STUDIES ON THE FERTILITY AND BREEDING MANAGEMENT OF NEW ZEALAND DAIRY COWS

A thesis presented to Massey University as a requirement for the degree of Doctor of Science

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The contents of this thesis are based on papers written by me as the senior author or co-author. They have been published (or accepted for publication) by recognised journals or in official conference proceedings.

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Summary

This thesis reviews an extensive research program on the fertility of dairy cattle in New Zealand. Most of the work was completed between 1967 and 1977. It involved studying numerous basic aspects of reproductive physiology by analysing extensive amounts of data either lodged within a large centralised recording system, or produced through the participating cooperation of herd owners or inseminators. New concepts were developed and old recommendations sometimes found to be inappropriate.

The highlights of this research program would be:

(i) *Dairy cow fertility*

The New Zealand dairy cow is highly fertile, at least in a statistical sense. The average calving interval is 364 days, the confirmed pregnancy rate to first insemination is 60% to 65%, and the final empty rate after a 17 week breeding program less than 5%. Having large herds, grazing pasture, with a seasonally concentrated calving pattern and without the use of concentrate feeds, has not prejudiced fertility.

(ii) *Oestrus detection efficiency*

The average interval from calving to the first post-partum oestrus may be longer than with higher energy feeding systems. This does result in an increase in the proportional incidence of genuine short oestrous cycles of 8 to 12 days commonly occurring after first insemination. This increase only partly explains the unusually high frequency of return intervals to first insemination of less than 18 days. It is mostly due to herd owners "liberally" interpreting symptoms of oestrus in their attempts to ensure that most cows are inseminated when experiencing oestrus. The advantages or limitations of this attitude need to be considered in the context of the different effects of the three main types

of detection errors. There are errors of identification, omission and diagnosis. The comparatively high frequency of errors of diagnosis in New Zealand herds has depressed the computed 49 day non-return rate to first insemination but has also maintained a concentrated herd conception pattern.

The testing, development and promotion of tail paint as a simple, reliable aid to detection would be one of the most rapid adoption sequences seen in New Zealand livestock farming.

(iii) *Non-physiological factors in AB usage*

Previously, inseminating services have been promoted as a vital ingredient for maximising genetic progress in production through the effective use of semen from progeny tested sires. This use has also required recognition of the importance of dairy cow reproductive physiology. That was until analyses of herd records showed that a herd owner's management objective in his herd breeding program should also be directed towards obtaining a high submission rate. Similar analyses showed that the way in which the insemination service was charged for influenced:

(a) the proportion of the herd inseminated;

(b) the period for which the service was used;

(c) the comparative incidence of short return intervals to first or second insemination;

(d) the average 49 day non-return rate to first insemination;

(e) the proportion of returns to service which were re-inseminated;

(f) the completeness of the breeding records;

(g) the proportion of the herd reported in calf to AB sires;

and (h) the proportion of replacement heifers which were progeny of AB sires.

(iv) *Potential for increased pregnancy rates*

Most overseas trials with prostaglandin $F_{2\alpha}$ in cattle have been conducted to demonstrate the potential of these drugs for oestrus synchronisation, with this outcome possibly offering an alternative to oestrus detection. The extensive New Zealand trials finally led to the conclusion that with improved efficiency in oestrus detection, necessary if some degree of synchrony has been achieved, it is possible to increase pregnancy rates to first insemination by 10% with the strategic use of prostaglandins. Comparable increases may be possible with gonadotrophin releasing hormones.

(v) *Sire differences in fertility*

Field studies showed that "on average", highest conception rates were obtained among cows inseminated during late oestrus with the descending order then being post oestrus, mid oestrus and early oestrus inseminations. This result was the same as had been previously reported. But whereas it was presumed that the time trends were "cow effects", the New Zealand trials showed they were "sire effects" which appeared to reflect differences in *in utero* sperm survival. The widely adopted recommendation of delaying the time of insemination after the detection of oestrus is one which only applies to the use of semen from bulls of below average fertility.

This research program has produced important results which have been incorporated into management aspects of breeding programs in many New Zealand dairy herds. One major area in which only limited progress was achieved was in the prevention and treatment of anoestrum. Several areas for future research have been identified, but anoestrum would be the greatest single factor restricting improvements in reproductive efficiency in some New Zealand dairy herds.

Biographical Outline

Christened Keith Lindsay Macmillan soon after being born in Sydney in 1940, neither christian name has been used, with the name of "Jock" unofficially given at birth, being the preferred and widely used form of identification. He came to New Zealand in 1958 to study at Massey Agricultural College as part of the training program of the Dairy Division of the Victorian Department of Agriculture. His first degree, Batchelor of Agricultural Science was awarded in 1962. In the same year, he completed the post graduate degree, Master in Agricultural Science with Second Class Honours in Animal Science. The title of his thesis was: "The Use of Oestrous Cows for the Pre-Collection Preparation of Mature Bulls Standing at an Artificial Breeding Centre". It described a trial undertaken at the New Zealand Dairy Board's Artificial Breeding Centre at Awahuri, 16 km from Palmerston North.

On returning to Victoria in 1963, Jock worked as a Dairy Husbandry Officer in the Department of Agriculture. His designated area of specialisation was dairy cow nutrition. However, his interest in artificial breeding and reproduction had been aroused. In 1964 he accepted a research assistantship in the Department of Dairy at Michigan State University to work with Professor Harold Hafs. The 2½ years at Michigan State, saw the completion of:

(i) a large course load with chosen emphasis on biochemistry and statistics;

(ii) research written up in 10 scientific papers on topics not directly related to thesis research; and

(iii) a comprehensive thesis study entitled "Endocrine and Reproductive Development of the Holstein Bull from Birth through Puberty".

These efforts were recognised in his being awarded a SigmaXi Outstanding Graduate Student Award in 1967.

Instead of returning to Melbourne, Jock accepted a position in 1967 as a Research Officer at the New Zealand Dairy Board's Artificial Breeding Centre at Newstead. Ten months later he transferred to the Board's other centre at Awahuri. Although his thesis training had involved endocrinological studies, he did not have facilities to continue this type of work. The immediate problem requiring investigation was the disturbing increase in the already high proportional incidence of cows returning to service and being reinseminated within 18 days of first insemination. This problem appeared to be one of oestrus detection - except it varied in its severity in different regions throughout the country.

Once "field" aspects of AB usage were critically investigated, it became apparent that the "problem" was not a simple one. Rather, it was a reasonably accurate reflection of a host of interactions involving sires and their semen, cows and their owners, and inseminators and their employers' management decisions within the comparatively unique system of seasonal dairy farming with large herds cared for with a minimum of labour. To study and resolve the comparative importance or influence of these interactions involved a series of experiments using a wide variety of experimental procedures. While most of these studies have been made in other dairy industries, the New Zealand series was one of the few instances where so many aspects had been investigated in one industry.

The outcome of these studies was that some perspective was given to the nature of problems encountered in the breeding management of New Zealand dairy herds and recommendations provided for advisers and herd owners. An unusual aspect of some of these studies was the involvement of large numbers of herd owners to produce precise information which was then analysed to provide answers to questions of a physiological

nature. Inadequate numbers may plague progress when studying aspects of reproduction in dairy cattle, but some of the Awahuri trials showed how herd owner co-operation and participation could sometimes be imaginatively used to advantage.

It was this advantage which partly resulted in the commencement of trials with a synthetic prostaglandin ("Estrumate") to study the effects of synchronising oestrus in lactating dairy cows. Many similar trials in other classes of cattle were simultaneously being conducted throughout the world. In most cases, scientists promoted the concepts of synchronisation, conducted initial trials and only rarely persisted with further trials to resolve some of the problems which frustrated the application of a promising technological development. The continuing prostaglandin trials in New Zealand finally identified previously unrecognised aspects of the use of this drug, not the least of which was its fertility effect.

In 1977, Jock resigned from his position at Awahuri and moved to Ruakura Animal Research Station as a Scientist in the Research Division of the Ministry of Agriculture and Fisheries. This provided him with an opportunity to branch out into other aspects of animal production besides dairy cattle reproduction. He was appointed leader of the Animal Physiology Group in 1979.

The results and recommendations of Jock's research have usually been published promptly in recognised local or international scientific journals, in the proceedings of numerous farmers' or scientific conferences, or in the farming press. Since 1972 he has had his own regular feature column in the New Zealand Dairy Exporter. He has been

an active member of several scientific organisations including 7 years on the management committee of the New Zealand Society of Animal Production. He was President of that Society in 1979.

The varied nature of Jock's research has meant he has had a close association with many people. Invariably these associations have been beneficial, with most co-workers enjoying the opportunity to become involved in the detailed investigation of an area of work which they may know something about. The co-workers who became co-authors on numerous occasions included Prof. Fielden, Norm Hart, John Watson, Ray Curnow, Tony Day and Graham Morris.

The period from 1967 to 1980 was one of intensive investigation in dairy cattle reproduction in New Zealand. New concepts in breeding management were defined and new interpretations of previous conclusions presented. These concepts and interpretations are now being confirmed and applied in other countries besides New Zealand. The next objective in dairy cattle reproduction is to produce simple regimes for the use of selected drugs which will result in pregnancy rates to first insemination being substantially increased above those currently obtained in well managed herds.

This 1967-80 period has also been personally important in Jock's life.

Acknowledgments

The research program reviewed within this thesis was largely completed at the Awahuri Artificial Breeding Centre of the New Zealand Dairy Board. Therefore, the opportunity to conduct the research was provided by the Board; but the essential support for staff and equipment was provided by the Centre Superintendents, David Caldwell and Graham Morris. Whenever necessary, this support was endorsed by Pat Shannon. As Director of Research, Pat also allowed an original program to develop with a minimum of administrative intervention and accountability.

All these advantages could not be utilised without outstanding technical support. The three principle contributors were Norm Hart, John Watson and Ray Curnow. Each made his own original contribution: Norm as a reliable and fastidious laboratory technician; John with his ability to discern "trends" in data; and Ray with his capacity to go out and work with herd owners.

The program was not a "one-man-band". Collaborative trials were frequent, especially those involving Des Fielden, Tony Day, Knut Moller, Mike Berwyn-Jones and Bruce Kyle. The frequent field trials would not have been possible without the assistance of Cliff Broad and Nolan McEwan (Taranaki LIA), Tom Page and Ian Hook (Wellington-Hawkes Bay LIA), and Olive Castle and Sue Lane (Dairy Board). In many instances, the "practical sounding board" for the "theoretical nail" was Consulting Officer Don Johnston.

The unnamed unpaid "technicians" in many of the trials were the participating herd owners. Their interest and enthusiasm meant that many trials became possible. They were as keen as the research team

to continue conducting field trials. Their participation helped establish the name of "Awahuri" in the research literature. It also allowed a permanent contribution to be made to improved breeding management in New Zealand's dairy herds.

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APPENDIX A

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