Future needs: current tools

Address to the Research Forum, 25th NZDFA Conference

J S Rowarth, S L Goldson and A J T Pearse

Summary

Today's venison consumer, and increasingly those new customers of tomorrow, will demand a high quality product that is primarily "food safe", produced in an environmentally and ethically acceptable manner and sold at competitive prices. They will also insist on the right to make informed choices of product origin between, for instance, organic and other production systems, and demand traceability through all steps of the supply management chain

To meet these requirements, scientists and technologists are working on animal and plant breeding, forage production systems, traceability and marketing. Capabilities employed include soil science, agronomy, pest management, animal and forage selection, marker-assisted technology, and veterinary products developed using genetic engineering are also likely to be involved. E-(electronic) commerce/e-procurement and traceability via the Internet are becoming important aspects of all of this, as are gene ownership and intellectual property rights The ensuing output should allow the game and farmed deer industry additional financial returns resulting from advances in animal improvement and selection in relation to land sustainability and optimal use of livestock relative to land carrying capacity.

To maintain and increase markets, primary producers in New Zealand must make use of all technologies available to them, and the Government must continue to invest strongly and strategically in the primary production research that gives New Zealand the market edge.

Background

Consumers of farmed venison, now and in the future, are encouraged to make informed choices relating to product and production systems to meet their definition of 'quality'. That the venison will be fresh, safe, and produced in an environmentally and ethically responsible manner are a given The extremes of choice will be between production systems involving strict internationally standardised organic certification, to genetic engineering (GE) Research will involve the development of high productivity systems that promote additional efficiency and cost effectiveness, irrespective of where they sit on the organics-GE continuum

New Zealand is currently in the midst of an argument around GE, based in part on outrage in the Northern Hemisphere Factions ideologically support organics or genetic engineering; although many scientists would see the latter as being extremely beneficial for the former, the former sees nothing good in the latter According to Jeanette Fitzsimmons, leader of the Green Party, the recent canola seed contamination incident in Britain provides irrefutable evidence that organics and genetic engineering cannot exist side-by-side. However, between the two extremes, there is a wide range of biological techniques, or biotechnologies, which, when employed in the 'right place', have the potential to improve our lives and those of our livestock When we consider what the consumer wants, and what the producer desires, it is clear that we must make appropriate use of the technologies To be 'clean, green and Luddite' is a limited option.

Biotechnology represents a range of tools and skills which include biochemistry, molecular genetics, physiology, applied genetics, molecular biology, computer science, and bioinformatics, proteomics and probably a whole lot of other things Understanding how biology works, from the individual gene, to protein interaction to the whole organism, gives a powerful way to derive benefit from plants and animals This capability is creating a global race as biotechnology is applied to food, fibre, fuel, pharmaceuticals and medicine

Knowledge and products accruing from biotechnology are increasing as never before - we have moved through the arithmetic and geometric increases, and are now into logarithmic increases. Getting to this stage has taken 10,000 years It was at least that long ago that humans started selecting grain for shattering resistance, small awns, thin seed coats and large edible parts Darwin, in his book 'The variation of animals and plants under domestication', published in 1868, reported that increase in size with domestication was often greatest in that part of the plant of most interest to humankind. Further genetic modification during domestication related to selection for rapid and even germination, synchronisation of flowering and maturity, decrease in bitter and toxic substances and competitiveness against weeds.

Similarly, in animals there was selection for fast growth, fertility and fecundity, hardiness, antler or wool growth, longevity and tractability. The animal breeder who uses the best animals to improve productivity, or create a new breed, is practising genetic selection given that the traits are genetically based and there is sufficient variation to allow effective selection.

However, by their very nature, conventional breeding techniques tend to be slow and somewhat haphazard Biotechnology-based marker assistance allows us to select specifically for genes that promote such things as 'rapid growth', or 'efficient growth' or 'lean carcass', or 'disease resistance' etc Genomics and mammalian gene mapping have dramatically increased the speed of development; there are many linked genes that have been mapped across a variety of species

New Zealand deer and interspecies hybrid research has provided an international gene mapping resource that has highlighted several gene linkages and chromosome sites with direct application in terms of quantitative production traits. These offer substantial advances in deer disease resistance and improved carcass attributes

In general

- Rapid and efficient animal growth will become increasingly important as land use intensifies through competition. Humankind is already using most of the productive land in the world. Assuming that we want to protect the marginal land (and hence the biodiversity it supports), we must increase production efficiency from the currently used land. To date productivity increases have come from improved cultivars, efficient fertiliser and pesticide use and improved harvesting and storage. On this basis however, production has reached a plateau; our next production increases must come from the new technologies
- Lean carcasses appear to be a sign of quality in our current market. For instance, Kune-kune, the so-called Maori pig, is not found in the supermarket as it has a back-fat depth of at least 50-mm; the average bacon pig is required to have 8-10 mm
- Natural disease resistance reduces the need for chemical treatment and reduces inadvertent suffering of stock in the absence of timely health care. At Lincoln University, Jonathon Hickford and his team have identified the gene for resistance to foot-rot in sheep; foot-rot is estimated to cost New Zealand $40 million, not including the time involved in prevention dipping and treatment Marker-assisted selection will be an invaluable tool in stock breeding. It is already being used in humans to identify individuals at risk from genetic diseases.

Knowledge of genes will assist in developing appreciation of the true extent of natural variation. As yet this is in no way fully defined for livestock groups and there are potential gains to be made.

Very recently, a whole new industry has grown up around genomics The search for new genes has been variously described as a 'race' or even a 'gold rush'. Gene discovery, the attribution of function to genes and their patenting has become industrialised. Sector groups have developed an interest in securing those genes that pertain to their industry as they could have a major influence on the development of livestock and forages. Whether these genes are eventually used in genetic engineering *per se* is not the issue The genes themselves have already become a valuable sort of currency or bargaining chips. There are estimated to be 180 thousand bovine genes, each of which has value

Using genetic knowledge, biotechnology should allow the continued, and scientifically verified, development of a pharmaceutical industry based on deer. Deer-antler and co-products are already in demand overseas in traditional Oriental markets and are emerging as powerful and effective food and health supplements in western culture, with developing application to canine and equine veterinary medicine Ongoing, focused biotechnological/pharmaceutical research will add scientific credibility and value to these emerging products

It is important to note that there are numerous biotechnological applications that do not involve genetic engineering Genetic engineering involves the shifting of DNA (i e, genes) from one organism into the DNA of another Well-known examples are the insertion of the *Bacillus thuriengensis* (Bt) gene in cotton (which reduces the need for frequent insecticide spraying) and the use of genes in soya bean and canola to confer resistance to 'Roundup', thereby allowing the herbicide to be used more generally in the crop What we are currently facing in the GE 'debate' is a 'food scare' and concerns about possible environmental impacts. The issues of increased yields, decreased pesticide use, improved nutrient value and potential medicinal benefits are sometimes lost amongst fears of delayed or unknown health and environmental impacts. If there is a choice between organically-produced food, and GE food, we, the socio-economically advantaged, right now are likely to choose the 'natural' product However, it must be remembered that there are issues around the safety of organic products, not all organic practices are sustainable, and that claims of better taste and 'better for you' have yet to be substantiated Perhaps the biggest problem with organics is yield and variability in production, but New Zealand is one of the few countries in the world which can produce more food than it needs for its population, so we might be able to afford to become a niche supplier.

In fact, the decision we have to make in the near future about whether we should remain free of producing GE crops and animals, will be based on the perceived risk by society creating an actual risk for our market (M Williams, Commissioner for the Environment, pers. comm , 2000)

Genetic engineering is, however, about more than food Crops, animals and micro-organisms may be grown for a range of purposes be they as substrates for biodegradable polymers, new fibres, phamaceuticals or as tools for bioremediation There is little debate about genetically engineered medicines. When one is ill, the risk of becoming more ill or dead outweighs the risk of late-manifestation of a side effect. Similarly, risk benefit also colours decisions about food. In many areas of Africa and Asia, people are deficient in vitamin A and iron. GE rice has improved content of essential vitamins and minerals, eating it improves health. Where there is food shortage the risk equation changes Survival and hunger are the immediate considerations

Analysis of effects will be made more precise, at least in theory, by increased traceability. AgResearch has been instrumental through Easi-trace in developing a DNA-based individual animal logging system that gives the consumer the ability to trace all steps of the supply chain from muscle cut to farm This system can provide specific reward for those who supply premium product and links to potential future direct marketing and procurement between producer and consumer via the Internet. Such traceability can work from an ear-tag, an implanted micro-chip, or DNA finger-printing or an inserted gene

The game industry is ideally placed through its high profile marketing of product in the hotel and hospitality trade and a personalised dialogue with chefs and individual high end supermarkets to develop close relationships. Images of contented deer surveying their animal-friendly and environmentally friendly pastures are the basis of the industry QA scheme, in association with the innovation and skill of farmer and researcher in combination

The final, and most fundamental point to make when considering current tools for future needs, is that they change all the time and the tools become rapidly outdated. We have to have research biotechnologies, we must have funding for this research. The Minister for Research, Science and Technology, the Hon Peter Hodgson, agrees that primary resources underpin this economy, and that we cannot afford to forget it. He wants to increase Government funding to research, particularly in 'strategic areas', increase private sector funding, and retain and enable our scientists The research environment during the last decade of competition, profit orientation and short term funding has, however, sent various messages to our research administrators, and production-based research does not appear to be attracting funding Biotechnology is near the top of the production pyramid, which starts with soil science and climate With that basic knowledge, the appropriate plants are selected, and the right animals chosen to graze on them. The only way the right plant and animal combinations can be selected is by research The plants and animals, as well as their pests, must be managed appropriately - again relying on research results. Technology transfer partnerships are well known in the deer industry. The challenge is to mix farmer innovation, adaptation and practical experience with the clear production directions from market trends and biotechnology arising from ongoing research This vision requires a working partnership and excellent communication with common and well understood goals The product must then be prepared for market and marketed to best advantage - throughout, research is paramount

New Zealand has a reputation for good all-grass farming, in a clean, green environment We should be investing in research to ensure that our reputation is deserved - investing in research in 'environmental technology' (i e , soil science, agronomy, pasture ecology, animal science, etc.). Unless our reputation is justified, we jeopardise our markets for any of the products of 'biotechnology' Why would anybody buy it if it hasn't been tested by reputable practitioners?

The game industry provides a very good example of the sort of research liaisons that the minister wishes to encourage. The Game Industry Research Trust, Game Research Holding Ltd , and Velvet Antler Research New Zealand Ltd., present a well-structured means of generating research results targeted at industry problems, and capturing them for the benefit of the industry. The new technologies, from selection methods, to GE, to traceable products, in the setting of New Zealand, and in conjunction with the forethought that has gone into the establishing of the research trust, should mean that the deer industry will flourish in the next few decades; in the crystal ball of the 21st Century, the deer industry future looks rosy with its pathway underpinned by sound research, market understanding and farmer assimilation of the excitement of the new and emerging biotechnology in all areas

Deer performance projects