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Future directions for meat research and development in New Zealand

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ABSTRACT

If meat research, from production through to the marketplace, is not adequately funded, then much of the research needed to improve New Zealand's position in the marketplace will not be undertaken. A prime need for the overall industry is to harness and coordinate the research efforts of all sectors as their overall goals are essentially the same. For example, improved information systems would benefit all participants. Better information is needed to encourage improvements at all stages of the production to marketing chain. As part of this process, work is needed to give a better system of rewarding producers for the quantity and quality of saleable product produced. Research is needed to enable prediction of the eating quality of meat from measurements taken shortly after slaughter. A smoothed system of payment is needed to replace the present "steps-and-stairs" system. This paper considers some issues affecting the conduct of research in the meat industry, and discusses selected areas of research that show promise.

Keywords: research funding; information systems; objective carcass classification.

INTRODUCTION

Meat research may be defined as the systematic study or investigation of meat-related topics to produce new findings and/or provide new interpretations of existing knowledge. Meat research covers all investigations relating to meat from the farm to the plate, including production, processing and marketing and involving all aspects relating to quality and trade barriers. This includes animal welfare which affects meat quality and can also be the basis of trade barriers if certain standards are not met. It includes food and other health related values and bacterial and other contaminants and residues. Meat research may include processing engineering and even meat-industry related social research. This paper first considers some issues affecting the conduct of research in the meat industry, and then discusses selected areas of research that show promise.

A. Issues Affecting Meat Research in New Zealand

Future directions and funding

At present, a high proportion of meat research is funded by the Public Good Science Fund (PGSF) via the Foundation for Research, Science and Technology (FRST). Changes in funding through this source will have a major impact on the future directions. In the research strategy for Output 1 (animal industries) released in spring 1995 (Strategy, 1995) funding for production research for the beef, wool and sheepmeat industries is scheduled to decline from \$26.4 mill. today to \$21.6 mill. by 2000/01. However, despite the overall funding decline, beef and animal welfare funding is targeted for increases, while sheep industry funding is scheduled to decline rapidly. In addition, meat processing funding and funding for improved product characteristics is scheduled to increase. This situation contrasts markedly with PGSF projections for the dairy industry. The difference is associated with a higher

level of direct financial support of dairy research compared to the low level of industry support for the sheep and beef industries. In August 1995, the Minister of Science noted the dairy industry had invested \$55 million - 1.1% of its gross revenue - in research in the last financial year (Upton, 1995). As a result, the sheep and beef industries have developed a strategic plan for the meat industry which shows promise for improving the research outlook for the scientific community.

While government funding for processing and improved product characteristics research is scheduled to increase over the next 5 years, it should be noted that this funding only contributed 21% of the New Zealand Meat Industry Research Institute (MIRINZ) funding in 1993/94 (MIRINZ, 1994) versus 40% funding from producer levies through the Meat Research and Development Council (MRDC) out of a total income of \$9.54 million; not a large amount compared with the over \$20 million spent on production research. However, historically the meat processing industry in NZ has been very slow to pick up the innovations developed by their own research institute (Kirton, 1994).

Industry analysis indicates that the subdivision into production, processing and marketing provides barriers to overall development and improvement resulting from adding value to all sectors in the marketing chain. The sharing of information is important so that all participants can benefit from the matching of product requirements back to the appropriate target on farms. With a few notable exceptions, most processors have been reluctant to build partnerships with selected producers to target production of preferred carcasses. A recent report that lamb can return \$50/kg in Germany indicates that added value may be achieved by the production of the right product without further processing. The meat industry, which currently contributes just over 20% of the value of NZ tradable

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exports, requires a more thorough scientific study of research needs than has been achieved to date by MORST (Ministry of Research, Science and Technology) research priority committees, or by MRDC which had to place priority on the perceived needs of the funders (producers).

At a conference in Palmerston North in 1995, Professor G.C. Smith from Colorado (Smith, 1995) reported on the US National Beef Quality Audit of 1991. This was an analysis of the need to improve American beef quality – the need to establish a quality framework. While this is occurring in NZ for both beef and lamb on an *ad hoc* basis, an overall plan is required for industry certification. The initiatives to gain ISO 9000 certification are a step in this direction. The deer industry may well be ahead of the sheep and beef industries as evidenced by its branded, quality assured “Cervena®” product. Unless industry addresses these issues, meat research efforts will be less effective in producing industry improvements from innovation.

Information systems

A value-based marketing system was identified as essential for the economic well-being of the US beef industry (Cross and Savell, 1994), and this claim is equally applicable to NZ producers who must be paid premiums for products designed to meet consumer demands. Industry must be able to identify carcass value and an information system must link the farm product to the consumer. This information is also required for an effective research programme for the meat industry.

One module of a meat industry information transfer system planned to span from the consumer to the producer was discussed by Saunders & King (1992) and used as a MAF Qual information transfer system initially by AFFCO. The module applied to carcass inspection. Lambs identified by farm of origin were inspected for evidence of disease, and defects identified on the slaughter chain were recorded by Meat Inspectors on computer keyboards. The information was summarised for each farm after slaughter. For a small charge, the information was returned to the farm of origin allowing management changes to be brought to bear on identified problems. Historically, meat inspectors put up to 2 tags (the maximum allowed) on carcasses identifying defects, tags were collected, recorded, and counted at the end of each day (with farm identification lost) and the information was collated by MAF to give an annual picture of the disease and defect status of the national kill at the end of each season. The new system resulted in a database that warns inspectors of the problems previously detected from each farm so that MAF could allot the number of inspectors required accordingly. Also, as the site of carcass defects/contamination was identified on each carcass, the location where the defect was originating could be targeted and the slaughterman involved instructed how to avoid the problem. A sample of carcasses (a quality assurance approach) may be adequate from trouble-free farms thus reducing inspection costs. Some other meat companies have developed similar systems.

A hide and pelt module was envisaged involving their identification to individual farms. They were to be followed through subsequent processes until value could be

identified - ideally by the leather end user. Higher payments could be then made to producers of better hides and skins to lift the overall standard. However, some meat processors are reluctant to penalize large suppliers of problem stock because they may change their allegiance to a competing processor who doesn't apply such penalties. To succeed, meat company stock procurers should have skills in advising clients on methods to avoid quality problems with skins, additional to the service of drafting cattle and sheep for slaughter. It is understood that some meat companies have now adopted pelt identification and are rewarding quality; and that as a result, the overall standard of pelts they are receiving has improved.

For another module, animals arriving at a processing plant would be identified by farm of origin, transport operator, dead or alive off the truck, disease status and “clean” or “dirty” on arrival. Lambs identified as clean would not have to be washed, saving water and labour (both costs), while dirty stock would require washing. The stock person identifying clean lambs would gain improved skills as their judgement was checked against the contamination results coming from the slaughter chain.

Another module planned was intend to link the meat product through to the consumer (the marketing chain). The overall system that was envisaged would link all stages of the chain and identify weak links where major improvements could be made. Until such systems are implemented, the contributions of research to innovation in the meat industry will be limited.

B. Examples of Promising Research Areas

Research areas are divided here into those where the findings may be applied with a minimal amount of development work, and others that are further away from application, and that, in some cases, may never yield results that will be of value from a commercial point of view.

Research and Development Giving Early Returns

Implementation of the three examples outlined below will depend not only on the requisite research being done, but also on there being a demonstrable benefit to all those involved.

Example 1: Measuring or predicting beef carcass lean-meat yield from objective measurements for the purpose of classification and payment.

Many beef processing plants in New Zealand are well placed to carry out such a classification by direct measurement of product yields because all the steps from slaughter to packing the trimmed, boneless cuts are carried out under the same roof. In addition there are a number of indirect approaches where one or more objective measurements may be used to predict meat product yields.

In assessing alternative approaches to the objective measurement or prediction of carcass meat yield it is necessary to have a clear definition of what is being measured and predicted. There are indications that the normal commercial preparation of trimmed, boneless cuts in New Zealand varies too much between plants and over time for any one of these to be chosen as a single end-point for evaluating alternative indirect procedures (Purchas,

1994). It may be appropriate to develop a more tightly specified boning and trimming procedure for use as a national standard. Such standards have been developed for research purposes in New Zealand (Everitt & Jury, 1964) and elsewhere (Kempster *et al.*, 1980) to give estimates of saleable meat yield (SMY%) resulting from tightly-specified processing and trimming procedures, while other countries have chosen to use an alternative, well-defined lean meat yield (LMY%) as a standard (eg. for pig research in Europe; Walstra, 1991).

Having chosen a measure of carcass meat yield to be used as the standard, there remain several approaches to measuring or predicting it. Direct measurement is likely to be the most accurate, and prediction from the results of a modified cutting procedure or by weighing a selection of standard cuts (Kirton *et al.*, 1994) also have potential, but their use requires that animal identification be retained for each cut that is weighed, and results are not available until after processing is completed. Greater interest has been shown in methods of predicting meat yield from measurements made on the slaughter floor or at the time of quartering, using technologies such as video image analysis (VIA) of carcasses or joint interfaces, and/or probes that measure fat depths (Swatland, 1995). These methods provide objective measurements at an early stage and can be used to better match raw product to product specifications prior to carcass processing. However, the accuracies with which SMY% can be predicted, and the stability of the prediction relationships for different classes of carcasses need to be established by research within New Zealand before any investment in measurement technology is made. It would be difficult to justify a mandatory classification system based on equipment that was not cost-effective for most meat products.

Example 2: *Standardised visual quality evaluation procedures within New Zealand.*

Meat quality is a broad term that encompasses all those features of meat that contribute to its value to the consumer. Making assessments of quality attributes at the time when classification is currently carried out on the slaughter floor has the disadvantage that a number of key traits including meat tenderness and colour are still changing. Delaying the time of assessment until after an ultimate pH is reached would overcome some such problems, but would create others, especially for plants that practice hot-boning.

Another approach is not to measure every carcass, but to focus instead on specifying conditions pre- and post-slaughter that will increase the chances that meat from all carcasses will reliably meet product quality standards. The development of accelerated conditioning and ageing (AC and A) specifications in New Zealand is a good example of where this approach has been used to ensure satisfactory tenderness (Chrystall *et al.*, 1989). A shortcoming of this approach is that quality measurements are not available for individual animals, and therefore the farmer cannot identify those animals or lines that excel in certain characteristics.

Meat quality measurements are not mandatory within the current beef carcass classification scheme, but some meat companies do routinely assess characteristics in-

cluded in the Japanese Beef Grading System (fat colour, meat colour and marbling). Although these assessments are widely made, there is no New Zealand-wide standard that ensures that values from different plants are comparable. Research in this area would seem to be well justified, as results from different plants may vary considerably.

Example 3: *Smoothed systems of payment*

The most common method of rewarding farmers for providing better carcasses is to have a stepped system of payment so that the price per kilogram changes at the start of each step along scales for carcass weight, fatness and muscling. At present for beef carcass weight, for example, the steps are usually at intervals of 25 kg, and the changes from step to step may be up to 10 c/kg. The effect of such a payment system is that owners of cattle understandably tend to focus on getting their animals just over an upward step or just before a downward step. Research into ways in which such stepped systems of payment can be replaced by smoothed systems would seem appropriate, although alternatives in this respect have already been suggested from time to time. Apart from providing a fairer return to the farmer, smoothed systems of payment could also better utilise the advantages of more accurate systems of measuring fatness or muscling, or perhaps SMY% in the future.

The simplest way of smoothing the stepped payments for weight ranges would be to use a linear regression relationship between cents/kg and carcass weight. A disadvantage of this approach is the inflexibility associated with a straight line, and although this could be overcome by use of polynomial regression equations (e.g. Yu-Jichu, 1990), this would then become a challenge to explain. An alternative approach that retains a reasonable level of flexibility and simplicity is to have a series of contiguous straight-line relationships with slopes that may vary from one range of weight or fat depth or muscling to the next. This variable-rate-of-change approach has the advantages of retaining existing familiar ranges, and also of being flexible enough to cater for variable patterns of change such as that where the price per kilogram is lower at fat depths both above and below an intermediate optimum.

Whether or not a smoothed system of payment is adopted is a decision for individual companies to make, but they may be more inclined to consider the possibilities if research into alternative approaches and into the implications of using such systems were conducted.

Examples of Important Areas of Fundamental Research

Projects in this category will tend to be those that include an element of "blue-sky", relatively high-risk research. Such research needs to be conducted without high expectations or assurances of success in commercial terms. Important contributions to the meat industry in New Zealand may be forthcoming from many areas, including the following three.

Example 1: *The development of methods for the early measurement or prediction of meat tenderness*

Early measurement in this context ideally means at a time within 30 minutes of slaughter so that individual carcasses can be classified on the basis of this important

characteristic. However, measures are more likely to be feasible after completion of *rigor mortis* (24-48h), and most recent research has focused on this possibility. Meat tenderness is a complicated characteristic associated with all three of the main tissues of meat (muscle, adipose, and connective). Any one of these may be the dominant determinant for a particular sample. A further complication arises from the fact that other influences affecting cooked meat tenderness, such as cold-shortening and ageing, which may have little or no effect on the same meat in the uncooked state (Purchas, 1973).

In light of these problems it is not surprising that satisfactory methods for predicting the tenderness of meat either immediately following dressing, or even 24 h later in the chiller, are not yet in widespread use. In light of the importance consumers place on this component of palatability, however, (eg. Dransfield *et al.*, 1982), it is important that continuing basic research be conducted into the reasons for tenderness variation, and also into new and improved ways of measuring it, particularly under commercial conditions.

Example 2: *The physiological basis of variation in the rate, efficiency and composition of animal growth*

This is a broad area of research, some aspects of which are covered in more detail in other papers within this symposium. The benefits from an improved understanding in this area are threefold. First, if the rate-limiting points of control in growth can be established and the key enzymes or hormones identified, then molecular genetic techniques may be used to locate the appropriate genes, and eventually to develop DNA probes that can be used to identify superior animals at a very young age. Secondly, an understanding of the basic mechanisms responsible for variation in animal growth will serve as a base from which to devise precise methods of improving animal growth with minimal disturbance to overall metabolism and minimal side effects on productivity. Growth promoters in current use have generally been developed in spite of an incomplete knowledge of the physiological basis of their actions. The third value of a detailed understanding of the physiology of animal growth is the development of marker assisted selection procedures, using live animal metabolic indicators and/or associated genetic markers. The knowledge will also enable better control of carry-over effects of metabolic variations among animals on the development of meat qualities post-mortem.

Example 3: *Characteristics of meat as a food in terms of both desirable nutrients and potentially harmful components.*

Much has been written over recent years on the value of meat as a food for humans. Because of the complexity of meat as a food, and because of the wide variation in the

types of products that come within the usual definition of meat, it is possible to make convincing cases both for and against meat consumption. The meat industry understandably aims to either maintain or increase levels of consumption, but at the same time it is important to be able to assure consumers that the product is safe, nutritious and wholesome, as well being highly palatable and attractive in appearance. Therefore it behooves the industry to learn as much as possible about the food value of meat, and to use this information so that meat products excel in the market place with regard to the desirable features, while the not-so-strong points are minimised or eliminated.

Four specific examples that impinge on the nutritive value and safety of meat as a food, that require further research include: (a) The question of the relationship between meat consumption and the risk of atherosclerosis, particularly with regard to whether it is only the fat portion of meat that is of concern (O'Dea *et al.* 1990), and the extent to which the different fatty acids are important (West 1990; Kritchevsky 1994). (b) The extent to which potentially carcinogenic substances such as heterocyclic amines may be produced on the surface of meat during certain cooking procedures, and the identification of cooking procedures that minimise this risk (Thomson & Lake 1995). (c) Clarification of the role of iron in meat as a risk factor in heart disease, especially in light of the importance placed on iron as a desirable feature of meat as a food (Watson *et al.* 1993). (d) Ways in which the microbiological safety of meat can be better and more efficiently ensured, especially in light of the relatively recent concern about newly recognised pathogenic bacteria such as *Escherichia coli* O157:H7 (CAST 1994).

CONCLUSIONS

- Levels of research within the meat industry are low in relation to its contribution to the export and internal economy.
- All sections of the industry will benefit as communications are improved with the continued development of accurate and meaningful information systems.
- There are a number of areas where it appears that a moderate input of further research could have significant benefits in the short term.
- A continued, and preferably increased, commitment to basic "blue-sky" research is crucial if the industry is to maintain its not unfavourable position in the international and domestic marketplace.