SHEEP AND BEEF CATTLE PRODUCTION SYSTEMS

Stephen T. Morris
Institute Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11222, Palmerston North 4410, New Zealand

ABSTRACT: The New Zealand climate favours pasture growth, and it is the key to sheep and beef cattle production as pasture provides over 95% of the diet of sheep and beef cattle. Production systems range from intensive sheep and beef cattle farms on the highly productive lowlands, through to extensive high country farms involving mainly sheep. The New Zealand meat and wool sector has always been a principal driver of the New Zealand economy, generating approximately $7.5 billion annually in export earnings, and forming the basis of the visual and social landscape of New Zealand. New Zealand is the largest exporter of lamb in the world accounting for around 47% of the world's trade in lamb. Lamb and mutton export revenues for the year ending 30 September 2012 were estimated at $2.96 billion. Since the 1980s there has been a 25% increase in lambing percentage and carcass weight and a 50-gram-a-day improvement in lamb growth rate without changes in stocking rate. These gains have occurred at a time when labour inputs have been reducing as sheep productivity per labour unit has also improved by at least 35%. Much of the sheep and beef cattle in New Zealand are farmed on hill or high country at low stocking rates and hence often biodiversity is maintained in such habitats. The pastoral landscape is becoming more dynamic and sophisticated, with greater movement of animals between farms and the boundaries between sheep, beef, and dairy farms becoming increasingly blurred. New Zealand will, in the future, promote and market its livestock products on the basis of quality and position itself at the top end of the market. The industry will think more in terms of quality not quantity and value not volume.

Key words: beef, beef cattle, lamb, mutton, profitability, sheep, wool.

INTRODUCTION

From its establishment the sheep and beef cattle industry has proved to be the cornerstone of the New Zealand economy. Reared for meat and wool, sheep have dominated the New Zealand farming landscape since their introduction over 180 years ago (Carter and Cox 1982). Today sheep and beef cattle production is the dominant land use, utilising 66% or 9.7 million hectares of New Zealand's agricultural and forestry land (MPI 2012a).

The New Zealand climate favours pasture growth, and it is the key to sheep and beef cattle production as pasture provides over 95% of the diet of sheep and cattle (Hodgson et al. 2005). Production systems range from intensive sheep and beef cattle farms on the highly productive lowlands, through to extensive high country farms involving mainly sheep. New Zealand grasslands can be conveniently divided on the basis of topography and elevation into three broad farming groups: high, hill, and flat to rolling country (Table 1). Each varies in the quantity of pasture produced and the number and type of animals carried. High country is characterised by hilly terrain and low pasture production, especially during the cold winter months, and is used predominantly for sheep farming based on fine wool production. Flat to rolling country usually has good all-year-round pasture production and supports almost all of New Zealand's dairy cattle in addition to large numbers of sheep and beef cattle.

VALUE OF SHEEP AND BEEF PRODUCTION TO THE NEW ZEALAND ECONOMY

The New Zealand meat and wool sector has always been a principal driver of the New Zealand economy, generating approximately $7.5 billion annually in export earnings, and forming the basis of the visual and social landscape of New Zealand. The sectors have a strong export focus with 82% of beef, 92% of sheep meat, and 90% of wool exported. The sector exports for the year ended 30 September 2012 represented approximately 28% of all designated agricultural exports. New Zealand produced an estimated 602 000 tonnes of beef and bobby veal, 448 000 tonnes of sheep meat and 164 000 tonnes of wool in 2012 (Beef + Lamb New Zealand 2013). Strong revenues for the sheep and beef sector over the past 2–3 years have been driven by historically high prices and good production levels. However, the sustained strength of the New Zealand dollar – which has appreciated against most major trading currencies since June 2012 – is a concern for the sheep and beef sector as such a large proportion of the production is exported (MPI 2013).

Lamb and mutton

New Zealand is the largest exporter of lamb in the world accounting for around 47% of the world's trade in lamb (Morris 2009). Lamb export revenues for the year ended 30 September 2012 were estimated at $2.59 billion with mutton exports generating another $377 million dollars in export receipts (Beef + Lamb New Zealand 2013). The major market for lamb is the European Union, which takes around 50% of New Zealand lamb exports by value, while the United Kingdom is the biggest single-country market, taking 25% of lamb exports. New Zealand has a tariff-free quota of 227 854 tonnes carcass weight equivalent for sheep and goat meat imports into the European Union. This quota was underfilled by 20% in the 2012 year as China became New Zealand's largest market for frozen lamb cuts during the 6 months to 30 June 2012, accounting for 31% of export volume.

TABLE 1 Area, pasture production and number of livestock carried on the three grassland regions (from Hodgson et al. 2005)

Region	Area (millions of hectares)	Pasture production (tonnes DM[1] per hectare)	Livestock (millions)			Stock units[2] per hectare
			Sheep	Beef	Dairy	
High country	4.5	2.0	2.5	0.1	-	0.7
Hill country	5.0	7.0	20.3	1.9	0.2	7.5
Flat to rolling	4.5	11.0	26.7	2.9	3.4	14.0

[1]*DM = dry matter.*

[2]*Since most farmers have both sheep and cattle, the stock unit (su) is the common unit used to express stocking rate where 1 su = one breeding ewe, consuming 550 kg DM per year.*

Morris ST 2013. Sheep and beef cattle production systems. *In* Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand.

A high proportion of the sheep meat exports to China were of lower-value cuts and the average price of lamb sold to China is about half that obtained in the European Union (MPI 2012a).

Beef production

Beef exports (including beef co-products) for the year ended September 2012 generated $2.5 billion in export receipts. Between 100 000 and 120 000 tonnes is consumed in the domestic market. Of the adult cattle that were slaughtered for export in the year ended 30 September 2012 approximately 26% were steers, 17% heifers, 37% cows and 20% were bulls (Beef + Lamb New Zealand 2013). The dairy industry contributes significantly to beef production with an estimated 35% of calves entering the beef industry each year being born on dairy farms and an estimated 600 000–700 000 dairy cows processed for beef each year (70–75% of the adult cow kill) being of dairy origin.

Wool

New Zealand is the third largest producer of wool in the world, producing 12% of world production on a 'clean' basis. In 2012 New Zealand export receipts from wool totalled $889,000 (MPI 2012b). Most of the wool produced (88%) is described as strong crossbred wool (greater than 31 microns) and China is the major market with the proportion of wool exports going to China increasing from 27% to 53% over the last 5 years, with 70% of this being classified as strong wool largely used in carpet manufacture (Beef + Lamb New Zealand 2012). Fine wool (less than 25 microns) accounts for around 10% of our production. Thirteen percent of the wool clip originates as slipe wool (that which is removed from pelts after processing of sheep at meat plants).

DYNAMICS OF THE LIVESTOCK SYSTEMS

There are few specialised sheep or beef cattle farms in New Zealand. A farmer having sheep and beef cattle on the same farm increases management flexibility through the ability to preferentially feed some livestock while maintaining high levels of grazing pressure with other livestock classes. The role of the breeding cow has been, and continues to be, important in the sustainability of hill country farms where the contour requires that pasture control – the maintenance of species within the sward, and the prevention of pasture deterioration and weed ingress – is primarily a function of livestock pressure and grazing management. This requires that beef cattle graze with sheep and this is seldom to the short-term benefits of the cattle, but often improves the performance of sheep and the pasture (Morris 2007). The higher herbage allowances required by cattle than by sheep means that cattle are likely to be wintered separately, but that they are likely to suffer from the low herbage covers operating in early spring on sheep-breeding hill country farms.

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. The expansion of the sheep flock and the decline in cattle numbers through the late 1970s was driven by market prices favouring sheep. Growth in beef cattle numbers has occurred since 1983 but numbers are relatively static (3.8 to 4.5 million head) with fluctuations mainly due to changes in the number of calves of dairy origin reared for beef production.

Sheep and beef cattle farms have marked differences in annual and seasonal pasture production (Matthews et al. 1999), and sward composition. In the wet North Island hill country the challenge is to winter sufficient stock to be able to utilise the high levels of pasture production over the spring and summer. This requires that a high proportion of the livestock units farmed need to be breeding ewes and cows, which can be fed at maintenance levels in the winter, while lactation demand and the development of grazing activity in lambs and calves will lift spring and summer pasture demand. Increasing the proportion of finishing stock on the farm will lead to increased pasture demand in the winter and decreased demand in the summer. The key to success is to adjust livestock numbers in the autumn to achieve pasture cover and animal live weight and condition score targets at the start of winter. This then enables feed to be rationed throughout the winter to transfer pasture into the more productive period after lambing and calving. This rationing will be best achieved under a rotational grazing regime. The aim is to feed ewes and cows fully during lactation. For ewes and lambs target sward conditions and animal intakes at lambing and during lactation are best obtained under continuous stocking (Hodgson et al. 2005). On hill country farms it is important that cattle and/or ewes after weaning are used to control surplus pasture growth, maintain pasture quality, and prevent sward deterioration.

In the drier areas of the East Coast the requirement is to achieve maximum production through the spring and early summer and then to significantly reduce demand over the summer when drought reduces pasture production. This pasture production pattern suits lamb production providing lambing can take place early enough in the spring to enable lambs to be marketed before the onset of the summer dry (Hodgson et al. 2005). Lambs can be sold in prime or store condition. Cattle breeding is less suitable in these areas due to lactation demand over the summer, but cattle finishing systems can be successfully operated provided supplementary feed is available over the winter and finishing stock are sold early in the summer. Cash crops (cereal and herbage seeds) integrate with sheep and beef cattle systems in this environment as they reduce the grazing area during the high spring pasture growth peak while providing extra forage for the grazing animals over the winter and early spring. The summer climate is also suitable for crop development and harvesting.

Today's forage supply systems on sheep and beef cattle farms are similar to those of 20 years ago, in that they are still based on permanent grass–clover pastures. The focus is on increasing efficiency through minimising costs, and the major production expenditure is on those inputs with a high return on investment, for example fertiliser, subdivision, and labour-saving devices. There is an increasing awareness of the potential of increasing utilisation of pasture growth through better matching of livestock feed demand to forage supply. The use of supplementary feed either as hay, baleage, silage or fodder crops is limited to farms that have an area of cultivatable land. In recent times the use of brassica crops has increased and a new development has seen the increased use of herb-based pastures (usually plantain and chicory with or without red and white clover) for growing

TABLE 2 Total livestock numbers (000s) in New Zealand 1985, 1995, 2005 and 2012

	1985	1995	2005	2012
Sheep	67 854	48 816	44 002	31 939
Dairy cattle	3308	4090	4494	6369
Beef cattle	4613	5183	4787	3884
Deer	320	1179	1800	1090
Goats	427	256	175	160

Source: Beef + Lamb New Zealand Economic Service.

lambs or providing high nutritive value feed for highly productive animals, for example triplet-bearing/lactating ewes or ewe hoggets (Kemp et al. 2010).

The sheep meat and wool sectors have maintained their production via an impressive increase in sheep performance despite a dramatic decline in livestock numbers (Table 2). Since the 1980s there has been a 25% increase in lambing percentage and carcass weight and Bray (2004) estimates that this increase in carcass weight equates to a 50-gram-a-day improvement in lamb growth rate without changes in stocking rate, mating dates, or the use of new pastures and little change in the slaughter pattern. These gains have occurred at a time when labour inputs have been reducing as sheep productivity per labour unit has also improved by at least 35%. Mackay et al. (2011) also notes there has been little change in stocking rates in the last 20 years but a change in livestock performance resulting in a lift in sheep meat production of 72% in hard hill country since 1989/90. At the same time the meat industry has shifted to exporting value added cuts rather than the frozen carcasses that had previously dominated the industry.

The sheep industry

Sheep farming in New Zealand is extensive in nature, with sheep being farmed on the high or hill country at stocking rates around 7–12 sheep per hectare, mostly with no supplementary feed and no housing. Annual lambing percentages have increased significantly over last the 15 years from 98% in 1987 to 122% in 2012 (Beef + Lamb New Zealand 2013) and range from 92% (lambs tailed per 100 ewes mated) on high country to 130% on intensive finishing country (Table 3). The potential under more intensive management on improved land is vastly greater than the figures given in Table 3 and lambing percentages can often be as high as 150%.

Most of the sheep farmed are straightbred Romney ewes or their crossbred derivatives. These sheep produce wool suitable for carpet manufacturing. Less than 7% of the sheep are of the Merino breeds that produce fine wools suitable for clothing manufacturing. A recent change in the flock has been the increased use of two-, three-, and four-breed composite sheep. These have incorporated the use of East Friesian, Finn and Texel genes with the existing Romney, Coopworth or Perendale flock. It is estimated that about 25% of the 21 million female sheep are mated to terminal or meat sire breeds such as the Poll Dorset, Suffolk, or Texel, or composite terminal sires, the progeny of which have faster growth rates and reach slaughter weights earlier than straightbred lambs. Average carcass weights for lambs slaughtered for export each year have increased dramatically over the last 15 years from 14 kg to 18 kg (Beef + Lamb New Zealand 2012). In fact the primary sector in New Zealand has had a 3.3% annual compound growth rate (from 1984 to 2007) compared with forestry at 1.6% and the wider economy at 1% (Ministry of Agriculture and Forestry 2008).

The beef cattle industry

The different systems of beef cattle production that exist in New Zealand can be conveniently divided into those involving beef breeding cows and those that are concerned with the growing and finishing of beef cattle (Morris 2007). Both systems are operated on the same farm in some cases. An alternative division of the industry is into prime or table beef production, primarily from steers and heifers of beef breeds, and dairy beef production, which involves the raising of dairy-bred bulls for the processing or ingredient beef trade. Most beef-breeding cowherds are found on hill country farms in the North Island, usually in conjunction with other livestock such as sheep and deer. The growing and finishing farms for beef production, in contrast, are mainly on lowland farms where the cattle can be finished on high quality pastures. For almost all beef cattle raised in New Zealand pasture contributes over 95% of their total diet. Forage crops other than pasture are not used widely, but supplementary feed of various types (hay, silage, and forage crops) may be used during times of feed shortage during winter or during particularly dry summers. Under extensive conditions cattle can be considered as complementary to sheep but when subdivision and stocking rate increase on an individual farm, it is true to say that the role of cattle changes from complementary to a competitive one.

The dairy herd contributes to beef production directly through slaughter of cull cows and bobby calves and indirectly through the supply of Friesian and crossbred calves to beef cattle farmers. It is estimated that beef from the dairy herd contributes around 50–55% of product by weight and around 45% of total beef income. Typically, spring-born Friesian calves are purchased as weaned calves in October and November at 3–4 months of age and 100 kg live weight. These bulls will be farmed through the following year and sold for slaughter over the period December to April when 16–20 months of age at 550–580 kg live weight (280–310 kg carcass weight). To achieve this weight an average live weight gain of 1.10 kg head^{-1} day^{-1} is required for the entire

TABLE 3 Average statistics for three types of sheep/cattle farms in three regions of New Zealand (2011/12). (Adapted from Beef + Lamb New Zealand Economic Service.)

	Marlborough Canterbury (Class 1 South Island High Country)[1]	East Coast (Class 4 North Island Hill Country)	Taranaki Manawatu (Class 5 North Island intensive finishing)
Area of farm (ha)	8665	530	205
Stock units[2]	9305	4569	2134
Stock units[2] per hectare	1.1	8.6	10.5
% stock units as cattle	13	29.6	33
Lambing %	91.6	125.0	129.7
Labour units	2.56	1.71	1.39
Av. lamb price $ per head	95.86	101.14	104.14
Av. wool price $ per kilogram	9.72	3.68	3.68
% gross income Wool sales	38.6	12.5	8.7
Sheep sales	39.5	61.0	52.0
Cattle sales	11.5	22.2	23.0
Other[3]	10.4	4.3	15.5
Total gross revenue ($)	864,600	455,800	252,400
Working expenses as % of total gross revenue	52.6	46.2	54.4
Farm profit before tax ($)	243,500	141,899	62,600

[1]*Farm classification system used by Beef + Lamb New Zealand Economic Service (http://www.beeflambnz.com/information/on-farm-data-and-industry-production/sheep-beef-farm-survey/nsi/).*
[2]*One stock unit = one breeding ewe (see Table 1).*
[3]*Other includes dairy grazing, deer, goat, and cash crop revenue.*

period (McRae 2003). Like for other livestock systems the key to success is the use of an appropriate stocking rate (Cassells and Matthews 1988; McRae 2003). The seasonal match of feed demand and pasture growth rate is achieved by increases in livestock numbers in November when weaner bulls are purchased, sale of older bulls through the summer and autumn, and by adjusting the rate of live weight gain achieved per bull per day according to the seasonal patterns of pasture production (Cosgrove et al. 2003).

A large proportion of Friesian bulls are now being farmed on hill country rather than in specialised bull farms, and Hereford–Friesian heifer calves are now also being sourced from the dairy herd as a source of high-producing beef breeding cows, for once-bred heifer systems, and for heifer beef finishing (Morris et al. 1992). Only a very small proportion of cattle in New Zealand are finished on feedlots, mainly because of the high price of local grain relative to pasture. There is, however, one large feedlot (10 000-head capacity) in the South Island part-owned by a Japanese company that markets the entire product in Japan.

PROFITABILITY

A sheep and beef cattle farm is made up of two businesses that are often, but not necessarily, linked – the property business, where success is measured by changes in asset values over time and is derived by smart purchase and sales decisions, and the farming business where success reflects effective and efficient sustainable operation of the resources (Shadbolt and Gardner 2005). Historically in New Zealand the property business has outperformed the farming business. Green (2008) quotes a compounded return of 10.46% per annum for farm property over a 20-year period to December 2007. This is significantly ahead of commercial property investments at 3.8% and residential at 7% and the New Zealand Stock Exchange top 50 at 4.27%. Profit and loss accounts tell a different story with return on capital invested averaging 1–2% return and real farm profits of around $40,000–$60,000 since 1990. In fact for the financial year 2007/08 the lowest profit in 50 years was recorded (Morris 2009). This is a similar return on capital figures to that reported by Smeaton et al. (2008) using a simulation model.

However, longer-term demand and prices for sheep meat and beef are influenced by the fundamental economics of food production. Food consumption patterns vary widely between countries and over time. An example is the Westernisation of Asian diets and the introduction of more ethnic eating patterns in Western diets. It is also important to realise that the products that consumers consume embody characteristics other than basic food. For example, increasing consumption of fresh or organic meat reflects a desire to purchase 'health'. Similarly, the increasing consumer demand for ready-to-eat meals is indicative of a desire to purchase 'convenience'. As incomes rise the desire for these attributes increases as does the purchase of non-food inputs such as preparation, service, and/or transportation (i.e. food miles). Our customers will want to understand not just the quality of the food but also the environmental footprint associated with producing that food (Caradus 2007).

While costs are often expressed per enterprise, per hectare or per stock unit basis, the most relevant measure is cost per unit of output. Allocating variable costs to an enterprise (say sheep production) is simple but allocating fixed costs causes significant debate especially on multi-enterprise sheep and beef cattle farms. Recent calculations, and after considerable debate in the farming media, place the cost of lamb production in New Zealand within the region of $50–70 per head for a 17-kg carcass. Thus in the 2007/08 season farmers did not meet their costs of production whereas in 2008/09, at a predicted lamb price of $80 per head, costs of production were being realised (Morris 2009).

ENVIRONMENTAL CONCERNS

The big environmental issues faced by the sheep and beef cattle industry revolve around water quality and supply, climate change and greenhouse gas emissions, and the use of food miles as a non-tariff trade barrier. Sheep and beef cattle contribute significantly to the economic well-being of New Zealand, so minimising environmental impacts while maintaining but preferably increasing economic returns is a major national concern. It is presumed that water resources in almost all regions in New Zealand will become fully allocated within a decade. Sheep and beef cattle farming occupy about 33% of the land area of New Zealand and as such have significant effects on the quality of the country's waterways.

Much of the sheep and beef cattle in New Zealand are farmed on hill or high country at low stocking rates and hence often biodiversity is maintained in such habitats. This is illustrated in the study of the Waitaki catchment by Ausseil et al. (2012) using an ecosystem services approach to help resource managers achieve a balance between natural and managed ecosystems. Their model suggests the optimal land use on tussock grasslands would be the existing sheep and beef cattle at low stocking rates. They further suggest that intensification to high stocking rates would increase bare ground and degrade soil, introduce weeds, and lower the biodiversity pattern.

As a first step the Beef + Lamb New Zealand environmental strategy has recognised that an important target for the industry is to look at reducing phosphate and sediment loss to waterways. This is further encouraged with the land use and environmental plans, with Beef + Lamb New Zealand introducing a Land and Environmental Planning toolkit (LEP) in 2005. This has now been revised into a concept called Good Management Practice (GMP) and is actively promoted through the Beef + Lamb New Zealand Farmer Councils. Effective riparian management, including livestock exclusion where topography allows, should be prioritised; however, livestock exclusions on sheep and beef cattle farms, especially hill country properties, pose significant challenges.

Eco-efficiency

Farming within biophysical limits is seen as an emerging feature of the operating environment for the sheep and beef cattle farming sectors. Have the substantial productivity gains over the last 20 years translated into improved eco-efficiency and a reduction in the sector's environmental footprint? Mackay et al. (2011) in their study used the Overseer® nutrient budget model and data from the MAF Sheep and Beef Farm Monitoring models that cover hard hill country (Gisborne and Central North Island) and easy hill finishing country (Manawatu). For the hard hill country extensive sheep and beef farm, the productivity gains made since 1989/90 translate into significant eco-efficiency gains including a 47% increase in saleable product per hectare (107–167 kg ha^{-1}), 21% reduction in nitrate leaching per kilogram of saleable product (0.065–0.054 kg kg^{-1} animal product) and 40% reduction in the greenhouse gas emissions per kilogram of saleable product (27–19.2 kg CO_2-e per kilogram animal product). All these improvements have come from improved meat production with the contribution from wool remaining unchanged from 1989/90. However, these gains did not extend to include an overall reduction in nitrate leaching or greenhouse gas emissions

per hectare. In the easy hill option, where the MAF farm size model has doubled over the last 20 years, there was little change in eco-efficiency or in total emissions. However, the easy hill finishing system is more eco-efficient with the amount of saleable product per hectare higher and the nitrates leached and greenhouse gas emissions per kilogram of saleable product lower than on the hard hill country. This highlights that considerable scope remains to increase the amount of saleable product on hard hill country through further gains in per-head performance. The focus of the sheep industry on reproductive performance and higher growth rates in lambs and cattle provides a buffer to increases in emissions generally associated with intensification of a livestock system (Mackay et al. 2011).

EXPANSION OF DAIRYING

New Zealand's pastoral landscape is becoming more dynamic and sophisticated, with greater movement of animals between farms and the boundaries between sheep, beef cattle, and dairy farms becoming increasingly blurred. There has been, and continues to be, considerable interplay between different land uses. For example, many sheep and beef cattle farmers use their land for 'dairy support' activities such as winter grazing of dairy cows, rearing dairy heifer replacements, and growing silage crops. The expansion of dairy and dairy support, as well as land going into forestry, conservation, and lifestyle subdivisions, has reduced the area of sheep and beef cattle farming and has resulted in a decline in sheep and beef cattle numbers. A side effect of the expansion has been an increased number of heifer calves reared at the expense of male beef-producing animals and an increase in rearing costs through higher prices of milk powder for calves. There has also been a short-term effect of a reduced cow kill as dairy farmers retain more cows to benefit from the high milk solids price offered in that season.

A significant portion (around 55% by numbers) of New Zealand's beef production is a by-product of dairy production. The national dairy herd is changing in breed structure from Friesian–Holstein and Jersey to a mixture of these two breeds and an increasing proportion of Friesian–Holstein cross Jersey cows. The bull beef industry was built upon the New Zealand Friesian in the 1970s and 1980s, and an increased use of North American Holstein genetics and, further, the use of crossbred dairy cows, will dilute the superior meat-producing attributes of the original New Zealand Friesian.

SEASONALITY OF PRODUCTION

Sheep and beef cattle production is considered a seasonal industry principally because almost all sheep meat and beef is produced from grass and the slaughter pattern follows the pattern of annual pasture production. The major constraint to a consistent year-round throughput of sheep meat and beef is the marked decrease in availability of animals in the July–October period. This marked seasonality in supply of stock (85–90% of slaughter occurs during the months November to June inclusive) results in processing plants that are underutilised, as export flows are seasonal and depend on the ability of marketers to meet the demand of some markets that require a year-round supply of product. Their upper limits to supply become fixed by the availability of suitable lamb, mutton and beef in July, August, September, and October. To some extent, especially for lamb, the key traditional export markets' domestic lamb supply is counter-seasonal to New Zealand's and hence one option for our marketers is to cooperate with domestic suppliers in those markets to promote lamb as a year-round product.

The geographical remoteness from markets has meant our animal products have to be suitably processed to withstand extended periods of storage during transport. In fact, our meat processing industries have become expert at processing both lamb and beef into a chilled or frozen product and then preserving the quality of the product while in transport to the other side of the world. Although premiums for quality and supply have not as yet been sufficient to encourage wholesale changes in sheep and beef cattle systems, it is likely that initiatives started by some meat companies will encourage product quality to become increasingly important, as well as supply contracts between producers and consumers.

FUTURE PROJECTIONS FOR SHEEP AND BEEF PRODUCTION IN NEW ZEALAND

Competition for land in New Zealand has begun in earnest in the last 20 years. Historically, the pastoral industries expanded as land was cleared from bush and converted to pasture. Today, the pasture area available to agriculture is shrinking for a variety of reasons. The total area in pasture and arable land peaked at 14.399 million hectares in 1982, which also coincided with a peak in sheep numbers (70.3 million head). Today the pasture/arable area has declined to around 10 million hectares.

Meanwhile, even within the shrinking pastoral sector, there is a steady redistribution of traditional sheep, cattle, and crop usage of land into dairying, deer, and other holdings such as 'lifestyle blocks'. The combined effect of this redistribution of land use has been a loss of nearly 17 million stock units from the sheep and cattle sector over the past 20 years.

The meat and wool sectors have maintained their returns over the past decade despite the dramatic reductions in stock numbers. Profit margins have been maintained by the use of more intensive farming methods, increased application of fertilisers, new and higher performing pasture types and improved management techniques, introduction of new breeds and crossbreeds, changing management practices such as hogget mating, and increasingly producing to specification.

It has been known for at least a decade that New Zealand's low-cost production systems, based on a comparative advantage in growing pasture and year-round grazing, have been losing ground to others who have taken up New Zealand's grassland technologies but with even lower costs. Productivity needs to increase if New Zealand sheep meat and beef is to compete in the international marketplace. Recent gains in the sheep industry (i.e. reduced numbers but increased production by improved lambing percentages and higher carcass weights and increased processing of carcasses) provides an example for future productivity gains.

More farm specialisation is likely to occur in the future, into breeding and finishing units. Increased networking will occur between breeders and finishers, and farmers will increasingly align themselves with particular supply chains and processors. Breeders will continue to operate in the predominantly steeper country while finishers will operate in easier country producing a large amount of forage year-round by using short-term pastures such as Italian and hybrid ryegrasses, winter and summer brassicas, chicory, plantain, red clover and lucerne.

New Zealand will, in the future, promote and market its livestock products on the basis of quality, and position itself at the top end of the market. The clean, green and natural production images, seen by the 2 million or so tourists that visit New Zealand each year will almost certainly be an advantage for our meat and

wool exports as they compete in the high-priced 'niche' markets of the world. The industry will think more in terms of quality not quantity and value not volume.

REFERENCES

Ausseil A-G, Herzig A, Dymond JR 2012. Optimising land use for multiple ecosystem services objectives: A case study in the Waitaki Catchment, New Zealand. 2012 International Congress on Environmental Modelling and Software, Leipzig, Germany.

Beef + Lamb New Zealand 2012. New Season Outlook 2012–2013. Paper No. P012022.

Beef+Lamb New Zealand 2013. Annual Report 2011–2012 sourced www.beefandlambnz.com.

Bray A 2004. More lambs from less. Primary Industry Management 7: 32–33.

Caradus JR 2007. Presidential address pastoral agriculture – New Zealand's competitive advantage. Proceedings of the New Zealand Grassland Association 69: 1–10.

Carter AH, Cox EH 1982. Sheep breeds in New Zealand. In: Wickham GA, McDonald MF eds Sheep production Vol. 1. Breeding and reproduction. Pp. 11–38.

Cassells JB, Matthews PNP 1988. Bull beef production. Proceedings of the New Zealand Grassland Association 49: 47–51.

Cosgrove GP, Clark D, Lambert MG 2003. High production dairy-beef cattle grazing systems: a review of research in the Manawatu. Proceedings of the New Zealand Grassland Association 65: 21–28.

Green RB 2008. Innovative and adaptive future farming particularly as it relates to profitable use of dry land country in New Zealand – a personal view. Proceedings of the New Zealand Grassland Association 70: 7–11.

Hodgson J, Cameron K, Clark D, Condron L, Fraser T, Hedley M, Holmes C, Kemp P, Lucas R, Moot D, Morris S, Nicholas P, Shadbolt N, Sheath G, Valentine I, Waghorn G, Woodfield D. 2005. New Zealand's pastoral industries: Efficient use of grassland resources. In: Reynolds SG, Frame J eds Grasslands, developments, opportunities, perspectives. New Hampshire, USA, Science Publication. Pp. 181–205.

Kemp PD, Kenyon PR, Morris ST 2010. The use of legume and herb forage species to create high performance pastures for sheep and cattle grazing systems. Revista Brasileira de Zootecnia 39: 169–174.

Mackay A, Rhodes AP, Power I, Wedderburn ME 2011. Has the eco-efficiency of sheep and beef farms changed in the last 20 years? Proceedings of the New Zealand Grassland Association 73: 119–124.

Matthews PNP, Hodgson J, White JGH 1999. Livestock farming systems in New Zealand. In: White J, Hodgson J eds New Zealand pasture and crop science. Auckland, Oxford University Press. Pp. 133–151.

McRae AF 2003. Historical and practical aspects of profitability in commercial beef production systems. Proceedings of the New Zealand Grassland Association 65: 29–34.

Ministry of Agriculture and Forestry 2008. Ministry of Agriculture and Forestry. Briefing for incoming Ministers November 2008. http://www.mpi.govt.nz/news-resources/publications.

Morris ST 2007. Pastures and supplements in beef production systems. In: Rattray PV, Brookes IM, Nicol AM eds Pasture and supplements for grazing animals. Occasional Publication 14. New Zealand Society of Animal Production. Pp. 243–254.

Morris ST 2009. Economics of sheep production. Small Ruminant Research 86: 59–62.

Morris ST, Parker WJ, Purchas RW, McCutcheon SN 1992. Dairy cross-breeding alternatives to improve New Zealand beef production. Proceedings of the New Zealand Grasslands Association 54: 18–22.

MPI (Ministry for Primary Industries) 2012a. Pastoral input trend in New Zealand: A snapshot. ISBN 978-0-478-38864-0 (online) http://www.mpi.govt.nz/news-resources/publications.

MPI (Ministry for Primary Industries) 2012b. Situation and outlook for primary industries 2012. ISBN 978-0-478-38853-4 (online) www..mpi.govt.nz.

MPI (Ministry for Primary Industries) 2013. Briefing for incoming Ministers . ISBN 978-0-478-40543-9 (online) www..mpi.govt.nz.

Shadbolt N, Gardner J 2005. Financial management. In: Shadbolt N, Martin S eds Farm management in New Zealand. Melbourne, Oxford University Press. Pp. 139–181.

Smeaton DC, Rains ST, Peyroux GRJ 2008. The FeedSmart 'Costs of Supplements and Cost of Pasture' models. Proceedings of the New Zealand Grasslands Association 70: 145–151.