NEW ZEALAND'S LIVESTOCK AND MEAT INDUSTRY AND RESEARCH PROGRAMS

by

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Livestock Production in New Zealand

New Zealand is small (almost the size of Colorado) and rather mountainous with more than 3/4 of the land area 200 m or more above sea level. No large reserves of metallic minerals and other resources needed by an industrial nation are found but the country is favoured with a climate and geology which supports an abundant growth of grass, encouraged by heavy applications of phosphate fertilizers. The simplest and most economical form of harvester for the grass is the live animal. This is especially true on the more rugged hill country which is too steep for any mechanical cultivation or harvesting equipment.

The importance of livestock to New Zealand is clearly illustrated in Figure 1 which shows that livestock and other agricultural industries make up almost 80% of the total value of exports from New Zealand. The livestock industry can be divided into three sectors, Dairy, Wool and Meat. These sectors overlap, to some extent, with some of the meat being derived from the dairy industry and the wool derived from the sheep, which form a large part of the meat industry. In 1977 New Zealand's livestock population comprised 6.5 million beef cattle, 2.1 million dairy cows in milk, 57 million sheep and 0.5 million pigs. Fifteen thousand deer are being grown on farms for velvet and venison, and a feral population many hundred times this number is found. The distribution of livestock reflects the terrain, with dairy and beef production concentrated in the less mountainous North Island which grazes 92% of the dairy cows and 75% of beef cattle. The sheep population is evenly spread between the North and South Islands.

The relative importance of dairy, wool and meat products to the New Zealand economy is shown in Figure 1. Meat and meat-related products account for nearly 50% of the total earnings from the livestock industry, *i.e.* almost 33% of New Zealand export income.

The New Zealand Meat Industry

Every year approximately 26 million lambs, 6.5 million sheep, 2.6 million cattle, 1.3 million calves and 0.75 million pigs are slaughtered in New Zealand, and just over two-thirds of all the meat so produced is exported (Table 1). The main markets for these exports are shown in Table 2. As a result of the seasonal nature of meat production, and, the distance to the markets, the vast majority of meat from New Zealand is exported frozen – most of the lamb as carcasses, and much of the beef as boneless meat.

The New Zealand meat export industry is bound by a host of hygiene regulations and processing requirements imposed by the various importing nations. One of the more recent requirements to come into force requires all lambs to be stunned prior to slaughter and the heads be completely skinned prior to inspection. The cost of meeting these and other hygiene regulations is generally passed on to the producer in the form of increased killing and freezing charges, which, at present, are about $3.30 per lamb carcass plus 6 cents per kilogram, and about $50 per beef carcass plus 9 cents per kilogram. The price paid to the farmer varies throughout the year but representative prices for 1977 for prime lambs about 14 kg in weight were 65-70 cents/kg and for prime beef carcasses weighing 220 to 340 kg were 50-70 cents/kg depending on quality grade. The actual return to the farmer is approximately two-thirds of the value of the carcass f.o.b. N.Z.

Research

With about 70 percent of New Zealand's export earnings arising from the total livestock industry, it is not surprising that a number of different agencies are concerned with research into various aspects of the industry. The major agencies are: Ministry of Agriculture and Fisheries' Research, Animal Health and Meat Divisions, Department of Scientific and Industrial Research, Universities, Wool Research Organization, Dairy Research Institute, and Meat Industry Research Institute. Research, affecting the livestock industry, centers on production and management of the pastures animal production and manage-

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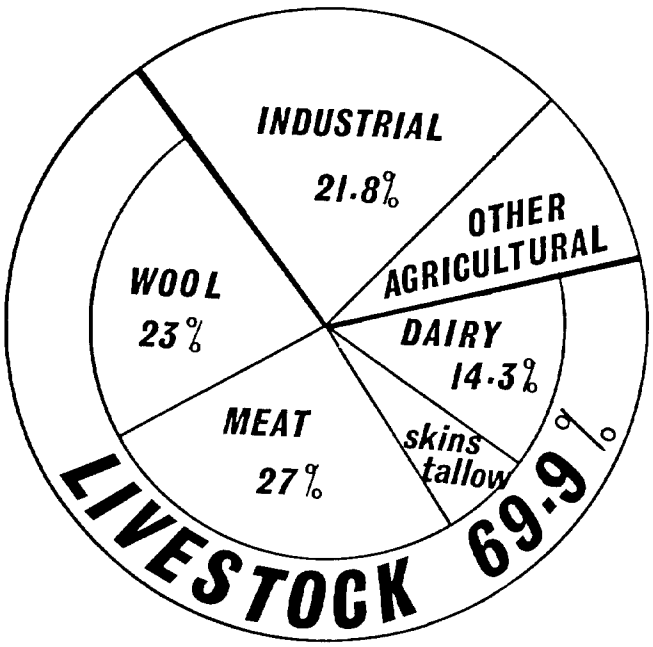

FIGURE 1

Contribution of various sectors to New Zealand's export earnings. The percentage contribution of the major sectors is shown.

ment practices, animal health, and product processing and utilization. This paper describes aspects of livestock research which relate directly to the meat sector.

Animal breeding studies of note are those concerned with evaluation of "exotic" beef and sheep breeds in terms of their usefulness under New Zealand's extensive grazing systems. Traditionally, most of export lamb carcasses have been derived from the early maturing Romney-Southdown cross, but over the last few years increasing interest in later maturing breeds giving heavier, leaner carcasses has been shown. "Exotic" breeds, such as the highly fecund Finnish Landrace, are being evaluated with a view to increasing productivity per ewe.

For cattle similar projects compare the role of large heavily muscled breeds, such as the Charolais, Simmental, and Limousin, with the traditional beef breeds of Hereford and Aberdeen Angus.

Other animal breeding projects center around the genetics of producing leaner sheep. This is one aspect which is of considerable importance in these days of "fat consciousness." The biochemistry and genetics of fat deposition in very lean species such as deer, are also under consideration.

Management practices may influence the total quantity and quality of meat produced from a given land area and are, therefore, considered to be important areas of research. Examples are early weaning of lambs as a means of reducing fat deposition; evaluation of the total production capacity with mixed grazing systems using sheep and cattle; growth and carcass performance of pasture-fed deer.

Animal health research is concerned with any disease which may affect the efficiency of production or the wholesomeness of the product. One of the major diseases under investigation is facial eczema. This disease, which affects both sheep and cattle, is due to a toxin produced by a fungus which grows on dead pasture litter under warm, damp conditions. Research is being carried out both to understand the toxic principle and to develop better preventive measures.

Research into various aspects of meat production and processing are centered on Ruakura Animal Research Centre (part of the Ministry of Agriculture and Fisheries Research Division), Massey University, and the Meat Industry Research Institute of New Zealand (MIRINZ). Ruakura's Meat Section is largely concerned with body composition as influenced by breed, nutrition, and management. However, it also

TABLE 1

MEAT PRODUCED IN AND EXPORTED FROM NEW ENGLAND

	Production	Export ('000 tonnes')	% Exported
Lamb	357.6	334.4	94
Mutton	155.2	92.7	61
Beef	599.0	455.0	76
Veal	29.1	19.0	66
Pig	32.8	0.4	1

Source: N. Z. Meat Producers Board. Ann. Report 1978

TABLE 2

DESTINATION OF MEAT EXPORTS FROM NEW ZEALAND

	Lamb	Mutton (tonnes)	Beef
United Kingdom	204069	7736	11647
Rest of EEC	11338	548	3252
Eastern Europe	—	44951	52963
North America	14729	—	144933
Middle East	39676	442	6046
Asia	17220	38560	12371

Source: N. Z. Meat Producers Board. Ann. Report 1978

has been involved in studies of slaughter practices. Massey University researches several areas, behavioural aspects of stockyard design, bruising, growth of muscle. It also is involved to some degree in meat processing, and investigation of stunning and slaughter practices.

Meat Industry Research Institute of New Zealand (Inc.)

The Institute, which was established in 1955, is a research association serving the New Zealand meat export industry. It is financed by government, the New Zealand Meat Producers Board, and the meat processors, and, has a staff of 97 comprising 36 scientists with appropriate technical and support staff. The projects undertaken by the Institute are broadly classified into the following areas: *Meat Processing; By-Products; Pollution; Management; Engineering* and *Meat Science*. At present there are over 130 projects under way and, hence, it is not possible to cover them all in this paper. One or two projects in each area are highlighted to illustrate the scope of research activities at MIRINZ. More emphasis is placed on Meat Processing and Meat Science areas since these are more pertinent to this Conference.

By-products: Projects in this area cover viscera cutting, offal handling, rendering, blood-processing, pharmaceuticals, heparin and waste-meat recovery.

Fluidized-bed drying of blood has been a project at the Institute for a number of years. The aim of the project is to improve the quality of dried blood to make it suitable for adhesive and high-grade animal feed applications. Originally an asymmetrical-bed drier was designed to use blood itself as the bed material. The concept has been altered slightly so that now inert polypropylene beads are used as the bed material. This has simplified plant operation and enables lower drying temperatures to be employed, resulting in a more soluble product. Ultrafiltration of the blood to partially de-water it increased the capacity of the drying plant. Market research for the product is being undertaken.

Pollution: Projects in the area cover valuation of analytical methods, electroflotation, treatment of fellmongery effluents, in-plant pollution abatement, aerobic biological treatment with protein recovery, nitrification – dentrification of meat works effluents.

The concept of waste treatment is evolving from mere treatment to avoid a pollution problem to one of not only reducing the pollution from various departments, but also recovering resources, such as protein, from the waste stream. One example is protein recovery after aerobic biological treatment. In this process, instead of limiting biomass and aiming for maximum nutrient depletion, the aim is to maximize biomass and yet produce an acceptably clean effluent. The protein-rich microbial product can be harvested and used as an animal feedstuff. Preliminary economic analysis of the proposed system showed that aerobic biological treatment of meat works effluent with protein recovery could be economically self-supporting, unlike many other forms of waste treatment.

Management: This is a very new area of endeavour for the Institute. The initial projects are the consideration of labour utilization in rendering plants and redesign of offal floors. Although these are in their initial stages, possible savings of labour have been shown in both areas by better task allocation and plant placement.

Engineering: Projects in this area include survey of refrigeration plant at meat works, co-generation of heat and electricity in meat works, computer control of chillers and freezers, various instrumentation projects, corrosion control, and ultrafiltration.

Refrigeration is virtually the backbone of the New Zealand meat industry. Thermodynamic surveys of refrigeration plant at meat works throughout the country are being conducted. These have shown a wide range in coefficients of overall performance due to poor equipment design and operation. Efficiency of refrigeration utilization varies widely with from 720 to 1380 MJ of refrigeration being used per ton of meat processed. The percentage of total refrigeration effect lost on electrical loads, such as air blast fans, was as high as 28% in some plants. Recommendations for possible changes in plant operation to increase efficiency and reduce costs are given to individual companies.

Meat Processing: Projects in this category during the past year include humane slaughter, blood splash, subcutaneous haemorrhagic speckling, electrical stimulation of lambs and beef, carcass freezer design, plastic films and meat packaging, quality of frozen lamb, and carton sorting.

Humane slaughter methods have recently been introduced into New Zealand sheep dressing systems, and, with the introduction of electrical stunning, the industry has been faced with the problem of blood splash. Research projects have attempted to establish

the factors which influence the incidence of blood splash. Electron microscopic study of blood splash showed that the haemorrhages were associated with areas of muscular super-contraction. A theory for the mechanism of blood splash was proposed. Blood splash has now been largely eliminated by a head-to-back stunning procedure.

An apparently new "bruise"-type lesion in lambs was reported during the present slaughtering season. It was characterized by small sharply defined haemorrhages within the subcutaneous fat layers on lambs. Histological examination of the lesion suggested that the lesion resulted from shearing of the blood vessels within the fat layer. The lesion could be produced at will by causing a marked shear between skin and underlying tissues. Large scale trials demonstrated that the V-shaped restraining conveyors used for lambs induced a shearing action within the subcutaneous layers. Increasing the angle included between sides of the restrain conveyors reduced the incidence of the lesion.

Electrical stimulation of lamb has been studied extensively and processes involving stimulation of lambs either immediately after slaughter, or, after completion of dressing, developed. Both processes are designed to ensure reasonably tender lamb even when early freezing is used. Figure 2 compares the tenderness of lamb legs and loins from stimulated and non-stimulated carcasses moved into a freezer about two hours after death. It is anticipated that by the beginning of October 1978 approximately 50% of all lamb slaughter facilities will include either predressing or post-dressing stimulation tunnels.

Electrical stimulation of beef has proceeded on similar lines, and specifications for stimulation of either sides or carcasses have been released to industry. The potential advantage to be gained in terms of tenderness can be seen in the histograms of shear force values from stimulated and non-stimulated beef loins after rapid chilling (Fig. 3).

Automatic carcass freezers currently in use, or, being built in New Zealand, are all horizontal air flow systems. Measurements of air velocities and freezing rates have shown that over a freezing room these are highly variable. Research at the Institute has suggested a vertical airflow system which based on a 1/4 scale model will greatly increase the uniformity of airflows around carcasses. This will reduce variability in freezing times and simplify freezer operations.

Meat Science: Projects in this area cover the basic

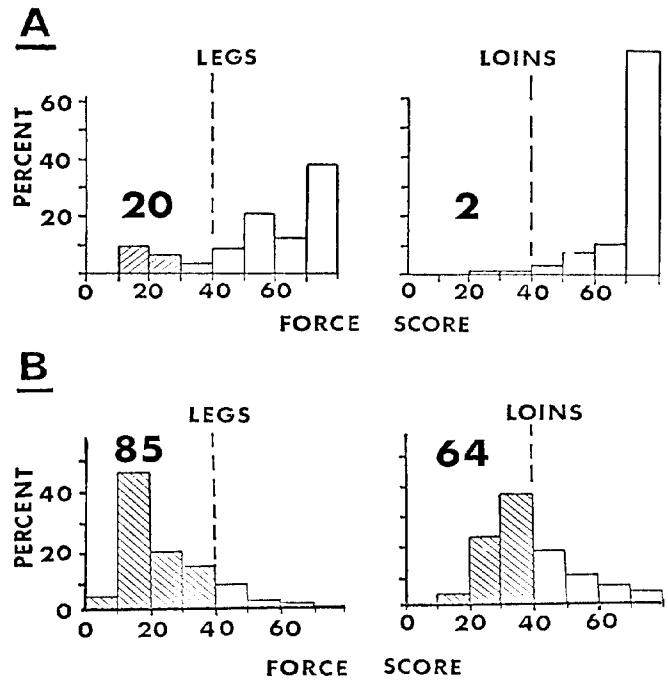

FIGURE 2

Histograms showing the frequency distribution of shear force values for legs and loins from early frozen nonstimulated (A) and stimulated (B) lamb carcasses. Cuts roasted from the frozen state. On the MIRINZ tenderometer values less than 40 are considered to be acceptably tender, the shaded portion and the large numbers to the left of the 40 line indicate the percentage of acceptably tender values.

aspects of electrical stimulation, structure and function of muscle thick filaments and gap filaments, oxygen limitation of bacterial growth, microbiology of hot boning, staphylococci, Yersinia enterocolitica, Salmonella, mould growth on wall sealants, early determination of ultimate muscle pH, spoilage of DFD meat, bacterial survival in carcass tissues.

One aspect of basic research has been the study of the effect of delay on electrical stimulation of muscles. Stimulation immediately after slaughter, whether it be indirectly via the nerves or directly through the muscles, gives significant decreases in muscle pH and changes in the subsequent rate of pH fall. However, if stimulation is delayed 30 minutes, nervous stimulation is completely ineffective whereas direct muscle stimulation remains effective (Figure 4). Confirmatory evidence has been obtained using neuromuscular agents.

Gap filaments, first observed in bovine sternomandibularis muscles stretched so that actin and myosin filaments no longer overlap, are being extensively studied. As muscle fibres are stretched they reach the point where the A band becomes dislocated with

approximately half of the thick filaments moving in each direction. This has led to the hypothesis of a structural organization centered on the Z-line with gap filaments passing through the Z-line and attached to a thick filament in each of two sarcomeres. The protein of the gap filament appears to resemble 'connectin' obtained as a residue after exhaustive extraction of myofibrils. The change in gap filaments during cooking of stretched unaged or aged meat has been noted and as a result a theory of aging based on gap filaments has been proposed.

Spoilage of D.F.D. meat has generally been related to the more rapid growth of bacteria at higher pH values. This research, however, has shown that under aerobic conditions the more rapid onset of spoilage is due to the lack of glucose in D.F.D. meat. Spoilage bacteria consume glucose preferentially, but, when this is exhausted, consume amino acids and produce "off" odours. In D.F.D. meat this occurs earlier and therefore of lower cell densities. The spoilage of D.F.D. under anaerobic conditions is being studied.

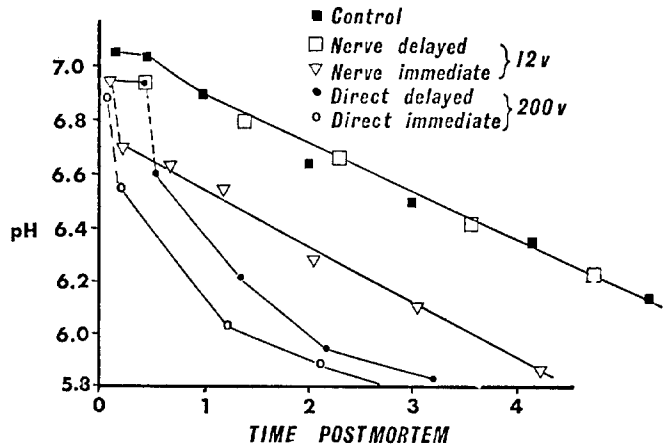

FIGURE 4

pH - time curves for BICEPS FEMORIS muscles in isolated lamb legs stimulated either directly (on the muscles) or indirectly (via the nerves) and held at 30°C. Immediate stimulation was within 5 minutes of slaughter. Delayed stimulation was 30 minutes post-mortem.

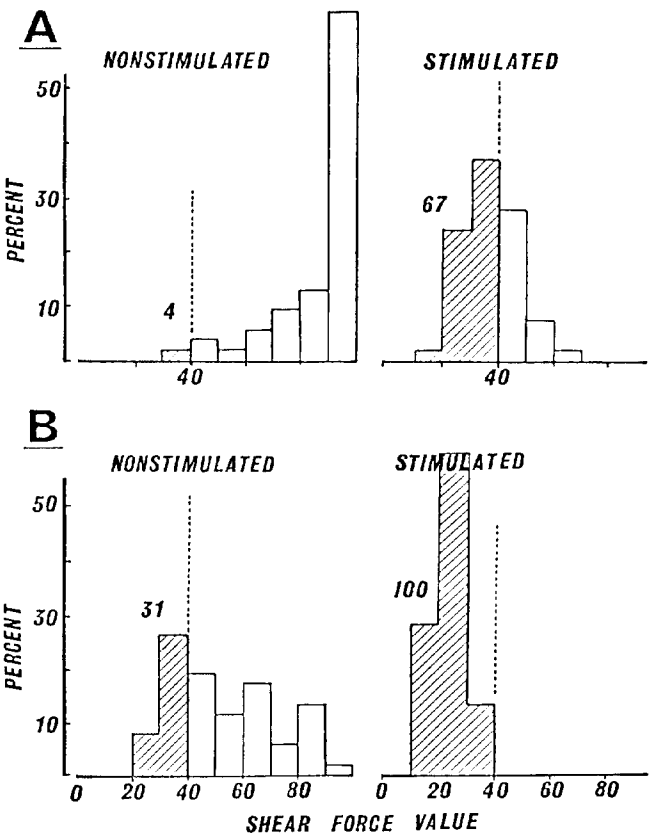

FIGURE 3

Histograms showing the frequency distribution of shear force values for grilled steaks from the longissimus muscles of nonstimulated and stimulated beef sides chilled to 7°C deep leg in 20 hours.

A Frozen at 20 hours post-mortem

B Aged at 5°C for 66 hours before freezing.

All cuts grilled from the frozen state. Shaded portion and numbers as in Figure 2.

Research into the structure of the thick filament and the myosin molecule has been progressing over a number of years. Investigations have been based mainly on the electron microscopy of synthetic thick filaments assembled from solutions of monovalent and divalent cations. Stereoscopic techniques are being used to increase the amount of information that can be obtained.

This paper has only touched on a few of the projects being undertaken at MIRINZ but it highlights the wide range of activities at the Institute. The balance between basic and applied research is difficult to define but is one of the strengths of the Institute. The balance is considered essential since without the basic elements applied research becomes very constrained and short-sighted.

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