drug treatment—there are very strict rules around use and withholding times.

Prevention of Theileria infection is complex as there are a number of factors involved. To reduce the risk of infection ticks need to be controlled. New cattle brought onto the farm are a potential source of Theileria infection. Breeding bulls should be tested for Theileria before they are brought on farm.

For more information on Theileria and tick control contact your local vet for area and farm specific advice.



High levels of nitrate and nitrite in plants and water sources cause acute nitrate poisoning in cattle

Bloat occurs when stable protein foam develops in the animal's rumen and cannot be belched out

Theileria orientalis is a blood borne parasite and is transmitted via ticks causing anaemia

Bovine Tuberculosis

Bovine TB is potentially one of New Zealand's most serious animal health problems. TB levels in cattle and deer herds are high by international standards. To protect our export markets and maintain New Zealand's reputation for high quality farm products, we need to get TB levels below those of our overseas competitors and trading partners. Tuberculosis is an infectious disease caused by a bacteria, *Mycobacterium bovis*. In cattle it mostly causes disease in the throat, lungs and associated lymph nodes, but can affect other organs as well. The disease can develop into a lingering chronic condition leading to wasting and death. Bovine TB can be a major health problem in cattle and deer. It also affects a wide range of wild animals, especially possums, deer, ferrets and pigs.

In the past, bovine TB was a significant cause of tuberculosis in humans. Most cases were caused by drinking unpasteurised milk from infected cows. Nowadays, pasteurisation of milk and good slaughterhouse hygiene have virtually eliminated the human health risk. However, occasional cases do occur, mostly among people handling infected animals or carcasses. Most cases of human tuberculosis are caused by a closely related bacteria, *Mycobacterium tuberculosis*.

Infection usually occurs when one animal inhales bacteria which are coughed up or breathed out by another. In this way cattle and deer can infect each other. However, in New Zealand, livestock primarily get TB from contact with infected wildlife. Infected wild animals, such as possums, which spread TB to livestock are known as vectors.

TB can be controlled, provided we can control the disease in livestock and vector populations. Disease control in livestock involves:

- TB testing all herds and further testing or slaughtering animals which react to the test
- Classifying the TB status of herds
- Controlling the movement of animals from infected herds or areas where herds are at greater risk of TB breakdown.

Vector control involves reducing populations of vectors, usually possums, but sometimes ferrets, pigs and deer, by combinations of trapping, poisoning or shooting. The lynchpin of livestock TB control is the test and slaughter of infected animals. Frequency of testing varies depending on an assessment of the TB risk in a herd or locality. Beef cattle and deer herds in low-risk areas which send most animals to slaughter may be exempt from testing, because any TB in the herd will be identified by slaughterhouse inspection.

All cattle and deer herds are classified according to their history of TB infection to provide a measure of the risk of TB infection.

Contact TBFree for further information specific to your farm and area.

Animal status declarations

All movements of cattle and deer one month of age or over must be accompanied by a completed Animal Status Declaration Card. This includes movement to slaughter. All questions on the declaration card must be answered fully and correctly.

National animal identification and tracing (NAIT)

This scheme was introduced by the AHB in 1999 to support the objectives of the National Pest Management Strategy for Bovine Tuberculosis. It provides for the compulsory identification of cattle and deer to their herd of origin. This is to help trace sources of infection when TB is identified in stock during the course of routine herd testing or by post-mortem inspection of slaughtered animals.

The ID scheme is governed by regulations under the Biosecurity Act 1993. Under these regulations two separate ID systems have been approved. One system is operated by the AHB. The other is the MINDA identification system operated by the Livestock Improvement Corporation. Both systems have the same standing in law, but differ slightly in their details. Cattle and deer farmers may choose which system they use, but only one system should be used for identifying any one animal.

In essence any animal over one month of age, moving from its herd of origin, even to slaughter, must be identified with approved ear tags.

Since the introduction of the scheme, it has also become apparent that a compulsory, regulated ID system for cattle and deer will be required if New Zealand is to maintain overseas market access for beef, dairy and venison products, especially into the European Community.

The ID scheme applies to all cattle and deer. See the "Further Reading" section for more details.



Bovine TB is potentially one of New Zealand's most serious animal health problems

TB vector control involves reducing populations of possums and sometimes ferrets, pigs and deer

There are stringent national monitoring requirements for TB particularly in high risk areas

Clostridial diseases

The risk of Clostridial diseases such as Blackleg, increases as young stock are better fed. Therefore, all calves should be vaccinated against this bacterial family of diseases with an appropriate Clostridial vaccine at weaning and given a booster vaccination four weeks later. Cows require an annual booster prior to calving to provide short-term protection for the calves when they are born.

Leptospirosis

Leptospirosis is particularly important due to the human health risk infection poses. Leptospire survive well in cool and wet conditions such as stagnant or swampy water. In cattle the consequence of leptospirosis infection depends on a number of factors, including age of the animal and serovar (type) of leptospirosis involved. Cattle act as a maintenance host for *L. hardjobovis*, which means they are easily infected, but usually with mild or no clinical signs of disease. They then shed the leptospire in their urine, which can act as a source of infection for other animals (e.g. sheep and deer) and humans. If cattle are infected with other serovars of leptospirosis, clinical disease can occur. This may present as fever, anaemia, jaundice, “red-water” (red tinged urine), abortion or death.

Testing can be done by a veterinarian to confirm leptospirosis infection and to establish if cattle have been exposed. Vaccination is recommended for prevention and control, and also to reduce the human health risk from handling potentially infected cattle.

Ryegrass staggers

Many perennial ryegrasses contain a “live in” fungus or endophyte, which produces toxins. One of these toxins, peramine, is beneficial in that it reduces the damage that Argentine stem weevil, black beetle and some other pests may cause. However, another endophyte, lolitrem B, causes ryegrass staggers which can cause stock losses due to misadventure and difficulty moving stock. A third toxin, ergovaline, causes reduced feed intake and heat stress. These toxins are produced mostly during later summer and autumn.

Endophyte free ryegrass and ryegrasses containing a non-toxic endophyte (ARI) are available. The latter type also retains a high degree of resistance to insects.

Trace element deficiencies

Trace element deficiencies can be avoided by monitoring the trace element status of target livestock classes and supplementing as required. Ongoing veterinary consultation and monitoring of tissue and blood samples is necessary to ensure the supplementation programme has been effective, and to detect any changing status caused by fertilisers, seasons and time.

Copper. Copper deficiency is not uncommon in cattle in New Zealand, with deficiency causing reduced growth rates in young cattle, poor coat condition, diarrhoea and reduced reproductive performance. Severe copper deficiencies can lead to abnormal bone development and increased risk of fractures.

Most copper deficiencies are not due to soil deficiencies, instead they are due to elements such as molybdenum or iron binding with the copper in the rumen and making it unavailable to the animal. Copper levels deplete over the winter and are at their lowest in early spring. It is therefore important to ensure breeding cattle do not become deficient during late pregnancy and early lactation. Monitor copper levels in cattle every autumn to ensure adequate supplies over winter and spring.

Copper status in cattle is best assessed via liver samples. These samples can be collected via liver biopsy done by a veterinarian, or liver samples can be collected from cattle sent for slaughter. Copper levels can also be assessed using blood, however this will only show if the cattle are deficient and have used up their copper reserves.

The ideal times to monitor the copper status of various cattle classes is:

- Cull cows in the autumn
- Pregnant cows in late winter using liver biopsy samples
- Culled growing cattle at any time
- Rising one year-old cattle in mid winter using liver biopsy samples.

From the above results, copper supplementation requirements can be calculated to prevent a deficiency.

There are a range of supplementation options available for copper. The most common are injectable copper or copper rumen bullets. Copper can be toxic in overdose, particularly in sheep, so speak to a veterinarian about an appropriate monitoring and supplementation scheme. Other options are copper in the water supply or adding copper with topdressing.



The risk of Clostridial diseases increases as young stock are better fed

Ryegrass staggers can cause stock losses due to misadventure and wasted time while shifting stock

Copper deficiency is not uncommon in cattle in New Zealand causing reduced growth rates in young, cattle, diarrhoea and reduced reproductive performance

Selenium. Selenium is required for animals, but not for plants, with a number of areas in New Zealand being at risk for selenium deficiency. Traditionally selenium deficiency was observed as white muscle disease (WMD) in lambs and calves, with affected animals dying within a few days of birth or in older animals with gait abnormalities and diarrhoea. Now selenium deficiency commonly results in reduced growth rates and ill thrift in young growing cattle and reduced fertility in adult cattle. Selenium deficiency has also been associated with increased risk of retained fetal membranes following calving.

Selenium status in cattle can be assessed via blood sampling, with only a small number of samples required. There are two commonly used tests available. One looks at the selenium status over the past two months to diagnose deficiency, while the other reflects recent intakes which can monitor supplementation.

Ideally, monitoring of the selenium status is done:

- Just prior to calving
- At any time in growing stock, but at least two months after any selenised drench or vaccination has been administered.

Selenium can be supplemented in a number of ways such as selenium prills applied to pasture, selenium drenches, injections and pour-ons or in controlled released rumen capsules. As with copper, selenium is toxic in overdose so it is best to seek veterinary advice before implementing supplementation.

The level of deficiency, the time of the year, the accessibility of the stock and ease of administration will determine the type and frequency of selenium supplementation.

Cobalt. Deficiencies occur most commonly in the summer, and mostly in lambs. Cobalt deficient diets result in low levels of vitamin B12, which depresses growth rates with few or no other symptoms. Cobalt deficiency in cattle is now rare.

Measuring the level of vitamin B12 in the livers of calves is the best measure of cobalt status. It is best done in the late spring so that any potential deficiency can be identified and prevented in time.

Cobalt can be supplemented by vitamin B12 injections, cobalt topdressing, cobalt in the water supply, cobalt rumen bullets, or controlled release capsules. The option taken will depend on the level of deficiency, the accessibility and convenience.

General trace element monitoring tools:

- Monitoring tools:
 - Liver, blood and pasture—on farm collection (vet) or via slaughter house.
- Risk assessment tools:
 - Age of animal.
 - Type of tissue tested
 - Time of year
 - Farm history.

Monitoring meat company slaughter sheets

As a final monitoring option, it should be possible to retrieve valuable information from meat company slaughter reporting sheets. Table 3 details the sort of information, which should be available from the meat processor. Unfortunately many of the animal health observations on kill sheets are cryptic and difficult to understand without help from a veterinarian. Most meat processing companies only report if there are disease defects.

In Table 3 over page, comments under the column heading recorded as 'major' indicate a major opportunity for a meat company to report whereas those recorded as 'service' and "feedback" indicate that this would be useful in better understanding the animal's performance.



Selenium deficiency is prevalent in some areas causing white muscle disease or reduced growth rates

Cobalt deficiency is rare in cattle but can cause ill thrift and reduced growth rate

Meat company slaughter reporting sheets can be valuable for monitoring disease



Table 3: Summary of information that should be available on meat company slaughter sheets. Unfortunately, most of this information is only reported if the defect is present, the farmer has to assume that “no news is good news”.

Key beef cattle slaughter observations	Comment	Comment type
Peritonitis	Associated with arthritis	Major
Arthritis	Navel infection from calf stage especially with bulls.	Major
TB (Tuberculosis)	Regulatory requirement	Major
Abscesses	From injections?	Service
Trace element status	Full range	Service
Facial eczema	Liver damage: incidence and severity, age	Service
Liver Fluke	Incidence and severity	Service
Pregnancy status	Possible increase in value	Service
Bruising	Area, severity and age	
Connects to farming activity and animal welfare	Interest	
Injection site lesions	Area, severity and age	
Connects to farming activity	Feedback	
Johnes Disease	Observation	Feedback
Leptospirosis	Occupational health and safety issue as this disease could easily transfer to humans.	Feedback



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NAIT (National Animal identification and tracing) scheme links people, property and livestock in New Zealand. www.nait.co.nz

BEEF CATTLE WELFARE, HANDLING AND YARDING

Recommendations

- Well managed welfare, including good stockmanship, will optimize productivity.
- Minimise unpleasant animal experiences when handling cattle, particularly in yards.
- Remember efficient handling depends on the skill of the handler, the type of animal and its previous experiences, the facilities and the environment.
- Keep cattle at a low level of arousal to make handling easier.
- Empty cattle out before transport; careful driving makes transport easier for cattle.
- Disbud and castrate calves when they are as young as possible.
- Consider use of curved feed pens and races for ease of cattle movement.

Introduction

Beef cattle should be managed to optimize their productivity and welfare. In New Zealand virtually all beef cattle are grass fed, in an environment which is generally good for their welfare. There are few feedlots and most cattle are bred, reared and finished in situations where they have opportunities to exhibit a wide range of natural behavior. They can usually find shade and shelter when necessary. Welfare problems are mainly associated with calving, dehorning, castration and transport. Good yard design and stockmanship are important to minimize distress during yarding and processing.

Cattle have to be moved into and through yards for various procedures. Factors affecting good cattle handling include the skill of the handler, the type of animal, its previous experiences, and the facilities. Cattle are social animals and work best in small groups. They remember bad experiences but can learn quickly to move through yards. With good people and good yards, cattle can be worked with little effort and without the need to use force.

The working distance is the distance at which cattle start to move away from humans or dogs. It can be used like an accelerator, moving into the working distance will increase the speed at which cattle move and withdrawing will slow them down. Cattle have two movement lines or balance points; one along their backbone and one in the shoulder-neck region. Moving to the left or right of the backbone line will encourage cattle to move in the opposite direction. Moving behind or before the shoulder-neck line will encourage a beast to move forward or backwards respectively.

Depending on previous experiences, cattle can learn that yards, races, crushes and head bails are to be avoided. Management practices can be adopted to encourage cattle to move more efficiently in yards.



Beef cattle should be managed to optimize their productivity and welfare

The welfare of cattle depends on how they are managed, the quality of stockmanship and the environment

Welfare of beef cattle

Beef cattle include breeding bulls, beef cows, calves, weaners, store cattle and finishers. Dairy bulls may also be reared as beef animals. The welfare of cattle will depend on how they are managed, the quality of stockmanship and the environment. The number and class of cattle held on a property will determine the size and quality of the facilities required and the handling skills needed. Managing beef cattle involves moving them into and through yards for various procedures. The degree of restraint required for a particular procedure will vary depending on stock class and the procedure being undertaken.

The welfare of farm animals is important to farmers but it is also a social, political and trade issue which has legal and marketing implications. Fundamentally animal welfare is concerned with what animals' experience. We cannot know what an animal experiences and therefore discussion about animal welfare is usually structured around what we can measure and how we interpret these measurements. There are three major elements used when assessing animal welfare:

- The animal itself
- The environment
- The people involved with the animals.

The nutrition, health and physical comfort of an animal can be measured as can its ability to engage in a range of normal behaviours. These can then be interpreted to determine whether the animal's experiences are good, neutral or unpleasant. Thus its welfare can be classified as good or acceptable and poor or unacceptable.



A beef cow living on a typical sheep and beef farm is generally well-fed, healthy and has, to some extent, opportunities to choose its environment and express its natural behaviour. Angus and Hereford cows can cope with the range of environments they encounter on New Zealand farms. However, if a cow becomes lame, then despite all its advantages, its welfare would be reduced substantially due to the pain caused by the lameness. As a general observation the welfare of beef cattle in New Zealand is excellent. Beef cows live a reasonably natural, well fed and healthy life; weaning is late and cattle are finished on grass. Beef cows are yarded infrequently for procedures such as weaning, pregnancy testing and drenching. Good yard design, which facilitates movement and restraint, and good human behaviour can minimise this stress.

There are things which impact negatively on the welfare of beef cattle. Many of which are common to beef production systems worldwide. Included are calving difficulties or dystocia, especially with heifer mating, castration, dehorning, lameness in bulls, transport, inclement weather and feed scarcity either seasonal or due to a range of environmental factors such as drought. Heifer mating, bull testing, the overuse of dogs and cattle prods, and calf mortality are all possible welfare problems. In New Zealand, disease issues are not especially significant and internal parasites, trace element deficiencies and some infectious diseases are easily controlled.

There are some unique aspects to New Zealand beef production. Cull dairy cows are an important source of manufacturing beef and there are specific welfare issues associated with the management of these animals. They may be shipped for slaughter without being dried off and may be in very poor body condition when slaughtered. Dairy bull beef production, when managed well, has few welfare problems but injuries can occur from fighting and riding. Bobby calves are dairy calves, unwanted by dairy farmers and slaughtered in the first few weeks of life. These calves are well able to cope with transport and lairage if they are healthy, old enough and fed before transport. Feedlots are unusual in New Zealand. Large well established feedlots have few welfare issues but poorly designed feedlots may have issues with poor drainage, wet bedding conditions and physical discomfort.

Cattle handling: moving cattle

The factors that make for good cattle handling are summarized in Figure 1. Included are the skill of the handler, the type of animal and its previous experiences, the facilities and the environment. Good handling reduces stress and danger for humans and animals, saves time and effort and makes working with cattle more enjoyable. Rough handling makes cattle more skittish and difficult to handle in future.



The welfare of beef cattle which are well fed, healthy and living on a typical sheep and beef farm is generally good

The main things causing welfare problems with beef cattle are dystocia, castration, dehorning, lameness in bulls, transport, inclement weather and feed scarcity



Figure 1: The elements of good and safe cattle handling.

The behaviour of beef cattle during mustering and yarding will be influenced by breed, class of stock, the frequency of yarding and the style of handling. Cattle that are mustered infrequently and are usually observed from a distance will be more skittish but may move through yards quickly. Cows with calves may be protective of their calves. Seriously aggressive or wild cows or heifers should be culled as their behaviour will affect the activity of other animals in the herd. All bulls should be treated with caution as they are often unpredictable and may become dangerous if overexcited.

Calmness is important in handling cattle safely and effectively. Constant awareness of what is happening, and rapid and decisive responses are also necessary. The experience of working with good cattle handlers is beneficial to novice stockpeople.

Cattle have a poor ability to perceive distance and speed of movement. A simple change in footing may appear threatening to a cattle beast and it may baulk and then put its head down to inspect the ground. Cattle tend to move towards light and do not enter dark areas freely. They are social animals and work best in small groups. They remember bad experiences but can learn quickly to move through yards. An electric prodder should be used sparingly, and only when the animal can actually move forward. It may be useful for moving a cattle beast into a crush or head bail or on to a truck.

The level of arousal of cattle will influence their behaviour. Over-aroused cattle may break away, go through fences or attack dogs. Keeping cattle at the right level of arousal makes handling easy. Cattle dislike a lot of noise, and easily become over-aroused if too much noise is used to shift them or move them through yards. Some cattle dislike

motorbikes and overreact to them. Dogs used for mustering should be kept under control, and tied up away from yards to reduce the level of excitement of cattle. After arriving in the yards, cattle should be given 20 minutes to settle down before being shifted into forcing pens or drafted. The entrance to yards should be wide to allow cattle to move in without being too tightly crushed. Bulls especially dislike other bulls coming into their personal space: this lifts their arousal level and may cause fighting.

Working in yards

Cattle learn quickly how to move through yards. Newly purchased stock should be moved through yards and given the opportunity to learn the layout. This will facilitate easier movement by these cattle through the yards in future. Good yard design facilitates ease of movement. Little things, such as a change underfoot or a shadow across a gateway, can cause cattle to baulk as summarised below.

Reasons why cattle baulk include:

- People in the way
- Noise—hearing shouting, clanging or bawling from the front of the race
- Activity—seeing activity at the front of the race
- Smells that are unfamiliar or frightening
- Dead ends—such as a loading ramp directly in front of the head bail
- Unfamiliar yards
- Shadows across their pathway
- Changes underfoot, such as a change of surface, drains
- Cattle in adjacent pens standing or moving in opposite direction
- Sunlight in their eyes.

Drafting cattle is a basic procedure and is usually carried out through a gateway. Slow deliberate movements, the restrained use of a piece of alkathene piping or a flag and definite encouragement when the animal chosen is headed through the gate is required. Eyeing the cattle to prevent movement and ceasing eye contact once the animal moves appropriately is important during drafting.

The level of arousal during drafting must be kept low and quiet animals should be drafted away from more excited stock. It is usual to draft cows from calves as the former have experienced drafting before. Drafting should be from small mobs and when mistakes occur, the animal should be left in the incorrect mob until the drafting is complete. Harried cattle are difficult to draft through a gate as they tend to bunch and are reluctant to separate from the mob. It may be better to draft them through a race.



Behaviour of beef cattle is influenced by skill of the handler, the type of animal and its previous experiences, the facilities and the environment

Cattle remember bad experiences, which should be minimized, but can learn quickly to move through yards

Using forcing pens

Forcing pens are designed to funnel cattle into a race. These should be narrow enough to allow cattle to be worked from outside the pen, preferably from a catwalk. It is best not to work inside the forcing pen if possible. Forcing pens should never be over filled as this prevents cattle from being directed to the entrance of the race. The material underfoot should be the same in the pen as in the race. Cattle may balk at the junction of a dirt floored pen and a concrete race.

Working in races

People should not get into races with large cattle, nor should they place their arms or heads into races. If working in a race with small cattle, work should start at the front of the race then proceed backwards. The race should be packed tight to prevent stock movement and reduce space to kick. Working from a cat walk is preferable to working from the ground. The catwalk and race wall height should be sufficient to prevent a person falling into the race. Workers should not bend too low over an animal to inject them or to place an ear tag, as cattle may lift their heads suddenly and hit the worker in the face.

It is important to fill a race tightly if cattle are to be treated from a catwalk as this prevents cattle moving back and forward as they are treated. Filling is done best by walking back along the catwalk and encouraging cattle to move forward through the shoulder balance point. An automatic shutting gate at the tail of the race assists with packing the race tightly.



Forcing pens are designed to funnel cattle into a race

For safe and effective use of races a catwalk should be used

Most yards are square or rectangular but circular or semi circular designs encourage animal flow

The use of semicircular forcing pens and races may reduce time to move cattle by up to 50%

Yard design

Most yards are square or rectangular in shape with a straight race leading off a forcing pen up to a crush and head bail. Newer yards may have circular or semi-circular designs to encourage animal flow. Yards should be on flat ground and be well drained. Cattle tend to move up a slope, so if the yards are on a slope, use this to facilitate movement into forcing pens and races. There should be no large stones or pieces of timber underfoot which may be hazardous to people. Bolts should be cut off flush with nuts and not stick out. Boarding should be placed to act as a barrier to prevent cattle from seeing outside the yards.

Boarded up yards, pens and races may encourage quicker movement of cattle, as they may head towards possible escape routes through gates and into races. In a straight race the leading animal should be able to see right through the head bail. A visual barrier such as a loading ramp immediately in front of the head bail will act to stop the lead animal two body lengths back and well away from the head bail. This is common in yards and it makes getting cattle into the head bail difficult.

The entry gates into yards should be wide to facilitate entry. Drafting gates should be wide enough to allow drafting by two persons without too much difficulty. Corners should be boarded up to stop cattle piling up into a corner. Escape routes should be available and underfoot should be dry and firm without hazards to trip people up.

One wall of the forcing pen should run straight onto the race and the other should be at a 30 degree angle. The tail of the race should be straight for two or three cattle body lengths to encourage cattle to enter. The race tail gate should have an automatic latch to make closing easy.

The use of semicircular forcing pens and races may reduce time to move cattle by up to 50%. Semicircular races and their forcing pens are usually boarded up. This calms cattle and prevents them seeing what is happening elsewhere. If the race is semicircular the lead animal moves around the race because it cannot see any barrier and is looking to escape. Followers tend to chase the preceding animal as they do not want to lose sight of it. The shape means that cattle suddenly come into the crush or head bail without time or space to balk. Loading ramps can come off the semicircular race and not act as a barrier.

Conclusions

The keys to good cattle welfare is sufficient feed and water, available shade and shelter, space to behave reasonably normally and good health. Minimising pain and distress during routine procedures is also important. The efficient working of cattle in yards is influenced more by the behaviour of people and cattle rather than in the design of the yards. Calm, but alert and active people, will shift and treat stock safely and quickly without difficulty. Well-handled and trained cattle respond to quiet handling. The occasional wild animal should be culled to prevent bad behaviour spreading. Some simple modification to yards may speed up cattle movement and reduce baulking. With good people and good yards, cattle should be able to be worked without the use of force.

The key areas to encourage cattle to move efficiently in yards are:

- Board up the wall of the forcing pen at the entrance to the race
- Make sure head bail opens to open space
- Make footing similar through forcing pen and race—remove drains and grating
- Use small pens to work smaller groups of cattle
- Position the race so that the sun does not shine along it during usual working hours
- Board up corners of square yards
- Use rubber tubing to reduce clanging of steel gates
- Hang gates so that they open and close freely
- Use automatic closing gates at the back of the race and forcing pen
- The sun is not in their eyes.

In a squeeze crush or head bail, cattle need to be restrained at the optimum pressure, not too tight and not too loose. Cattle remember being hurt by equipment and if so will balk at entering crushes in the future.



References and further reading

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ENVIRONMENT MANAGEMENT

Recommendations

- Develop and use a whole farm plan to adapt farm system and management to optimise the use of each area of the farm and to target actions to manage environmental risks.
- Identify areas of your farm (critical source areas) where the risks of overland flow entering waterways is greatest, or where soil and faecal matter can be channelled into waterways—look at ways to reduce loss from these areas as a priority.
- Think about how subdivision works on your farm to manage each of these areas, and where possible, provide reticulated water to cattle to encourage them away from natural water.
- Work towards excluding cattle from waterways starting with areas where they are intensively grazed and/or are causing significant bank damage.
- Winter is a critical time of year where management of cattle can increase risks to the environment—plan and execute winter management in a way that will hold on to and minimise damage to soil, keep stock out of water and reduce potential concentration of nutrients under bare soil.
- Careful winter grazing of crops that protect soil and waterways can reduce contaminant loss by at least 40%.
- Help further guard against erosion with good pasture establishment, reduced or no tillage and strategic space planting of trees in erosion prone parts of the farm.
- Retire less productive areas of the farm that are harder to manage.
- Use soil tests and nutrient budgeting to determine fertiliser requirements and target paddock based pasture and stock class management to reduce nutrient loss.
- Protect natural habitat and control pests to help retain and restore biodiversity.
- Strive for improved production efficiency to help minimise greenhouse gas emissions.
- Work with other farmers in your sub catchment to understand what the needs and priorities are for your catchment and work together to address those.
- Monitor and record the progress that you do make.

Introduction

Managing natural resources on-farm is critical to profitability and sustainability and continues to attract the attention of governments, consumers, the general public, lobby groups, researchers and farmers. Many of the environmental impacts of farm management reach beyond the farm boundary and can affect people and environments outside the farm. The fertility, health and conservation of soils are vital to successful beef farming.

Farm development planning is the key to ensuring areas of the farm are treated appropriately. Important components to manage environmental impacts are to:

- Keep cattle out of waterways
- Prevent soil erosion
- Manage winter grazing carefully
- Use fertiliser carefully
- Avoid draining wetlands and swamps
- Establish buffer strips along streams
- Prevent and minimise animal waste runoff where possible
- Use a nutrient budget.



*Good on-farm
management of
natural resources
is critical*

*Nutrient management
and avoiding damage
and pollution of
waterways is important*

How to maintain an environmentally sustainable beef cattle farm

Since the 1970s there has been an increasing focus on the environmental impacts of farming in New Zealand. Some of the main issues are:

- Soil erosion on North Island hill country
- Rabbits and hieracium on South Island high country and their effects on soils and pastures
- Impacts of heavy animals, pasture development and cropping on more fragile soils
- Leaching and nutrient run-off
- Bacterial contamination of waterways by farm animals through direct access and run off
- Loss of native bush and lowland wetlands, birds and other species through farm development
- Effects of ruminants on greenhouse gas production and climate change.

Product processors have implemented quality assurance schemes including aspects of environmental management. These same processors have had to meet increasingly tight controls on their waste disposal practices with regard to water and land contamination.

Three key environmental management points:

1. People's perceptions vary over time. Acceptable management actions and environmental impacts change periodically. The requirements for managing natural resources on-farm are a moving target and vary across the country. Fortunately, much of what can be done to address environmental impacts is also good for the farm business.
2. Many of the environmental impacts of farm management reach beyond the farm boundary and impacts of all the farms within a catchment or region can have an accumulating effect. As an extreme case, effects of animals contributing to global warming may be felt most on the atolls of the South Pacific. Locally, the effects of erosion on waterways may accumulate on the floodplains and estuaries well downstream of the erosion sites.

3. For beef farmers, there are a number of environmental issues that may be important for them to consider. Important issues will vary from region to region, and even from farm to farm. This depends on the soils, climate and waterways in the area. For example, a farm in the Canterbury region with no surface water may not be concerned with erosion into waterways, but may have issues relating to groundwater contamination. A farm in the Lake Taupo catchment will have concerns about nitrate leaching and pollution of the lake. Hill country farms in the Waikato area might be more concerned about stream-bank management and the access of cattle to waterways. So, setting priorities for any one farm relies on an understanding of the regional and local issues for that environment. Priorities then need to be linked back to the soils, landscape and management practices on each farm to optimise the range of solutions.

These actions may sound complicated. However, once there is a goal identified, it is often surprising how simple and obvious the steps can be.

So what are the major environmental downsides of beef cattle farming and how can they be reduced by farmer management? This chapter considers issues related to:

- Soils
- Water
- Native biodiversity
- Greenhouse gases.

Soils

The fertility, health and conservation of soils are vital to successful beef farming.

Soil erosion is the most visible of environmental issues. New Zealand geology and climate mean that erosion is an on-going natural process, which has had a large role in the formation of our landscape. Plate tectonics lift up the mountains and hills and storms erode them down. The fertile plains of the country are built on the eroded remnants of mountains. However, there is strong evidence that the clearance of native forest and shrub vegetation from hill country has increased erosion rates many times above the 'natural' level. In North Island hill country it is estimated erosion rates are about 10 times higher under pasture than in native forest.



Priority setting is important for managing environmental impacts on-farm to ensure they are relevant for the area and the farm system

Soil erosion is the most visible of environmental issues and can be minimised with good pasture establishment, matching land use to land class and strategic planting of trees

Typically, erosion rates are very high immediately following forest clearance, then the rate reduces, as pastures establish and the hills become less erodible. This was illustrated in a project at Whatawhata Research Centre, where a sediment budget for the 200ha catchment hill country farm showed 80% of the land area was erosion prone. The study used a record of aerial photographs and field surveys to calculate that hill erosion had occurred on 22 ha or 11% of land in this catchment since bush clearance in the 1920's. Slip erosion had generated a total of 1000 tonnes/ha of sediment over the whole catchment since bush clearance with most of the hill erosion occurring pre-1943.

Beef cattle farming is carried out on a wide range of landscapes. On erosion prone land options to manage erosion risk often requires some form of vegetation to help bind the soil. This vegetation cover can take many forms, including selected afforestation, native regeneration, space-planting of poplar and willow poles or strategic planting of other tree species. All Regional Councils have staff experienced in use of soil conservation trees, and other organisations have a wealth of practical experience and advice. Improving grazing management can also be beneficial depending on the degree of erosion risk. This can include practices such as contour fencing, only using lighter stock classes (e.g. sheep or young cattle) on erosion prone land, increasing grazing residuals and managing critical source areas.

Looking after soils to reduce pugging, the development of "bull-holes", and the careful allocation of stock to different soil types within the farm at wet times of the year can reduce the amount of surface erosion from pastures. Controlling cattle access to stream banks can also reduce bank erosion and contamination of waterways.

Soil fertility

Good environmental management of farms involves maintaining viability of the soil resource and minimising the losses through leaching export or direct run off. In most parts of New Zealand, soil fertility is naturally lacking in some components, and fertiliser application has been required to build and then maintain high levels of pasture production. Long-term trials show that phosphorus-based fertiliser tripled yields in the development of irrigated pastures on the Canterbury Plains. Experience shows that in the absence of fertiliser inputs, production declines and eventually ceases in much of the hill country, with reversion of pastures to scrub due to poor grass establishment and persistence and lack of grazing pressure.

Fertiliser inputs are required to maintain soil fertility by supplying deficient components. This is often replacing the loss of nutrients through farm production, soil immobilisation and leaching. It is referred to as nutrient balancing, and having a sound nutrient budget is an important component of sustainable farming. The principles of nutrient management are well understood and are incorporated in the Overseer® nutrient budgeting model. It is important to understand that on average, about a third of nutrients that can pose a risk to waterways come from fertilisers, and the remainder comes from animal waste produced as part of the nutrient cycle in a farm system.

The Farm Environment Award Trust (2002) summarised the results of interviews with their winning farmers. The consistent messages for good nutrient management were:

- Establish what fertiliser is needed, based on soil tests, monitoring and expert advice
- Seek advice on switching from super phospahte to reactive phosphate rock
- Apply what is needed, where it is needed, when it is needed
- Manage soils to achieve healthy plants and animals
- Recycle nutrients, within the farm from standoff areas and effluent disposal
- Manage fertility transfer from stock camps through smart subdivision
- Minimise losses to the environment by careful use of buffer strips and wetlands as nutrient traps.

While soil fertility has been associated with soil tests for nutrients, it is clear that the soil physical structure is also important for good production. "Hoof and tooth" cultivation of hill country pastures has been part of the method for development and control of weeds and poor quality grasses. However, there has been considerable research in recent years showing the damaging effects of pugging on soils and pastures, plus the increased risks of runoff to waterways so these methods need careful management or are best avoided.

Farmers responded to these results and their own experiences of the wet winters in the 1990s by adopting two management options: utilising naturally, free draining parts of the farm to winter cattle on; and minimising the liveweight of cattle wintered by improving growth rates and finishing cattle before a second winter. As a consequence of these actions, farmers have reported improved pasture growth and clover content which in turn have allowed further improvements in animal performance.



Managing soil fertility is required to build and maintain high levels of pasture production

Establish what fertiliser is needed, based on soil tests, monitoring and expert advice

Subsequently, the impact of wintering cattle on free draining soils has been linked to high leaching rates of nitrogen to groundwater and this creates a challenge for beef farmers. Management practices of cattle to minimise this impact and other impacts include:

- Using rotational grazing to maintain soil cover on a winter active crop (e.g. Italian ryegrass)
- Moving cattle off areas prone to pugging when heavy rain is forecast
- Using buffer strips to prevent surface runoff reaching waterways
- Minimising the time animals spend on bare soil and establishing cover as soon as possible following grazing
- Moving hay/silage/bailage feeding sites throughout winter to avoid nutrient hotspots
- Strategic grazing of winter crops.

The role of grazing animals in controlling weeds and maintaining feed quality, and the need to ration feed at certain times means that hard grazing and occasional pugging damage are sometimes difficult to avoid.

Water

Water is essential for human life, plant and animal production and the New Zealand lifestyle. Highly correlated with the recreational use of water are expectations of New Zealanders of healthy aquatic ecosystems and good water quality and quantity. The consequences of poor water quality is the limitations this places on use of the water resource, either for human activities or for supporting healthy aquatic ecosystems.

Some indicators of water quality include nutrient concentrations, sediment or clarity, stream temperature, light levels, and habitat modification. Habitat modification and its resulting effects is often the most important factor impacting on aquatic ecosystems in streams in agricultural landscapes.



Indicators of water quality include nutrients, sediment, stream temperature, light levels, and habitat modification

Soil nutrients and water

Nutrients applied to the land via fertilisers or animal deposition promote plant growth. Similarly in waterways, additional nutrients promote growth of aquatic plants, including macrophytes and algae, often in situations where this growth is undesirable. This is seen through the effects of increased weed growth and declining water clarity in some of New Zealand's waterways. Excessive aquatic plant growth can lead to a wide range of adverse effects including problems with water abstraction and reduced recreational potential.

Water borne pathogens

Bacteria and pathogens such as cryptosporidia, giardia, campylobacter in waterways pose a risk to human health through infection from drinking water, eating shellfish or recreational activities. Some human diseases are also carried by animals. Hence, faecal material from humans, feral animals and livestock entering waterways poses a risk to human health.

Sediment

Sediment influences aquatic habitat by smothering plant communities and reducing water clarity. High sediment loadings also cause sediment build-up downstream leading to infill of harbours and lakes and greater flood risk.

Habitat modification

Habitat modification in waterways occurs through changes in the physical condition of the water and the nature of the stream and its surrounding vegetation. Stream temperature is elevated when clearance of stream-side vegetation reduces shading, and higher water temperatures limit the species able to live in a waterway. Similarly, smothering of the stream-bed with sediment reduces habitat for insects and puts nutritional pressure on fish species.

Undisturbed streams have a structure of pools and runs, associated wetlands and vegetation that the resident plants, insects and fish are adapted to. Disturbance to this structure either at local or regional level will influence the aquatic ecosystem. These disturbances might include dams and culverts which prevent fish passage, or the removal of wetlands and vegetation that are important in the lifecycle of insects and fish.

Links to farm management

Nutrients, sediment and bacteria can be carried in surface runoff. This is particularly important for phosphorus. Alternatively, nutrients such as nitrogen can be leached through soils to ground water and will re-appear in surface water via mole-tile drains some minutes later or via deep groundwater. In many cases, losses to ground water won't appear until several years later. The increased loss of nutrients to waterways is caused by three main changes:

1. Different water flow with conversion of forest to grassland and through drainage events from rainfall or irrigation that exceeds the soil field capacity
2. Increases in the fertility of the land and nutrient levels in pastures through long-term fertiliser use and nitrogen fixation by clovers
3. Nutrient application from fertiliser or animal deposition.

Research has shown that each of these factors can be important in nutrient loss, depending on the situation. For sheep and beef farmers, the most important factors are the land use changes and the increase in soil fertility. Careful and precise application of fertiliser using variable application rates is important, and this is detailed in the Fertiliser Industry Code of Practice (1998). However, the effect of any one year's fertiliser application is not the main influence, except where more than 2% of phosphate fertiliser applied falls directly into waterways. Nutrients applied from animal deposition can also be significant contributors to nutrient loss.

The levels of faecal pollution in streams tend to be higher in farmland than forested streams. This reflects the greater number of animals carried on pastures. It is also clear that "hot-spots" of faecal pollution in rivers and lakes are often caused by non-agricultural human activity such as leaking sewers and septic tanks. It is important for farmers to limit the possible risks of faecal contamination of waterways to downstream users, and attempt to minimise risks of farm families and visitors contracting illness from their animals and contaminated water. New Zealand has very high rates of campylobacter and cryptosporidia in both urban and rural areas. Both of these potentially disease-causing bacteria are carried by animals and spread by water and animal contact.



It is important for farmers to limit the possible risks of faecal contamination of waterways to downstream users

Keep cattle out of water, use fertiliser carefully near waterways and don't drain swamps

Sediment comes from erosion. In hill country this is derived initially from hill slopes, with secondary erosion of stream banks. In pumice country, the free-draining soils mean hill slopes are more stable, but stream bank and gully erosion can be a major problem. On flat land, erosion rates are much lower and erosion is much less obvious. Runoff from bare ground, roads and tracks and stream bank erosion are however, all possible sediment sources.

Management responses to minimise effects of sheep and beef cattle farming on waterways include:

- Keep cattle out of streams—this is particularly important for minimising bacteria in streams and reducing bank erosion
- Prevent soil erosion—this reduces sediment and phosphorus run-off into streams. This applies to both mass slip and slump erosion, to surface runoff from pugged pastures and cropped areas near waterways
- Apply fertiliser carefully using precision methods and especially avoid spreading directly into waterways
- Do not drain every wetland—these filter nutrients and sediment from runoff and leaching before they get into waterways
- Maintain yards, raceways and tracks so that runoff passes over a settling area or into another area before going into waterways— ideally avoid placing this infrastructure adjacent to watercourses
- Establish buffer strips and riparian planting to shade streams and provide habitat for natural stream-based fauna and to filter runoff from surrounding pasture.

These actions have many positive benefits for farmers as well as waterways.

Biodiversity

Biodiversity is the variety of life within and between species and ecosystems. In New Zealand we are particularly concerned about the survival and diversity of native species and ecosystems. In *“The State of New Zealand’s Environment”* (1997) the decline in biological diversity was identified as the number one environmental issue facing New Zealand. New Zealand ratified the international Convention on Biological Diversity in 1993. So we are committed to helping stem the loss of biodiversity worldwide.

New Zealand has been isolated from other major land masses for so long that land, fresh water and inshore waters have a very high number of flora and fauna found only in this country. New Zealand has about 30,000 described and named species of native animals, fungi and plants. It has been estimated that there could be up to 80,000 species here in total. While the focus of conservation has been on birds and forests, the major groups are the insects and fungi, each with a possible 20,000 species, and the nematode worms, with more than 10,000 species. Plants and large animals account for barely 5,000 native species in total.

In New Zealand, in only 700–800 years or about 30 human generations, humans and accompanying animals have eliminated about 32% of the endemic land and freshwater birds, three of the seven frogs, possibly three of the 64 reptiles and one of the three bats. Numbers of most surviving species and subspecies have been heavily reduced. Today, nearly 1,000 animals, plants and fungi have been identified as threatened. One of the worst affected groups are the endemic land and freshwater birds; 37 out of 50 species are now threatened.

The main threats to most species are insufficient habitat caused by the farms, roads and settlements which now claim 63 percent of the total land area. Introduced pests and weeds which prey on native species compete with them or damage their habitat. Although nearly 30% of New Zealand’s land area is protected most of this is on steep and mountainous land. Lowland forests, dune lands, streams and wetlands are under-represented in protected areas. This imbalance is illustrated with nearly eight million hectares of publicly owned mountain areas protected, compared with several thousand hectares of lowland reserves and unoccupied offshore islands. In addition, approximately 200,000 hectares of habitat on private land is protected through government-funded covenants and purchases.

Many farmers are already active in preservation through formal activities such as Queen Elizabeth Trust covenants and contributions to possum control through the Animal Health Board. In addition, there is much informal fencing off and active management and restoration of native bush areas, replanting of both exotic and native vegetation and control of weeds and pests.

Measures to manage and improve biodiversity include:

- Ensure that dams and culverts are built in ways that allow fish passage
- Consider re-establishment of wetlands or enhance partially drained wetlands with planting
- Conduct regular pest and weed control
- Protect areas of native bush and wetlands
- Consider which species of vegetation are planted to provide food for native birds
- Create passages of biodiversity across the farming landscape and in conjunction with neighbours.



Decline in biological diversity has been identified as one of the most important environmental issues facing New Zealand

The main threats to most species are insufficient habitat caused by farms, roads and settlements



Greenhouse gases

Farmers are well aware of climatic variability with El Niño and La Niña cycles part of farming vocabulary. In addition to climatic events, there is now widespread scientific acceptance that human activities that release greenhouse gases into the atmosphere are altering the earth's climate. These greenhouse gases include methane, carbon dioxide and nitrous oxide. In most industrialised countries, carbon dioxide from fossil fuels is the main source of greenhouse gases. New Zealand is almost unique among developed countries, in that methane and nitrous oxide outputs from agriculture are the main source of greenhouse gases. Recent estimates are that agriculture is responsible for nearly half of New Zealand's total greenhouse-gas effect on the atmosphere. The energy sector contributes about a third and industrial processes less than 5%.

Methane is produced in ruminants by microbial fermentation of feed in the rumen and then belched into the atmosphere. Dung from grazing animals deposited directly onto pasture produces insignificant amounts of methane, but dung stored in ponds or pits can produce significant amounts of methane from fermentation. Management changes that reduce methane output have the potential to increase utilization of energy by the animal and hence animal performance. The amount of methane produced in the rumen varies with factors such as diet type, level of feeding, size, age and species of animal. Feeding animals better, through increased intake and the use of high energy feeds like

concentrates and better quality pastures, has the potential to increase animal performance and reduce methane output per unit of production. Forage species including lotus and sulla that contain high concentrations of condensed tannins appear to produce less methane when digested by ruminants. Other dietary additives such as probiotics and ionophores may be cost-effective options to reduce methane emissions in future.

Nitrous oxide emissions from agriculture are a result of biological processes in soils and swamps. The two processes are denitrification, the process of changing soil nitrate to nitrous oxide and nitrification, the process of changing soil ammonium to soil nitrate and nitrous oxide.

Management practices that reduce the amount of nitrogen excreted by animals yield the biggest reduction in nitrous oxide emissions. This might be achieved by diet manipulation, in the same way as reduced nitrate leaching.

Altering soil conditions by liming, improving drainage and avoiding compaction have the potential to reduce nitrous oxide emissions by providing soils with better aeration and higher pH. Capturing and storing animal wastes on feedpads in winter could also reduce nitrous oxide outputs. The net effect of these practices must be considered. As well as influencing costs and returns to farmers, these management changes might influence nitrate leaching, soil quality, and methane outputs.



Greenhouse gases include methane, carbon dioxide and nitrous oxide and agriculture contributes nearly half of New Zealand's total

Feeding animals high energy diets can increase animal performance and reduce methane emissions per unit of production

New Zealand has committed to lower greenhouse gas emissions to 5% below 1990 levels by 2020

Industry goals and research in progress

Emissions of greenhouse gases per animal have declined by about 1% per year since 1990 due to increased production efficiency.

As part of the UN Framework Convention on Climate Change New Zealand has committed to lower greenhouse gas emissions to 5% below 1990 levels by 2020.

The Pastoral Greenhouse Gas Research Consortium and the NZ Agricultural Greenhouse Gas Centre are working on additional interventions to help achieve the 2020 goal without sacrificing agricultural production. Methods being investigated to reduce livestock emissions of methane and nitrous oxide and increasing carbon sinks to absorb emissions include:

- Providing means of selecting low methane emitting animals
- Producing low methane feeds
- Developing a methane vaccine
- Identifying inhibitors against methane producing microbes
- Reducing nitrous oxide and nitrate leaching
- Increasing soil carbon.

Farmers should be extremely cautious about purchasing products or making management changes aimed at reducing greenhouse-gas emissions before there are guidelines from the above research. At present the best thing farmers can do is to continue increasing the efficiency of their production. A farm level greenhouse gas report can be obtained from the nutrient budgeting tool Overseer®.

Optimising the farm's natural resources

When planning to intensify a farming operation in an environmentally sustainable way, it is important to have a good understanding of the farm's natural resources and how they will react under different management conditions. This helps ensure management decisions are made that do not compromise water quality, soil health, or accelerate erosion. Long-term productivity gains can only continue if the farm's resources are managed sustainably.

The major capital investment on a livestock farm is the land. Each farm is a unique and complex mix of natural and managed features that create opportunities and present challenges. Landowners are coming under increasing pressure to demonstrate sustainable land use. Understanding the farm's natural resources enables the farmer to confidently predict the effects of changes in management practices including intensification. This will enable the farm business to grow both economically and sustainability.



Understanding the farm's natural resources enables the farm business to grow both economically and sustainability

For effective management of natural resources, develop a land and environment plan for the farm



References and further reading

Beef + Lamb New Zealand Land and Environment Plans, Farm Environment Plans, Farm Environment Management Plans and three Winter forage crop grazing fact sheets are available to download from our website—www.beeflambnz.com

Pastoral Greenhouse Gas Research Consortium—www.pggrc.co.nz

McCaskill LW (1973) *Hold this land. A history of soil conservation in New Zealand*. A.H. and A.W. Reed, Wellington.

A process for optimal land use

Anybody can produce beef but a good farmer will also manage resources for the long term, so that pasture growth is maximised without compromising the land and water. By doing this returns should be maximised.

Farm environment planning is a tool which has been used in New Zealand since the late 1940's, adapted from a process used in the United States to deal with reoccurring drought conditions (McCaskill 1973). It provides a useful process for farmers to assess their resources and develop a plan to achieve the best economic and environmental outcomes, which should lead to positive social outcomes as well.

There are several examples of environmental plans delivered across the country, and increasingly Regional Councils are using them as a way of getting farmers to demonstrate progress and action towards meeting environmental limits. Other Councils have developed whole farm plans and deliver these to farmers on a voluntary basis. Beef + Lamb New Zealand have a Land and Environment Planning toolkit which is supported through a levy-funded workshop. They have also developed plans for regions where they are required by regulation (e.g. Canterbury, Hawke's Bay, and Waikato).

Completing a Land and Environment Plan, in whichever form it is, is a really useful process to objectively assess the land resource and make plans to manage it in the most effective way. In all of these cases, the plan is specific to the farm system for which it is developed and if used well plays a critical role in understanding and managing your farm business.

MANAGEMENT FOR FARM PROFIT

Recommendations

- Identify your beef farming objectives. Take into account the integration of other farm enterprises, and implement management plans accordingly.
- Develop a good management framework including effective strategic, operational and monitoring activities.
- Don't be averse to practice change; these may have substantial benefits
- For benchmarking comparisons, use other farm performance measures based on similar assumptions.
- Consider both the farming and property businesses when assessing profit.
- Implement risk management strategies for financial or environmental influences beyond your control.
- Use key performance indicators as an overall gauge of beef enterprise and farm viability.

Introducing management for profit

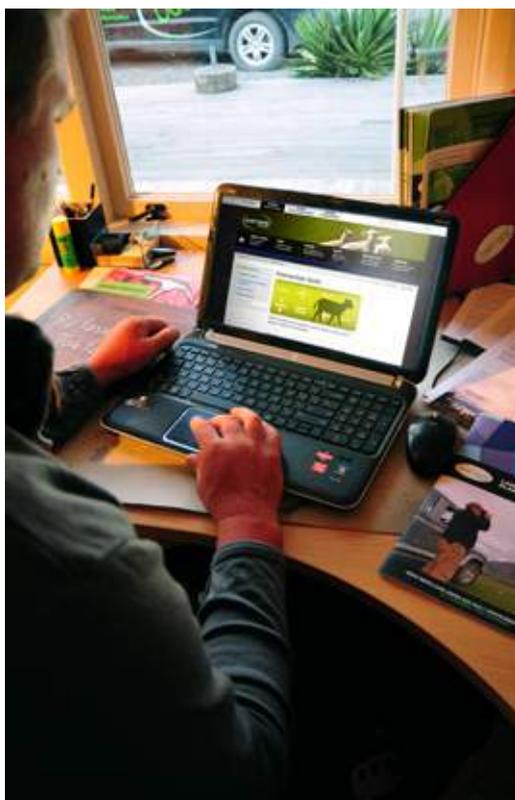
To farm profitably and maintain financial viability beef cattle farmers need to match or exceed the world's best practice. To achieve this, there need to be well-developed processes for the successful management of a farm business, and the integration of beef cattle with other farm enterprises such as sheep.

Management involves planning, implementation and control and can operate at the strategic, technical and operational level. Strategic planning is all about answering the question—"What do we wish to achieve from our beef farming enterprise?"

Benchmarking is about understanding management processes and learning and/or changing for the better. It requires the identification of superior performance which helps in establishing targets for a farm business.

The next step in achieving outstanding performance is "practice change". Old practices need to be dropped or forgotten. Change is often difficult to make because of ingrained habits.

Analysing options is an important part of beef production. Computer models are available to help explore the viability of different options. Gross margin analyses can provide a means to select between beef production options and integration with other farm enterprises.



Beef farmers need to continually strive for best management practice for profit and financial viability

A brief farm business plan, prepared in association with your adviser or accountant, is a necessity

Management framework

The process for successful management of a whole farm business and the risks associated with it are well defined:

- Know where you want to be
- Identify the best strategy and tactics to achieve this
- Implement operations with precision on a timely basis
- Control outcomes through regular monitoring and take corrective action when required.

The business principles underlying this are to:

- Focus on revenue and profit growth
- Use equity effectively
- Avoid over capitalisation, especially in machinery and equipment
- Control costs but not to a level that compromises profit
- Retain a degree of spending flexibility
- Maintain ethical business relationships through regular communication and proper conduct.

Every beef cattle farmer should have a business plan, preferably written and less than five pages. Other enterprises should be included for the overall farm business. It can be prepared in consultation with an adviser or accountant, with both medium term and current year forecasts in it. This plan should be updated several times a year for the current cash balance, and then re-forecasted in light of new information. The business plan should be consistent with the overall mission and goals for the farm. Preparation of these plans for effective farm business management requires quality time and farm work priorities should include office time for this.

Key elements of this farm business plan could include:

- A statement of what you want to achieve and how you will go about it—your farm vision
- Beef enterprise and whole farm goals and objectives
- Current and future farming policy—including balance of enterprises
- PEST and SWOT analysis—strategic planning
- Risk analysis and management
- Monitoring program including key performance indicators (KPIs).

Strategic planning

The purpose of strategic planning is to position the farm business so that it has a long-term competitive advantage in beef production. This requires an understanding of the key influences on present and future beef markets.

The first stage towards strategic planning is to answer the question; “What do we wish to achieve from farming beef cattle?”

The role of management is to consistently implement strategies to realise the farm vision. This can be expressed in a mission statement or concise summary of the overall purpose of the farm business and the aspirations and values of those involved in it. An example might be “To generate equity through beef production to meet our succession and retirement needs.”

Strategy formulation requires:

- A clear definition of the farm’s current position or internal strengths and weaknesses
- An analysis of how farm-level competition, or threats and opportunities within the beef industry may develop
- An understanding of the external environment including future Political, Economic, Environmental, Social and Technological factors, known as a PEST analysis, affect the future for beef farming?

The above information can be arranged into a SWOT analysis of the farm business. Identification of internal Strengths and Weaknesses and external Opportunities and Threats.

This analysis has to be critical and honest. A good way to achieve this is to get outside advice to complement and test your ideas. Seek a consultant, business person or leading farmer who has vision, good analytical skills and an up-front character for this task, and involve all members of the family. Set aside quality, uninterrupted time, possibly even off the farm, to do this planning exercise; it will shape your farming future. It should be an early business task, not one put off until “on-farm” jobs have been done. If the latter priority applies, strategic planning seldom happens.



Strategic planning will position the farm business so it has a long-term competitive advantage in beef production

Management of the farm involves planning, implementation and monitoring for control

The functions of management

Management of a farm involves three basic functions:

- Planning—“bridging the gap” between the present and the future
- Implementation—actioning plans so that they become a reality
- Control—measuring or monitoring and correcting performance as required.

All above three functions must be closely co-ordinated for management to be effective—“doing the right things” and efficient—“doing things right”.

The dynamic and on-going process of management is to work through the cycle of planning, implementation and control which, at times is dictated by the rate and magnitude of change in the factors critical to the success of the business. These “critical success factors” can be identified through planning and should be monitored through Key Performance Indicators (KPIs).

For example, beef production and price are both critical to beef farm profitability, and of these the farmer can most significantly influence production. Management activity should therefore measure total beef output and its efficiency of production. This can include c/kg of DM consumed, carcass sold/kg DM produced and total cost/kg carcass sold versus the net farm gate price received per kg carcass. Management can influence price through timing of sale, meeting quality specifications and forward contracts, and these will be reflected in the average price/kg carcass sold.

A farmer’s management may be informal and largely based on experience, intuition and visual observation, or involve objective measurement and formal analysis. Most New Zealand farmers prefer to operate at the subjective or informal level. This approach may have been adequate in earlier years, but is less suitable to cope with the dynamic, market-led economic environment in which farm businesses now operate. In addition, farmers must now contend with greater constraints on the use of natural resources, and be able to exceed the expectations of increasingly more demanding and discerning consumers. They must therefore develop and apply a wider repertoire of business skills, including those associated with business strategy, to complement their strengths in production management. New tools for monitoring farm performance are regularly becoming available to farmers. From simple enhancements to weighing scales, rainfall and soil temperature collection to feed quality analyses, soil nutrient and water quality tests. These all enable earlier and better decision-making. There are also good systems available for storing and analysing these records.

Levels of planning

Three levels of planning or management can include:

- Strategic—to achieve a sustainable, long-term fit for the farm business with its environment
- Tactical—determining new adjustments to a farm strategy or policy, so that it “fits” with current circumstances, often day-to-day fine tuning
- Operational—further fine-tuning of plans, up to a one month in timeframe, so they can be actioned efficiently.

Strategic or longer term planning should drive lower levels of planning. In practice, farmers often react operationally as events unfold rather than operating to a clear strategy. This short-term reactionary approach to farm management, often compromises farm business growth and success.

Monitoring

Farm monitoring and evaluation is part of the control function of management. It provides information about the farm’s current and future state with the aim of improving the quality of decision making. Good information leads to good decisions. Monitoring also helps to ensure compliance with legislation, and industry quality standards. The aim of monitoring is to connect day-to-day operational management to the strategic goals of the manager or owner. It is not restricted to the current year’s business plan.

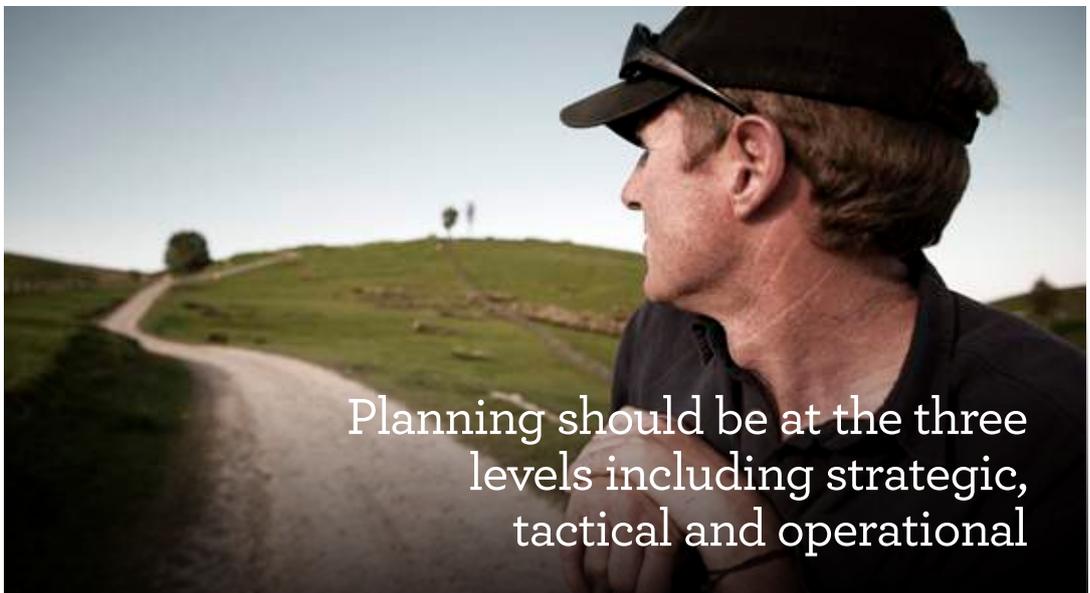
Monitoring describes the actual outcomes of plans as they are implemented, comparing actual and planned values, and correcting deviations from these; either by modifying the original plan or formulating a new plan. Performance indicators, measurement techniques and sources of error are important elements of efficient monitoring and evaluation.

The techniques for monitoring can be broadly classified as objective such as using scales for liveweight, or a revised budget (actual to date compared to planned cash flow), or subjective including visual and intuitive assessment of pasture mass. Alternatively monitoring can be classed as being either formally structured or informally haphazard with accumulation of knowledge over time.

Objective measures are repeatable, provide clarity for communication and can be calibrated against standards. But, these benefits may be offset by greater direct costs, more time and sometimes instrument failure compared to a subjective assessment. Many farmers therefore, prefer informal visual methods of monitoring. Other aspects of the farm business such as social values and personal satisfaction, are usually best expressed and monitored in qualitative terms.

Knowing your current financial position is far better than wondering or worrying about it. This is especially the case for high levels of indebtedness. In these cases the bank often insists on close monitoring of the farms financial position through cash forecasts and associated reviews.

The most critical point is that measurement and a response by management to this occurs, the old adage “If you cannot measure it, you cannot manage it” applies to beef cattle farming too!



To get the best out of monitoring:

- If visual assessments are preferred, then make sure these are calibrated against some standard. If it is pasture cover, then visual assessment should be compared against pasture cut or height using available tools eg sward stick or plate metre
- It is possible to mix objective and subjective monitoring. Once the skills of visual assessment have been honed, it may be quite acceptable to use a formal method for every second, third or fourth measurement. Formal monitoring will build confidence in the informal measurement techniques
- Learn the required skills from an expert such as a farm consultant or researcher
- Be clear about the economic benefits of monitoring—this will make it easier to prioritise time to monitoring. Time is a scarce resource and most is allocated to non-negotiable tasks such as essential farm maintenance and stock management, and personal family interests. Farm monitoring is perceived by many as a “non-urgent, but important” task and without careful time management tends to get left out altogether
- Ensure a clear link between what is being measured and the farm business strategy or goals. This can be very motivating
- Ensure monitoring equipment is fully functional and ‘user friendly’. Stock weighings, for example, can be overlooked because scales are difficult to use
- Get the supporting equipment and tools in place to quickly process and help interpret the data. Data is of no use to management until it is converted into information that can be used for decision-making. Results of monitoring should be mapped to identify whether progress is on track and to help identify whether any corrective responses are required—such as increasing targets. For example, a beef producer should have a detailed live weight profile for steer or bull growth, against which to assess recorded weights. A direct read-out from electronic scales provides real time information such as the average weight, liveweight gain since last weighing, outliers, proportion of mob that can be drafted and animals that may have health problems.



Benchmarking performance against other farms can identify areas for improvement

Benchmarking

Farm benchmarking is about understanding management processes and learning and/or changing for the better. Farmers instinctively “benchmark” against other farmers in an informal manner through the exchange of ideas and experiences. Benchmarking may occur internally for example, for a multi-farm business, but is generally done externally. The four steps in benchmarking are to:

- Understand what is important to benchmark relative to your goals, eg. price of weaners at local weaner fair vs \$/ha
- Identify superior performance properties—or at least the top 5%—either in a defined area of business or the overall business. These performance values can become the basis of target values
- Define “best practice” by investigating and understanding the management practice(s) that give rise to superior performance
- Adopt and if necessary adapt best practice to an individual farm in order to better meet its performance goals. Consideration should be given to personal aspirations and learning styles.

As an example, if the main limitation to farm performance is labour management, then visiting a farm with a reputation for exceptional labour management may be of value. Observe the practices that work, identify the basis of their success, and then evaluate their suitability and adaptability to your farm.

How to benchmark

Contact your local B+LNZ Extension Manager or go onto the B+LNZ website www.beeflambnz.com for benchmarking tools. Another option is to approach your local farm consultant who may already have a benchmarking service.

Best practice is usually related to a process or processes. The process is a set of activities or steps that transforms inputs into outputs, for example pasture into beef. These activities such as grazing management are repeated and can be described. Benchmarks can be defined for each step. For beef production, steps might focus on maximising pasture production through fertiliser policy, grazing management, regrassing and pest and weed control. And progress in animal growth through purchase policy, genetics, feed requirements, or animal health. Computer management programmes, such as FARMAX™, can assist to put all of these pieces together in an ‘optimum’ system for the farm. Management’s challenge is to try and exceed the targets or benchmarks that the computer model suggests are technically and financially feasible.

Practice change and learning

Learning is at the heart of identifying and applying best practice and should be an integral part of a farm strategy. The farm business must anticipate and invest in acquiring the knowledge and skills it will require to succeed in the future. Future beef businesses will need stronger financial risk and information management capabilities than they have at present. Ultimately best practice and associated performance indicators need to be related to farm business strategy and its implementation.

To make further progress, farmers must look for new opportunities beyond those revealed by analysis of data for current systems and technologies. Opportunities lie in the future. They represent un-tapped potential both on- and off- farm. Benchmarking and practice improvement, which is focused on doing extremely well what others are already doing, therefore needs to be balanced by taking a look outside the square.

Risk management

Primarily risk management is about planning for things beyond your control and making sure that things within your control are well planned. Eg. Having a farm plan is within your control and price volatility is beyond your control.

The plan should include:

- A calendar of events
- A recent farm map detailing the hazards, water reticulation system and electric fence infrastructure
- Animal health plan
- Grazing plan.

Another form of risk is the possibility of accident or illness of the farm manager or key staff.

Risk can be alleviated by:

- Developing a cash reserve
- Reducing debt
- Diversifying farm enterprises
- Maintaining an up-to-date cashflow and regularly reviewing the budget
- Developing strategies to cope with adverse weather or environmental impacts
- Ensuring backup management or staff are available.



Practise change is not always easy but it can improve performance

Good planning is a great way of managing risk

Farm profit enables a farmer to achieve the objectives of their beef farming business

Farm profit

For the majority of farm businesses including beef production one of the key outcomes will be a profitable financial result. Profit can be defined as earnings before interest, rent and tax (EBIRT). This will enable the farmer to:

- Maintain the farm
- Service borrowings
- Provide the family with an adequate standard of living
- Allow investment to maintain the farm's productive assets
- Provide funds for further investment to increase long-term productivity
- Ensure ecological and environmental sustainability.

Profitability measures will help benchmark a farm business against standards external to the business. Always state the assumptions used when calculating performance measures and, when comparing with others, ensure they are based on the same assumptions. It is recommended that a farm consultant or accountant assist with guidelines initially.

Other useful benchmarking indicators of business efficiency and profitability are costs of production, costs per unit of output and costs per unit of input.

Determining profit

To determine profit, there first must be an assessment of income and expenses. Both cash elements and non-cash adjustments are used in calculating income and expenses. To determine the profitability of any one product, including beef/sheep animals or meat on the farm, an allocation of expenses to that product is required. Direct expenses such as animal health and freight are relatively easy to assess and allocate. But, overheads such as consultancy, repairs and maintenance are more complicated. A decision has to be made on how much of each overhead expense should be charged to each product produced by the farm. Overheads should also include both a value for unpaid family labour and management, and an annual charge for the cost of capital invested in the farm to provide a full economic costing for the products.



Income and inventory changes. The actual income relevant to the costs incurred in any one year is the sum of cash sales less cash purchases plus any changes in inventory. Inventory includes both produce in store such as grain and 'live' inventory, such as beef cattle. Because these live inventories may also reproduce animals, it is essential to complete inventory reconciliations with every assessment of income.

When income or Gross Farm Revenue (GFR) is calculated for management purposes, the same values are used for valuing both opening and closing stock of the same age or classification. Values selected are as close as possible to market values. This method is used in the "Sheep and Beef Farm Survey" produced annually by the Beef + Lamb New Zealand Economic Service. Their GFR calculation includes inventory adjustments for changes in cattle and sheep numbers, between the beginning and end of the year. For livestock inventories, the IRD national average market values at closing are acceptable for the calculation of GFR, whereas inventory of other stock or produce is valued at fair market value.

Gross farm revenue can also be expressed per kg DM consumed, per hectare or per stock unit. This can be compared with similar farms provided the financial year is the same. This is termed benchmarking or comparative analysis. GFR can also be compared for the same farm for different years—a time series analysis or within-farm comparison over years.



Key determinants of profit are income and expenses but inventory changes should also be included

Operating costs. These are a combination of the cash expenses incurred including farm working expenses and non-cash expenses. These latter expenses include:

- Those that account for changes in the amount of input inventory such as chemicals, feed supplement, on hand at year-end
- The annual allocation of capital costs through depreciation charges
- The recognition of inputs that have not been paid for such as family labour and management.

Changes in input inventory are seldom recognised in New Zealand financial statements although, it is recognised as good practice in other businesses and is common overseas.

Structure of farm profit. To assist in understanding farm profit it is helpful to split the farm into two businesses that are often, but not necessarily linked (Figure 1). The two separate entities are:

- The property business, where success is measured by changes in asset values over time and is driven by smart purchase and sale decisions and respective valuations
- The farming business, where success reflects effective and sustainable farm operations.

The profitability of a farm investment is the sum of its farming and its property businesses. One is delivering primarily a cash result and the other is not. 'Asset rich, cash poor' is a commonly used term by some farmers. The problem inherent in a land investment is therefore that of liquidity not profitability.

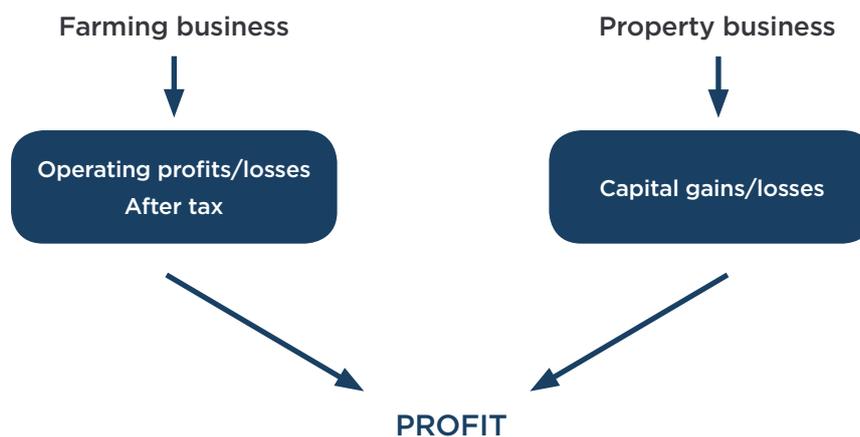


Figure 1: Components of profit estimated for each financial year.

Table 1: Key financial performance indicators for sheep and beef cattle farms in New Zealand.

Indicator	Strong/Safe	Average	Weak/Careful
Equity	>90%	75-90%	<75%
Operating Costs as % Farm Income	<50%	50-75%	>75%
Interest Costs as a % of Income	<7%	7-20%	>20%
Return on Capital	>8%	2-8%	<2%
Debt to Gross Income Ratio	<1:1	1:1 to 1.3:1	>1.3:1

If the above indicators have cause for concern it is recommended that a farm consultant or accountant be contacted for discussion. The picture often becomes clearer with an outsider looking in at your farming business and such discussion may lead quickly to resolution of any identified problems or opportunities.



References and further reading

Beef + Lamb New Zealand economic tools including a production calculator available at our website www.beeflambnz.com

Lincoln University Financial Budget Manual, can be purchased via Lincoln Bookshop. shop.lincoln.ac.nz

Lincoln University farm Technical Manual, can be purchased via Lincoln bookshop. shop.lincoln.ac.nz

Machado, C., Morris, S.T., Hodgson, J., Arroqui, M.A., Mangudo, P.A. (2010). *A web-based model for simulating whole-farm beef cattle systems*. Computers and Electronics in Agriculture 74:129-136.

Martin, N., and Shadbolt, N. (2005). *Farm Management in New Zealand*. Published by Oxford University Press ISBN 019558389 2.

APPENDICES



APPENDIX ONE

*Assessment of pasture mass and pasture quality***General comments:**

Assessment of pasture mass and quality is thoroughly described in the Meat New Zealand sponsored publication described below under "Further Reading". A colour photo supplement showing differences in pasture quality is included in the package. Therefore, the following outlines principles only.

Pasture assessment is used to estimate how much feed is available to grazing animals on pasture: either the "average cover" over the whole property or block, or "pre- and or post- grazing" particular grazing breaks. Assessment of pasture mass is notoriously difficult due to:

- The wide variation encountered in even the most consistent looking paddocks
- Differences in cutting height between operators.

The "golden standard" of pasture assessment is based on cutting quadrat sample sites to ground level, collecting the samples, washing them and then drying them overnight in an oven. From a dry weight assessment, the per-quadrat area is determined to estimate pasture mass per hectare. Assessment of pasture quality is carried out in a similar manner except that sub-samples of the components of the sward (green, dead pasture etc) are dissected out and dried separately. Both processes are quite laborious. Very few farmers are willing to invest either the time or the equipment to do them. Most scientists, consultants and farmers use some indirect method, which is calibrated to the above (refer Chapter eleven, "Management for farm profit").

Visual assessment is a preferred method of assessing pasture mass for the following reasons:

- It can be surprisingly accurate for individuals who are confident, experienced and properly calibrated.
- Calibration can be achieved in a half hour session or two.
- Calibrated individuals can mentally adjust for variation in sward composition, sward density, season and the proportion of dead DM in the sward.
- Visual assessment is by far the quickest and most convenient method available.
- It can be readily adapted for "broad brush" type assessments of whole paddocks from some vantage point (such as a motorbike seat!). Clearly, accuracy suffers with this type of approach, but it may well be perfectly satisfactory for grazing management purposes and could be a great deal better than nothing.
- Because it is so easy, farmers are actually more likely to use it!

Other indirect pasture assessment methods include the:

- "Falling" or "rising plate"
- "Pasture capacitance meter" or "pasture capacitance probe"
- Height measurements (pasture rulers).

The main strength of these devices lies in their objectivity, a potential weakness of visual assessment. Their main weakness is in their inability to adjust for different pasture conditions or composition, a potential strength of visual assessment. In addition, they can create an illusion of accuracy well beyond that actually being achieved. The devices struggle to be accurate on pastures with very high dead matter regardless of the calibration chosen. For example, the modern capacitance probes do not measure "dry" dead material and will give higher readings when pasture is wet than when dry. In these conditions (often dry summer/autumn periods), it may be preferable to rely solely on visual assessments or the pasture ruler.

Despite the above comments, the above devices have a useful role to play, especially when accurate calibration of visual assessment (see below) is not easily available. They are regularly advertised in farming magazines. Suppliers of these products usually include several calibration equations with the product, which enables pastures to be assessed in a range of conditions or different seasons. "Pasture rulers" relating pasture height to pasture mass at different times of the year are available from fertiliser companies and stock and station agents.

Calibrating for visual assessment is done through a professional "expert" such as a field day or consultant or by using the pasture probe or the rising plate described above.

When visually assessing pasture there are a few common biases:

- High dead matter pastures are under-estimated.
- High mass paddocks are under-estimated.
- Low fertility swards with a "mat" are under-estimated.
- Upright, low-density swards are over-estimated.
- Swards with high legume content are over-estimated.
- When the pasture is highly variable the eye will be drawn to the longer pasture.
- Pastures look longer when the sun is low because of the shadows.
- Pastures appear of higher mass when looking down hill because of the appearance of camp and track areas.

It should be possible to assess pasture mass measurement to within 200 kg DM/ha

Further Reading:

Beef + Lamb New Zealand, 2012. *Pasture quality: Principles and management, The Q Graze Manual*. First published January 2002 AgResearch.

Webby, R.W.; Pengally, W.J. 1986. *The use of pasture height as predictor of feed level in North Island hill country*. Proceedings of the New Zealand Grasslands Association. 47:249-253.

APPENDIX TWO

The “wash” method for facial eczema spore counting on pasture

Collecting the sample: To sample a paddock, cut (or using finger and thumb, pinch) samples of pasture from about 1cm above ground level from at least five places about 10m apart. It is important to at least sample down to the grazing height of the animals. There will be some variation in spore numbers from place to place even in an apparently consistent paddock, particularly if pasture is long. Collection from several places averages this variation.

Do not select for any particular pastures species and try not to include soil in the sample as this makes counting needlessly difficult. Avoid parts of paddocks sheltered by trees or hedges. If the same site is sampled regularly, always follow the same route across it.

Method of spore counting: Spores are washed off pasture leaves by shaking the leaves with ten times their weight of water. The spores in the wash water are then counted in a haemocytometer or blood counting slide (Figure 1) under a microscope. With a little experience the whole procedure takes about 10 to 20 minutes.

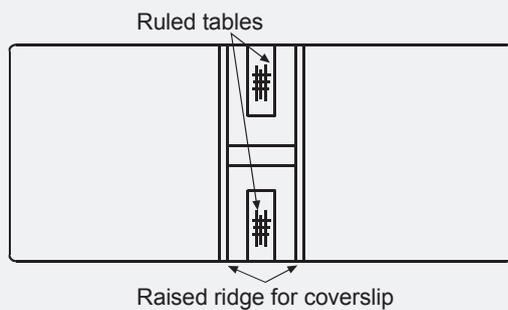


Figure 1: Approximate life-sized diagram of a blood counting slide used for facial eczema spore counting.

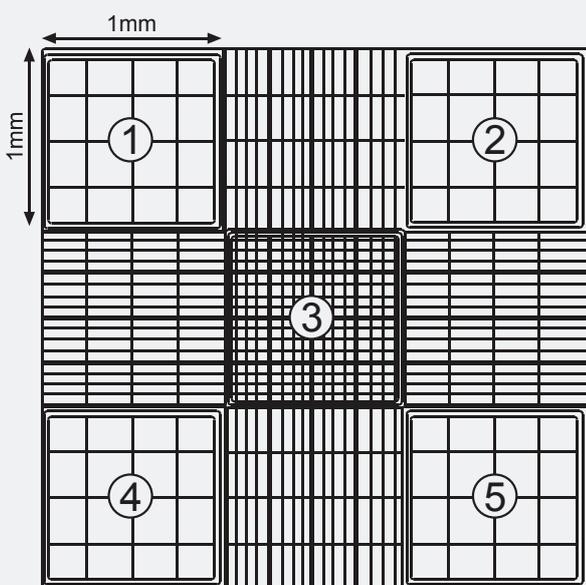


Figure 2: Highly magnified representation of one of the ruled spore counting tables shown in Figure 1. Only large squares 1 to 5 are used for counting. At the appropriate magnification, one large square should fill the microscope eyepiece field.

The two tables of the slide are each ruled into nine large squares, the sides of which are 1 mm long (Figure 2). These large squares are further divided by fine lines, which are ignored for spore counting.

At the magnification used for spore counting, 100 x or thereabouts, only one square of side 1mm can be seen. The raised ridges on each side of the rule tables are 0.1mm above them. When a cover-slip is placed across the ridges, it makes a chamber 0.1 mm deep so that the volume of wash water above each of the large squares is 0.1 cu mm.

There are a number of brands of haemocytometer slide on the market. Some models may have slightly different fine rulings.

Making the count: To make the spore count: weigh 60g of the pasture sample, put in a screw capped jar with 600ml of water and shake well for three minutes. Good quality kitchen scales and a measuring jug are suitable for weighing and measuring. As soon as possible after shaking, take some of the wash water in a dropper and, with the cover-slips in place, fill the haemocytometer slide. Never apply the wash water before putting on the cover-slips.

Count the spores in the middle and corner squares of each haemocytometer slide chamber (Figure 2). Count two slides worth of samples. Re-shake the bottle prior to taking more wash water samples.

The calculation: The sum of the spores seen in 20 squares multiplied by 5000 is the number of spores/g of leaves.

Clean the haemocytometer slide immediately after use by rinsing in cold running water and dabbing dry with a paper towel, toilet paper or soft cloth (e.g. t-shirt!).

Recognition of *Pithomyces chartarum* spores: The spores are of characteristic appearance, brown or slightly green and barrel or hand grenade shaped (Figure 3). Very young cells may be greenish.

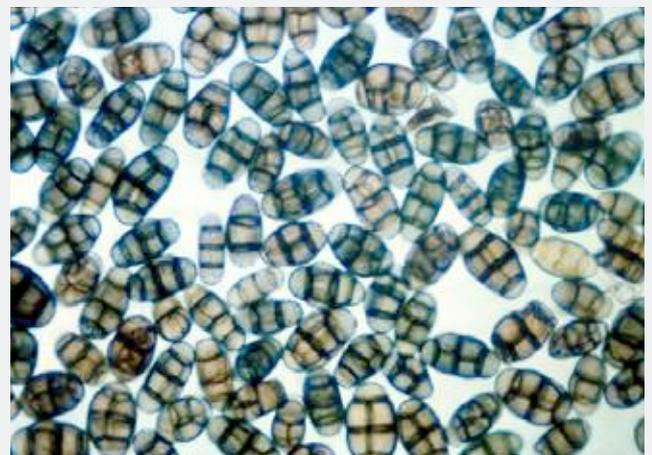


Figure 3: Appearance of *P. chartarum* spores under the microscope. There are many more spores in the figure than are normally seen in counting slide samples.

APPENDIX FOUR

Condition scoring (CS) for beef breeding cows

Beef breeding cows in New Zealand often fill a pasture “grooming” and management role on-farm, which can contribute to considerable fluctuations in the quantity and quality of feed offered to the breeding cow herd.

Beef cows are resilient and can withstand periods of restricted feeding by mobilising body reserves to buffer the feed supply, provided they are in sufficient body condition prior to the feed shortage.

Body condition scoring to a standard scale allows consistency within and between herds over time, and more objective assessment of BCS differences.

- A BCS scale of 1-10 is detailed in this booklet.
- BCS should be between 5-7 depending on the time of the year.
- A cow with BCS less than 3 is considered emaciated.
- A cow with BCS of more than 8 is considered obese.

The BCS in this appendix relates to British breeds such as Angus, Hereford, Shorthorn or their crosses.

Live weight or condition?

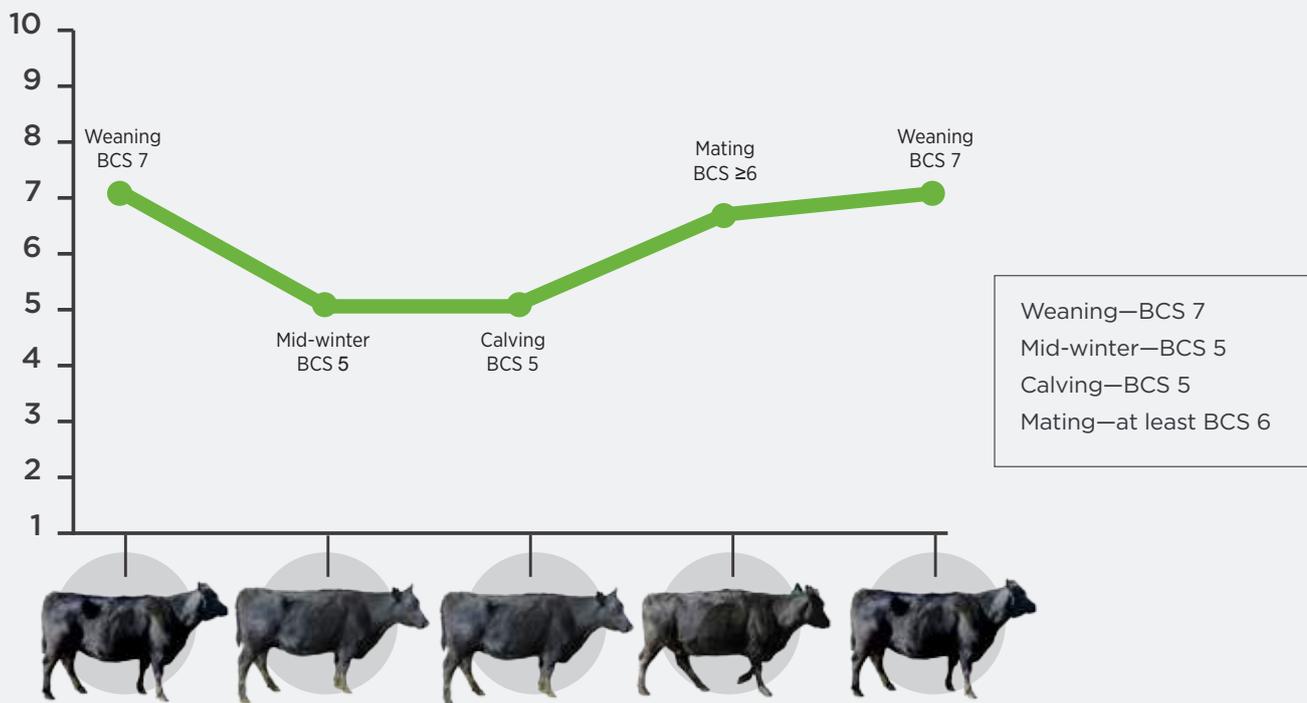
Body condition scoring offers several practical advantages over live weight recording.

Firstly, it is a more accurate predictor of body reserves and measure of change in body reserves over time. This is because it is not affected by weight of the fetus during pregnancy, and it is independent of frame size. Cows continue to grow in size until around six years of age and may increase in live weight without increasing in condition.

Secondly, body condition score can be assessed in the paddock. Accurate measurement of live weight requires cows to be moved through the yards, whereas BCS can be assessed in the paddock or as they are moved through a gateway from one paddock to the next.

Preliminary investigation indicates that 1 unit of BCS is approximately 30 kg of live weight for cows with a mature live weight of 520 kg, for those between BCS 4 and BCS 8.

A tall thin cow and a short fat cow may have similar live weight but be in quite different body condition. Decisions around their management should be based on body condition score, not live weight.

Body condition score targets

Calving to mating

The most important period of the year for the beef cow is from calving to mating.

Gaining body condition during this period gets her calf off to a good start and increases the chances she will conceive early in the mating period.

A BCS of at least 6 is recommended at mating. How well cows can be fed between calving and mating determines the BCS target for calving. A BCS 5 at calving, increasing to BCS 6 at mating, is sensible. When cows are fed well post-calving they have the capacity to gain >1 kg lwt/day. An increase of 1 BCS over this time is just 0.4 kg/day.

If cows fail to reach the target BCS for mating, they will have delayed mating and a protracted calving spread the next year. They will also have reduced milk production and calf growth rate in the current season—this will result in smaller weaners.

Post-weaning and winter

BCS at weaning depends on the summer feed conditions each year, but should usually be BCS 6-8. Cows with BCS 7 at weaning can safely lose up to 2 BCS in autumn and early-mid winter.

Running beef cows at too high a BCS wastes valuable feed resources. There is usually a compromise between fat on the back and feed in the paddock. It is better to take body condition off earlier post-weaning to preserve covers in winter, than to eat the grass in autumn/early winter and be forced to take the condition off the cows just prior to calving.

It is not recommended to let cows drop below BCS 4 during winter. If they drop as low as BCS 4 then they should be drafted off and preferentially fed. Ideally they should regain some condition prior to calving at which time they should be BCS 5.

In harsh winter environments, some surplus BCS may be useful to buffer cows through adverse weather events. Cows should not drop below BCS 5 in these conditions.

Consider BCS on a per cow basis, not a herd average. If the light cows are drafted off the bottom of the herd, the rest of the cows can be worked harder.

When to condition score

- Weaning—to understand how much “fat on the back” which can be considered as “hay in the barn”. This is useful for feed planning for winter.
- Over winter—to monitor BCS loss with the objective of losing up to 2 BCS over the first 100 days post-weaning. As cows are shifted between paddocks, draft-out cows that have dropped to BCS 4 for preferential feeding.
- Two months pre-calving—last chance to gain condition if needed before calving.
- Calving to mating—monitoring to ensure cows are at least BCS 6 at mating.

Autumn body condition

Cows that are BCS 7 at weaning can afford to lose 2 body condition scores to calve at BCS 5.

By mobilising 2 body condition scores, a 560 kg cow in BCS 7 at weaning requires 19% less energy over the 100 days post-weaning, than a cow that remains in BCS 7.

This is equivalent to 12 bales of hay over the winter period (assuming 9 MJ ME/kg DM and 16 kg DM bales).

The feed saved by mobilising 2 body condition scores from 100 cows would increase pasture reserves later in winter, enough to maintain 800 ewes at BCS 3* rather than have them drop to BCS 2.5.

**Note: cows are scored on a 1-10 scale, whereas ewes are scored 1-5 including half scores.*

How to condition score

Condition scoring can be done standing on a catwalk as cows move through a race, or by inspecting the cows in a yard or paddock.

Cows can be condition scored as you drive slowly through a paddock or off the back of a horse as you move cows through a gateway.

The same approach should be used consistently if you want to compare between observations.

When learning to score, it may be useful to use your hands to touch the spine, short ribs, rump, hips, pins and tailhead of a few cows in the race first. This lets you get a feel for the condition carried at the different scores and is useful to calibrate your visual assessment.

Look beyond the cow's rough or smooth coat to assess the underlying body condition.

A herd average BCS is of limited value. The real value of BCS is knowing how many cows are under the target BCS so feed can be planned to address this challenge.

Dairy-cross beef cows will have target BCS 0.5 less than recommended for British breeds, but BCS 4 should be the minimum for all cows.

There is an old but true saying that over winter “you cannot have fat on the back and feed in the paddock” in a productive farm operation.

BCS 4-7 for the same cow



BCS 4



BCS 5



BCS 6



BCS 7

BCS 4



BCS 5



BCS 6



BCS 7



BCS 8



BCS 9



APPENDIX FIVE

Nutrient composition of commonly available feeds for cattle and sheep

Feedstuff	DM (%)	Cr protein (g/kg DM)	ME content (MJ/kg DM)	Mineral content (g/kg DM)				Av. Range of yield t/ha
				Ca	P	Mg	Na	
GREEN FEEDS								
Grass/clover mixes								
Spring, leafy	14	240	11.8	6.0	4.5	1.5	1.5	5-7
Summer, leafy	20	150	10.0	8.5	4.0	2.0	2.0	
Summer, dry & stalky	25	100	8.0	7.0	3.0	2.0	1.0	
Winter, autumn saved	17	200	10.0	7.0	4.0	1.8	1.5	
Winter, leafy	14	260	11.2	7.0	4.5	1.5	1.5	
Kikuyu grass, summer	22	140	8.5	6.0	3.9	1.8	0.6	
Lucerne, leafy	18	280	12.0	16.0	3.0	2.5	0.6	10-15
Lucerne, 10-20% flower	23	220	10.0	13.0	2.8	2.4	0.5	
Maize, 1.3 - 1.6m	22	90	10.3	4.0	2.5	1.5	0.2	
Oats, leafy	18	180	12.3	6.0	3.0	1.5	4.0	5-8
Paspalum, leafy	18	180	10.5	7.5	4.0	2.5	0.6	
Paspalum, flowering	23	100	9.3	5.6	3.0	2.5	0.4	
Red clover, spring	17	280	11.5	11.0	3.5	3.0	0.8	6-8
Sorghum, Sudax (1m)	20	180	10.0	4.7	2.3	2.0	0.2	
Tama ryegrass	12	240	12.0	4.0	4.0	1.5	2.5	
White clover	15	280	12.2	12.0	4.0	3.0	3.0	6-8
SILAGES								
Pasture, high quality	23	200	10.0	7.0	4.3	1.7	1.7	
Pasture, poor quality	28	150	8.0	5.5	2.8	1.4	1.6	
Lucerne	20	200	9.5	10.0	2.6	2.0	0.5	10-16
Maize, early dent	30	80	10.3	3.0	2.0	1.2	0.1	15-18
HAYS (pasture)								
good quality	85	170	9.7	8.0	4.0	2.0	2.0	
medium	85	110	8.5	6.0	3.5	1.9	1.7	
poor	85	70	7.3	4.0	3.0	1.8	1.5	
STRAWS								
Barley	85	40	6.5	3.0	0.8	1.7	1.1	4-10
Maize stover	85	50	7.5	6.0	1.0	4.5	0.7	
Pea	85	80	7.0	16.0	1.2	-	-	4-6
Ryegrass	85	60	7.5	4.0	3.0	1.5	1.5	
CROPS/BYPRODUCTS								
Carrots	12	9.9	13.2	0.4	0.4	0.2	1.0	60-70
Choumoellier	15	145	11.5	15.0	2.4	2.7	3.3	
Fodder beet	18	100	11.5	1.2	1.7	-	-	22-28

Feedstuff	DM (%)	Cr protein (g/kg DM)	ME content (MJ/kg DM)	Mineral content (g/kg DM)				Av. Range of yield
Mangolds (roots)	10	100	11.5	1.5	1.8	2.0	6.0	
Potatoes	24	90	12.0	0.3	2.5	1.0	1.0	60-80
Pumpkin	8.4	16	12.9	0.3	0.5	0.1	0.0	20-30
Rape	17	160	12.0	15.0	4.0	0.7	0.5	5-12
Swedes, bulbs	10	120	12.4	1.3	2.0	2.0	1.0	10-16
Swedes, tops	15	150	12.8	25.0	2.7	4.0	2.0	
Turnips, bulbs	9	150	12.4	6.0	3.0	2.0	2.0	5-10
Turnips, tops	13	180	12.8	35.0	3.4	4.0	3.0	
Barley	86	110	13.0	0.6	4.4	1.8	0.3	8-14
Bran (wheat)	86	160	9.8	1.0	12.0	6.0	0.4	
Linseed cake	87	300	12.0	4.4	8.0	6.0	0.7	3
Lucerne meal	87	200	11.0	16.0	3.0	3.0	1.5	
Maize	86	80	13.6	0.03	4.2	2.0	0.03	11
Oats	86	130	11.5	1.1	3.9	1.4	0.1	8-15
Palm kernel extract (PKE)	90	16	11.0	0.3	0.7	0.3	0.0	
Peas	87	240	13.0	1.4	4.3	1.7	0.1	
Skim milk powder	94	350	13.0	12.5	10.0	1.2	6.0	
Soya beans	90	500	12.9	2.7	5.5	2.6	0.1	
Wheat	86	130	12.6	0.6	4.0	1.6	0.1	8-17
MISCELLANEOUS								
Brewers grain	24	230	10.0	3.0	6.0	1.0	2.0	
Molasses	75	40	12.0	12.0	1.0	4.3	1.5	
Urea	99	2875	-	-	-	-	-	

Break feeding calculation Works out the size of your break each day

Feed type

In this example a rape crop:

Yield—5,000 kg DM/ha

Energy content—12 MJ ME/kg DM

Worked example 1

Animals

A mob of 75 400 kg cows at maintenance:

Feed requirement—55 MJ ME/head/day (Table 1, Chapter 4)

So require $55/12 = 4.6$ kg DM/head/day

A mob of 55 350 kg steers to grow at 0.5 kg/day

Feed requirement—71 MJ ME/head/day (Table 4, Chapter 4)

So require $71/12 = 5.9$ kg DM/head/day

Worked example 2

Amount of feed

DM/square metre = $5,000/10,000 = 0.5$ kg DM/sq m

So each day require $4.6/0.5 = 9.2$ sq m/head/day

For 75 cows need $75 \times 9.2 = 690$ sq m/day

DM/square metre = $5,000/10,000 = 0.5$ kg DM/sq m

So each day require $5.9/0.5 = 11.8$ sq m/head/day

For 55 steers need $55 \times 11.8 = 649$ sq m/head/day

Break size

Say width of break is 75 m, distance to move fence is $690/75 = 9.2$ m

Say width of break is 75 m, distance to move fence is $649/75 = 8.6$ m



beef+lamb
new zealand