Australian Nuffield Farming Scholars Association

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Subject:
Electronic milking and monitoring in the dairy industry

by

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1. AIM OF STUDY

The purpose of this Nuffield study was to investigate the use of sophisticated electronic milking and monitoring equipment for Australian dairy farmers. The future for Australian agriculture is in productivity gains and the Australian dairy industry can be proud of its record in this area.

The last decade has seen the dairy industry rise to new prominence in Australian agriculture. The average sized herd has increased by 50%, production per cow has risen by 30%, and returns on investment have been consistent. Despite this success, there still remains many areas where producers have made relatively little headway. For example, conception and pregnancy rates, cow health problems (some old ones solved, some new ones appear!) and milk harvested per labour unit. In particular, I would highlight the changing role of milking parlours and equipment in a world of increasing cow numbers (yield per cow) and the pressure to monitor and manage a herd. Outside of buying a farm or herd of cows, the milking facility is usually a dairy farmer's major investment. A farmer must ensure that it will serve a long and useful life and fulfil its expectations to ensure future productivity gains.

It is my expressed wish not to recommend any particular manufacturer of milking equipment and I believe my approach has been completely impartial.

2. SUMMARY

The general introductory part of the study, February 14 to March 20 was an excellent experience in seeing a very broad range of successful agricultural businesses plus some wholesale, processing and retail businesses. This no doubt builds on this already legendary part of the scholarship. The large and diverse group – at times unwieldy – ensured that interest was shown in all topics.

Turning to the specific study I can confidently offer the following conclusions after visiting milking facilities world wide;

a) Electronic Identification (EID) is the first step to be taken to implement more electronic monitoring. Without EID, all subsequent hardware is practically useless as cow identification must be entered manually at every milking. There are at least five main manufacturers of these devices. They all claim to be the best, most work fairly well, some really well.

b) Electroconductivity (EC) monitoring of milk was also an invaluable guide to udder health.

c) Activity monitoring of cows, usually referred to as pedometers (as they are strapped on the leg and count the number of steps the cow takes) have been a great success.

I say this, however, with some qualification because positioning on the cow's rear leg at hock level is the worst environment for a piece of electronic equipment. Ones located on the neck have been much more satisfactory. Some farmers have been able to rely almost entirely on these to monitor cow health and oestrus.

d) The use of milk yield meters in themselves were of limited use and value, but used in conjunction with the above three devices, the total package of EID, EC, activity and milk yield was a very powerful combination. I visited and observed five farms using these complete systems from three manufacturers and was very impressed. Even three out of four devices was good value.

e) Australian dairy farmers simply must start taking more interest in what milking equipment is appropriate for their farm and why. Higher yield per cow and more cows to be milked will very quickly show up inadequate equipment as will poor milk out, poor teat condition etc.

f) There is a lot of milking equipment available overseas that is not generally offered in Australia. We are principally offered equipment from the European Economic Union (EEU). They have relatively small herds, often lower yield per cow and a large variety of cattle. The USA, on the other hand, has a predominance of large herds, a national average production of 8,000l/cow and milk almost exclusively Holsteins. They also are the main source (along with Canada) of our genetic material.

Yet they milk with quite different equipment than us. Why? Even the main EEC milk machine manufacturers offer completely different equipment in the US (with some exceptions). Why? I am not suggesting that the US 'system' of dairy farming, or their equipment range, is the 'be all and end all', but they have a lot to offer which I will expand on in this report.

g) Robotic milking is looking very good. I expect to install some type of robot or be assisted by one in my working lifetime.

3. ASIA REPORT

My study tour started with an organized tour of three Asian countries with 8 other Nuffield Scholars from Australia, New Zealand and United Kingdom.

The good points about the Asia trip were;

- The pertinence of this market to all primary producers in Australasia,
- I personally had previously only had indirect experience with exporting to Japan,
- I knew very little about wholesale and retail in Asia, or Asian eating habits and incomes.

To study Asia's agricultural production systems is not particularly enlightening of Australian farmers. They battle undercapitalization, lack of space and room to expand and low levels of infrastructure support to store, process and transport commodities. Having said that, they cope very well and import what they cannot provide themselves for their large population bases. Malaysia can only produce 18% of its food requirements, Thailand is a net exporter. The variation is enormous.

We visited some good dairy farms but man, was it hot! You can only admire a cow that wants to eat in that environment. The visits to a meat distribution company, fruit wholesalers and supermarkets were invaluable experience. We learnt what sort of products they desired, on what terms, and what they thought of Australian exporters. Some good and some bad! If I had a desire to export to Asia, I would only consider a product that they really wanted. If it was a product that they could easily source elsewhere at a cheaper price, then they will source it from the cheaper supplier (understandably). Price is king. As an Australian dairy farmer I felt really proud looking at the Thai dairy processing plant outside Bangkok. Funded 50% by Australia, it is a magnificent facility and should cement a really good relationship between Australia and Thailand in dairy trade.

The bonus for some of the group was that Asia was also the area that they wanted to study so they were able to establish some good contacts and form plans for their return.

The short comings of the Asia trip is the heat in February, the sheer time spent travelling and the large size of the group this year (9). We often only had two or three 'contact' hours a day and spent a lot of time being lost.

4. STATE OF DAIRYING INTERNATIONALLY

a) European Economic Community

As most people know, dairying in Europe is driven by politics and quotas. Despite harsh winters it is a relatively favourable area for dairy production and their farming population has a passion for milking cows. The only way to control surplus production at their favourable (and supported) price levels has been by quotas. These have been in place for twelve years and appear likely to remain for at least another six years. In fact, no one, in any sector of the

industry, could suggest to me how quotas could be dismantled, particularly with fifteen member states. My agricultural economics training tells me that quotas will probably remain in place until the Union can no longer afford to pay support prices. Nor is there any political will to change it anyway! It seems to be the best way to restrict production in their circumstance and I firmly believe it is in Australia's interest that quotas remain.

Prices received by farmers are around AUS 60c to 50c/*l* and have fallen from a high of over AUS 60c/*l* two years ago. The price in the United Kingdom is the lowest in all Europe, mainly due to an ever strengthening currency. The recent good times meant that few farmers controlled costs and even fewer knew their cost of production, particularly on mixed farms. They are now finding that the cost of production is close to AUS 45c/*l* (or more). This is putting their production system under pressure, but they have plenty of scope to cut costs or improve productivity.
The countries that will prosper in the future will be the ones that target the consumer. Those that produce principally intervention type products such as butter, Skim Milk Powder and Whole Milk Powder could find this support reduced in the future.

b) United States of America

The US dairy industry has an odd mix of 'laissez faire' and support. There is almost a total absence of quotas, free trade between states and a lot of processors. A lot of unprocessed milk is trucked interstate and the huge population base ensures nearly all milk is consumed domestically. However, producers have the added benefit of a Federal milk price intervention scheme, currently US$9.50/cwt (approximately AUS 35c/*l*). Current farm gate price is around US $13/cwt (AUS 44c/*l*). Cost of production varies from AUS 35c/*l* to 44c/*l* so some have a profit margin of AUS 10c/*l* and some have no profit at all. Return on capital varies from 0% to 7%, rarely above the latter figure.

The trend of increased production along the West Coast and decreasing production along the East Coast continues. California has produced more milk than Wisconsin for two years now. Over a five year period, production on the West Coast has risen 24%. The use of Bovine Somatotropin (BST) is now firmly entrenched in the industry. The majority of cows, once pregnancy tested in-calf, receive BST until production falls to 25*l* or they are 30 days prior to drying off.

National average production per cow is 8,000*l*, but of the 17 farms that I visited, not one was doing less than 10,000*l*/cow. This puts tremendous pressure on the cows with high herd replacement rate. 3.5 to 3.8 years is the average age of a herd; one herd in California had an average age of 2.5 years. BST only accentuates this problem.
Producers in Wisconsin are being encouraged to cart their own milk. A farmer will typically have no fixed milk storage on the farm, but will own two articulated trailers. Milk is chilled in a plate cooler and pumped directly into the tanker. The farmer may own his own prime mover or contract someone to haul it to the processor. While one is away, the other is being filled. There is also a push generally in Wisconsin to maintain or grow the size of the industry. Hence there are now many 400 to 800 cow units (all free stall housing all year) with very modern parlours milking 20 hours or more a day. They are even getting Mexicans! Parlour operation was actually more frantic in Wisconsin than it was in California.

The future for dairying in the US looks stable with most growth in the West Coast states. The whole economic outlook in the US is fairly bright, even with an overheated stock market. What happens in the rest of the world is fairly irrelevant to them.

5. SOPHISTICATION IN MILKING SYSTEMS

a) Broad Overview

The consideration of more sophisticated (and chiefly electronic) milk harvesting and monitoring equipment will not be appropriate for every farmer. If the goal is very low cost of production from relatively low production per cow, then expensive equipment will be unsuitable. However, I envisage three main scenarios to which it will be appropriate;

- operators who wish to keep production per cow around 5,000*l* to 6,000*l* but already, or intend to, run a large number of cows,
- operators who wish to keep cow numbers fairly constant but raise production by higher yield per cow,
- operators who wish to combine both higher yield and higher cow numbers.

It is breath taking to visit the commercially operating farms that have fully implemented these systems. The control that they have over their management is brilliant, and does not involve being present every working hour. Equally inspiring were the robotic milking units. The two main manufacturers claim that they will install 100 this year between them. I saw some working and they are very good.

b) Electronic Identification (EID)

Research into electronic identification started in earnest in the 1970's and has now reached wide acceptance and reliability. I tried to view as many of these systems as I could. For information purposes, the list is:

Table 1:

Brand	Developer Maker	Site of Tag	Site of antenna
Afikim	own	leg	ground level, each stall
Alfa-Laval	NEDAP	neck	archway
Boumatic	own	neck	brisket or archway
Dairymaster	TI	ear	side panel
Lely	NEDAP	neck	brisket
Liberty	NEDAP	neck	brisket
Surge	NEDAP	neck	brisket, each stall
Westfalia	NEDAP	neck	archway

Note: Both Afikim and NEDAP incorporate an activity meter.
There are three principal types of tags;

- strapped to hind or fore leg,
- ear tag,
- hanging on neck or neck collar.

These are coupled to one of three types of antenna;

- walk through archway,
- walk past side panel,
- individual antenna at each stall.

The initial benefit of EID is so that an individual cow can be positively identified for an operator. However, more benefits rapidly appear;

- attention status can be notified to treat, withhold milk etc.,
- cow can be automatically drafted post-milking,
- feeding can be tailored for each cow,
- activity, milk yield and conductivity can be automatically recorded.

i. Tags

From the outset, I would say that leg tags are not desirable in Australian conditions. They require accurate strap tension (not too tight or too loose), constant monitoring as straps can stretch or shrink, in wet and muddy conditions tags will be prone to contamination, if the tag is lost in pasture retrieval is uncertain. The ear tag type appear quite suitable as they do not involve a strap, are unlikely to be lost and are compact. As well, it can be

made to pass very close to a side panel antenna in a raceway. The NEDAP neck tag is also good in that it incorporates an activity switch, but it is on the neck and so stays clean and dry.

ii. Antennae

All antennae require orderly cow flow in single file with the cow EID tag as close as practical to the antenna. Hence archway and side panel antennae will require relatively long entrance races onto the platform and on sort gate areas - at least 1.5 to 2 cow lengths. For stall antennae, individual stalling gates are a must. The tag must be consistently within a predetermined distance of the antenna, typically 300-400m. This is relatively easy for brisket antennae, but harder for leg antennae. Leg antennae also have the disadvantage of being close to the platform and will be constantly sprayed with water.

iii. Drafting

The implementation of sort gates controlled by the EID system also require good single file traffic flow. Ideally, the cows should exit through this race every milking so that they are not alarmed by its operation. Non-return gates are also good to prevent cows reversing. Dairymaster have a very positive system whereby every cow is locked in a stall, identified, then sorted if necessary. It did, however, slow cow flow from the parlour. Unfortunately, there is not enough room to pursue this topic further in this section.

c) Activity

I managed to visit and observe five farms using activity meters and all reported great success despite some having early problems. The essence of these devices is a small mercury activated switch. As the tag is swung backwards and forwards a globule of mercury oscillates from one side to the other in a tube closing contacts so each swing is counted. They need to have a battery to power the counting and memory feature and the whole unit is enclosed in epoxy, polypropiline etc. and therefore non repairable. All only measure movement in one plane of motion.
Below is a list of the ones that I observed. Others are available, but I did not see them.
Table 2:

	Tag site	Battery	Function
Afikim	leg	yes	EID and activity
Boumatic	leg	yes	Activity only
NEDAP	neck	yes	EID and activity

I believe that the Australian industry would be best served by a dual EID/activity meter on either the neck or ear, but it must be passive ie. energised by the antenna so that there is no battery to wear out. NEDAP currently supply this, but motion is only recorded in one plane. If it were recorded in two or three planes of motion this would greatly increase the accuracy of activity monitoring.

d) Conductivity
Electrical conductivity measurement is offered on many of the milk meters on the market. I had previously heard bad reports on its usefulness (or lack of) in indicating udder health, but would have to say that my findings were to the contrary. In some Dutch research, 70% of new infections were detected by conductivity. 9% of cows were falsely identified. This is consistent with Australian farmers' experience with SCC ie. around 10% of cows with a high SCC develop no mastitis and SCC subsequently falls.

Most milk meters now incorporate conductivity probes and can offer a conductivity reading for every milking. Some farmers use it and some don't. The ones that did use it could easily demonstrate to me on their computer screens how they picked up about 70% of cases with conductivity one to five days earlier than they otherwise would. They also had to watch out for false positives, possibly 10% of cases.

The farmers who did not use the conductivity readings were typically the ones who did not have EID to automatically record the cow's identification or did not even know why they had milk meters.

e) Milk Meters

All of the major milk machine manufacturers produce a milk meter. The system of measurement varies greatly. The three main types of measurement are;

- volume chamber,
- volume and time to fill, and
- weigh all.

The initial interest in the 1970's and 1980's was from stud cattle breeders so all meters were made to meet the International Committee for Animal Recording (ICAR) specification of +/- 2.5%. Electronic load all weighing is by far the most accurate method of measuring as it is unaffected by froth or flow rate. All meters are expensive and the emphasis has shifted from demand for a highly accurate meter for ICAR purposes to a more affordable, but less accurate meter to monitor cow health. Approximately half the cost of a meter is in the cost of the control panel that accompanies each meter. Surge, in the US, offer a meter without a control panel, you only have to buy as many control panels as you require, typically two for a herringbone.

In Australia, attempts are underway to develop 'non ICAR' specification milk meters and these efforts are to be applauded. Let's hope they are successful.

I would caution anyone against buying a milk meter that did not offer a conductivity reading as well. In my research, paying around $2,000 for a meter without conductivity is a considerable waste. As highlighted previously, the primary role of the meter is to re-enforce the strength of the other indicators. As an example, let us look at a daily report from 18 June, 1998 on Doug Van Beek's Afikim system installed in Tulure, California (1,900 cows 2x)

Table 3:

18.6.98 Cow ID	% change in milk yield		% change in conductivity		% change activity	
	am	pm	am	pm	am	pm
3902	-67%	-66%	+5%	-2%	-12%	-45%
4157	-6%	-5%	+17%	+19%	- 9%	+4%
4951	-60%	+62%	-1%	-5%	+35%	+29%

Cow no. 3902: milk yield is down 67% and 66% and activity is down 12% and 45%. This cow is probably sick or lame. Will check this cow.

Cow no. 4157: milk yield is slightly down, activity is stable, but conductivity is up 17% and 19%. Possible mastitis. Check this cow.
Cow no. 4951: milk yield was down 60% then up 62%, activity is up 35% and 29%. She is probably on heat, will be checked for days since last heat and other oestrus signs.

This is but a small example of how this technology is being used to improve management and profit per cow. If the system is not used to its fullest potential or deviations are not followed up and acted on, then the investment cannot be profitable. All five operators used the system fully.

f) Associated Computer Packages

Each supplier of EID, meters etc. offers a computer package to manage and interpret the information generated, mainly in report format. I looked at the packages offered and all appeared adequate. I don't profess to speak with any great authority as Cathie, my wife

does all of our herd health and yield recording computer work at home on PC Farm. All systems generated reports on deviation of yield, activity etc., individual cow reports and some even did parlour management reports eg. average milking time, average time on platform, cows milked per hour, stop and start times AND MORE. This information was used by supervisors to monitor labour performance and habits. Dairymaster have an 'in-house' computer programmer who has tailored their program to interface with PC Farm, a big bonus for PC Farm users. Boumatic offer the Dairy Comp 305 program written and managed by the vet clinic at Tulare, California. By far the majority of dairy farmers that I visited in the US used Dairy Comp 305 and spoke very highly of it.

g) Robotic Milking

As part of the study I had expected to visit Holland to investigate the reports of robotic milking. I was given the name of a farmer in the UK, Kevin Leach, who had a Lely 'Astronaught' robotic milking unit. I was amazed to find this was a farm where a robot milked all of the cows (56) on an 'on demand', 24 hour basis.

After two visits to the farm I can inform you that the unit is thoroughly competent at letting cows into the stall, identifying the cow, washing and preparing the udder and milking the cow. It records total yield, conductivity per quarter, activity, dumps milk not suitable for the vat, drafts cows and rinses cups between cows. Cows presenting themselves for milking that are not required are pushed through the bail and the next cow enters. I could not think of much more for it to do! The Lely Astonaught operates one stall per robot.

I also looked at the Liberty robot made by Prolion (also Dutch made). These units were equally exciting, but for different reasons. The Liberty unit involves a robot roving up and down a track servicing up to four milking stalls. The mechanics are vastly different from the Lely, but it has the potential to milk far more cows: 60 cows per stall, so if there are 4 stalls, 240 cows could be serviced by this unit. Fullwood in the UK are assembling units as well, utilizing the Lely arm.

These units have huge potential to be partially or fully implemented in Australia, particularly on rotary platforms. I did not reach Holland due to time constraints.

6. IMPROVEMENTS IN EXISTING SYSTEMS

a) Clusters

One of my objectives on the study was to better understand the relationships of liner, teat cluster from 'first principles'. To this end, I spent time at Moore Park, Ireland and the University of Wisconsin, Madison and believe that I achieved that objective. The majority of Australian milking installations work adequately, but there have been a lot of disappointments;

- excessive cup slip,
- uneven or poor milk out,
- short liner life,
- high maintenance rates,
- poor teat condition, and
- slow milking

to name a few. This experience has been world wide and in response we have seen the appearance of narrow bore liners with light clusters, wide bore liners with heavy clusters, three sided liners, four sided liners etc.

The real issue about liner diameter or 'bore' is contact surface area and teat trauma. If we were to take an average teat length of 50mm before milking and expect it to stretch by 50% during milking, then its length in contact with the liner is 75mm.

Table 4:

	18mm	Liner bore 23mm	26mm	30mm
Surface area for stretched teat length of 75mm	1.9cm^2	3.1cm^2	3.9cm^2	5.3cm^2
% Increase		↑63%	↑105%	↑179%

Table 4 above illustrates the increase in contact surface area between the liner and teat for incremental increases in liner bore. With an 18mm bore liner there is likely to be a contact area of 1.9cm^2. The tendency is for this to be insufficient surface area during periods of no or low milk flow (just after applying cups and when milk flow stops at the end of milking). As the teat does not fill with milk in this no flow period and is not applying additional pressure against the liner wall, the teat tends to 'collapse' and the liner slips. Hence these liners are exclusively run with light clusters to minimise slip. This configuration has a disadvantage in that there is often insufficient weight to stretch the teat canal fully open so some residual milk is often left in the udder. The advantage is that the teat is not being dilated beyond its normal physical size (other than being stretched lengthwise) and so there is less oedema and trauma to the teat tissue. This is principally why they are used in the US, as they are chasing good teat condition.

You can see from the table that by increasing the bore to 23mm we have increased the contact area between liner and teat by 63%. However, if teat diameter was say 20-22mm, we are just starting to distend the teat on every B phase (liner open), teat oedema will be increased, but the liner is less likely to slip due to the 63% increase in surface area. Moving up to 26mm and 30mm bore inflation gives more surface area contact (teat to liner), more liner stability, but more distention of the teats both sideways and down into the inflation. The reason that the teat is pulled further down into the inflation is that the wider liner bore does not support the teat wall as well and so the teat is pulled down into the inflation. Producers must make their own decision which route they want to go down.

Uneven and poor milk-out is also cited as a shortcoming of many modern milking plants. The most common ways to overcome these problems are to use heavier teat cup shells (and consequently larger bore liners) or better hose alignment and balance. Both treatments work, but circumstances (such as type of parlour) will determine the best solution.

Short liner life and high maintenance rates are also cited by some operators. The only options on liner life are really rubber or silicone. Silicone is not widely accepted by the industry, but we have personally trialled a full set of silicone liners and they are easily capable of 10,000 cow milkings. Used correctly, they are far more cost effective than rubber liners. High maintenance rates on the more complicated milking machinery can be avoided by keeping away from equipment with too many moving parts; keeping away from too many plastic components and talking to plenty of users before choosing. Some complicated equipment is very reliable, some basic equipment is just that, basic.

On teat condition, I saw a lot of herds with poor teat condition, solely in Europe and the UK. It appeared to be related to excessive over milking or poor milking routines. The Europeans suffered from more skin disorders eg. warts, lesions, cracks etc. The US farmers appear to avoid this by pre-dipping all cows and using automatic cluster removers.

Slow milking is a recognised issue in the Australian industry with bull proofs even including an indication of milking speed. With higher yields per cow, milking speed becomes critical as even big milk harvesting facilities find their throughput slashed when cows' yields exceed 30l/day. The time cows are on a platform can often rise to 12 or 15 minutes to harvest these yields. One of the big surprises in the US was the very short cups-on time to milk high yielding cows. Consistently it was 5.6 to 5.8 minutes for a 30 to 34l per day average. They were unable to achieve overall higher throughputs due to preparation time on the herringbone and parallel parlours, but there are strong messages here for Australians that we could be milking a lot quicker, particularly if let-down stimulation could be effected separate to milk harvesting.

b) Auto Cluster Removal (ACR)

Use of ACR devices had begun to build up acceptance in the 1980's when cheap, non-electronic units were offered from New Zealand. However, higher milk yield per cow and less teat washing in the late 1980's and early 1990's saw them disappear from the market as they restricted milk flow rates and small orifices blocked with sand, hair and dirt. Newer electronic units were very

expensive, but seemed to offer no new features other than no flow restriction.

There is, however, a whole new generation of ACRs recently appearing on the US market and these certainly require a closer look as they offer many new, useful features.

Briefly, the new features are:

- delayed vacuum on
- compressed air rams, not vacuum
- milk sweep
- remote attach
- claw drop
- fully water-proof circuit boards
- maximum milking time

Hence, the sequence of events can become something like this:

- hit remote attach button (located on the side of the deck)
- vacuum to cluster is delayed (up to 3.5 seconds) so operator has the cluster up at the cow's udder when vacuum begins
- cow milks – if desired, cluster can be automatically removed after a predetermined time rather than flow rate
- cluster comes of, there is a burst of vacuum to clear milk out of the cluster and milk hose (maximum 10 seconds)
- an then be dropped out of the way to make teat spraying easier.

These work very well and have great potential for use in Australia.

c) Milking Routines

Every time that an Australian farmer visits the Northern Hemisphere, they are confronted with the issue of teat preparation for milking. The difference since my last trip to the UK in 1989 is not what is done by way of teat preparation in the UK and US, rather what has been happening in Australia. Production on our farm has risen from 6000l/cow to 8000l/cow. Typically, cups-on time at peak lactation is 7-9 minutes with some cows at 12 minutes plus. This has seen big rotary parlours having a similar experience; 12 minute rotations (or longer) at peak milk flow. The US data always quoted 5½ minutes average milk time for similar production with maximum around 7 minutes (36l/day). Why? The first task was to verify the US data and then find out how they achieved these quicker milking times.

Verification of data proved to be extremely simple. No long and tedious hours in the parlour with stop watch etc, just turn up any time of the day, go to the office and turn on the computer. At the push of a button you have the average cups-on time for the last 2,000 milkings (or more), by group, by cow etc. Average cups-on time for some farms is listed below, all two times.

Table 5:

Name	No. of cows	Production/day	Average cups on time
Van Beek	1,900	34l	5.4 minutes
Douma	2,600	34l	6.1 minutes
Ribeiro	I,500	36l	5.7 minutes

Now, how many rotary parlours run at say 7 minutes/lap with cows giving 34l or 36l/day? Try 12 minutes with some cows still going around twice! The US claim the issue is about stimulation and oxytocin levels in the cow. Oxytocin has a half life of only 1½ - 2 minutes and milk extraction becomes very slow and difficult once oxytocin levels fall. Hence the objective of pre-stimulation, wait 30-60 seconds and then apply cups. You would have to say it works. Certainly faster milking, better teat condition and less trauma on the teat canal.

It is our objective to incorporate some sort of preparation into our routine to facilitate this quicker milking time. It has to be done in a way that does not increase overall time in the parlour.

7. NON-DAIRY FARMING

A part of the Nuffield mandate is to investigate alternative pursuits for agriculture or even non-agricultural pursuits. I took limited time to do this as well.

a) Vertical Integration

I made a particular point in visiting two large milk processing plants as well as two smaller, family owned operations. The smaller plants certainly were successful. One made luxury ice-cream, the other carton milk and cream.

b) Non-dairy agriculture

There is a strong and growing public demand for 'free range' produce in Europe, particularly for the intensively housed livestock such as hens, broilers and pigs. Price premiums are very significant and free range eggs for instance, are £1.50/dozen, battery 70p/dozen. I have collected a lot of information on these industries and will watch them closely. Australia would be very well positioned for this market.

c) JCB Fastrac tractors

We had been investigating the suitability of JCB Fastrac tractors for our farm for some time. While over in the UK, I was able to have a really good look at them. I was so impressed that I bought one to try and, in fact, a second (different) unit as well.

8. CONCLUSION

This report has, by necessity, only been a brief overview of the results of the study. Behind the report lies a large quantity of detail, photographic evidence and information. None of this would have been possible if it were not for the help of all the people I visited and the love and devotion of my family and staff at home. I would have gone mad if my wife, Cathie, and the girls had not come over to participate in the study for six weeks.

The Nuffield Trust is also equally responsible for the success of the study. Providing the selection process, raising funds and, of course, providing all those previous scholars who help you along!

I consider that the study has been a great success in terms of giving Australians a whole new array of options in harvesting milk efficiently and hopefully, helping farmers prepare for what might be 'around the corner'. I personally am filled with optimism about where our business might go in the future.
We commence building a 60 unit rotary parlour in July 1998, four weeks after my return. On this unit we will incorporate the majority of features that I have discussed in the report. It is very exciting to be able to put the results of the study into action so quickly!

Finally, thank you to Roger Mercer for suggesting that I write the report before heading home!