

# DEER FARMING: DEVELOPMENT, PROGRESS AND PERSPECTIVES

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Peter F. Fennessy, Anthony J. Pearse and Kenneth R. Drew<sup>1</sup>

## ABSTRACT

Contemporary interest in the farming of deer has developed rapidly over the last 20 years although the practice of husbanding deer probably has a very long history. The foci of recent developments have been New Zealand and the People's Republic of China in particular, but the factors stimulating development are different. The New Zealand industry is export-oriented with venison the major product while the Chinese industry is basically built on velvet antler. The importance of an infrastructure is clearly identified as a feature of the New Zealand industry. The paper discusses aspects of the New Zealand industry and in particular the technology supporting it and the importance of animal health are highlighted. The successful development of markets for high quality products is seen as the critical factor which will influence the success of the New Zealand deer industry. The deer industry in New Zealand is likely to develop into a major one that will rival the traditional livestock industries.

**Key words:** Deer, farming, New Zealand, China, *Cervus elaphus*, venison, antler.

## INTRODUCTION

International interest in the utilisation of non-traditional animal species is increasing rapidly. This is reflected in the symposium and in the numerous conferences and publications in the last decade (see Wemmer, 1987; Hudson *et al.*, 1989; Renecker and Hudson, 1991). Deer farming is the most spectacular example, stimulated by the developments in Scotland (Blaxter *et al.*, 1974) and New Zealand (Drew, 1976) in the 1970s. However managed utilisation of deer in rangeland situations, often

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<sup>1</sup> AgResearch, Invermay Agricultural Centre, Private Bag 50034, Mosgiel, New Zealand.

involving herding, has been practised for centuries as illustrated by the Arctic reindeer industry (Hudson, 1989). Deer farming itself has a long history and the opening up of China and the USSR through the late 1970s revealed some of the extent and history of deer farming in these countries (Pinney, 1981; K.R. Drew, unpublished). In this paper we discuss some features of deer farming with particular regard to its recent development in New Zealand. We also consider the future possibilities for utilisation of the international deer resource.

## HISTORY AND DEVELOPMENT

The practice of husbanding deer probably has a very long history and may even go back to pre-Neolithic times (Hudson, 1989). However there is some evidence that with the development of agriculture in the Neolithic period, deer species gave way to other species such as sheep and goats (e.g. the Natufian culture of Palestine; Cole, 1963; Henry, 1985). There is reference to Chinese emperors of the Shang dynasty keeping deer, probably for game, over 3000 years ago (Xu, 1992), while 2000 years ago the Romans also kept deer for game (Anderson, 1985). The interest in the use of deer for medicinal purposes in China goes back to around the time of the Qing dynasty (221-207 BC) with references to the use of velvet antler and hard antler in Shen Nung Pents'ao Ching of around 200 AD (Xu, 1992; Kong and But, 1985). Until the last 100 years or so, recent involvement in managing deer has arisen mainly through interest in deer as a game species with the game parks and managed estates of Europe being good examples. Reindeer herding, with the animal providing a major source of food to its managers, is of course an exception. However the more recent interest in both reindeer and in the other deer species has arisen out of the possibilities for the economic management of deer mainly for venison but also for velvet antler production.

In considering developments in deer management, some clarification is necessary with regard to the level of management involved. Management may mean hunting or herding, or it may mean ranching or farming, the latter two involving considerably more human control (Hudson, 1989). Hudson (1989) characterises ranching and farming as systems where animal distributions are critically controlled by physical barriers. The containment system offers opportunities for more extensive (i.e. ranching) or more intensive (i.e. farming) approaches to husbandry. In this context, ranching refers to populations which are fenced, but otherwise managed as wild animals. Farming is markedly more intensive and would generally involve supplementary feeding, controlled breeding, veterinary treatment and selection of individual animals for different purposes (e.g. breeding, slaughter, etc). This paper is concerned with deer farming.

## RECENT DEVELOPMENTS

The four major foci of the recent developments of deer farming have been China, the old USSR, Scotland, and New Zealand. A comparison of the situations which led to development in these different countries is interesting.

### China

In China, the revolution of 1948 stimulated the recent developments. The interest in a traditional indigenous medicine and the consequent demand for velvet antler was the main driving force. The major product of the Chinese industry is velvet antler, much of which is used within the country. However considerable quantities are exported, much of it to South Korea, generally via Hong Kong. Xu (1992) gives estimates of 350,000 sika deer (meihualu, *Cervus nippon hortulorum* and other subspecies) and 150,000 wapiti (malu, *Cervus elaphus xanthopygus*, *c. e. songaricus* and other subspecies) with about 5,000 of other species such as white-lipped deer (*C. albirostris*), sambar (*C. unicorn*), reindeer (*Rangifer tarandus*) and musk deer (*Moschus moschiferus*). The meihualu are largely concentrated in the north-eastern provinces of Jilin and Heilongjiang while the malu are mainly in Heilongjiang and the north western province of Xinjiang. Other centres are the provinces of Sichuan, Laoning and Hunan.

### Commonwealth of Independent States (CIS)

There have been considerable developments in deer ranching and farming in the area of the old Soviet Union (the CIS) over the past 100 years. The major drive behind the developments of the last 50 years has been the velvet antler trade. Until the breakdown of the USSR, the vast majority of this product was used within the country, much of it for the production of pantocrin and rantarin, the alcohol-based extracts of velvet antler of wapiti, red or sika deer and reindeer respectively. Quantities of velvet antler were also exported to Hong Kong, with most of this ending up in South Korea. With the establishment of the CIS and the other republics, velvet antler exports have increased.

The numbers of deer ranches or farms within the CIS are unknown but are likely to number several hundred thousand. For example, Drew *et al.* (1989) gave estimates of around 55,000 red deer, and up to 160,000 Asiatic wapiti (both *Cervus elaphus* spp). Large numbers of sika deer are also farmed. The Altai region provides an example of deer farming where large numbers of stags are kept for their

velvet antler. The velvet antlers are particularly large and apparently reflect 60 or more years of selection and genetic improvement ( T. W. Wallis, pers. comm.).

The development of deer farming in the old USSR has been backed up by a considerable research effort into the properties and uses of velvet antler and its extracts. The evidence for its pharmaceutical properties was promoted by Medexport, the state agency responsible for marketing the products (Brekhman, 1971).

### Scotland

The Scottish deer industry arose out of the demand for venison in West Germany, the wild herds of Scotland having provided venison for this market over a period. With the rising prices of red deer venison, Blaxter and his colleagues at the Rowett Research Institute and the Hill Farming Research Organisation set up a project at Glensaugh in 1970 (Blaxter *et al.*, 1974). The success of the Glensaugh work has resulted in the establishment of an industry in Great Britain. Fletcher (1989) gave a figure of around 15000 breeding hinds at that time.

### New Zealand

Like the Scottish industry, the NZ deer industry arose out of demand for venison in Germany. The wild red deer population of NZ had increased rapidly since the first introductions in 1851, such that by the 1950s they were regarded as a serious pest. In the 1960s large quantities of wild shot venison were exported and concerns about the future of this industry led to legislation allowing deer farming in 1969 (Fennessy and Drew, 1983). From the establishment of the first deer farm in 1970, the industry grew so that by 1993 there were 1.1 million farmed deer. The basis of the industry is venison, but there is a substantial income from velvet antler. Over 90% of the deer are red deer (mostly of *C. e. scoticus* background) and their hybrids, with European strains of red deer and North American wapiti (both *C. elaphus* ssp). The remainder are European fallow deer (*Dama dama*).

### Other Countries

The developments in New Zealand and Scotland in the 1970s stimulated interest in deer ranching and farming in several countries. For example, the rusa deer (*C. timorensis*) of Mauritius, the fallow and red deer of Australia, the fallow deer of Germany, the fallow and red deer of Denmark, the red deer of Ireland, Sweden, Spain, Argentina and Hungary, all form the bases of small deer farming industries.

There is also considerable interest in North America with the native wapiti (*C. elaphus* ssp), white-tailed deer (*Odocoileus virginianus* ssp) and the European fallow deer and red deer all being farmed. However, there is considerable controversy in many of these countries, especially where there is interest in farming or ranching a native animal for financial gain. The risk to native species from disease possibly carried by an imported species is also often raised as a concern about deer farming (Geist, 1992).

## INDUSTRY OUTLINES

The New Zealand and Chinese (Peoples Republic of China) deer farming industries are the well established ones. In both countries, deer farming is continuing to expand with the NZ industry having grown from around 100,000 deer in 1981 to 1.1 million in 1993. Over the same period, the Chinese industry is estimated to have expanded from around 220,000 animals (Pinney, 1981) to over 500,000 in 1992 (Xu, 1992). The New Zealand deer industry is pasture-based while the majority of deer in China are intensively managed in feedlot situations.

### New Zealand

The development of an industry infrastructure has been the key feature supporting the development of deer farming in New Zealand. In this respect, the formation of the NZ Deer Farmers' Association (NZDFA) in 1975 provided a focus which stimulated interest in deer farming. Until this time developments were slow so that by 1975, there were only about 5000 deer on farms. The real stimulus came in the late 1970s with the rapid increase in demand for deer which stimulated developments in capture of deer from the wild (Fennessy and Taylor, 1989) such that in 1979 alone, an estimated 20,000 to 25,000 deer were captured. Features which supported the early development of deer farming were the availability of suitable fencing materials and the development of appropriate management techniques by the farming pioneers of the industry. Other key infrastructural developments included the establishment of deer research facilities at Invermay in 1973, the development of markets and processing facilities for velvet antler in the late 1970s and the involvement of the traditional stock and station companies in the industry from the mid 1970s. The establishment of deer slaughter plants with both ante- and post-mortem veterinary inspection was also a key factor which underpinned the development of the industry, probably the most important development was the establishment of the Game Exporters Advisory Council in 1983. This led to the establishment of the Game Industry Board in 1984.

The increase in demand for deer in the late 1970s was stimulated by the option to defer taxation for investment in agriculture. As deer numbers increased, prices tended to fall, a decline which was exacerbated by changes in the method of treatment of deer investment for taxation. Prices for breeding hinds reached their lowest in 1991-1992 but since that time, prices have tended to increase with the market exhibiting more discrimination regarding animal quality. Associated with the declining value of breeding hinds on the open market has been a very marked increase in the number of hinds slaughtered. For example, virtually no hinds were slaughtered in the June 1988 year, but 7000 representing 8% of the total kill were slaughtered in 1989. Since then the number of hinds slaughtered (and the percentage of the total kill) has risen dramatically to 156,000 (56%) in 1992. Indications are that female slaughter rate will fall substantially after 1993. The slaughter of females also represents some long delayed culling decisions and allows considerable emphasis in improving the quality of breeding females. Table 1 presents a summary of deer population statistics over the last 11 years.

**Table 1**  
Population data for New Zealand farmed deer ('000)  
(NZ Dept Statistics)

	Total	Males	Females	Deer Slaughtered	
				Males	Females
1982	151	57	94	12	-
1984	259	96	163	22	-
1986	389	128	261	37	-
1988	619	194	425	81	1
1989	783	259	524	76	7
1990	977	340	637	70	30
1991	1,133	406	727	107	70
1992	1,194	462	732	123	156
1993 (estimate)	1,080	371	709	225	137

The New Zealand deer industry is basically an export industry although about 4% of total venison production was marketed within the country in 1992. A summary of the value of exports over the last 6 years is shown in Table 2. The export income of \$141 mn in 1992 represented about 1 % of NZ's total export receipts.

**Table 2**  
**Export Returns (\$NZ mn, FOB) for Velvet Antler and Venison and Venison Tonnages**  
**For the June Years From 1987 to 1992**

	Export Returns (\$NZ, mn)			Export Volume of Venison (tonnes)
	Velvet Antler	Venison	Total	
1987	11	25	36	2,809
1988	12	32	44	4,011
1989	25	38	63	3,789
1990	43	39	82	3,600
1991	49	53	102	5,860
1992	60	81	141	10,111
1993 (estimate)	47	126	173	13,159

Source: NZ Dept. Statistics.

## Peoples Republic of China

The Chinese deer industry is based on velvet antler. While data are scarce, it is possible to estimate that the total production could well be around 400 tonnes of green velvet (i.e. fresh undried velvet antler). The major export markets are Hong Kong and South Korea, but the majority of the velvet antler production is utilised within China itself. While velvet antler products are used in the hospital situation, there is a considerable variety of products available on the consumer market.

## THE PRODUCTS

The major product of the deer industry worldwide is venison, but in both New Zealand and China, velvet antler is particularly important. However New Zealand is the major international trader of deer products, and is in the process of major developments so that in this section we will concentrate on the New Zealand industry.

The New Zealand Game Industry Board (GIB) is the deer industry body charged with responsibility for promoting and assisting in the orderly development of the deer industry and products derived from

deer. The GIB is set up by Government regulation, with its members nominated by the NZDFA and the Deer Industry Association (i.e. the venison and velvet antler processors). The GIB is funded by compulsory levies on venison (both farmed and feral) and velvet antler.

## Venison

The future of the New Zealand deer industry depends on the ongoing development of export markets which will pay acceptable prices for high quality farm-raised venison. Total venison exports reached over 10,000 tonnes in 1992, 132% greater than the record 4300 tonnes exported in a single year in the early 1970s. The major difference is that almost the entire 1992 export was from farmed deer, whereas the earlier exports were made up entirely of venison from wild animals. As with the early wild animal based industry, Germany is still a major market. In the early 1990s the German market went through some upheaval with the influx of cheap venison from Eastern European countries. However the market has now stabilised. Current international market prospects are well regarded and prices to the farmer have firmed over the last year. Prices for the top quality carcasses to the farmer over the last year have been in the range of \$5 to \$6 per kg.

The GIB is involved in supporting the development of the markets for venison, in association with the exporters, in Europe, North America, Scandinavia and Japan/North Asia. There is also a substantial effort in the internal New Zealand market. Over the last three years, the GIB has led the move towards a repositioning of New Zealand's farm-raised venison in the international market. This development is proceeding through several stages and has very wide industry support, from both the key processing sector and the farmers. The accreditation of processing plants to ISO 9000 quality standards has been part of this process. The accreditation of the on-farm end of the product to market chain is now being pursued. An integral part of the total repositioning package is the development of a new industry brand which was launched in the United States and New Zealand in April 1993. The name is **Cervena™**. The total quality approach is also a feature in other markets which operate under the **Zeal** trade-mark. The quality management approach, to be successful, must cover the whole product to market chain from the farm, through transport, slaughter and processing, packaging and marketing. Research into the impact of factors affecting quality is an integral part of the overall programme. The widespread industry commitment and the market reception for farm-raised venison augers well for the future of the industry. The **Cervena™** strategy and the **Zeal** mark, with their emphasis on quality are the basis for the future of the New Zealand deer industry (NZ Game Industry Board, 1992).



## Velvet Antler

In contrast to the breadth of the international venison markets, the velvet antler industry is virtually dependent on the single market of South Korea. Production and exports have increased rapidly over the past few years with levies paid on 416 tonnes in the year to June 1992. Prices rose rapidly to reach a peak in the late 1970s before halving in price to around \$100/kg for the top grades in 1980. Prices then rose slowly through until 1987 but then there were large increases in the late 1980s. Prices have now fallen back. This volatility is a particular feature of the velvet antler market and is largely a function of supply and demand in the Korean market. In particular, this relates to the supply of the cheaper Russian reindeer product. While the Korean market continues to absorb the increased New Zealand production and that from other countries, the future is not at all clear.

While the quality of the New Zealand velvet antler processing (velvet is largely exported in the dried whole stick form although market requirements may mean that the lower tines are removed), is regarded very highly by the Korean market, the New Zealand red deer velvet antler is smaller than the preferred Russian and Chinese velvet antler which is from larger species of red deer or wapiti. The market perception also requires that the New Zealand red deer antler is harvested at an earlier stage of growth than the Russian or Chinese product. The peculiarities of the velvet trading market do not always allow identification of the product and the country of origin, and it is suspected that a proportion of the larger NZ velvet antler is marketed as Russian or Chinese product. A New Zealand source identification strategy is now under way in South Korea. Such an identification/brand strategy will likely be important for the future of the market.

Recent developments in the New Zealand deer industry with improved management (Fennessy, 1989) and the increased use of larger strains of red deer (Fennessy, 1992) and North American wapiti (Fennessy and Pearse, 1990) means that the size of the larger end of the NZ velvet antler is increasing. However, with the increase in stag numbers, much of the velvet antler still comes from young animals. The Korean perception of velvet quality and its association with size and shape mean that traditional measures of quality, rather than composition or pharmacological activity determine the market position. The implementation in 1990 of a new objective grading system based on size, shape and stage of growth is the first step toward a quality assurance programme in the velvet antler side of the industry. Although grading does not increase size, this emphasis on quality is proving to be a very positive step in the marketplace.

The long term future of the velvet antler industry is dependent on an expanded market, with an emphasis on the development of non-traditional products and markets. The GIB has, as part of its

strategy, the development of non-traditional products in traditional markets (e.g. prepared pharmaceuticals to cater for the changing markets in Korea) and the development of non-traditional markets for various products. The GIB investment in research to investigate the pharmacological effect of velvet antler is part of this strategy. Certainly velvet antler extracts have pharmacological activity (Fennessy, 1991) but whether the activity is unique to velvet antler is not known. However, the emphasis on quality means that the prospects for the top end of the New Zealand velvet industry are very good.

### **Other Products**

Other products from deer, including hides, tails, pizzles and sinews, are subject to fluctuation in demand. Hides which are manufactured into leather for the fashion industry are a growing market, and ensuring the top quality necessary is the objective. In this respect, the developments in animal handling procedures are resulting in improved quality. This will continue to improve with the systems being developed for accreditation of farmers, transporters and processing factories in association with the venison quality assurance programme. Tails, pizzles and sinews find their market in the volatile traditional medicines industry (Kong and But, 1985). Quality of these products in the traditional markets, mainly Hong Kong and China, is regarded as being related to size and shape. To date, there have been few investigations of the pharmacological activity of these other deer co-products.

## **TECHNOLOGY AND PRODUCTION ISSUES IN NZ DEER FARMING**

New Zealand livestock production is pasture based, with virtually no use of concentrates. The deer industry is no exception. Growth promotants are not used in the deer industry, and have even found little use in the cattle industry.

As the deer industry has developed with increasing numbers of female deer being slaughtered, demand for live animals has meant premiums for good quality breeding animals. Quality is generally perceived as being related to size, the larger strains of European red deer and North American wapiti finding particular demand (Fennessy, 1992).

Development or expansion of deer farms now commonly involves a high-fenced perimeter with cheaper subdivisional fencing. Management systems usually involve large mobs and controlled grazing with pasture hay and silage as supplements for grazed pasture over winter. There is an

increasing interest in some of the newer pasture species (e.g. Puna chicory, Pawera red clover, Hunt, 1993, Wilson *et al.*, 1991) whose seasonal pattern of production may be more suited to the deer enterprise. However, the ease of management of the traditional perennial ryegrass/white clover pastures means that they will probably continue to form the mainstay of the New Zealand deer farming scene for many years to come. The newer pasture species will then be used in specialist situations, such as red clover-based pastures for lactating hinds and their calves.

## Genetics and Hybridisation

New Zealand livestock farmers have a strong interest in genetic improvement. The possibilities for improved genetics based on the local herd were being explored during the 1970s (Fennessy, 1982a). At this time the emphasis was on the different strains of red deer derived from the different importations a century or so earlier. However, it was the natural hybridisation between the larger North American wapiti (*C. e. nelsoni*) and the smaller red deer in the Fiordland National Park (Smith, 1974) which alerted the industry to the possibility of such hybridisation to increase body size and antler size in the farmed deer. There are populations where red deer and the smaller sika deer have hybridised (Harrington, 1982). As well, hybridisation between malu and meihualu is practised in China (Xu, 1992). It is the remarkable capacity for hybridisation among the greater red deer-wapiti family which offers so much flexibility to the deer producer to produce the appropriate animal for the market. This applies to systems of both venison and velvet antler production.

The European red deer were believed to be genetically larger than the Scottish red deer which formed the basis of the New Zealand farmed deer industry in the 1970s. There was also the relationship between antler size and body size which was generally well known based on the work of Huxley (1931) who showed that hard antler weight increased at a rate about 1.6 times faster than that of body weight from an analysis of data from over 500 red stags from around Europe. As well, the selection for antler size (and often numbers of antler points) in the European deer parks offered numerous possibilities for New Zealand deer farmers searching for new genetic material. Consequently there were large numbers of red deer from Europe and wapiti from North America imported during the 1980s. There was also interest in the possibility of manipulating production characters such as the timing of the breeding season and twinning. A hybrid between the red deer and the summer breeding Père David's deer (*Elaphurus davidianus*) potentially offered an earlier breeding season. Père David's deer were imported in the mid 1980s, and although the purebred herds have suffered very badly due to malignant catarrhal fever caused by a bovid gammaherpesvirus (Reid, 1992), hybrids are now being used commercially (Fennessy, 1992). However it is their growth performance and carcass potential rather than their breeding season which is attracting interest.

## Production Efficiency in Practice

As the industry has moved from one based on trading of live animals to one based on venison and velvet production, the focus on production efficiency has sharpened considerably. This is evident in the increasing interest in the larger strains of European red deer and North American wapiti. A partly stratified industry structure has developed with a few stag breeding operations producing the larger strains of sires. These sires, both purebreds and their hybrids with the smaller New Zealand red deer, are finding increasing use as sires in commercial herds. The concept of hybridisation to make use of the large male/small female cross is becoming well accepted in the industry. This is especially so for venison (Fennessy and Thompson, 1989) but also for velvet antler production (Fennessy and Pearce, 1990). However large numbers of farmers are still using New Zealand red stags as sires, often selected from within their own velveting herds.

The changing focus, however, is reflected in the deer farming statistics which indicate that wapiti hybrids account for 10% of the total farmed deer while fallow deer account for 8%. The wapiti x red F1 hybrid, which is about 40-50% heavier than the New Zealand red deer and the so called New Zealand wapiti (the natural hybrid which has developed in the Fiordland region since the release of the Canadian wapiti, *C. e. nelsoni*, about 80 years ago) are being used increasingly. The larger European strains will likely fill a similar niche to the wapiti x red F1 hybrids, probably being of similar size, although good comparative data are scarce (Fennessy, 1992). The demand for the larger sires has arisen out of a need for flexibility in the production system, particularly the returns available for achieving good slaughter weights in the spring when the animals are approaching 12 months of age. The demand is for carcasses of over 50 kg, a target which is difficult to achieve with New Zealand red deer strains at less than a year of age.

Some comparative data for the relative yearling live weights (1.1-1.3 years of age) for the various hybrids with New Zealand red deer are presented in Table 3 (from Fennessy, 1992). Only the Canadian wapiti hybrid data are based on a reasonable data set, highlighting the shortage of good data on the potential for hybridisation at this stage. The deficiencies of the data notwithstanding, the information does indicate that the North American wapiti and the larger European red deer strains do have much to offer the New Zealand deer farmer looking to produce a heavier animal.

**Table 3**  
**Yearling Live Weights of the Various Strains Compared With NZ Red Deer (NZR) and**  
**The Ratio of Male to Female Yearling Live Weight Within Each Strain**  
**(i.e. sexual dimorphism)**

	Relative Yearling Live Weight			Sexual Dimorphism Ratio
	Male	Female	Average	
NZR	100	100	100	123
¼German/¾NZR	108	112	110	119
Hungarian/NZR	*	118	118	*
¼CW/¾NZR	117	122	120	115
¼PD/¾NZR	124	128	126	120
Hungarian	*	139	139	*
CW/NZR	141	147	144	121
¾CW/¼NZR	142	159	151	108

NZR=NZ red deer; CW=Canadian wapiti; PD=Père David's deer

## Fallow Deer

Fallow deer constitute only a small proportion of the New Zealand deer industry. They are largely concentrated in the North Island and the major processor has developed niche markets for fallow venison. Venison is the major product with velvet antler having only a very minor place. Fallow deer farming is a specialist operation and as with the red deer, there is the capacity for hybridisation to increase adult body size and hence growth rate of young animals. A few Mesopotamian fallow deer (*Dama dama mesopotamica*) have been imported and their hybrids with the European fallow deer (*D. d. dama*) are now being farmed commercially (Asher and Morrow, 1993).

## ANIMAL HEALTH

During the establishment phase of deer farming, capture from the wild and stress associated with the confinement of wild animals can cause problems (McAllum, 1985). Transport, inadequate nutrition and other stresses can all seriously compromise the animal's immune system. For example in young deer, such stress can predispose animals to clinical yersiniosis (Mackintosh, 1990). However such problems

are minimal on well established and well run deer farms. In fact, death rates in well managed herds of deer from one to ten years of age are generally no more than 2% per year and are often less, but accurate data are not available (MacKenzie, 1990).

Bovine tuberculosis (Tb) caused by *Mycobacterium bovis* is a potential problem for farmed deer in New Zealand. However a compulsory test and slaughter scheme is having the desired result with the number of herds on movement control declining steadily. While the incidence of Tb in the deer is very low (0.33% in 1991; CVO 1992), testing and control of movement of animals between herds are two of the critical arms of the approach to control the disease. However the major problem is the role of the wild animal vector of the disease, the Australian brush-tailed possum (*Trichurus vulpecula*) (Livingstone, 1990; Barlow, 1991). An intradermal mid-cervical skin test using the purified protein derivative (PPD) from *M. bovis* is the standard screening test now required. The whole herd test is carried out at one or two year intervals depending on the geographical location (Mackintosh, 1993). Immunodiagnostic research has resulted in the development of a blood test (BTB) based on the specific lymphocyte transformation response to *M. bovis* and the antibody response measured using ELISA (enzyme linked immunosorbant assay) techniques (Griffin *et al.* 1990). The BTB used in conjunction with the skin test improves specificity and minimises the slaughter of animals which have a non-specific reaction to the skin test. The BTB is now widely used in New Zealand farmed deer herds and there is a strong demand from other countries, notably North America (Griffin, pers. comm.).

Yersiniosis, an acute enteritis caused by *Yersinia pseudotuberculosis*, is the most common cause of 'death' in young deer, particularly during their first winter. It is believed that virtually all deer are exposed to *Y. pseudotuberculosis* in the farming environment, but if they are fed and managed well, the majority experience a subclinical infection only (Mackintosh, 1990; 1993). A killed multi-strain vaccine, which studies at Invermay have shown to give significant protection, is now commercially available (Mackintosh, 1992). Malignant catarrhal fever, caused by a bovid gammaherpesvirus (Reid, 1992) was a significant cause of mortality in the early days of deer farming. However, improvements in management and a recognition of the probable role of sheep in transmission of the disease (see Fennessy, 1988) have resulted in a much reduced concern about the disease, although it is still probably the single greatest infectious cause of mortality in adult deer in New Zealand (Mackenzie, 1990). As with yersiniosis, stress is probably involved in causing the disease. In red deer, internal parasites, particularly lungworm (*Dictyocaulus viviparus*) are important but are well controlled by anthelmintic treatment. Wapiti and their hybrids with red deer are apparently particularly susceptible to gastrointestinal parasites, such as *Ostertagia*, and appropriate control methods are now being devised (Waldrup and Mackintosh, 1992).

The Deer branch of the New Zealand Veterinary Association is very active in promoting an interest in and knowledge of deer health through its annual conferences. The excellent published proceedings meet a wide demand.

Overall, the New Zealand experience has been that farmed deer are very healthy animals. Appropriate management and recognition of the potential problems results in a good level of production. The development of appropriate management skills and the emphasis on animal health are key features of the farming enterprise and overall quality management. The emphasis is on well planned disease prevention programmes (Mackintosh, 1993).

## INTERNATIONAL PERSPECTIVE

Deer farming internationally is dominated by New Zealand and the Peoples Republic of China, both countries having experienced considerable growth in the last decade. During that time the number of farmed deer in New Zealand has increased nearly ten-fold while the numbers in China have probably doubled. The recent international interest has been around for two decades yet deer farming in other countries does not appear to have developed as might have been expected. Australia is probably an exception, where numbers are now at a level the NZ industry was at 10 years ago. However, the New Zealand developments indicate the importance of an appropriate industry infrastructure alongside the development of markets. In New Zealand's case, with only a small human population, the major markets must be export ones. Other countries can and are building their domestic markets for deer products.

Overall, the conclusion must be that it is the combination of the political situation and markets which have had the major impact on the development of deer farming to date. The New Zealand industry was helped in its early stages by a tax regime which encouraged investment in agriculture. This was modified over the years and finally stopped 8 years ago, but the critical early stage of the industry development was over. However, no industry can develop without a major effort in marketing and this has been and will continue to be the key factor. Deer farming in New Zealand developed initially because there was a market for venison at a higher price than for the traditional export products of beef and lamb meat. As well, the red deer of New Zealand proved to be highly adaptable to being managed in a pastoral farming system. In many European countries, subsidised agriculture meant that there were never the incentives to start farming a new species. In North America, health issues and concerns about the potential impact on native species of deer have inhibited developments.

Overall, it seems likely that deer farming will continue to expand worldwide but that only a very few countries will develop major industries in addition to China and New Zealand. However, niche industries are likely to continue to expand in several countries. Most of these will service small local markets with venison. The long-term future of any deer industry, except perhaps that of China, must be based on venison, with velvet antler being a valuable product in some countries.

## CONCLUSIONS

The international development of deer farming is proceeding. However apart from a few countries, such as China and New Zealand, it is unlikely to develop into a major industry. For New Zealand, where the industry is an export one, the future is totally dependent on the further development of international markets. Product quality is the critical objective.

## REFERENCES

- Asher, G.W. and Morrow, C.J. 1993. Observations on gestation length of European, Mesopotamian and hybrid fallow deer *in* G.W. Asher, ed. Proc. First World Forum on Fallow Deer Farming, pp 169-172.
- Anderson, J. K. 1985. *Hunting in the Ancient World*. University of California Press, Berkeley.
- Banwell, B. 1970. *The Red Stags of the Rakaia*. A.H. & A.W. Reed, Wellington.
- Barlow, N.D. 1991. Control of endemic bovine tuberculosis in New Zealand possum populations: results from a simple model. *J. Appl. Ecol.* 28: 794-809.
- Brekhman, I.I. 1971. *Pantocrine*. Medexport, Moscow.
- Blaxter, K.L., Kay, R.N.B., Sharman, G.A.M., Cunningham, J.M.M., Eadie, J. and Hamilton, W.J. 1987. *Farming the Red Deer*. Her Majesty's Stationery Office, Edinburgh.
- Cole, S. 1963. *The Neolithic Revolution*. 3rd ed. British Museum (Natural History), London
- CVO (Chief Veterinary Officer). 1992. Annual Report, 1991. *Surveillance* 19 (3): 9-11.
- Drew, K.R. ed. 1976. *Deer farming in NZ: Progress and prospects*. NZ Soc. Anim. Prod. Occ. Publ. 5, Hamilton.



- Drew, K.R., Bai, Q. and Fadeev, E.V. 1989. Pages 334-345. *in* R.J. Hudson, K.R. Drew and L.M. Baskin, eds. *Wildlife Production Systems: Economic Utilisation of Wild Ungulates*. Cambridge University Press, Cambridge.
- Fennessy, P.F. 1982a. Genetic improvement. Part 1. First understand basic principles. *The Deer Farmer* (Summer), 24-25.
- Fennessy, P.F. 1982b. Growth and nutrition. Pages 105-114 *in* D. Yerex, ed. *The Farming of Deer: World Trends and Modern Techniques*. Agricultural Promotion Associates, Wellington.
- Fennessy, P.F. 1988. Malignant catarrhal fever - workshop report. *Proc. Deer Course for Vets., NZVA Deer Branch Course 5*: 186-194.
- Fennessy, P.F. 1989. Velvet antler production: feeding and breeding. *Proc. NZ Deer Farmers Assn Ann. Conf.* 14: 15-17.
- Fennessy, P.F. 1991. Velvet antler: the product and pharmacology. *Proc. Deer Course for Vets., NZVA Deer Branch Course 8*: 169-180.
- Fennessy, P.F. 1992. Deer: possibilities and experience with expanding the gene pool. *Proc. Aust. Assn. Anim. Breed. Gen.* 10: 195-199.
- Fennessy, P.F. and Drew, K.R. 1983. Development of deer farming in New Zealand. *Phil. J. Vet. Anim. Sci.* 9: 197-202.
- Fennessy, P.F. and Taylor, P.G. 1989. Deer farming in Oceania. Pages 309-322 *in* R.J. Hudson, K.R. Drew and L.M. Baskin, eds. *Wildlife Production Systems: Economic Utilisation of Wild Ungulates*. Cambridge University Press, Cambridge.
- Fennessy, P.F. and Thompson, J.M. 1989. Biological efficiency for venison production in red deer. *Proc. NZ Soc. Anim. Prod.* 49: 5-10.
- Fennessy, P.F. and Pearse, A.J. 1990. The relative performance of Canadian wapiti and their hybrids. *Proc. Aust. Assn. Anim. Breed. Gen.* 8: 490-497.
- Fletcher, T.J. 1989. Deer farming in Europe. Pages 323-333 *in* R.J. Hudson, K.R. Drew and L.M. Baskin, eds. *Wildlife Production Systems: Economic Utilisation of Wild Ungulates*. Cambridge University Press, Cambridge.
- Geist, V. 1992. Deer ranching for products and paid hunting: threat to conservation and biodiversity by luxury markets. Pages 554-561 *in* R.D. Brown ed. *The Biology of Deer*. Springer-Verlag, New York.
- Griffin, J.F.T., Buchan, G.S., Cross, J.P. and Rodgers, C. 1990. Ancillary tests in epidemiological investigations of tuberculosis in deer. *Proc. Deer Course for Vets., NZVA Deer Branch Course 7*: 52-59.

- Harrington, R. 1982. The hybridisation of red deer (*Cervus elaphus* L 1758) and Japanese sika deer (*C. nippon* Temminck 1838). Pages 559-571 in F.O'Gorman and J. Rochford, eds. Transactions Fourteenth Int. Congr. Game Biologists. Irish Wildlife Publ., Dublin.
- Henry, D.O. 1985. Preagricultural sedentism: The Natufian example. Pages 365-384 in T.D. Price and J.A. Brown, eds. Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity. Academic Press, New York.
- Hudson, R.J. 1989. History and technology. Pages 11-27 in Hudson, R.J., Drew, K.R. and Baskin, L.M. eds. Wildlife Production Systems: Economic Utilisation of Wild Ungulates. Cambridge University Press, Cambridge.
- Hudson, R.J., Drew, K.R. and Baskin, L.M. eds, 1989. Wildlife Production Systems: Economic Utilisation of Wild Ungulates, Cambridge University Press, Cambridge.
- Hunt, W.F. 1993. Maximising red deer venison production through high quality pasture. Proc. 17th Int. Grassland Congr. in press.
- Huxley, J.S. 1931. The relative size of the antlers of red deer (*Cervus elaphus*). Proc. Zool. Soc. Lond., pages 819-864.
- Kong, Y.C. and But, P.P-H. 1985. Deer - the ultimate medicinal animal (antler and deer parts in medicine). Pages 311-324 in P.F. Fennessy and K.R. Drew, eds. Biology of Deer Production. Royal Society NZ, Wellington.
- NZ Game Industry Board 1992. Stagline, NZ Deer Farmers Association, Wellington.
- Livingstone, P.G. 1990. Epidemiology of tuberculosis: a national perspective. Proc. Deer Course for Vets., NZVA Deer Branch Course 7: 8-17.
- McAllum, H.J.F. 1985. Stress and post capture myopathy in deer. pages 65-72 in P.F. Fennessy and K.R. Drew, eds. Biology of Deer Production. Royal Society NZ, Wellington.
- MacKenzie, J. 1990. Disease status of farmed deer in New Zealand. Surveillance 17 (1): 17-18.
- Mackintosh, C.G. 1990. Yersiniosis vaccine research. Proc. Deer Course for Vets., NZVA Deer Branch Course 7: 200-204.
- Mackintosh, C.G. 1992. Yersiniavax efficacy under field conditions. Proc. Deer Course for Vets., NZVA Deer Branch Course 9:107-110.
- Mackintosh, C.G. 1993. Importance of infectious diseases of New Zealand farmed deer. Surveillance 20 (1): 24-26.
- Pinney, B. 1981. Delegation to China. The Deer Farmer (Spring), 22-35.

- Reid, H.W. 1992. The biology of a fatal herpesvirus infection of deer (malignant catarrhal fever). Pages 93-100 in R.D. Brown, ed. The Biology of Deer. Springer-Verlag, New York.
- Renecker, L.A. and Hudson, R.J. eds. 1991. Wildlife Production: Conservation and Sustainable Development. AFES misc. pub. 91-6. University of Alaska, Fairbanks.
- Smith, M.C.T. 1974. Biology and Management of the Wapiti (*Cervus elaphus nelsoni*) of Fiordland, New Zealand. NZ Deerstalkers Assn. Inc., Wellington, New Zealand.
- Waldrup, K.A. and Mackintosh, C.G. 1992. Fading elk syndrome research. Proc. Deer Course for Vets., NZVA Deer Branch Course 9: 170-174.
- Wemmer, C.M. ed. 1987. Biology and Management of the Cervidae. Smithsonian Institution Press, Washington.
- Wilson, P.R., Barry, T.N., Hodgson, J., Ataja, A., Niesen, J.M., Semiadi, G. and Freudenberger, D. 1991. Grazing options for deer growth. Proc. Deer Course for Vets., NZVA Deer Branch Course 8: 76-84.
- Xu, H. 1992. Deer farming and management. Pages 267-297 in H. Sheng, ed. The Deer in China. East China Normal University Press.