INTRODUCTION

Steve RICE*

The Australian and New Zealand dairy industries are responding to the domestic and international market place by producing a wider range of high quality milk products that meet the consumers' expectations of price, safety, taste, nutrition and convenience. The producer, manufacturer, marketer and researcher must take account of the following trends:-

1. Demand for high quality products.
2. Increased emphasis on fresh products with better keeping quality.
3. Demand for freedom from contamination with chemicals or additives.
4. Increased demand for convenience foods and foods eaten away from home.
5. Increased role of supermarkets.
6. Greater awareness of nutrition and demands for low fat and low sugar products and high calcium products.
7. Public health concerns over pathogens such as Salmonella and Listeria.
8. Environmental considerations relating to packaging materials.

These demands place pressures on dairy farmers to economically produce milk of high microbiological quality, of improved chemical composition (increased protein) and free of antibiotics, pesticides, iodine and other contaminants.

The processor is expected to process this milk into high quality dairy products using a minimum of additives, to produce products with an increased shelf life. More quality tests are carried out with increased pressure placed on the development of rapid test methods. These high quality dairy products are marketed through a complex chain involving transport vehicles, warehousing, retail and vending outlets and specific overseas markets.

Governments in Australia and New Zealand are reducing resources allocated to regulating industry and as a consequence industry is increasing its own quality control programs. Approved quality assurance programs involving Hazard Analysis Critical Control Point (HACCP) principles are gaining acceptance.

To produce high quality milk and milk products significant advances have been made by producers, processors and researchers and in the area of genetic improvement. The following papers will address these areas as they relate to milk and milk products.

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A FARMER'S VIEWPOINT

Ian WILLIAMS*

Introduction

Generally farmers take pride in the quality of milk they produce, but their main concern is to receive the highest price for their milk, taking account of reasonable costs for quality control.

To obtain the full monetary return for milk produced, the main concern of a farmer is to avoid suspension of the city milk licence. If the licence is suspended the farmer then loses the market milk premium payments which will reduce returns by around 20%.

Should the problem be serious enough, the manufacturer may refuse to collect the milk and hence the vat of milk is lost. If a continuing problem occurs then the milk may not be taken by the manufacturer until testing proves the milk is of a desirable quality.

Milk Board Standards

The following standards are imposed by the Metropolitan Milk Board and milk authorities in other states for milk collected from farms:

1. Freedom from taints and foreign matter as may be physically detected by the milk tanker driver. The temperature of the milk will also be checked to see that it has been properly cooled to prevent the multiplication of micro-organisms.

2. Extraneous water as detected by freezing point tests.

3. Somatic cells (mastitis). From 1/7/90 monthly tests will be conducted and the standard is set at 750,000 somatic cells/ml (S.A.)

4. Standard plate count. The maximum is 50,000 colonies/ml and at least one test is done within each 21 day period.

5. Penicillin and other inhibitory substances - no residues permitted.

6. Iodine - levels in milk should not exceed 500 ug/litre.

7. Pesticides - levels must be below specified health standards.

The use of normal good management practices will achieve these standards, but it is interesting to note that in the 1988-89 year there were 114 cases where the Milk Board suspended licences.

The cost of quality control

To maintain milk quality below the specified plate count standard generally requires most effort and expense. It costs about $20 per cow per year for detergents and rubberware. The cost of power is in the vicinity of $50 per cow per year and by far the greater portion of this would be used for heating water and cooling milk to ensure a good quality product.

As we strive to reduce costs of production and also to protect our environment Through reduced use of chemicals and more energy efficient systems, we could do well to concentrate more attention on these cost areas.

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The newly introduced standard for somatic cells, should be no hardship to farmers as lowered counts due to reduced mastitis levels, are associated with higher milk production per cow.

Advisory service

At farm level quality problems are not easily predicted and often difficult to overcome. An advisory service is essential to assist the farmer to find the source of the problem and to ensure that it is quickly rectified. A clearer understanding of why problems occur should help prevent them in the future. I find the level of plate count failures to be disappointingly high - in fact, in the vicinity of 10% of all samples tested.

Currently farmers in S.A. are advised on quality problems by officers from the Metropolitan Milk Board, dairy companies and the Department of Agriculture. Although the system is working effectively, a clearer definition of roles in this State, could be an improvement.

Milk composition and breeding plans

The other aspect of quality not to be overlooked is the solid's content of milk. As the emphasis in our basis of payment changes away from butterfat we are encouraged to breed cows producing greater volumes of milk with higher yields of protein. The tendency is toward more kilograms of protein per cow, but at a lower percentage of protein or solids not fat. Will it be necessary to devise a payment system to ensure that the protein and/or solids not fat content is maintained at a desired level?

The breeding of dairy cows being such a long term program means that we should clearly define our future goals now.

Farmers are looking for guidance to formulate breeding programs to give them the cows that will generate the greatest profit and in so doing will also produce the type of milk that the industry requires.

Conclusion

Farmers will respond and produce high quality contaminant-free milk, providing the additional costs of doing so are recognised and appropriate incentives are provided.

A PROCESSOR/Marketer VIEWPOINT

Max THOMAS*

In today's sophisticated and competitive market place the consumers' wants and needs must be catered for by a widening range of consistently high quality contaminant-free products. The role of the milk processing industry is to meet these wants and needs by thoroughly understanding the market sector in which it works and ensuring that these expectations are met on every occasion.

Modern high technology and increasingly accurate marketing techniques are being used to assist in the decision making process which ultimately leads to the production and marketing of products which meet the requirements of any particular sector of the market.

In an industry such as ours, the quality of the final product is a reflection on the long chain of specialist sectors within the industry. However, an increasing focus on the reliability of products is being directed toward the milk processing companies and their brand names.

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As such, the processing sector must set more stringent standards for its raw materials and finished products and ensure that these standards are consistently met. These standards may range from simple but basic parameters such as temperature levels through to difficult to measure microbiological and chemical contaminants such as Salmonella and Listeria organisms, increasingly sophisticated antibiotic type substances used in the general health care of the animals or other materials such as pesticides, herbicides and even radioactive elements as experienced by European producers.

Variations in milk composition, whether they be due to feed, breed or seasonal factors will need to be rigidly controlled both from quality and productivity points of view. Some recent developments throughout the world are now showing that not only fat levels can be standardised. Other milk components such as protein, lactose and salt levels are important factors in producing consistent finished products.

One particular system of ensuring the consistency of raw and finished products is the Quality Assurance system, in which the producer of the raw material or finished product or various levels between those can assure the next consumer/user that the product is within a set of agreed specifications. Again, for this system to reach its optimum effectiveness, close communication and understanding is essential at all levels of the industry.

The future wellbeing and prosperity of our industry will depend on how quickly each sector of the industry can overcome the various challenges and make the best of opportunities which will present themselves in the constantly and rapidly changing scenarios in front of us. The use of new and improved technologies to increase our existing controls, to develop new products and to generally improve our productivity will be a key element in the improved viability of our entire industry.

**DEVELOPMENTS IN MILK HARVESTING TECHNOLOGY**

Bruce KEFFORD*

The Australian dairy industry is an integrated agribusiness chain extending from feed through the cow, the milk harvesting, the manufacturing and finishing at the all important customers. Efficient milk harvesting is crucial to the maintenance of high productivity and high quality, contaminant free dairy products.

Australasian milk harvesting research in recent years has very largely been carried out by the Milking Research Centre (MRC) and the Animal Research Station, Ruakura, New Zealand.

Ruakura researchers have focused on the development of a novel milking machine which separates the air from the milk during milking. This means that rather than the milk being transported to the vat as a mixture of air and milk, arriving with high impact velocity; the milk (largely free of air) is transported gently under lower pressure. The resultant milk is lower in volatile fatty acids and consequently of higher quality. This system also facilitates "in-line" measurement of milk yield and other important data (e.g. conductivity as a measure of mastitis).

In Australia the MRC is the only group devoted to milk harvesting research and it has recently been relocated to Ellinbank (100 km East of Melbourne). This has meant a fresh start with an influx of new staff and an opportunity to review the research direction.

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Our role is to help the Australian dairy industry prepare for the challenges of the future, to take advantage of the opportunities and cope with threats that arise through the rapidly changing environment. We are particularly interested in problems peculiar to the Australian dairying environment.

Product management

The solution to one local problem is central to the Australian dairy industry meeting domestic and international consumer demands for a greater range of consistently high quality dairy products year round. Seasonal calving practised in Southern Australia and New Zealand is low cost and very efficient. However, it leads to the majority of the best quality milk being produced in spring. This leads to higher manufacturing overheads to cope with the spring peak volume and deficiencies of premium quality milk for manufacture at other times with resultant fluctuations in product quality.

Mary Christian is currently investigating the influence of period of lactation and the level and quality of cow nutrition on dairy product quality. The aim is to develop cost-effective strategies for feeding, calving or sourcing milk to provide a consistent supply of premium quality milk. This is crucial for the expansion of domestic and international markets particularly in the higher value (shorter shelf life) dairy products which cannot be stored for long periods.

Teat management

Mastitis costs Australian dairy farmers more than $100m/year and its control is important for improved farm productivity as well as product quality.

Teat disinfection At MRC we have developed and commercialised a novel teat disinfectant (Tasman’s Natural). This product is not only very effective but also very safe as all the ingredients are food grade materials. Its action is different from other teat disinfectants in that it is selective — very effectively killing mastitis causing bacteria such as staphylococci and streptococci, while allowing other less harmful bacteria to survive and occupy the potential binding sites on the teat. This leads to slower recolonisation of the teat surface with mastitis causing bacteria. A similar product is also being assessed as a potential dry cow treatment.

Teat-liner interactions Dr. Werner Schmidt, a milking machine specialist from Germany, is developing a compressive load meter to measure the compressive load applied by milking machine teat cup liners. This device enables the measurement of the performance of experimental and commercially available liners while the machine is operating. This device will provide essential information for liner design by assessing the performance and wear of liners in the field.

Herd management

The need for continuing improvement in dairy farm productivity is placing greater demands on labour productivity of milk harvesting. As herds increase in size the associated productivity gains can be lost to some extent if the important management tasks of herd recording, mating management and herd health are affected. Our aim is to find and test a cost-effective system, that is suitable for the Australian dairy environment, for automating data capture and analysis associated with these tasks.

As a first step Geoff Mathews is assessing the multitude of electronic identification technologies available world-wide. The eventual aim is to incorporate the selected identification system(s) into a cost effective
integrated management information system where cow identity, production performance, mating and health information is automatically collected and analysed.

Conclusion

The long term success of the Australian dairy industry will depend to a large extent on its capacity to cope with the rapidly changing environment. Recognition of the needs of customers and for/continual improvement in productivity is crucial. Australian and New Zealand researchers in milk harvesting technology are investigating the new ways of applying technology to improve productivity through improved labour productivity and management information as well as improve product quality through more effective, safe teat disinfectants and better milking machines. Strategies to meet the modern domestic and international customer needs for consistency of supply and consistency of quality are also being developed.

REVIEW OF DEVELOPMENTS IN ANIMAL BREEDING TO ACHIEVE GENETIC IMPROVEMENT IN THE DAIRY INDUSTRY

A.E. (Sandy) McClintock

Introduction

Milk quality and quantity of dairy cows have been recorded since the 19th century but only with the advent of artificial insemination (AI) has there been a useful understanding of the genetic basis of production. Before the introduction of AI the genetic influence of the sire was confounded with the management influence of the herd in which he was used. With this understanding came the ability to design appropriate breeding programs for progeny testing dairy sires.

Data processing

In the 1950s breeding programs had to rely on primitive data processing equipment (e.g. Holrith cards). In the 1960s computers started to appear but their speed and cost restricted their use to data collection and storage; data processing for sire and cow indexing had to be kept fairly simple (e.g. Contemporary Comparisons). Most countries had introduced Best Linear Unbiased Predictor (BLUP) sire evaluation software by the end of the 1970s but only a few could provide similar facilities for cow evaluation. The 1980s saw the advent of computers capable of solving the large sets of simultaneous equations which were required for sire and cow evaluation (Full Animal BLUP model). Australia was a leader in this respect for most of the 1980s; only in 1989 did Canada and USA introduce national listings based on the Full Animal BLUP model.

Second and later lactation records were excluded for sire evaluation in the early days, but this practice persisted much longer in Canada and UK, probably a tradition arising out of necessity during the 1950s. At that time all compositional quality tests were done by hand and completed lactation data was calculated manually. To minimise costs, only the data for heifers was punched onto cards for processing. Today we find most milk samples are analysed by automatic equipment and the results transferred electronically into the database. For this reason it costs very little to process the additional data since it is captured electronically as part of normal herd recording.

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The sponsorship of Victorian Artificial Breeders is gratefully acknowledged.
Australia would be the development of a national ranking system for recorded cows under the auspices of the Australian Dairy Herd Improvement Scheme (ADHIS). A national ranking of all sires and cows is provided and has become an important tool in the marketing of genetic improvement. Before the advent of ADHIS, each state had local lists of sires with Estimated Breeding Values (or Relative Breeding Values) based on the Contemporary Comparison method.

**Semen processing**

The ability to obtain large quantities of semen from the top bulls is important in that it maximises the availability of the best genes at reasonable cost. In the 1950s semen was mainly distributed fresh but for a time was distributed in glass ampoules, pellets, 0.5 cc straw and then the 0.25 cc straw which would be the current standard. The best semen donors can produce in excess of 80,000 straws per year. With the strong selection of AI bulls for fertility it is possible that this may explain a large proportion of the difference between semen production in dairy and beef breeds.

Semen processing has been improved to a point where little 'additional work is being carried out. The normal sperm count would be 20 million per straw but this could be lowered for certain bulls with benefits to all. Semen sexing is not yet a reality, although there are some indications that progress is being made.

**Breeding program design**

Most breeding programs around the world are based on the sale of semen from progeny tested sires. Only in small populations is it necessary for almost all cows to be mated to young bulls. More recently it has been shown that groups of full, and maternal half sisters produced as a result of embryo transfer (ET), can be used to enhance the accuracy of selection of young bulls. In the pig industry, sib testing replaced progeny testing 20 years ago; ET lifts the prolificacy of the cow to something approaching that of a sow thus creating the possibility of full sib testing in dairy cows. So far, programs based on this idea (sometimes referred to as MOET Nucleus Breeding Programs) have been slow to take off in Australia; overseas, a number of programs have been started, Inbreeding rates can be substantially higher in such programs, particularly where BLUP models are used to evaluate the families.

**Traits other than production**

Conformation assessments of dairy cows in Australian progeny testing herds has led to evaluations of sires for their Estimated Breeding Value for 32 conformation traits. In overseas work there are clear indications that the most "desirable" conformation points are, at best, only weakly correlated with survival in stud herds. In commercial herds, most "desirable" conformation points have a zero (or even negative) correlation with survival.

Traits such as milking speed and temperament are now being assessed on daughters of progeny tested bulls. It is not yet clear whether these traits are being interpreted correctly. Although dairy farmers see these traits as very important, they may be sacrificing too much in production potential when rejecting sires for having slow milking daughters. In most countries where milking speed is assessed, a correction is made for the quantity of milk being produced; this is not specifically done in Australia.

Recently, survival (stayability) has been evaluated directly for sires in Australia but the first results were met with reservation. The problem is that the semen of some sires is so expensive that the breeder may retain recorded daughters that would otherwise have been culled. For analyses of stayability to be meaningful it is important for subset(s) of herds to be defined where the requirements, breeding aims and culling pressures of the dairymen are
requirements, breeding aims and culling pressures of the dairymen are reasonably consistent. So far the task of defining these subsets has not been concluded; the distinction between stud and commercial sectors is too vague to be of use.

**Future developments**

**Physiological screening** There is some hope that there is a sufficient correlation between an animal’s genotype for production and its physiological response to 48 hours of fasting that this could be used for improving the genetic merit of teams of young bulls entering progeny test.

**DNA screening** It is now possible to screen blood samples to determine which protein variants will be produced in the milk; some of these variants are reputed to be better for cheese making. In the case of a young bull this could be a useful pretest screening procedure. Marker assisted selection is the goal of a number of projects; the idea being to select for genes which are easy to identify and which are closely linked to genes of economic importance. Mapping the human genome has progressed to the point where the chromosomal positions of over 3500 genes have been determined. With cattle this figure is less than 20 but it is hoped that sufficiently detailed gene maps will be produced to let the genes of economic importance be identified directly. Many things we record in dairy animals are controlled by more than one gene so there is a great deal of work needed to make practical use of gene maps.

**Embryo manipulation** Embryos can be split into two halves each with only slightly reduced viability. The challenge of the 1990s will be to extend this progress to “infinite cloning”. If this technology becomes available cheaply it will revolutionise the AI industry. Invitro fertilisation may become cheap and effective enough to offer many of the benefits of cloning. The ability to create calves with two fathers and no genetic mother would permit AI breeding programs to generate much higher rates of genetic change. The ability to create calves with two genetic mothers and no father would permit clone testing to generate new variation by crossing elite clone-lines.

**SUMMARY**

Steve RICE

The dairy industry needs to produce a variety of high quality, contaminant free dairy products to meet market demands. At the producer level increasingly stringent standards need to be met and increased quality control costs must be covered by increased returns, or increased productivity. The producer is also changing feeding and breeding programs to produce milk with an altered chemical composition to meet market demand.

Advances in milk harvesting technology include improved milking machines which reduce air incorporation into milk and advanced teat dips which do not present a chemical residue problem. Advances in technology at the milk harvesting end are likely to lead to low labour input milking, reduced chance of contaminants entering milk and automatic data capture and analysis systems linking the cow to feeding, breeding, health and production parameters.

In the area of genetic improvement ADHIS has developed a national ranking of all sires and cows. Combined with advances in AI, ET and new developments in embryo manipulation the dairy industry has the potential to further increase milk production and significantly alter the components in milk.

The processor and marketer are producing and marketing an increasing range of fresh milk products, dairy spreads and cheese for a market demanding an increased shelf life for many products. The processor is increasingly adopting
strict quality assurance programs to guarantee product quality at all stages of the process. New processing techniques such as aseptic packaging and membrane technology are widening the product variety and market possibilities.

The dairy industry is part of the wider food industry producing many products which are hard to specifically designate as a dairy product. To remain competitive all sectors of the industry from production to marketing must ensure that they do their part to produce high quality contaminant-free dairy products that are safe, nutritious, palatable and good value for money,