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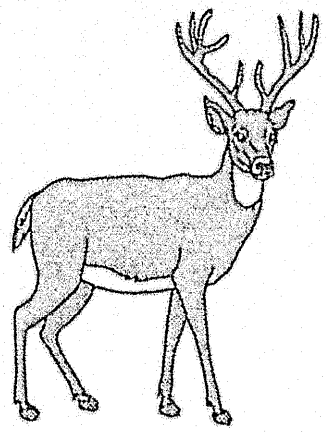
Dynamics of Supply and Demand for the New Zealand Deer Industry



Abstract

The New Zealand farmed deer industry, which grew significantly during the 1970s and 80s, is at crossroads in the 1990s. This is the result of recent developments in export markets for deer products such as venison and velvet and the consequent supply responses of New Zealand deer farmers.

In this paper, a detailed conceptual model of the deer industry which identifies the relationships between venison and velvet supply and demand is developed. This is subsequently used to estimate the dynamics of this important sector of pastoral agriculture and make medium term forecasts of prices, production and deer numbers. These estimates will facilitate a greater understanding of the workings of the deer industry, which is currently attempting better co-ordination between domestic supply and export demand.

Elaine Pearse, Ram SriRamaratnam and Chris Dake
MAF Policy

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DYNAMICS OF SUPPLY AND DEMAND FOR NEW ZEALAND VENISON AND VELVET

1 INTRODUCTION

From its beginnings in 1970, the farmed deer industry has grown rapidly. According to Statistics NZ, deer numbers peaked at 1.18 million at June 1992, though they have since fallen below 1 million. Deer now account for 1.5% of total New Zealand farmed livestock units, while export returns were worth $186 million for the 1993 June year.

Owing to its comparatively recent development, the supply and demand factors driving the growth in the deer industry have received little attention from economists. There has been no attempt to construct a formal supply and demand model. This paper seeks to address that deficiency through a detailed examination of the factors behind the industry's growth.

To achieve this objective, this paper sets out to draw the relevant framework together, for subsequent use in an integrated economic model of deer velvet and venison supply and demand.

2 OBJECTIVES

The following steps are identified to achieve this task:

(1) An examination of the international demand and supply for venison and velvet.

(2) The history of the growth of the New Zealand industry and the characteristics of the current situation.

(3) The development of a conceptual model of the deer industry to identify the relationships between venison and velvet supply and demand.

(4) Estimate the supply response behaviour of deer products in the New Zealand deer industry including the impact of trends in the dairy, beef and sheep sectors on deer product supply.

(5) Attempt to model the demand relationships for venison and velvet in the key overseas markets.

(6) Develop the key interrelationships between domestic supply and overseas demand for venison and velvet and the subsequent price determination.

(7) Employ the estimated model to make medium term forecasts of supply and likely returns to the New Zealand deer industry.

3 THE INTERNATIONAL DEER SCENE

As New Zealand exports 98% of its deer farming output, overseas demand and returns for deer products are likely to be the main determinants of New Zealand prices. It is therefore important to look initially at the factors driving world supply, demand and prices for deer products.

3.1 RANGE OF PRODUCTS

Apart from breeding stock, the main deer products produced are venison and velvet. There are also about twenty marketable by-products produced at the time of slaughter. The more important ones are tails, pizzles, sinews and blood. In this paper we just concentrate on venison and velvet.

3.1.1 Venison

Venison, the meat of deer, has a number of attributes that should make it highly appealing to the growing number of health conscious consumers. It is low in fat, cholesterol, sodium and saturated fatty acids, while being high in copper, iron and zinc. Venison is sold either in chilled or frozen form.

3.1.2 Velvet

Deer is the only animal that annually grows antlers. Velvet is the young antler of male deer, and both male and female reindeer. Its size and quality are dependant on stag type, genetic heritability, nutrition and the time of cutting. If left to grow it calcifies and this reduces its medicinal value. Removal by anaesthetic methods takes place within 55-60 days of growth.

3.2 WORLD SUPPLY

For centuries, northern Europeans and Russians have maintained herds of reindeer, deer and moose as sources of food and clothing. In many countries the hunting of deer has been, and still is, the preserve of the rich.

In Asia, for thousands of years, deer antler velvet and other parts of deer have been essential ingredients in preventive medicines.

3.2.1 Deer Numbers and Types

Precise information on production and numbers is not readily available, as world deer numbers are small. Also, compared with other farmed and feral animals, most deer products are consumed locally. Little international trade developed until the late 1960's.

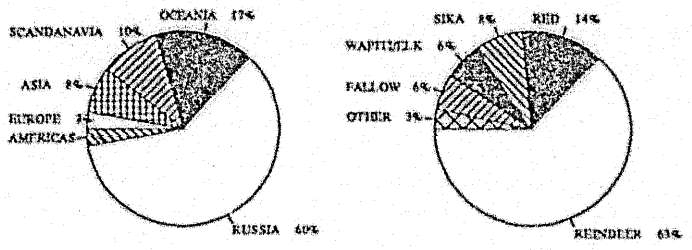
Most of the world's venison is provided by the feral herds of northern Europe, North America and Russia and from farmed deer in New Zealand. Velvet production, though much smaller than venison, is traded much more extensively. The main sources are Russia, China, The Republic of Korea (ROK), and New Zealand.

Reindeer are the most commonly farmed[1] deer type and are found in Scandinavia, Canada and Russia. These herds forage over large areas of tundra, and are often followed by their owners. The herds are penned infrequently, usually only for weaning, velveting or culling.

World farmed deer numbers, shown in figure 1, are estimated at 6.5 million. Russia has the largest number of farmed deer with an estimated 60% of the world total, most of which are reindeer. New Zealand with around 1 million deer is second with 14%. If reindeer are omitted, then New Zealand has around 40% of the farmed deer, and is the world leader in this type of farming.

[1] "Farmed" includes all managed deer/reindeer herds on range lands/tundra and farms

FIGURE 1: KNOWN FARMED DEER NUMBERS AND BREEDS
1992



A: DISTRIBUTION B: MAIN BREEDS

Source: Various

Reindeer are estimated at around 63% of the total farmed numbers. Red deer are the next most popular farmed breed, found mostly in New Zealand and Australia. World venison supply comes from all breed types, while sika, wapiti/elk type and red deer grow the most preferred types of velvet.

3.2.2 Venison Supply

The largest production of venison is from the reindeer herds of Scandinavia and Russia. As this meat is consumed locally and has little impact on world trade, it is omitted from this discussion on the supply of venison available for international trade.

The next most important venison source is the managed feral herds of Europe. These herds are systematically culled annually during the autumn and early winter, through the issue of hunting licences. About 80% of this kill is consumed by hunters themselves and only 20% is sold commercially.

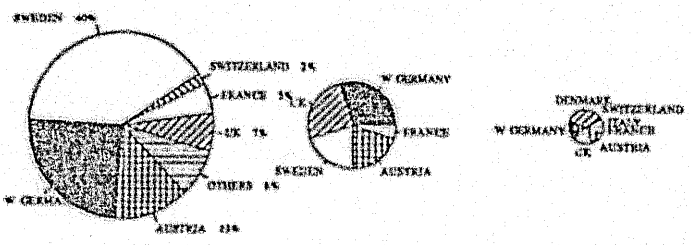
Up to date information on this annual cull is not readily available. The most comprehensive information on west European production found to date is from the European deer hunting and farming survey, complied by INRA of France. The results from this survey are shown in figure 2.

On a carcass weight basis, the 1988 European annual hunt tally was around 45,000 tonnes, 11,000 tonnes of which was sold commercially; farmed venison amounted to only 1,400 tonnes. The major producer is Sweden whose production of 18,300 tonnes is from moose meat. Germany is next with about 11,500 tonnes followed by Austria and Great Britain with around 6,000 and 3,000 tonnes respectively. For the same period, exports from the east European[2] hunt amounted to around 8,000 tonnes and were sent to Germany, Italy, Austria, France and Sweden.

Apart from heavy culling of the east German herd in 1991 that temporarily increased production by an estimated 1,000 tonnes, production from the annual west European hunt is fairly static and is most likely to remain around 45,000 tonnes in the future. However, some fluctuations could result if heavier culling proves necessary, because of over grazing of forests.

[2] Hungary, Poland, Czechoslovakia, Yugoslavia and the USSR.

FIGURE 2: EUROPEAN VENISON PRODUCTION
1988 (Carcass weight)



A: FERAL HUNT 45,000 TONNES

B: FERAL SALES 10,000 TONNES

C: FARMED VENISON 1,460 TONNES

Source : INRA France

A slow deterioration of central European forests had been occurring for several decades, but this accelerated in the early 1980's. Scientists have been unable to pinpoint a single cause, but air pollution is an important factor. The over-browsing of forests by large wild game populations also endangers the vitality of trees. To alleviate this problem, substantial deer culling could occur in selected areas.

3.2.3 Velvet Supply

Most of the world's velvet is produced in, and traded by Russia, China and New Zealand. Again detailed figures on world production are not available. Best estimates suggest that it is somewhere between, 5,000 and 10,000 tonnes, with nearly 80% of velvet produced from reindeer.

These figures are based on the estimates in table 1.

Table 1: Estimated World Velvet Production - 1993

Country	Deer Numbers Total	Deer Numbers Velvet Producers	Assumed per head velvet yield 1.1 kg	Assumed per head velvet yield 2.5 kg
China	300,000	180,000	198	450
ROK	143,000	85,500	94	210
Russia				
(Reindeer)	3.5 mill	3.5 mill	3,850	8,750
(Elk/red)	430,000	258,000	284	645
NZ	960,000	200,000	370	500
Nth America	60,000	24,000	26	60
Australia	60,000	24,000	26	60
Total Velvet Production			4,848	10,675

Source: MAFPolicy

3.2.4 Deer Farming

Commercial deer farming in Europe and New Zealand began in the early 1970's. For many farmers it has proved to be a lucrative alternative to other forms of livestock farming. In Europe it offers an unsubsidised alternative to sheep, beef and dairy farming, especially in areas with poorer soil types. One of the main advantages of deer farming is that, provided there is adequate tree cover, winter housing is not required.

European deer farms are small. Germany has over 2,000 deer farms stocked mostly with the smaller deer type (fallow deer), but herds only average around 18 deer. Because most countries have restrictions on the capture of feral deer, growth in deer farming in most European countries is constrained mainly by the non-availability of breeding stock, . In most European countries it is illegal to cut velvet for sale, although it has to be removed before deer are transported. This means that deer farming income is from livestock sales and venison production only.

In Asia deer are farmed mostly for their velvet, so the stag:hind ratio is around 60:40 compared to 35:65 in New Zealand. Herds are small, and they are generally held in yards and fed concentrates. Few deer are killed for venison consumption. In the Republic of Korea (ROK) numbers have increased to about 143,000 but, as feed costs are high, long term production is dependant on a high velvet price.

In summary, the major suppliers of world venison are Europe and New Zealand. The west European feral production is estimated at around 45,000 tonnes (carcass weight). As most of this is consumed by hunters only about 10,000 tonnes is sold. A further 8,000 tonnes is imported from eastern Europe.

There are several thousand deer farms in Europe but as herds are small, farmed deer numbers are thought to be around 300,000 deer and most of these are the smaller fallow deer type. The resulting farmed venison production is estimated at about 2,000 tonnes. With only 10,000 tonnes sold from the hunt and 8,000 tonnes imported from eastern Europe, total European venison sales from local production are thought to be around 20,000 tonnes.

Outside Europe, the main venison exporter is New Zealand. In the 1993 June year it produced around 22,000 tonnes of farmed venison on a carcass weight basis and just under 1,000 tonnes of feral venison.

Of world velvet production, estimated at around 5,000 tonnes, 80% is produced by Russia. New Zealand is thought to be the next largest producer with around 400 tonnes, followed by China with 200 tonnes.

3.3 WORLD DEMAND

World demand for venison comes principally from Europe and Scandinavia, an area with a population of just under 500 million people. Within this region the two largest markets are Germany and Sweden.

In contrast, demand for velvet is from the fast growing regions of Asia. The main market is the ROK, followed by Hong Kong and Taiwan. The population of these three countries is around 70 million. The Chinese also are traditional consumers of velvet. Imports, mostly through Hong Kong, are thought to be small, but with rapid income growth and a population of 1.2 billion, demand from this country is expected to grow.

3.3.1 Economic Factors Affecting Demand

The key economic factors traditionally affecting demand for meat are income and prices. A MLC analysis (February 1993) of the European meat market has identified changes in real incomes as having the most marked effect on total meat consumption levels. Price factors have been relatively

more important in determining trends for individual meats. There is usually a positive relationship between income and demand.

There are other factors of increasing importance. They are:

(1) consumer attitudes and taste factors eg diet and health also animal welfare;

(2) cultural and demographic changes eg ageing of populations;

(3) industry marketing and promotion and

(4) convenience of meat meals and ease of cooking.

Real meat prices in Europe have been trending downwards, reflecting efficiency gains in production and lower grain costs. This applies in particular to white meats, and this trend is expected to continue. A key historical determinant of changes in consumption of individual meat categories has been the changes in relative price levels for the respective meats. Beef and lamb consumption has fallen as beef and lamb prices increased relative to pork and chicken.

3.3.2 Consumer Expenditure and Meat Consumption

Changes in per head private consumption expenditure and meat consumption in New Zealand's major venison markets are shown in table 2. As information on venison consumption is not separately available, the best appropriation is the "other meats" category from the OECD Meat Balances.

Table 2: Percentage Change in Real Consumer Expenditure & Meat Consumption in the Main NZ Venison Markets (per head 1981-91)

	Private Consumption Expenditure	Consumption				
		Total Meat	Beef	Poultry	Pork	Other[3]
OECD-Europe[4]	17	7	-6	19	9	10
Germany[5]	-1	0	-8	24	-3	36
Belgium	21	10	-18	29	19	47
Denmark	16	30	39	40	28	0
France	21	0	- 6	32	-7	8
Switzerland	12	-6	- 5	38	-10	7
Sweden	19	3	-2	7	-9	8
Netherlands	16	15	9	100	6	100
USA	22	5	-9	48	-8	0
Japan	34	26	64	37	21	-100

Source - OECD Meat Balances

Over the period 1981-91, per head real private consumption expenditure and total meat consumption in most OECD-Europe countries increased by 17% and 7% respectively; however, variations in consumption between meats have occurred. Beef consumption has fallen by 6%, while pork increased by 19%, poultry by 9% and "other" meat consumption by 10%.

[3] The definition of "other" meats, "includes game and rabbit with the following exceptions: Norway and Finland, reindeer; Spain rabbit."

[4] The OECD-European countries include the EC 12 plus Austria, Finland, Sweden, Norway, Iceland, Switzerland and Turkey.

[5] Germany now includes East Germany

In Germany, the largest venison market, real consumption expenditure fell by 1% over the 1981-91 period. This fall results from the reunification with east Germany with its population of around 23 million people. Total meat consumption is unchanged and "other" meat consumption is up by 36% - eastern and western Germans, have similar meat consumption patterns.

Swedish consumption expenditure increased by 19%, while beef and pork consumption fell, but poultry and "other" meat consumption increased by 7% and 8% respectively.

US private consumption expenditure increased by 22%. Total meat consumption rose by 5%, while beef and pork consumption fell and poultry consumption rose by 48%. There has been little change in the consumption of "other" meats.

Japanese real consumption expenditure per head rose 34% over the 1981-91 period. Total meat consumption has increased by 26% over the same period, but in comparison, this consumption is only half that of the OECD average. This is largely the result of longstanding taboos in Japan against eating "meat of animals with four legs". Fish is the traditional source of protein and accounts for 49% of the total meat, poultry and fish consumption.

From table 2 it can be concluded that, over the period 1981-91, both private consumption expenditure and meat consumption increased, beef consumption declined while pork and poultry expanded. The consumption of "other" meats in Europe and Scandinavia also increased.

In 1991 (see Appendix B), annual consumption per head of other meat was the highest in France at around 6 kg, in Italy 4kg, while in Belgium, Sweden and Norway around 2.5kg, and in Germany just over 2 kg. The lowest consumption was in Denmark and the Netherlands with consumption less than 1kg per person. The US consumption is also around 1 kg per person.

3.3.3 Venison Demand

Europeans, Scandinavians and Russians, the largest consumers of venison, have traditionally consumed large quantities of game meat during the October-December hunting season. Table 3 shows the quantities consumed in selected countries in 1988. As exports are not shown in this table, figures do not always balance.

It is also interesting to note that, with the exception of the UK, only 16% of the hunt reaches the local market, the balance is consumed by hunters and their families or exported.

Table 3: 1988 Venison Supply and Consumption in Europe

Country	Hunt Tonnes	Imports Tonnes	Total Tonnes	Consumption (Gram/head)
West Germany	12,000	3,500	15,500	250
France	2,400	4,800	7,000	125
Switzerland	900	2,500	3,400	500
Austria	6,000	1,000	4,500	600
U K	3,000	180	1,000	20
Sweden	18,300	1,000	19,300	2500
Total	40,600	12,980	50,700	268

Source - INRA France

The European tradition of game consumption dictates that future demand for venison is expected to grow in this area. Some countries still do not allow venison sales outside the hunting season, but this is likely to change in the European market. Customers also need to be made aware, that NZ farmed venison is a slightly different product grown in a healthy environment.

One side effect of air pollution in central Europe has been the increasing levels of heavy metals, such as lead and cadmium, accumulating in organic matter in parts of the forest floor. Because these heavy metals have been found in significant quantities in game offal, local authorities have warned

consumers of the likely danger to human health from consumption. These warnings have reduced the demand for game meats.

Germany is the largest importer of venison: its imports of game[6] meat in 1992 were around 14,000 tonnes. Table 4, shows the main imports in 1992 were from New Zealand and Poland with 35% and 31% of market share respectively. Over the period 1988 to 1992, Polish exports to Germany have doubled and New Zealand's more than tripled. Growth in Polish exports was driven by the need for hard currency, while New Zealand's was caused by heavier culling after many years of rapid herd growth.

Table 4: German Game Meat Imports 1988 & 1992

Country	1988	1992	% Difference
	Quantity (tonnes)		
Spain	1,090	794	-27
France	419	335	-20
GB	1,107	720	-35
Yugoslavia	559	673	+20
Poland	2,123	4,382	+106
Czechoslovakia	1,264	1,162	-8
Hungary	1,131	399	-65
New Zealand	1,128	4,983	+341
South Africa	726	120	-83
Other	936	1,220	+30
Total	10,483	14,060	+ 34

Source - German Statistics

Demand for venison from other countries is growing slowly. In parts of Japan, game meat was excluded from the ban on meats. Therefore, meat of deer and boar was an important source of protein in mountain villages, while in other parts of Japan deer are still regarded as sacred. During the 1980's the annual hunt from December-January seasonally yielded around 1,400 tonnes of venison.

Within the USA, there is a strong hunting lobby but only a few deer farms. Deer farming and venison sales are still prohibited by law in some states. According to the NZ Farm Raised Venison Council only about 700 tonnes of venison is sold annually within the US. This is the equivalent of only 3 grammes per person.

Little venison is consumed in China but it is likely that demand from both the ROK and China could increase.

In summary, demand for good quality venison is expected to grow, especially in Europe and Scandinavia because of traditional consumption patterns. Venison also meets diet and health requirements and takes little cooking time. Growth prospects also look optimistic for the USA and Japan. In the longer term, Japan, the ROK and China could prove to be lucrative venison markets also.

[6] As well as venison, "game" also includes all types of game except for hare and rabbits.

3.3.4 Velvet Demand

The Asian, and particularly Korean, tradition of incorporating velvet in natural medicines is still the main source of demand for velvet. Large quantities are also used in Russia and China , but owing to a shortage of foreign exchange, in the short term it is likely that larger quantities of velvet will find their way into the more lucrative Korean market.

(a) The Republic of Korea (ROK)

The ROK, less than one third the size of New Zealand, with a population of 43 million, and the world's 10th largest trading nation. During the 1980's the ROK averaged an annual GNP growth of around 10% pa. This growth rate slowed to 8.4% in 1991, to 4.5% in 1992 and is expected to grow around 6% in 1993.

Deer farming in the ROK has grown rapidly from the early 1970's. By the end of 1992, around 143,000 deer were held in over 7,000 small enclosures and velvet production was estimated at around 100 tonnes (green). Official 1992 dried velvet imports in 1992 were around 106 tonnes (320 tonnes green), 53% of which was imported from New Zealand, 25% from the USSR and 17% from China. As import duties are high, and a large black market exists, total demand is difficult to determine. However, it is reported by The NZ Deer Farmer (October 1991) to be around 450 tonnes (green) pa, or 10g/per head.

The ROK government is under pressure from GATT to free up imports. As a result, among other things, it opened its market to venison in 1991, and in 1992 to live deer imports. Current tariffs are: venison 20%, deer 11%, and velvet 25%. Other taxes take the total velvet import tax to about 50%.

As live deer imports were prohibited from the early 1970's and deer livestock prices are high, any flood of imports is expected to reduce local prices. Because deer are held in small enclosures and food costs are high, any price fall could result in deer farming following the same pattern as that of beef. Initially when cattle import restrictions were eased, falling cattle prices drove farmers out of the industry, (Shin-Haeng Huh 1989). However, since the early 1990's the local beef demand has outstripped the controlled supply of imported beef, and cattle prices have risen sharply.

The ROK's third largest trading partner is China and trade continues to grow. Trade is also expanding with Siberia. As these countries are close to the ROK and offer significant trade opportunities, trade is expected to grow further.

(b) Other Markets for Velvet

In the past, China was the main source of the ROK velvet imports. But Chinese incomes growing rapidly - over 9% pa during the 1980's - and with a population of 1.2 billion, it could become a significant velvet importer.

Currently New Zealand exports about 30% of its velvet to Hong Kong. In the past much of this product was re-exported to the ROK. Now however, some Hong Kong product is being sold into China. In the short term, Hong Kong is expected to be the main gateway into China for velvet sales.

Other growth prospects for velvet sales are the other rapidly growing economies of South East Asia, and in particular Taiwan. As consumer incomes grow, and the time available to prepare herbal remedies declines, demand for these preparations is expected to increase.

To meet this market, Asian pharmaceutical companies are currently trialing raw materials from a variety of sources. If this market grows the companies will require significant quantities of velvet of guaranteed quality. This opening is expected to increase the demand for New Zealand velvet that falls outside the Korean requirements.

In summary, demand for velvet from the ROK, China, Taiwan and Hong Kong is expected to grow. As the combined population of these three countries is around 1.27 billion and their economies are expanding rapidly, demand could increase substantially.

3.4 WORLD PRICE

3.4.1 Venison Price

High prices offered in the West German market during the 1970's were instrumental in developing the world venison trade, and today Germany remains the dominant market. Wholesale prices of venison have traditionally been higher than for beef, but as shown in figure 3 there have been two exceptions over the past ten years. The fall in venison price during 1986-87 was caused by the Chernobyl disaster, and the 1990 decline resulted from the sudden increase in German supply and imports from eastern Europe and New Zealand. The health warnings about the presence of heavy metals in deer offals is thought to have weakened demand also.

Nuclear fallout from the Chernobyl disaster settled on Germany's southern forests. It contaminated mosses and lichens, a main food source for deer, and resulted in high radiation levels in game meats. As most venison is traded as a commodity and is not differentiated by country of origin, consumers assumed all venison products to be contaminated and prices fell.

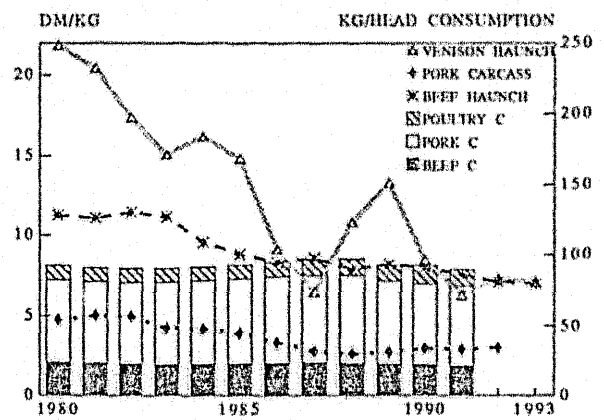
The 1990 downturn was caused by the sudden increase in supplies, especially from Poland and New Zealand. With the downfall of the east European communist regimes, and the subsequent demand for hard currency, increased numbers of East European sellers also led to lower prices.

In 1992, with reduced supplies from eastern Europe, venison prices started to firm. However, the 1993 economic slowdown in Germany together with increasing New Zealand supplies, resulted in a sudden fall in prices in the last six months of the year. Also weakening demand, were the previously noted health warnings of offal contamination from heavy metals.

3.4.2 Velvet Price

The ROK is currently the main velvet market and its prices are thought to dictate world prices. Dried velvet imports are regulated by an unofficial "check" price set annually by the Korean Pharmaceutical Traders Association - usually in late October or early November for the next year's imports. Documented import prices must be between plus or minus 10% of the set price. These check prices vary from country to country, depending on the perceived quality of that country's product, and influence both supply and demand.

FIGURE 3: GERMAN WHOLESALE MEAT PRICES & CONSUMPTION
1980-1993 (Real 1992 DM/kg)



Source - MLC Handbook, OECD Meat Balances, NZ Venison Exporters
(C) = Consumption.

Increases in demand from other Asian countries for velvet not meeting the Korean requirements is firming up prices for lower grade velvet.

4 NZ DEER INDUSTRY

Over the past 130 years, deer in New Zealand have proved to be very versatile animals, worthy of the mystique for which they are admired throughout the world.

4.1 DEVELOPMENT OF THE DEER INDUSTRY (1860 - 1980)

4.1.1 Feral Deer

The first successful importation and establishment of deer into New Zealand was in 1861 in the Matai Valley, Nelson, where one stag and two hinds were liberated. By 1917, over 100 deer had been imported by private individuals, Government and Acclimatization Societies. The liberation of New Zealand-bred stock continued until 1923, with the predominant breeds being Red and Fallow deer. Protection of most breeds lasted until 1924, then some hunting was allowed between 1924 and 1927.

Most breeds flourished, especially Red deer. It was not long before gradual over grazing of forest canopies by deer and other introduced species, such as opossums, started opening up forests and causing erosion. Legal protection was removed in 1930 and the Department of Internal Affairs was made responsible for the control of herd size.

For the next 25 years, with limited resources of men and money, the Ministry of Internal Affairs attempted to control the spread of deer. Government hunters were paid a bounty on tails. Then in 1933 this bounty was replaced by a payment for skins, which Government hoped would partially finance the cost of control. By 1955 payment was based exclusively on the number of animals killed.

In 1958, the possibility of selling venison into the European market arose. However, venison returns did not justify the cost of using helicopters to ferry hunters into the bush, and then return to pick up deer carcasses. From 1966, with the shooting of deer from helicopters, the financial return more then compensated for the cost outlay. In 1967-68 over 150,000 carcasses were recovered in the South Island alone.

Processing plants were built to handle the carcasses and hygiene standards were devised by exporters and overseas importers. Annual exports peaked at just over 4,000 tonnes in 1972 and 1973.

While such heavy culling was leading to a fall in numbers, European demand for venison and ROK demand for velvet were increasing, so the farming of deer seemed the logical alternative. It was made legal in 1969 by an amendment to the noxious Animals Act allowing the farming of deer by license holders. There was some concern about the ability of deer to adapt to life in captivity. But deer had already shown their versatility by feeding at night to avoid the helicopter shooters. Their adaption to farming, therefore, was relatively simple.

4.1.2 Factors Contributing to the Development of Farmed Deer

The factors contributing to the development of a farmed deer industry therefore were:

(a) the European market demand for venison,

(b) a falling supply of venison producing animals,

(c) the passing of legislation permitting farming of deer by license holders,

(d) the ability to source large numbers of deer from feral stocks to rapidly establish a livestock base,

(e) the evolvement of the capture of live deer from helicopters, and

(f) a growing velvet market in the ROK.

4.1.3 Other Factors Contributing to Industry Growth

(a) Deer Adaptability to Farming (Physical)

The captured deer, though rather flighty at first, continued to thrive in their new environment. In the farmed situation, over their growing period from spring to mid-March, deer proved to be more efficient converters of dry matter to meat than either sheep or beef cattle. High prices for the sale of progeny made live capture a lucrative industry. Breeding hind prices reached $3,000 in 1979, eased to around $1,200 in the early 1980's, before peaking in 1985 at around $3,500.

Although most farming technology had been developed from traditional farming, some new animal husbandry methods were developed. As the industry was new, this technology was implemented faster than it would have been in more traditional types of farming. Now deer are farmed on all soil types. Although the initial cost of deer fencing and the development of special handling facilities is high, returns justify the expenditure.

(b) Processing Facilities

Because deer were classified as game, the processing of the shot feral deer carcasses had to be kept separate from other meats. Therefore farmed deer required separate slaughtering plants, so special abattoirs were built alongside feral processing facilities. These small efficient plants enjoyed relatively low labour costs and good industrial relations.

Korean entrepreneurs set up the first velvet processing facilities in New Zealand in the late 1970's. This commitment to the processing of velvet further increased the demand for it.

(c) Government Aid

Deer industry growth was assisted also by tax incentives. Entrepreneurs, along with other livestock farmers, could write off the initial high capital costs of livestock and farm development against their income.

Hind prices fell rapidly when the livestock tax incentives were withdrawn in 1986. At the same time it was announced that the farm development scheme would be phased out over the next few years. But in spite of the high capital cost of deer fencing and handling facilities, the withdrawal of these policies had little impact on industry growth.

4.2 INDUSTRY STRUCTURE

The structure of the industry is set out in Figure 4. There are two principal sectors within the industry, the farmers and the processor/exporters. The farmers' point of view is put forward by the Deer Farmers Association, while the processors and exporters are represented by the Deer Industry Association. These groups both work together within the framework of the Game Industry Board.

4.2.1 NZ Deer Farmers' Association

The farmers' body, the New Zealand Deer Farmers Association (NZDFA) currently representing approximately 40% of deer farmers, is principally involved in policy issues, livestock research and farming technology.

The NZDFA executive comprises of six representatives elected by members - three each from the North and South Islands. There are also 30 branches throughout the country and branch Presidents meet with the Executive twice a year.

4.2.2 Deer Industry Association

The Deer Industry Association (DIA), an amalgamation of the Game Industry Association and the Game Exporters Council, consists of exporters, owners of deer slaughtering premises (DSP) and game packing houses (GPH's). All farmed deer for sale for venison consumption, must by law, be slaughtered in DSP's. The carcasses are then transferred to GPH's for cutting and packaging for export. Velvet is also dried and packed at game packing houses.

Velvet processors formed the Velvet Processors Association (VPA) in 1991, which has one representative on the Game Industry Board.

As some exporters own both DSP's and GPH's, there is some vertical integration, which leads to cost savings in this segment of the industry. Some rationalisation of the industry took place in the early 1980's when venison industry throughput fell to around 1,000 tonnes. With the large increase in venison slaughter during the 1991-1993 period new processors entered the industry, and existing processors increased their respective capacities.

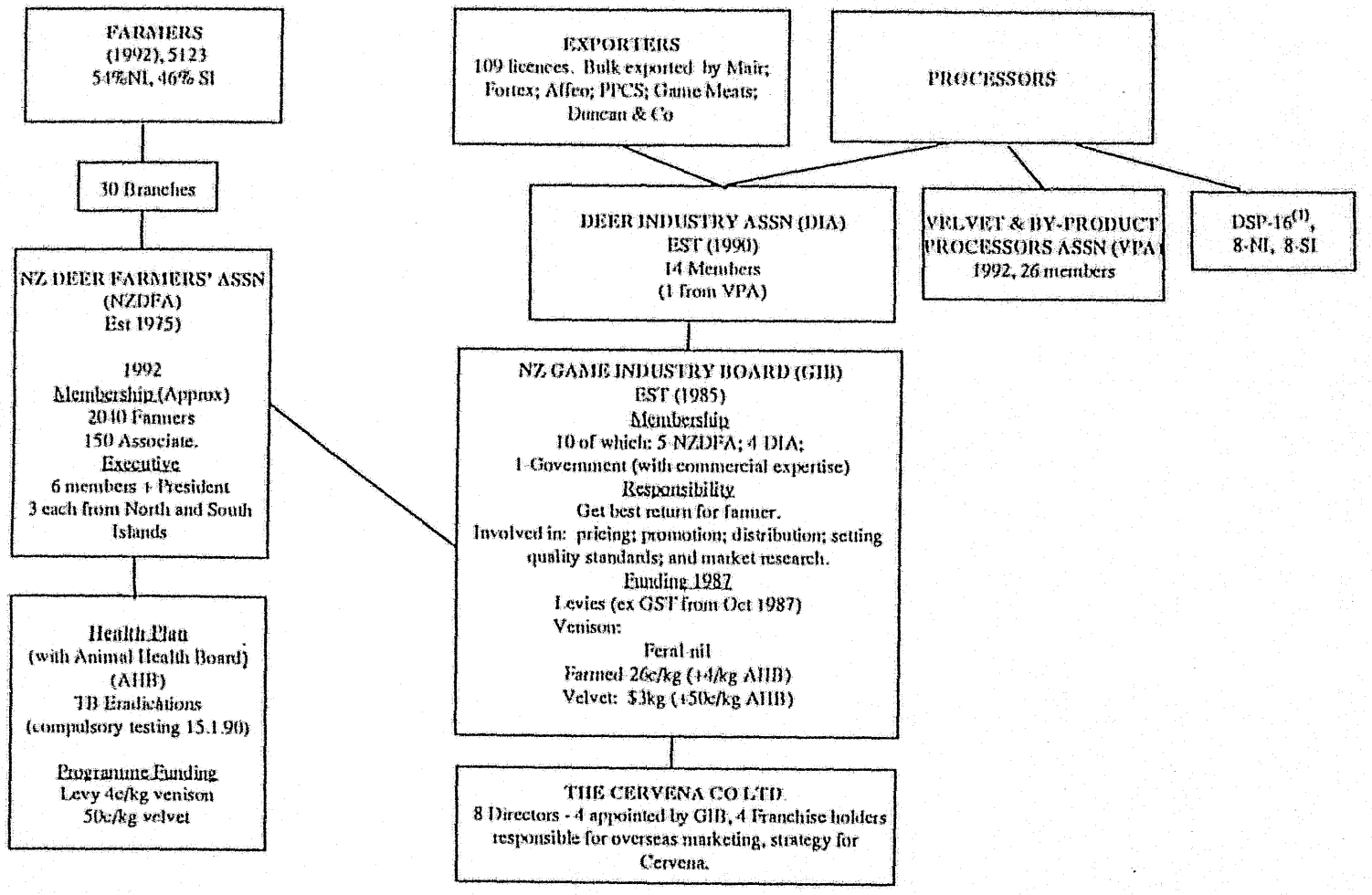
4.2.3 Game Industry Board

During the 1970's, the Game Expon Advisory committee, set up by exporters, had acted as an advisory group to exporters of game. In 1981 the Deer Farmers Association felt greater control of the industry was desirable. It made submissions to parliament outlining a draft proposal for the establishment of a Game Industry Board. The objective was to ensure co-ordination and co-operation between industry sectors.

As a result the Game Industry Board (GIB) was established under the Primary Producers Marketing Act Regulations of 1985. These regulations were amended in 1991 to increase the number of people with commercial expertise on the board.

The GIB now comprises of ten members in all, five from the NZDFA, four from the DIA, one of whom represents the VPA, and one government member; the government member must have commercial expertise. Details of this representation are set out in Figure 4.

FIGURE 4: NZ DEER INDUSTRY STRUCTURE



(1) Deer Slaughtering Premises

Figure 4: Deer Industry Structure

The function of the GIB is to assist in the orderly development of the game industry and the orderly marketing of game and products derived from game[7]. It is actively involved in pricing, promotion, distribution, the setting of quality standards and market research. The GIB is funded from levies on venison and velvet. These levies are collected from DSP's and from GPH's.

In 1990, the GIB initiated a far reaching marketing strategy for deer products. To handle the implementation and monitoring of this project, the Cervena Company Ltd was formed in 1991. The objective is to control quality from farm gate through to the end consumer. Product meeting the required standards will carry either the "Cervena[8]" name or the "Zeal" quality mark. The first sales of venison under the "Cervena" name and "Zeal" brand were made in April of 1993 - "Cervena" in the United States and "Zeal" in Germany and Switzerland.

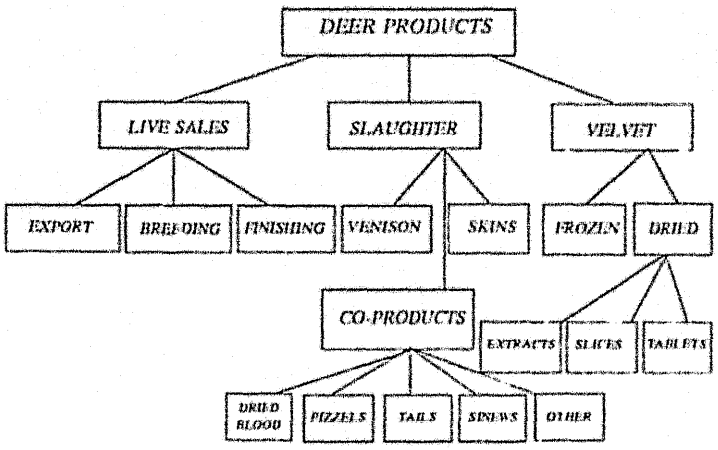
4.3 SUPPLY OF MAJOR DEER FARMING OUTPUTS (1981-1993)

The New Zealand herd is made up of the following breeds, red 77%, wapiti/elk 12%, fallow 6% and other 5%.

4.3.1 Range of Outputs

The range of products produced within the New Zealand deer industry are shown in figure 5. Apart from breeding stock, the two main deer industry outputs are venison, the meat from stags and hinds, and velvet the antler of deer. The most important co-products retrieved at the time of slaughter are skins, tails, pizzles, sinews and blood. Technology is being developed for the recovery of other glands and organs for which there are markets.

Figure 5: DEER PRODUCTS



All venison is further processed into a variety of cuts, then packed and exported under company brands. It is shipped mostly to game importers in the respective markets. There is little vertical integration of the industry after the product leaves New Zealand.

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[7] "Game", in this context means deer only.

[8] The Cervena name only ap[illegible] to venison.

After cutting, the velvet must be cooled before it is frozen, retaining the maximum amount of blood. It is sold as an ingredient for oriental medicines either in frozen, dried, or powder form. Around 90% of velvet is dried in New Zealand. Initially the special drying facilities were owned and operated by Koreans, but it was not long before enterprising New Zealanders developed their own techniques. Now New Zealand velvet drying technology is considered to be amongst the most advanced in the world. A small amount of further processed velvet is exported in sliced and capsule form. Research is being carried out into the making of velvet extracts. In the near future processed velvet is expected to be available for export in this form.

Some skins are exported in a wet/blue form but an increasing proportion are further processed into leather before either, being exported as leather or, manufactured into garments.

In New Zealand less than ten co-products are recovered from deer at the time of slaughter, but there are markets for up to thirty. Currently it is the cost, and lack of special processing procedures that make recovery of many glands and organs unprofitable. Co-products retrieved are either dried in New Zealand for export or shipped out in their raw form mostly to Asian markets.

4.3.2 Industry Growth and Current Status

Breeding stock were initially sourced from feral herds, and imports of superior deer mainly from Europe. Unlike overseas countries, there was no restriction on live capture because deer were considered to be a noxious animal.

Hinds of up to twenty eight years of age have produced fawns. The length of the hind reproduction span is comparable with horses. In the longer term, when herd numbers reach an equilibrium, hind culling and replacement is expected to stabilise at around twelve years of age.

Currently there is a difference of opinion between the Deer Industry Associations' and Statistics NZ over deer numbers. After two surveys the Deer Industry believes total farmed deer numbers are considerably higher than the official figure. In this publication we are using the official Statistics NZ figures, the most up to date of which cover the period to the 30th June 1992.

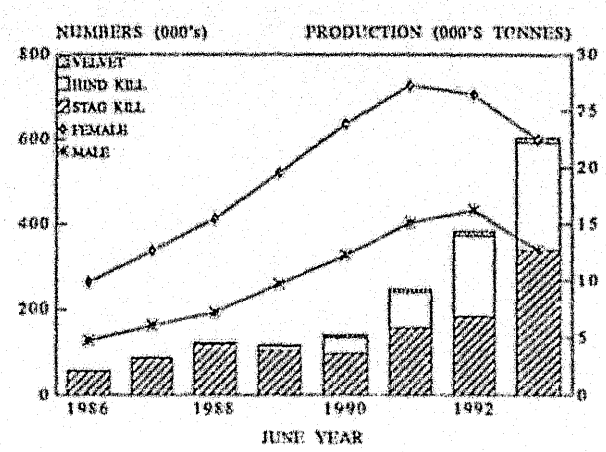
From the issue of the first licence in 1971, growth in deer farming has been rapid. On 30th June 1992 there were over 5,100 deer farms, and farmed deer numbers reached 1.14 million. This growth in deer numbers, the resulting production of venison from both hinds and stags, and the production of velvet is shown in figure 6.

Hind numbers peaked in 1991 at around 727,000 before falling back to an estimated 600,000 in 1993. Stag numbers peaked at around 433,000 in 1992 and declined to around 340,000 in 1993.

As shown in figure 6 venison production grew steadily until 1988 to reach 4,500 tonnes, declined in 1989, almost reached 6,000 tonnes in 1990, then increased rapidly to reach the highest level so far of 22,000 tonnes in 1993. The production increases for the 1991, 1992 and 1993 June years were 80%, 55% and 60% respectively.

Velvet production grew from around 20 tonnes in 1980 to reach 450 tonnes in 1993. These dramatic increases have had a significant impact on the industry.

FIGURE 6: GROWTH IN NUMBERS AND PRODUCTION 1986-93
(1993 Numbers are a MAFPolicy Estimate)



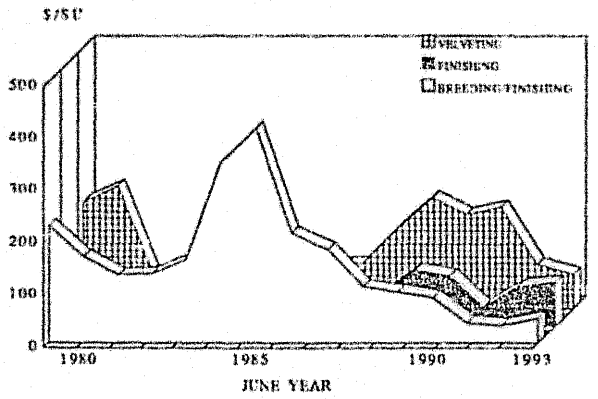
Source : Statistics NZ, MAFPolicy & CIB

4.3.3 Factors Driving Growth

What are the factors which have driven this rapid growth to June 1993? Industry growth through until 1989 was driven by the returns from breeding hinds, velvet production and to a lesser extent venison production. The variations in these annual returns on a per stock unit basis are shown in figure 7.

Until 1990 the gross margins per stock unit from deer breeding/finishing farms and velveting herds were higher than those from sheep, beef or dairying. A summary of gross margins for deer, sheep, bull beef, and dairying is shown in appendix C. Returns from velveting continued to surpass dairying until the 1992/93 season when velvet prices fell and dairying returns increased dramatically.

FIGURE 7: DEER FARMING GROSS MARGINS
Nominal Returns per Stock Unit(SU)



SOURCE MAFPolicy

After the deer, the next best returns came from bull beef. From 1991 to 1993 for the first time deer breeding/finishing returns fell below those for bull beef.

4.3.4 Current Status

Until 1991 few hinds had been culled and a portion of the breeding herd was ageing. This together with sharply declining breeding hind values started a hind cull, which escalated as venison prices fell. Improved velvet returns encouraged the build up of velveting herds. As prices weakened during the 1991/92 and 1992/93 seasons, heavier culling of poorer producing stags took place.

The impact on the industry of this hind and stag cull is covered in greater detail in the next section under the level of supply response. However, as a result of the heavy cull, deer numbers at 30 June 1993 are estimated to have fallen to around 950,000.

Production of venison and velvet for 1992/93 June year reached 22,200 tonnes of venison and 450 tonnes of velvet.

4.4 LEVEL OF SUPPLY RESPONSE

The level of supply response is determined by the number of animals available to provide breeding hinds, venison and velvet. The factors influencing breeding stock levels are the price of breeding hinds, relative to their venison value, and the comparative gross margin between deer breeding/finishing operations compared to other livestock enterprises. The main factor determining the growth of the stag herd is the price of velvet.

The number of deer available for venison production from either the stag or hind herd is influenced by changes in breeding hind values, velvet prices, venison returns and the relativities of these returns with those of other livestock enterprises.

As noted in Figure 6 the deer numbers and production graph the rapid change in prices over the 1991-1993 period resulted in substantial increases in venison and velvet production, and a significant fall in livestock numbers.

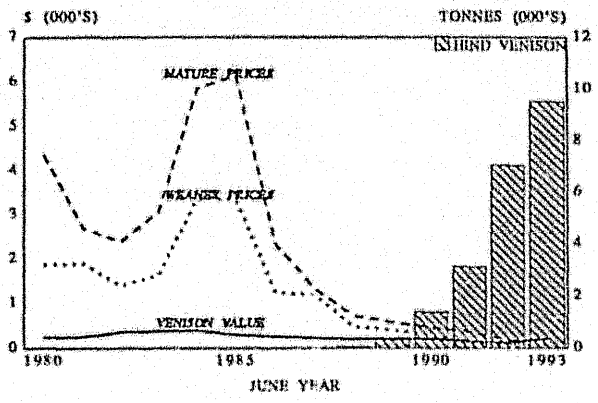
4.4.1 Growth in Hind Numbers

The hind herd which makes up about 65% of the total herd, grew by about 26% pa from 1981 to 1990. While returns from breeding were high, few hinds were slaughtered, so the age of the breeding herd increased. The live sales, venison values and slaughter rates for hinds over the 1980 to 1993 period are shown in figure 8.

Demand for breeding hinds kept prices above their venison value through until 1991. Nominal (real) prices peaked in 1985 at over $3,500 ($6,000) per head. A significant fall in the venison schedule price reduced industry confidence in 1991, and hind values fell to around their venison return. It was this fall to their venison value that caused hind slaughter to increase dramatically. It grew from 7,000 hinds (300 tonnes) in the 1989 June year, to peak at just over 224,000 hinds (9,000 tonnes) in the 1993 June year. The 1992/93 increase alone was up 40% on the previous season.

Apart from the fall in value and the aging of the breeding herd, this high hind kill was driven also by a loss of confidence in the industry after venison prices fell sharply during the 1991/92 season.

FIGURE 8: HIND VALUES & VENISON PRODUCTION
Real 1992 Prices



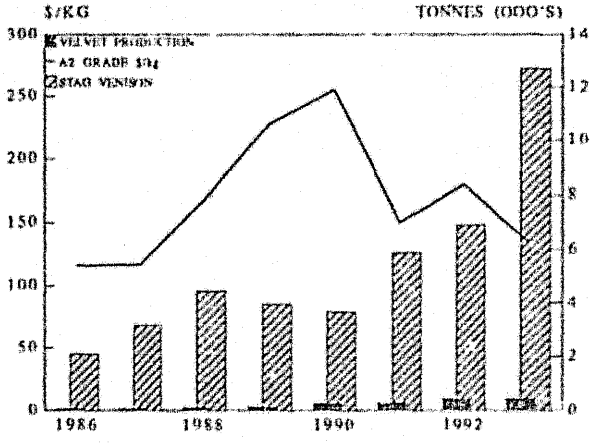
SOURCE MAFPolicy

As the growth and reproductive rate of the deer herd is dependant on the availability of hinds, the hind herd is expected to continue to grow so long as the live value of hinds is greater that their venison value.

4.4.2 Stag Herd Growth

The stag herd growth averaged about 17% pa between 1986-1988. As velvet prices rocketed in 1989-1990 stag herd growth increased by around 23% pa to peak at around 435,000 in June 1992.

FIGURE 9: STAG VELVET PRICES & PRODUCTION



Source MAFPolicy & GIB

The main influence on stag herd growth is the price of velvet. As shown earlier gross margins from velvet operations were higher, even than dairying through until the 1992/93 season.

Unlike other animals, stags grow velvet each year, and the quantity produced increases annually until they are six years of age. Provided they are healthy, stags continue to produce good heads of velvet until at least ten years of age. While the ageing of a stag improves velvet weights, it reduces the

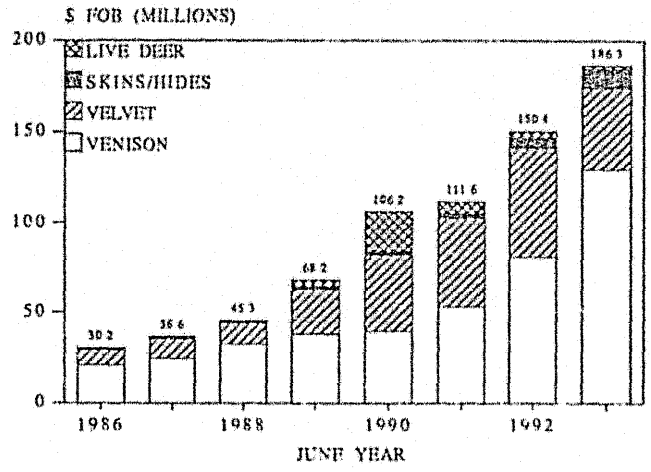
stags attractiveness for venison production. In older stags the venison texture is tougher and the flavour is stronger.

As can be seen in Figure 9, when velvet prices increased rapidly from $120 to $250/kg for A2 grade, venison produced from this source fell. Higher velvet prices resulted in farmers retaining additional stags many of which were poor velvet producers. After low prices for two consecutive seasons, farmers culled poorer producing stags. As a result the stag kill increased by 80% in the 1992/93 season.

4.5 DEMAND FOR NEW ZEALAND DEER PRODUCTS

In 1969 deer exports were worth $2.75 million. Since then total deer product exports have grown rapidly to reach $186 million for the 1993 June year. Their value by product for the period 1980-93 is shown in Figure 10. With the exception of 1990, venison is the main contributor to export earnings and velvet the next most important product. In 1993 venison exports were worth $130 million, velvet $44.5 million, skins and hides $10.5 million and live exports $1.5 million.

FIGURE 10: DEER INDUSTRY RETURNS
1986 - 1993



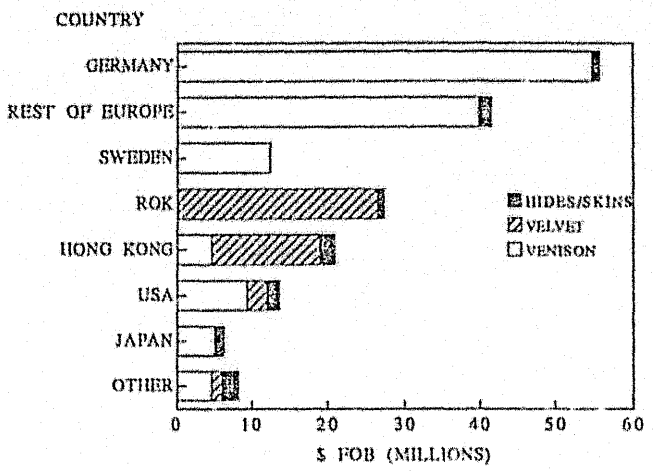
Source - Statistics NZ

Venison is sold to 39 countries in all - 16 within Europe and Scandinavia and 23 other countries including the US and Japan. Velvet is sold to 9 countries with the main markets being ROK and Hong Kong.

With around 98% of product being exported it is the returns from overseas markets that dictate the prices received by deer farmers in New Zealand. These prices in turn reflect the demand for product by New Zealand exporters.

From the New Zealand farmers' point of view demand for product is indicated by the weekly venison schedule price offered by exporters and the prices paid for velvet at the velvet pools held around the country.

FIGURE 11: MAIN EXPORT MARKETS
1992/93 Season ($ millions fob)



Source - Statistics NZ

As discussed previously in the international section and illustrated in figure 11, demand for New Zealand's venison is from Europe, and velvet is mainly from Asia.

As European demand for venison is highest during the October- December hunting season NZ schedule prices are higher over the August-October period. They then generally taper off from November through to April as larger numbers of deer are finished and ready for slaughter. This mismatch of market and production seasons, especially for chilled product, due to location is difficult to overcome. As a result most of the venison production is shipped out in frozen form.

Similarly Asian velvet consumption is highest over the August to December, while New Zealand production takes place from late October to early December. As it takes at least a month to dry velvet to be ready for export, only a small portion of the new seasons production is ready for shipment when ROK demand is at its highest. Around 90% of New Zealand velvet exports shown in figure 13, are sold in dried form; of this amount only about 10% is sliced or processed further into capsules.

Other factors affecting the demand for venison and velvet are stock levels and competition for the product among exporters.

High stock levels within New Zealand reduce the availability of capital for the purchase of new stocks. These stock levels also affect international demand as importers who are able to assess New Zealand stock levels put pressure on sellers wanting to reduce inventory levels.
Apart from international market demand, venison processing capacity has had an impact on demand, especially from 1991, when farmer confidence in the industry fell and the supply of stock for slaughter rose dramatically. Exporters responded to this 80% increase in supply by maintaining single shifts at deer slaughtering premises in an endeavour to control the quantity of venison produced. In some cases, companies were unable to increase capacity without additional modification to chilling of processing facilities.
As increased stocks sold the following season, companies increased existing facilities to process larger numbers of deer. At the same time new entrants entered the industry.

Capacity exceeded demand, so competition increased for stock, maintaining higher schedule prices and reducing company processing margins. Farmers responded to the higher demand by killing larger

numbers of animals, which in turn stemmed herd growth and resulted in large stocks of venison. These stocks have had a negative impact on demand. After the large kill New Zealand deer numbers have fallen and processing capacity now exceeds demand.

4.6 PRICE

As shown in the supply section, growth in venison and velvet production has been responsive to changes in the relative product prices. Figure 12 shows annual venison exports and the average return per kg fob, while Figure 13 shows returns for velvet exports and the price of A2 grade velvet in New Zealand.

FIGURE 12: VENISON EXPORTS & AVERAGE FOB RETURNS
1980 - 1993

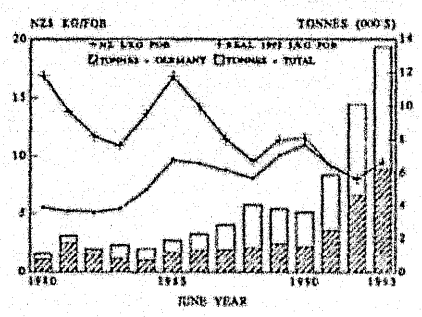
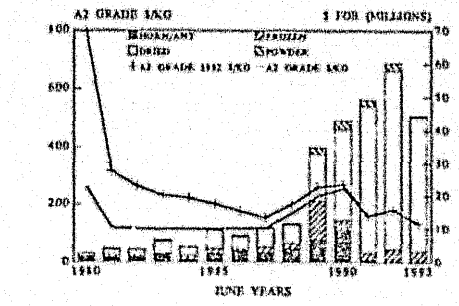
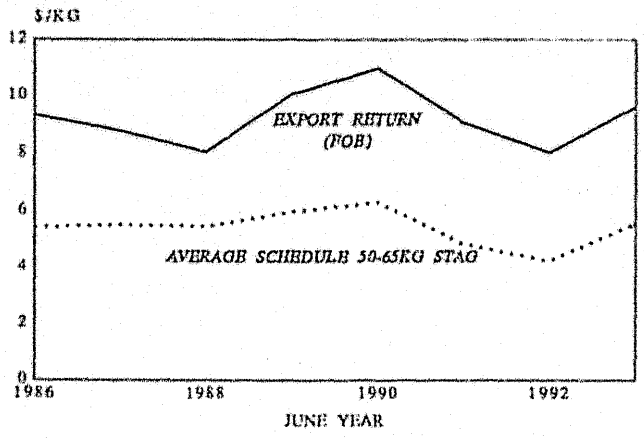


FIGURE 13: VELVET EXPORT RETURNS & A2 GRADE PRICES
1980 1993



As farmed venison production began in the early 1980's, real prices fell as supply of venison declined then trended upwards from 1983 until the Chernobyl disaster in 1986. Figure 14 shows average venison export returns. The schedule price offered by exporters to farmers mirrors movements in export returns. The fall in venison returns at the same time as a fall in velvet prices resulted in a significant stag kill.

FIGURE 14: VENISON FOB AND SCHEDULE RETURNS
1986-93



Source - MAFPolicy

Velvet prices improving sharply during the 1988 - 1990 period resulted in a rapid expansion of velveting herds, and caused venison production to fall. This decline venison production led to a venison price rise. In 1991 velvet prices fell sharply, but velvet producers were still receiving higher returns than other livestock enterprises, few velveting stags were culled. Meanwhile the hind cull was increasing.

The rise in 1990/91 venison production saw export-volume grow by 60%. This production spurt reached export markets at the same time as an increased east European cull, causing 1991/92 venison returns to fall sharply. Velvet prices declined further in 1992/93 after increased quantities of Russian velvet entered the ROK market. This fall, coupled with the lower 1991/92 schedules led many farmers to exit the industry. The resulting heavy stag and hind kill in 1992/93 saw venison exports reach 13,500 tonnes. However, the expected fall in export market prices from increased supply did not occur - instead fob returns rose. This price improvement was attributed to the smaller quantities of east European product sold into western Europe.

The surge in production, especially in the first half of 1993, has resulted in a build up of New Zealand venison stocks. Importer's knowledge of these large stock levels; coupled with a downturn in European economic growth, forced prices down. As a result New Zealand schedule venison prices fell again at the beginning of the 1993/94 season.

In summary consistent deer industry growth is dependant on relatively stable prices. Prices, however, are responsive to supply and demand fluctuations. With confidence in a new industry swinging to greater extremes than in more mature industries, greater pressure appears to be put on the supply rather than the demand factors.

5 NEW ZEALAND DEER MODEL CONCEPTUAL FRAMEWORK

In this section, the conceptual framework dealing with the domestic supply of and export demand for the main deer products (Venison and Velvet) are discussed. In order to do this, the model variables and data sources are identified and defined first. This is followed by the discussion of supply and then demand relationships.

5.1 MODEL VARIABLES AND DATA

The variables employed in the model can be categorised into those which are explained by the model itself (Endogenous variables) and those variables which are pre-determined and thus are known as explanatory (Exogenous) variables (Appendix C: Table 1, Sections I and II).

5.1.1 Endogenous Variables

The main supply related endogenous variables used in this model are the deer numbers (inventory), both male (stags - KDS & KYDS) and female (hinds - KDH & KYDH), and production levels for venison (QTVEN) and velvet (QTVEL). They are mainly sourced from the Department of Statistics Agricultural Census and other related series as well as those obtained from agencies related to the Deer industry (Appendix D: Table 1, section I).

The deer inventory levels are in thousands and the output levels are in tonnes of carcass weight. The schedule prices paid for stag venison (AP2 stag $ per Kg, net of GIB levy) and the velvet pool prices (A grade $ per Kg) paid to deer farmers are the main supply related endogenous price variables used in the model.

The endogenous variables related to venison demand are the export returns at fob level in the main export markets (ie Germany -NZRETG, Sweden - NZRETS, etc), used as proxies for wholesale venison returns, and the level of exports to these markets (ie Germany - NZEXPG, Sweden - NZEXPS, etc). These are sourced from the Department of Statistics export series and related data (Appendix D: Table 1, Section II).

The fob returns for venison are in the respective overseas currencies (ie, Deutch Mark, Kroner, US $) in which they are sold per tonne of product weight and the export quantities are tonnes on a product weight basis. The export velvet returns (ie Korea - VPRKOP and Hongkong - VPRHKP) are also in the respective overseas currencies (ie, Wan and HK $) per Kg of processed product.

5.1.2 Exogenous Variables

The main exogenous variables relate to several price series in domestic as well as overseas markets for venison and velvet related products. The price of breeding hinds (PBRH) in NZ $ per head and the price of beef (PPB), lamb (PL) and milkfat (PD) in NZ cents per Kg are the relevant domestic prices paid to farmers used in the model along with the Prices Paid for Inputs (PPIDR) by deer farmers (Appendix D: Table 1, Section II).

The wholesale beef prices in the overseas markets for New Zealand venison (ie Germany - BPWX, Sweden - SWEBP, etc) and the Velvet Cheek price in Korea (VCPRKO) are the prices in overseas currencies which are exogenous to the model. New Zealand venison return in other markets not modelled separately (ie USA, Asia - NZRETRN) is another exogenous variable.

Other exogenous variables are related to venison and velvet stock carry over levels in tonnes and Kg respectively, venison processing capacity utilisation, Consumer Price Indices (CPI) and New Zealand Dollar Exchange Rates (EXR) for countries such as Germany, Sweden and USA. There are also two (binary) dummy variables related to the Chernobyl nuclear accident in 1986 (DVCH) and the German Unification in 1990 (DVEG) (Appendix D: Table 1, Section II).

5.1.3 Data periods

As the farmed deer industry in New Zealand is relatively young, time series data on supply and demand was available only for a restricted time period. Deer numbers and slaughter data as well as the venison schedule and velvet pool prices for June years were available from about 1980 only.

The export returns and volumes for venison were available for a few more years starting from 1977 as there was some trade in feral venison during the earlier period. Velvet export levels and returns were however, available from 1983 only.

5.2 ESTIMATION OF SUPPLY RELATIONSHIPS

The nature and source of venison and velvet production is covered first in this section, followed by the inventory relationships for deer stags and deer hinds. The supply behavioural equations and some fixed ratios or relationships are discussed next before a brief outline of the nature of supply dynamics in deer farming.

5.2.1 Domestic Supply of Deer Products

Venison, the meat from deer, is produced from both deer stags and hinds. The volume of total venison output is determined by the number of stags and hinds slaughtered, which respectively produce varying amounts of stag and hind venison available each year for exports (Appendix D: Table 2, Section I).

The main factors influencing the level of deer stag and hind slaughter are the venison and velvet prices and the price of other pastoral products such as lamb, beef and milkfat along with total adult deer stags and hinds available for slaughter. The price of breeding hinds also influence the level of hind slaughter as well as the number of breeding hinds in the deer population.

Velvet, the antlers which grow on male deer, are harvested annually mainly from adult stags but some spikers are produced by younger male deer. The annual velvet harvest is thus dependent on the inventory of both adult stags and young male deer in the population (Appendix D: Table 2,

Section I).

5.2.2 Deer Inventory Relationships

These relationships represent the changes in total deer numbers and consist of young and adult stags and hinds. The level of young (under one year of age) male and female deer in the population the previous season when added to the opening inventory of adult stags and hinds increase the closing inventory. The number of stags and hinds slaughtered and the death of adult deer during the season lead to a decline in these numbers (Appendix D: Table 2, Section II).

The closing inventory of young deer stag and hind depend on the number of fawns weaned during the season less those die after weaning. The fawns weaned in return depend on the number of breeding hinds in the previous season times the fawns weaning rate. Fawns weaning rate is the ratio of fawns born which survive at weaning (Appendix D: Table 2, Section II).

5.2.3 Specification of Supply Equations

The supply equations represented in this deer model consist mainly of three behavioural equations and several fixed ratios or relationships.

5.2.3.1 Behavioural Equations

As noted before, the behavioural equations deal with the number of breeding hinds (KBDH) and the slaughter of deer stags (SLDS) and hinds (SLDH) respectively. These equations represent the aggregate responses by the deer farmers in terms of on-farm slaughter and breeding decisions to economic signals such as product prices and the prices paid for inputs used in deer farming. Products of importance include those from deer farming as well as outputs from other pastoral activities such as lamb, beef and dairy milkfat (Appendix D: Table 3, Section I).

The breeding hind numbers (KBDH) are determined by the available total adult hinds in the previous season (KDHt-1) and the price variables of importance. They are the real price of breeding hinds (RPBRH) which represents the level of demand for breeding stock, real schedule price of stag venison (RPSVEN) which indicates the extent of demand for venison, the price of velvet influencing the gross margin for velvet operations (GMV) and the real price of beef (RPPBPP), from an important alternative pastoral activity.

The stag slaughter numbers (SLDS) are determined by the available total adult stags in the previous season (KDSt-1) and the price variables of importance. They are the real schedule price of stag venison (RPSVEN), the real pool price of velvet (RPVEL) and the real price of lamb (RPLPP) and beef (RPPBPP) from other pastoral activities.

The hind slaughter numbers (SLDH) are determined by the available total adult hinds (KDHt-1) in the previous season and once again the price variables of importance. They are the real price of breeding hinds in the previous season (RPBRHt-1), the real schedule price of stag venison (RPSVEN) and the real price of milkfat (RPDPP) (Appendix D: Table 3, Section I).

5.2.3.2 Fixed Ratios and Relationships

Due to the limitations of necessary data to represent them in the form of behavioural equations, the fawning rate (FWR), the ratio of male:female fawns ratio (MFR.FFR) and the death rates for stags (DRDS), hinds (DRDH) and fawns (DRFW) were specified as fixed ratios in the model. The slaughter weights of stags (SLWDS) and hinds (SLWDH) as well as the velvet harvest weights from adult (PAVELWT) and young stags (PYSPKWT) were also predetermined in this model, once again due to the paucity of data to model these variables (Appendix D: Table 1, Section III).

5.2.4 Nature of Supply Dynamics

The dynamics of herd build up for New Zealand Deer has been studied extensively (Sandrey and Zwart, 1984). This study identified the optimal slaughter age of deer under alternative values of breeding hinds as well as velvet and venison returns, in order to understand the lack of venison supply in the early 1980's.

There is a delicate balance between the level of venison and velvet returns that lead to herd build up and those which result in greater venison and/or velvet production. Higher velvet returns usually lead to a buildup of the stag population to produce more velvet and in return reduce stag venison production. Higher velvet returns also lead to a reduction of hind slaughter and thus an increase in breeding hind numbers, which in turn enable further increase of the stag population to produce more velvet.

Higher venison returns conversely lead to higher levels of stag slaughter and venison production. It also results in higher breeding hind numbers, which allow for some herd buildup in turn. Higher values received for breeding hinds however, enhance herd buildup much more due to the combined increase in breeding hind numbers as well as reduction in hind slaughter.

5.3 ESTIMATION OF DEMAND AND PRICE RELATIONSHIPS

In this section, the conceptual framework dealing with export demand and price linkage relationships for the main deer products is outlined. In order to do this, the returns for New Zealand venison in three distinct markets in the continental Europe and the respective export demand relationships for venison are discussed first. This is followed by an account of the returns for New Zealand velvet in two Asian markets. The price linkage relationships between overseas returns for venison and velvet and domestic schedule and pool prices respectively, are discussed next.

5.3.1 Venison Returns and Export Demand

The main market for New Zealand venison at present is the continental Europe. More specifically, countries such as Germany, Sweden, France and other European countries take up most of the venison exports from New Zealand. In this model, the German and Swedish venison markets are modelled separately along with the rest of Europe. Both the returns (ie NZRETG, NZRETS and NZRETE) and export demand (ie NZEXPG, NZEXPS and NZEXPE) for venison in each of these three markets are estimated in this model.

The key factors determining the fob returns for New Zealand venison in all the three export markets are the level of New Zealand venison exports (ie NZEXPG, NZEXPS and NZEXPE) and the price of beef (ie BPWX, SWEBP and ECBP) in these markets. The level of exports into these markets are influenced by the level of total venison exports (NZEXPT) and the venison returns in each of these markets compared to the weighted average returns (WANZRET) (Appendix D: Table 3, Sections II and III).

5.3.2 Velvet Returns in Export Markets

The major markets for New Zealand velvet at present are the Republic of Korea (ROK) and Hongkong. The fob returns for processed velvet, the main form of New Zealand velvet produced, are modelled for each of these markets.

The most important factor determining velvet returns in the Korean market (VPRKOP) is the check price set annually by the authorities in the ROK (VCPRKO). The Hongkong velvet returns (VPRHKP) are in turn influenced by the returns in the ROK (Appendix D: Table 3, Section IV).

5.3.3 Specification of Venison and Velvet Return Equations

The venison demand equations represented in this deer model consist of three export return and three export demand equations for the three distinct overseas markets identified above. They are estimated in the logarithmic formulation (Appendix D: Table 3, Sections II and III).

The venison return equations are modelled as a function of beef prices in the respective markets and the level of New Zealand exports into these markets, as New Zealand imports make up a significant part of these markets. In Germany, the Chernobyl effect during 1986-88 is used as an additional (dummy) variable. For the Rest of Europe, total consumption of minor meat types which include venison is also included as an explanatory variable.

The velvet return equations for the two key export markets are employed in this model. They are simpler formulations than the venison export equations, due to the paucity of key data in these Asian markets.

5.3.4 Specification of Price Linkage Relationships

In order to provide the necessary link and the dynamics between the demand for and the supply of venison and velvet, the prices paid to deer farmers for their products have to be related to the returns for these products in the respective export markets (Appendix D: Table 3, Section IV).

The price linkage relationships relate real venison schedule prices (RPVENRL) in New Zealand to the weighted average returns for venison (WANZRET) in all the different export markets. An additional explanatory variable used in this price relationship is the level of venison processing capacity utilisation (VPRCAPUN), measured as the ratio of actual stag and hind deer kill to total potential processing capacity.

For velvet, the price linkage is between the real velvet pool price paid (RPVELRL) to deer farmers and the prices received in the Korean (VPRKOP) and Hongkong (VPRHKP) export markets. In this price relationship the level of velvet stock carry over (VELSTCO) is used as an additional explanatory variable.

5.3.5 Dynamics of Venison Supply and Demand

In summary, the dynamics of venison supply responses discussed before along with the price linkages outlined above provide an overview of the nature of overall dynamics in venison and also velvet production.

The level of New Zealand venison production and exports determine the returns for New Zealand venison in the major overseas markets due to their importance in these markets. These individual returns determine the average venison export returns, which in turn influence venison schedule prices along with the level of processing capacity utilisation. Deer farmers' responses to these venison prices lead to deer herd build up and/or additional deer kill which increase venison production and also exports. This then influences the level of export returns for venison and the cycle gets completed.

5.4 DEER MODEL ESTIMATION AND SIMULATION

The system of behavioural equations identified in the deer model conceptual framework (Appendix D: Table 3) were estimated by three stage least squares with instrumental variables. The statistical software package used for this estimation and subsequent base simulation was the Time Series Processor (TSP) version 4.2 developed for micro computers by TSP International.

The supply (breeding hinds and slaughter) relationships and the venison price linkage equation were estimated in the linear form. The venison export returns and venison export demand equations for the

three markets were estimated in natural logarithms. The velvet price relationships were not estimated as part of the simultaneous system due to their recursive nature in price determination.

5.4.1 Supply Equations

The three supply related equations estimated in the deer model provided a high level of explanatory power in terms of adjusted R2 values of more than 0.90. Most right-hand side variables hypothesised as important in explaining the variability in breeding hind numbers as well as deer stag and hind slaughter levels were found to be important and exhibited the right signs.
All price variables in the supply related equations were in real terms, where the Prices Paid Index for deer farms (PPIDR) was the deflator used (Appendix D: Table 3, Section I).

The available opening deer hinds were most important in determining both breeding deer hind numbers (0.621) as well as the level of hind slaughter (0.095). This result suggests that, when holding all other variables at their mean level, about 62% of the available hinds were bred on the average and about 9.5% were slaughtered. Similarly, about 58% of available deer stags were killed when all other variables are held at their mean levels.

These levels however, have fluctuated with variations in both real venison and velvet prices as well as the real price of breeding hinds and the real price of products such as beef, lamb and milkfat from alternative pastoral activities. Higher prices for breeding hinds as well as stag venison and velvet prices have led to a greater proportion of available hinds being bred. Higher beef prices however, have lead to a fewer hinds being bred. The parameters estimated are all significant at least at the 10% level of confidence. The overall equation is also statistically significant at the 1% level.

In the stag slaughter equation, higher real velvet prices lead to less stag slaughter, while higher real stag venison prices result in more stag slaughter as generally hypothesised. Higher real lamb prices also appear to lead to higher stag kill, while higher real beef prices lead to lower stag kill. This suggests competition for resources between deer and sheep activity but possibly some complementarity in beef and deer farming.

In the hind slaughter equation, higher real velvet as well as lagged breeding hind prices lead to less hind slaughter while higher milkfat prices appear to lead to higher hind kill. These results are consistent with the usual behaviour in the industry. Higher velvet prices lead to an increase in the stag population which can occur through an increase in breeding hinds for which there has to be less hind kill. The result on milkfat prices suggest some competition for resources between deer and dairy activities.

5.4.2 Venison Export Returns Equations

The three venison export returns equations relate to the German, Swedish and other European markets. These returns were measured at the fob level as the domestic wholesale price series were not available. They were also estimated in the natural logarithms. Overall these equations do not exhibit the same high level of explanatory power as the supply side equations discussed above. The R2 values range from 0.657 in Germany to 0.852 in Sweden with the rest of Europe in between at 0.797 (Appendix D: Table 3, Section II).

The main variables employed in these equations were the wholesale price of beef in the respective markets, used as a measure of the level of demand for red meats over the historical period, and the level of New Zealand venison exports into these markets. All the beef prices as well as New Zealand returns were in real terms (ie 1992 values), where the CPI for the respective markets were used as the deflators.

A binary variable for the Chernobyl nuclear fallout in the German equation, the lagged dependent variable in the Swedish equation and total game meat consumption level in the Rest of Europe

equation were used as additional explanatory (pre-determined) variables. Overall, all three equations were statistically significant at the 1% level of confidence.

In the German and Swedish quations, higher beef prices lead to higher venison returns and higher New Zealand venison exports lead to lower venison returns. These results are consistent with a-priori hypothesis of market behaviour. The Rest of Europe equation also implied higher venison returns when beef prices were higher, but higher venison returns even when New Zealand venison export levels into this market were higher. All these parameter estimates were significant at least at the 10% level of confidence.

The binary variable for Chernobyl had a negative impact on venison returns in the German market as hypothesised. The level of total game meat consumption in the Rest of Europe also had a negative relationship to venison returns in this market.

5.4.3 Venison Export Demand Equations

The three export demand equations also relate to the three markets as above and have identical specification. The level of total venison exports from New Zealand and the ratio of venison returns in the respective markets in relation to weighted average venison export returns in all markets were used as explanatory variables. These equations were also estimated in natural logarithms. All three equations exhibited a high degree of explanatory power with R2 values ranging between 0.871 (Sweden) and 0.956 (Germany) with Rest of Europe at 0.938 (Appendix D: Table 3, Section III).

The level of total New Zealand venison exports had a positive impact on the level of exports into the individual venison markets modelled and all related parameters were significant at the 1% level of confidence. The relative returns variable had a positive sign in the German and the Rest of Europe export demand equations as expected but a negative sign in the Swedish equation. This is possibly the reflection of the nature of venison being shipped to Sweden vis a vis Germany as well as the Rest of Europe (ie France, Switzerland etc).

5.4.4 Venison Price Linkage Equation

This equation provides the linkage between venison export returns and the domestic venison schedule prices. It is therefore, critical in identifying the dynamics between export demand as well as returns and domestic slaughter and venison supply responses (Appendix D: Table 3, Section IV).

The equation relates real venison schedule prices with real weighted average export returns and domestic venison processing capacity utilisation. It had a high degree of explanatory power with an adjusted R2 value of 0.968 and all parameters were significant at the 1% level of confidence.

The results suggest that, when the impact of venison processing capacity utilisation is not taken into account, about 57 % of the weighted average export returns are paid to farmers in terms of real venison schedule prices. Venison Processing capacity utilisation, which increases with additional available kill, has a negative impact on the venison schedule prices as hypothesised.

5.5 DEER MODEL VALIDATION

The validation results for the estimated simultaneous deer model relationships are summarised in table 5. These are based on the Actfit procedure in TSP and are comparisons of base simulation results for the 1981-1993 period with the actual historical data.

TABLE 5: VALIDATION OF DEER SUPPLY AND DEMAND MODEL

ENDOGENOUS VARIABLES	CORRELATION COEFFICIENT	REGN COEFF ACT VS PRED	THEILS COEFF	ERROR DUE TO BIAS
I VENISON EXPORT RETURNS				
a Germany	0.737	0.858	0.076	0.002
b Sweden	0.802	0.953	0.127	0.005
c Rest of Europe	0.603	0.812	0.103	0.006
II VENISON EXPORT DEMAND				
a Germany	0.995	0.956	0.034	0.010
b Sweden	0.952	0.629	0.225	0.043
c Rest of Europe	0.987	1.226	0.096	0.051
III SUPPLY				
a Breeding Hinds	0.975	0.972	0.055	0.002
b Stag Slaughter	0.917	0.897	0.134	0.002
c Hind Slaughter	0.902	1.086	0.205	0.001
V PRICE LINKAGE				
a Venison	0.821	1.034	0.052	0.006

The statistical measures reported in this table are the Correlation Co-efficient (CORR) and the Regression Co-efficient (REGR) of actuals on predicted. Also included are the Theil's Inequality Co-efficient and the Error due to Bias in estimation.

The CORR measures the degree of parallel changes in actual and predicted or estimated values, while REGR measures the extent to which the two series coincide together. In both cases, a value closer to one is most preferred and the value for REGR can be greater than one. Other two measures are an indication of systematic bias and consistent under or over estimation of endogenous variables. A lower value is preferred in both cases.

5.5.1 Venison Export Returns

In the case of venison export returns, the correlation co-efficient between actual and fitted values is not too high ranging between 0.603 (Rest of Europe) and 0.802 (Sweden) with Germany at 0.737. The regression co-efficients however, are higher and range between 0.812 (Rest of Europe) and 0.953 (Sweden) with Germany once again in between at 0.858 (table 5).

The measures of bias indicate that the German export return relationship is the best with the lowest error due to bias and Theil's Inequality co-efficient. These values are relatively greater in the case of Sweden as well as the Rest of Europe, but are still not too high.

These results suggest that the model is able to track the variability in venison export returns reasonably well, particularly in the case of Sweden and Germany. Rest of Europe being made up of a group of somewhat diverse markets for venison, the results are not as good.

5.5.2 Venison Export Demand

Overall, the results of model validation for venison export demand relationships are mixed. Correlation co-efficients of actual on fitted values are quite high, above 0.950 for all three markets. The regression co-efficients however, vary between 0.629 (Sweden) and 1.226 (Rest of Europe) with Germany closer to one at 0.956. The measures of bias are also the lowest in the case of the German market, but are somewhat greater in the case of the other two markets (table 5).

These results suggest that the ability of the model to describe export demand changes in the more important German market is good. This is however, is not the case for the developing Swedish and the Rest of European markets with some over and under estimation respectively.

5.5.3 Supply Relationships

The three supply related equations appear to track the actual data very well. All the correlation co-efficients are above 0.900 at. l the regression co-efficients range from 0.897 (Stag slaughter) to 1.086 (Hind slaughter), with Breeding hind numbers being the best at 0.972. The level of systematic bias in these relationships is also very minimal and is less than those for the export returns and export demand equations discussed above (table 5).

There appears to be some slight over estimation of stag slaughter and under estimation of hind slaughter, based on these results for the 1981-93 period. It is important to note that there had been some dramatic changes in the level and mix of stag and hind slaughter, particularly since 1991.

5.5.4 Venison Price Linkage Relationship

This key equation exhibits very good tracking ability of real venison schedule prices, based on reasonably high correlation (0.821) and regression (1.034) co-efficients which are closer to one. The level of error due to bias is also reasonably low in relation to other relationships estimated in this model as well as in absolute terms (table 5).

6.0 SUMMARY AND CONCLUSIONS

Over the last 4-5 years, the level of understanding of the workings of the New Zealand deer industry at the Ministry of Agriculture has been greatly enhanced. This has been possible mainly due to some very useful work carried out in gathering the necessary data and estimating some of the demand and supply relationships for venison and velvet within the spreadsheet framework.

The nature of the dynamics involved in both the supply responses of deer farmers as well as the nature of price determination for New Zealand venison and velvet in overseas markets suggested the need for a more rigorous approach to this analysis.

In this paper we have attempted to develop a conceptual framework which represents the dynamics of supply and demand for New Zealand venison and velvet. This is required in order to develop an econometric model and estimate these relationships and simulate the results in a systems formulation.

This paper initially provides a very detail background on the deer industry in New Zealand as well as in the International arena. The information on the factors contributing to the growth of the New Zealand deer industry in terms of deer numbers and those factors which currently determine the supply decisions of deer farmers in terms of venison and velvet output are very important for a good understanding of the dynamics involved.

The information on the world deer scene provides a perspective on the size and importance of the New Zealand industry with respect to deer numbers, production and export levels. This is also important to understand the way in which the returns and export demand for New Zealand venison and velvet are determined in overseas markets.

The work reported in this paper represents progress made so far with respect to model development, simulation and validation. Further model refinement and forecast simulations will be carried out in the near future in conjunction with wider industry consultation.

The estimated model and base simulation results reported in this paper suggest a reasonable ability to track changes in the industry with respect to the earlier emphasis on herd build up and more recent increases in venison and velvet production. There are however, areas for improvements in model specification as well as the nature and quality of data used in this model. The period of reliable local as well as overseas market data availability varies with the type of activity within the deer industry (ie venison and velvet), but is limited in general.

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Appendix A Estimate of World Farmed Deer Numbers

		TOTAL NUMBER	TYPE OF DEER: Fallow	Sika	Rusa	Red	Wapiti/Elk	Spotted	Sambar	Chital	Reindeer	Other
Australia	1992	161,600	92,100		6,440	53,400				3,220	0	6,440
NZ	1992	1,125,240	72,841			872,630	130,605					50,366
Papua NG	1991											
New Caledonia	1992	12,500			12,500							
EUROPE												
EC												
Belgium	1992											
France	1992	30,000	15,000			15,000						
Denmark	1990	29,300	25,780		3,520							
Germany	1992	71,000	64,000			6,000						
Netherlands**	1990	40				40						
Ireland*	1992	10,000	7,500			7,500						
Italy	1990											
Spain	1990											
United Kingdom	1992	42,000	16,150			25,170						1,680
OTHER EUROPE												
Austria	1991	1,984	1,984									
Hungary	1992	1,420	880			540						
Poland												
Switzerland	1990											
Czechoslovakia												
Yugoslavia												
USSR	1992	3,930,000		100,000		30,000	220,000				3,580,000	
SCANDANAVIA												
Finland		180,000									180,000	
Norway		220,000									220,000	
Sweden	1989	225,000	20,000			7,000					200,000	
AMERICAS												
USA	1992	110,400	30,000	2,000		10,000	30,000				17,400	21,000
Canada	1992	52,616	22,936	236		18,255	8,961				215	1,113
Chile	1990	5,900	400			5,500						
ASIA												
China	1992	300,000		220,000			66,000					5,000
Korea	1992	142,000		120,000		6,000	9,000					1,000
Mauritius	1992	10,500			10,500							
Taiwan	1991	44,400						22,200	21,200			
Japan	1987	540		340								
SUMMARY												
Total Oceania		1,309,342	165,741	0	0	18,940	926,030	130,605	0	0	3,220	0	56,806
Total EC		181,240	122,430	0	0	3,520	53,710	0	0	0	0	0	1,680
Total Other Europe		3,404	2,864	0	0	0	540	0	0	0	0		0
Total Scandanavia		625,000	20,000	0	0	0	7,000	0	0	0	600,000		0
USSR	1992	3,930,000	0	100,000	0	0	30,000	220,000	0	0	0	3,580,000	0
Americas		163,016	44,936	2,236	0	0	28,255	38,961	0	0	0	17,615	31,113
Total Asia		497,440	0	341,340	0	16,500	6,000	75,000	22,200	21,200	0	0	17,200
GRAND TOTAL		6,729,442	355,971	527,576	0	38,960	1,081,135	464,566	22,200	21,200	3,820	4,217,215	114,399
% BREED		100	5	8	0	1	16	7	0	0	0	63	2
NZ AS % FARMED DEER		17	19	0	0	0	82	28	0	0	0	0	89
NUMBER & % WHEN REINDEER EXCLUDED		2,622,829	15	20	0	1	40	18	1	1	0		4
THEN NZ BREEDS AS % WORLD		43											

OECD Meat Consumption - 1991
Kg/head

Area	Population (millions)	Meat Consumption Total	Beef	Poultry	Pork	Other
OECD-Total	840	89	27	24	30	1.4
OECD- Europe	436	83	20	16	34	2.2
West Germany	70	98	21	12	56	1.5
Belgium	10	104	22	17	49	2.8
Denmark	5	105	19	12	65	0.6
Netherlands	15	89	22	19	44	0.2
Italy	58	88	26	23	38	3.9
France	57	110	30	22	37	5.7
Norway	4	55	19	5	20	2.6
Sweden	9	61	17	6	31	2.5
Switzerland	7	83	26	11	39	1.5
USA	253	120	44	42	29	1.0
Japan	124	44	9	14	17	0.0
South Korea	43	29	5	16	5	
Taiwan	20	60	2	34	23	

Source - OECD Meat Balances
- Pacific Rim - Agriculture and Trade Report, USDA

Appendix C:

Gross Margins/(Per Stock Unit)

YEAR	DEER			OTHER			
	BREEDING/ FINISHING	FINISHING ONLY[9]	VELVET	BULL BEEF 20 month[10]	BULL BEEF 30 month[11]	SHEEP	DAIRYING
1988	108	91	153	71	59	71	61
1989	85	107	211	68	59	29	82
1990	65	96	179	69	51	34	100
1991	44	37	193	72	52	36	74
1992	34	77	84	64	43	29	75
1993	49	83	64	52	38	38	109
1994	52[12]	75	51				

[9] Return dependent on price paid for weaners

[10] Purchases weaners

[11] Purchases 18 month bulls

[12] Anticipating $6.00/kg AP2 Venison price

APPENDIX D - DEER MODEL VARIABLES AND ESTIMATED RELATIONSHIPS

TABLE 1: - NEW ZEALAND DEER MODEL VARIABLES LISTING

I ENDOGENOUS VARIABLES

A Inventory (000's)

1 Total Deer Number (KD)

2 Total Deer Hinds (KDH)

3 Total Deer Stags (KDS)

4 Young Deer Hinds (KYDH)

5 Young Deer Stags (KYDS)

6 Breeding Hind Numbers (KBDH)

7 Stag Slaughter Numbers (SLDS)

8 Hind Slaughter Numbers (SLDH)

B Outputs (Tonnes - Carcass Weight)

1 Quantity of Total Venison (QTVN)

2 Quantity of Stag Venison (QSVEN)

3 Quantity of Hind Venison (QHVEN)

4 Quantity of Total Velvet (QTVEL)

5 Quantity of Adult Velvet (QAVEL)

6 Quantity of Young Velvet (QYVEL)

C Returns

1 Venison Returns - German Market (NZRETG) - (DM/Tonne)

2 Venison Returns - Swedish Market (NZRETS) - (KR/Tonne)

3 Venison Returns - Other European Markets (NZRETE) - (US $/Tonne)

4 Stag Venison Schedule Price (PSVEN) - (NZ $/Kg)

5 Hind Venison Schedule Price (PHVEN) - NZ $/Kg

6 Velvet Pool Price (PVEL) - (NZ $/Kg)

7 Processed Velvet Price - Korea (VPRKOP) - (WAN/Kg)

8 Processed Velvet Price - Hong Kong (VPRHKP) - (HK $/Kg)

D Exports (Tonnes - Product Weight)

1 NZ Venison Exports - German Market (NZEXPG) → GWT

2 NZ Venison Exports - Swedish Market (NZEXPS) → SWT

3 NZ Venison Exports - Other Europe Market (NZEXPE) → EWT

4 NZ Venison Exports - Total Market (NZEXPT)

II EXOGENOUS VARIABLES

A Prices

- New Zealand -

1 Price of Breeding Hinds (PBRH) (NZ $/HD)

2 Price of Prime Beef (PPB) - (¢/Kg)

3 Price of Lamb (PL) - (¢/Kg)

4 Price of Milkfat (PD) - (¢/Kg)

- Overseas -

5 Beef Price - Germany (BPWX) - (DM/Tonne)

6 Beef Price - Sweden (SWEBP) - (KR/Tonne)

7 Beef Price - Europe (ECBP) - US $/Tonne)

8 Velvet Check Price - Korea (VCPRKO) - (WAN/Kg)

9 NZ Venison Return - ROW (NZRETRN) - (US $/Tonne)

B Other

1 Venison Stock Carry Over (VENSCO) - (Tonne)

2 Velvet Stock Carry Over (VELSTCO) - (Kg)

3 Venison Processing Capacity Utilisation (VPRCAPUN)

4 Dummy Variable - Chernobyl (DVCH)

5 Dummy Variable - East German Unification (DVEG)

6 Consumer Price Index - Germany (GECPI)

7 Consumer Price Index - Sweden (SWCPI)

8 Consumer Price Index - US (USCPI)

9 Consumer Price Index - NZ (NZCPI)

10 Exchange Rate - Germany (DMEXR)

11 Exchange Rate - Sweden (KREXR)

12 Exchange Rate - US (USEXR)

13 Prices Paid Index - Deer (PPIDR)

III FIXED/VARIABLE RATIOS (EXOGENOUS)

1 Fawning Rate (FWR)

2 Male (MFR)/Female (FFR) Fawns Ratio

3 Death Rates - Stags (DRDS)

4 Death Rates - Hinds (DRDH)

5 Death Rates - Fawns (DRFW)

6 Slaughter Weights - Stags (SLWDS)

7 Slaughter Weights - Hinds (SLWDH)

8 Velvet Weights - Adults (PAVELWT)

9 Spiker Weights - Young (PYSPKWT)

APPENDIX D: (Contd)

TABLE 2: NEW ZEALAND DEER MODEL PRODUCTION AND INVENTORY RELATIONSHIPS

I PRODUCTION RELATIONSHIPS

a Quantity of Stag Venison

$QSVEN_t = SLDS_t * SLWDS$

b Quantity of Hind Venison

$QHVEN_t = SLDH_t * SLWDH$

c Quantity of Total Venison

$QTVEN_t = QSVEN_t + QHVEN_t$

d Quantity of Adult Velvet

$QAVEL_t = KDS_t * PAVELWT$

e Quantity of Young Velvet

$QYVEL_t = KYDS_t * PYSPKWT$

f Quantity of Total Velvet

$QTVEL_t = QAVEL_t + QYVEL_t$

II INVENTORY RELATIONSHIPS

a Total Deer Stags

$KDS_t = KDS_{t-1} + KYDS_{t-1} - SLDS_t - DRDS * KDS_{t-1}$

b Total Deer Hinds

$KDH_t = KDH_{t-1} + KYDH_{t-1} - SLDH_t - DRDH * KDH_{t-1}$

c Young Deer Stags

$KYDS_t = MFR * FW_t - DRFW * MFR * FW_t$

d Young Deer Hinds

$KYDH_t = FFR * FW_t - DRFW * FFR * FW_t$

e Fawns Weaned

$FW_t = FWR * KBDH_{t-1}$

APPENDIX D (Contd)

TABLE 3: NEW ZEALAND DEER MODEL BEHAVIOURAL EQUATIONS

									R^2	F	DW
I	SUPPLY RELATIONSHIPS (1981, 1993)										
a	BREEDING HIND NUMBERS										
	$KBDH_t$	=	-40.0	+	0.621 KDH_{t-1} (8.734***)	+	0.946 GMV_t (5.838***)	+ 4.225 RPBRH$_{t-1}$ (1.512*)	0.978	110.1***	2.31
						-	89.976 RPPBPP$_t$ (-1.689*)	+ 2714.7 RPSVEN$_t$ (1.541*)			
b	STAG SLAUGHTER NUMBERS										
	$SLDS_t$	=	2.041	+	0.581 KDS_{t-1} (7.736***)	-	50.863 RPVEL$_t$ (-1.879*)	+ 4027.5 RPSVEN$_t$ (2.40**)	0.908	24.6***	2.34
				+	126.1 RPLPP$_t$ (2.83**)	-	196.871 RPPBPP$_t$ (-2.84**)				
c	HIND SLAUGHTER NUMBERS										
	$SLDH_t$	=	9.0	+	0.095 KDH_{t-1} (2.259*)	-	267.524 RPVEL$_t$ (-7.26***)	- 4.916 RPBRH$_{t-1}$ (-3.234**)	0.953	56.2***	2.09
				+	104.4 RPDPP$_t$ (7.1***)						
II	VENISON RETURNS RELATIONSHIPS (LOG SPECIFICATION)										
a	GERMAN RETURNS FOR NZ VENISON (1977, 1993)										
	$LNZRETG_t$	=	1.983	+	0.603 LBPWX$_t$ (3.337**)	-	0.119 LNZEXPG$_t$ (-1.692*)	- 0.108 DVCH$_t$ (-1.086)	0.657	11.2**	1.74
b	SWEDISH RETURNS FOR NZ VENISON (1978, 1993)										
	$LNZRETS_t$	=	-3.625	+	2.194 LSWEBP$_t$ (3.919**)	-	0.216 LNZEXPS$_t$ (-6.946***)	- 0.338 LNZRETS$_{t-1}$ (-1.529*)	0.915	54.6***	2.65
c	OTHER EUROPEAN RETURNS FOR NZ VENISON (1977, 1991)										
	$LNZRETE_t$	=	26.4	+	0.360 LECBP$_t$ (1.512*)	+	0.578 LNZEXPE$_t$ (6.490***)	- 2.813 LRETMTCN$_t$ (-2.000*)	0.797	19.3***	2.68

III VENISON EXPORT DEMAND RELATIONSHIPS (LOG SPECIFICATION) (1977, 1993)

							R^2	F	DW
a	NZ VENISON EXPORTS - GERMAN MARKET								
	$LNZEXPG_t$ =	-0.838	+	0.841 $LNZEXPT_t$ (18.536***)	+	1.819 $RNZRETG_t$ (5.786***)	0.956	174.5***	2.07
b	NZ VENISON EXPORTS - SWEDISH MARKET								
	$LNZEXPS_t$ =	-4.929	+	1.575 $LNZEXPT_t$ (4.958***)	-	3.053 $RNZRETS_t$ (-3.931**)	0.871	55.2***	2.38
c	NZ VENISON EXPORTS - OTHER EUROPEAN MARKET								
	$LNZEXPE_t$ =	-3.226	+	1.120 $LNZEXPT_t$ (8.592***)	+	0.628 $RNZRETE_t$ (1.510*)	0.938	123.6***	1.38

IV PRICE LINKAGE RELATIONSHIPS

							R^2	F	DW
a	STAG VENISON SCHEDULE PRICE (DEFLATED BY CPI) (1980, 1993)								
	$PSVENRL_t$ =	0.893	+	0.569 $WANZRET_t$ (10.0***)	-	1.827 $VPRCAPUN_t$ (-2.866**)	0.968	199.0	1.42
b	VELVET POOL PRICE (DEFLATED BY CPI) (1983, 1993)								
	$PVELRL_t$ =	212.1	-	0.128 $VPRKOP_t$ (-1.014)	+	0.230 $VPRHKP_t$ (2.462*)	0.356	2.8	1.87
					-	0.0002 $VELSTCO_t$ (-0.89)			
c	KOREAN PRICE FOR NZ PROCESSED VELVET (1984, 1993)								
	$VPRKOP_t$ =	403.5	+	0.329 $VEFCPRKP_t$ (5.239***)			0.746	27.5	1.87
d	HONG KONG PRICE FOR NZ PROCESSED VELVET (1983, 1993)								
	$VPRHKP_t$ =	-222.8	+	0.850 $VPRKOP_t$ (3.002**)			0.445	9.0	1.95