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What the market will need from milk production

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INTRODUCTION

During the coming decades scientific achievement may well change the nature of milk with extraordinary potential for progress. Technology will also change the way in which milk is processed and will produce products that are entirely unfamiliar today. Some of those products may be very sophisticated. Other products will need to suit the diets of cultures strikingly different to our own because our customer base will broaden geographically. The essential direction of those changes will not be settled by people in white coats, people in gumboots, or even salesmen wearing suits, but by the people who push the supermarket trolleys. They will be the decision makers, and they will be searching for "value-for-money spent". They will increasingly be city-living people who will be getting the message to keep their weight down despite using less energy in their daily life style. They will include those people who have difficulty in answering the questions posed by John Hawkesbury on "It's in the Bag". Many of them will be profoundly influenced by those vocal, frightened, pressure groups who appear on TV, radio, and in print telling our customers to pass by foods that are "unnatural" or foods that for some reason or another might seem to be harmful. The information that a scientist might classify as pseudo-science will have a powerful weight of authority for the 70% of the New Zealand population who did not attempt 6th form science subjects.

In New Zealand the proportion of the population who are "scientifically literate" is startlingly low. Among every 100 students who reach Form 5, we can expect the education system to produce:

- 4 graduates with science, engineering or technology-based degrees
- 2 certificate holders from technical institutes

1 diploma of Agricultural Technology

2 technology-based Trade Certificates.

A total of 9 technically literate people.

If you expect people in the general population to understand the impact of the scientific work which you are reporting today, consider what happened in our schools in 1987 (Table 1).

TABLE 1 Scientific studies among high school students in New Zealand in 1987.

	Males	Females
Cohort of 16 year olds (assessed)	32,087	31,137
Apparent Retention until Form 6 (% of form 3 entry cohort)	55.1	58.9
Proportion taking Biology and Biological Science (%)	16	28
Proportion taking Chemistry (%)	15	14
Proportion taking Physical Science (%)	23	9

During the decade from 1975 to 1985 the proportion of students in Form 6 who took science actually declined. Perhaps that is to be expected because primary school teachers do not consider science subjects to be a really useful part of their training. During the period from 1983 to 1986, 403 students from Wellington Teachers' College took subjects at Victoria University. Only 4 took science as their major (Clark and Vere-Jones, 1987).

"Real People" who actually make purchasing decisions at the retail level comprise a substantial

majority who do not understand the science which scientists regard as common place. They are, in the end, looking for a benefit from the food that they buy. Consider your own behaviour. When you are pushing the supermarket trolley, you are likely to be concerned with the price you will have to pay, the flavour or texture you expect to get, the ease of preparation, or the way the food looks. You may have special needs that are all your own. In marketing jargon, you are seeking benefits. If there is any doubt about the wholesomeness of a food item, then you will pass it by.

MILKFAT

Very few of you will buy high fat ice cream except as a special indulgence (reward!), because you are aware of your weight. Very few of you would buy butter because you believed that its cholesterol content was good for you. If you are very well informed, you might accept that cholesterol need be of little concern; but what benefit do you expect it to give you? The sophisticated markets of Europe and the USA have been turning away from butterfat products, and may well continue to do so. As a consequence, their farmers have produced unsaleable surpluses of milk fat which have profoundly affected the value of milk fat in New Zealand. In recent years the impact has been clear (Table 2).

TABLE 2 Changes in the relative value of milkfat and protein in New Zealand's dairy exports from 1980/81 to 1990/91

Season	Milk fat:Protein Component Values	
	NZDB Advance Price	Returns in all Markets
1980/81-1984/85	1.77-1.79	-
1985/86	1.64	-
1986/87	1.49	1.83
1987/88	1.03	0.93
1988/89	0.74	0.56
1989/90	0.65	0.56 (estimated)
1990/91	0.60	-

Butterfat has the benefit of desirable and attractive flavour. That benefit is being, and will continue to be, eroded by flavour improvement in competing

products. Vegetable oil marketers claim a benefit from the presence of unsaturated fatty acids. Fish marketers have found a benefit from components of fish oil (polyunsaturated fatty acids, EPA and DHA Omega - 3 fatty acids, which are said to extend life and to reduce heart disease).

The message for producers of milk is either to focus research attention upon providing benefit that buyers will want or to produce products more efficiently. The world market for milk fat products is not expanding and this is likely to limit the relative value of milk fat compared with milk proteins.

BREEDING

If you accept that milk fat is not the appropriate product for the future then you are placing trust in the future of milk protein. Breeding programmes should therefore target efficient low-cost milk production while recognising that the market for milk fat products is limited.

A shift towards Friesian herds is already having its impact on that. The coming decades will need to make further progress and the essential impact of breeding programmes should be to speed up progress. The opportunities are:

(i) to find animals from a world-wide search that have the best balance of low fat:high casein ratios consistent with high protein yield per hectare from grassland farming. These may be new breeds or perhaps deliberate selection of individual cows within the breeds that we have (either in New Zealand or abroad);

(ii) to speed up the introduction of new genetic material. Selective breeding is highly likely to be successful with costs little more than we currently accept, but it takes many years to obtain the benefits. An improvement in protein yield over the next decade of 10% would appear to be an upper limit. The techniques of embryo transplant and cloning of embryos can reduce this time delay. This acceleration of results could be more important than the higher costs that will be incurred in using the technology. This direction of research and application of technology could be very appropriate;

(iii) to utilise genetic engineering. The concept of a skim milk producing cow or a carotene free milk fat, or a cholesterol-free milk fat is appealing, but the costs and the time-scale involved are not encouraging. If it is going to take a decade or two to remove a component from milk products then it is likely that advances in processing technology will provide a direct route to achieving the target less expensively and more quickly. No doubt progress will be made in improving the success rate of transgenic trials and in isolating genes. Consequently, intelligent monitoring of progress as it is made by organisations with large resources seems to be more appropriate than undertaking major activity ourselves. It is important to recognise that the terms "genetic engineering" and "transgenic animals" are frightening terms for those people who push the super-market trolley. Don't expect that the "scientific genius" which these terms infer is necessarily welcome. If the words "Made from genetically engineered cows" were to appear on a package of cheese, sales would not dramatically increase, and would probably plummet. Consumers do have a "right to know", even if you think you should decide for them because of your greater knowledge.

COST REDUCTION

The fundamental factor that has permitted survival of dairying in New Zealand, despite the enormous subsidies paid to our competitors, has been the ability of farmers to succeed financially on the net returns that can be achieved. The financial forces that have driven the industry toward ever increasing farm size, dependence on seasonal grassland, and large-scale processing can be expected to continue. Any research directed toward increasing the total kgs of milk solids from the least number of kgs of grass solids at the least overall cost will continue to be important.

One offsetting factor of cost saving from the lower cost seasonal production is our inability to supply fresh product year round. We have to hold stocks so that we can continue to ship products from May through August. We also have to tolerate our inability to respond to new sales opportunities both at the peak of the season when our processing plants are full to capacity and not flexible to switch products. At the low point of the season, we cannot supply at all. We tolerate the

costs of low capital utilisation in plants that are used to only 40% of their capacity. This tolerance is acceptable while it minimises on-farm costs; but it also makes us less than ideal as a supplier of dairy products. The overall cost balance still favours seasonal production.

Research into the extension of the dairy season, perhaps using grasses that grow in the winter, or feeds that can be economically used through the winter to cows that tolerate cold and wet weather, would provide a real advantage to our marketing position, provided the costs were acceptable.

PRODUCTION INCREASE

Greater production per cow has to be of value provided it is not accompanied by a cost/litre increase. An encouraging way to do this is to identify those metabolic pathways that result in higher production and then to use the information to identify genetic markers in the breeding programmes.

The alternative way of speeding up or increasing the metabolism of secretion has very great risks inherent if it involves intervention in the natural process of milk production. The proposed use of BST (*Bovine Somatotropin*) in a number of countries provides evidence of the likely response of our customers to a scientifically exciting advance that they perceive to be unnecessary tinkering with an otherwise trusted product.

The development of BST utilised genetic engineering, and resulted in a "hormone" that would appear in the milk in the cartons that we want people to buy. This BST is not detectable (beyond those levels natural to milk) and there is convincing evidence that it is safe. But the proposition is turning into a time bomb. First, it requires intervention to the animal which raises issues of animal welfare. Secondly, it will be used widely and cannot be detected in the milk so customers cannot tell whether or not they are drinking it. Thirdly, the benefits to the farmer are much easier to see than are the benefits to the customer. Consequently many consumer organisations and pressure groups have been vocally opposed in all the media to the use of BST so that the legislative process both in Europe and in the USA is being deliberately delayed. Processors are not eager to get involved, even if formal approval of BST is achieved. Supermarkets such as Safeway have refused to stock

milk from cows that have been treated with BST. We would be foolish to expect any increase in consumption or improvement in market perception of dairy products if ever BST does come into use.

For the New Zealand industry, the BST uproar provides an awful example of what happens when "progress" ignores the person with the supermarket trolley. We actively promote the "naturalness" of our products, the "clean and green" image of New Zealand, and could not sustain that image if we allowed BST use. We supply over 100 countries and would be unable to segregate product for sale into only those countries that permit use of BST on the herds that supplied milk to our products.

The coming decades must see an acute awareness of customer concerns and we must respond to those concerns, not lead with technological progress if there is any danger that it will be unwanted.

This is not to suggest that we should halt all progress. It is rather a plea that the headlines in the media, which describe the wonders of your work, should highlight the benefits that you have created for the buyers of our products.

PHYSICAL FUNCTION OF MILK COMPONENTS

A strong selling point for purified milk components is the physical properties that they exhibit. We are only too aware that butter does not spread as easily as margarine. You may be less aware that protein properties also vary according to the types of components that are present. Heat stability varies seasonally. All of these physical properties have been treated, with varying success, by technological means.

There is some scope for improving the natural properties by feeding appropriately or by selection of those occasional animals that have appropriate genetically controlled components in their milk. Examples that we are aware of are:

- Milkfat that is soft (i.e. has a naturally low softening point).
- Protein that has low gel strength (i.e. having an unusual pattern of alpha-s casein).

Perhaps genetic engineering might suppress the appropriate genes to produce animals with no beta-lactoglobulin in the whey fraction. The milk would then be more like human milk.

These are possible developments that could be considered. However, if progress would require a decade, then it is likely that processing technology will outstrip breeding progress and the value of the work would be limited.

PHYSIOLOGICAL FUNCTION

It is becoming evident that some foods contain components that have a physiological impact upon the consumer. These are foods that provide more than nutrition in the form of amino acids and energy. They are not pharmaceuticals which are basically therapeutic in application. They are somewhere intermediate between these two and have been referred to in Japan as "functional foods". These are foods normally taken and designed to bring out certain effects on the living body. This happens through the body using the functional components which are present. It especially relates to foods with functions relevant to the diseases of adults and the elderly (e.g. diabetes, heart disorders, renal disorders and hyperlipidaemia). According to this approach, foods may also regulate immuno-protection, the regulation of body rhythm, the prevention of and recovery from illness, and the suppression of the ageing process (Dosako, 1988).

The first of this class of foods released in U.S.A. has been "Impact" which contains RNA, arginine, and a balance of omega-3 fatty acids, and omega-6 fatty acids. The product claims to preserve immuno-competence, reduce the incidence of sepsis, and to reduce time in convalescence.

In Japan, products which contain lactoferrin (for its iron carrying function and possibly for its pathogen controlling function) and sialic acid (for its claimed anti-infection function) have been released in the infant food sector of the market. The first food in Japan to be classified formally as a "physiologically functional" was probably a peptide of casein known as CPP which has the function of carrying calcium or iron through the digestive process to increase bio-availability.

Seventy-nine patents for foods that are able to be classed as "functional" were published during 1989

(Anon, 1990). These included foods that contained:

- (i) peptides from casein to treat hypertension;
- (ii) unsaturated fatty acids (EPA and DHA) to prevent atherosclerosis;
- (iii) polysaccharides with anti tumour effects;
- (iv) enzyme inhibitors to control obesity; and
- (v) oligo-saccharides for conditioning of the intestinal microflora.

These foods quite possibly represent the wave of the future. They provide clear benefit to the customer and they are of natural origin. They will hopefully be welcomed by the regulatory authorities. A number of them can be derived from milk, and some of them are of high value. They may need to be high priced if the desired component is present in only very low concentrations. Nevertheless, we already have the technological capacity to prepare lactoferrin and some of the peptides, and we will be looking for ways to improve yields and to reduce costs.

IMMUNE FUNCTION

The ability of the cow to pass the factors that provide immunity to her calf through her colostrum has been known for many years. The factors that create this immunity continue to be produced at low levels during lactation. We now have the technological capability to extract them in relatively pure form. Foremost among those factors, are the immunoglobulins. They have natural antimicrobial activity and, unlike antibiotics, they also have anti-viral activity. We have products on the market which can provide a supplement to colostrum. They have consistent levels of antibodies to at least 8 pathogenic organisms. They can adequately replace colostrum in a new-born calf's diet. This has been a major step forward, scientifically and technologically. Some of these products are being introduced to niche markets around the world.

The potential exists, and is being realised, to enhance the levels of immune function by hyper-immunisation of the herd so that the milk product can be

effective in meeting the challenges of intestinal pathogens. The use of vaccines that may produce antibodies to human disease appearing in the milk can result in products with highly beneficial properties.

At the experimental level, transgenic animals that can express human physiological biochemicals in the milk have been reported (Bremel *et al.*, 1989; Simons *et al.*, 1988). The concept of the mammary gland as a biological factory able to manageably produce rare components in a form which can be extracted and purified will be tested and either proven or disproved in the coming decades.

These developments differ from the BST scenario in that the products will be specifically produced and targeted to particular customers. The benefits will be clear and will be desired. Labelling will ensure that involuntary consumption does not upset consumers.

CONCLUSION

As the dairy industry moves into the next century, its needs must reflect the desires of its customers who live in many cultures. We must be market-led if we are to remain successful. This means that the person who pushes the supermarket trolley must see real benefits in the products that we have to sell. The shift which is already evident toward a higher value for protein relative to fat is expected to continue.

The fundamental strength of our industry lies in the low cost production of milk solids from pasture and this must continue to be a focus of research. However, we cannot pursue this aim by means that result in a loss of confidence in the safety and purity of our products.

An enormous potential exists for products of the future which will provide a physiological or immunological benefit and which can be seen to be pure and natural. The scientific challenge is clear, though the commercial environment will dictate progress by evolution rather than revolution. The world of biotechnology is already far ahead of the comprehension of the customers that the technologists may wish to serve. As a consequence, the rate-limiting step to progress is likely to be not the safety and validity, but the acceptability of the procedures which are to be used.

That acceptance has to be earned. The scare stories in the media have to stop. Both the marketers and the innovators must ensure that the results of

research work are welcome.

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