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THE APPLICATION OF DEVELOPMENTS IN REPRODUCTIVE BIOLOGY TO NUTRITIONAL RESEARCH WITH DAIRY CATTLE

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Dairy cattle nutrition experiments are expensive in terms of cost and resources required. Factors which contribute to this situation with dairy cattle include their initial cost, large feed requirements and need to be milked twice daily. The dairy cow partitions feed between milk production and liveweight, this partitioning not only being influenced by nutrition but also the genetic potential of the cow and her stage of lactation.

The use of genetically identical twins is one approach to reducing the number of cows required in nutritional experiments. Their use serves to reduce the between animal variation and so helps improve the precision of estimating effects of the experimental treatments. Hancock (1953) estimated the twin efficiency value; the number of unrelated animals in each of two groups that one set of monozygotic twins can replace without loss of statistical precision for various cattle characteristics. High efficiency values (greater than 25) apply to milk yield, milk fat percentage, casein percentage, growth rates, linear body measurements, faecal nitrogen content, blood magnesium and phosphorus levels. Other characteristics have lower efficiency values but few have a unit efficiency value indicating no twin efficiency.

The potential savings in terms of labour, feed and animals by using twins can be demonstrated in an experiment recently conducted at the Northfield Research Centre. This involved 87 cows and 3 treatment groups for 36 weeks of a lactation. If identical twins had been available for this project a twin efficiency value of 10 would have been applicable. This is the lowest efficiency value of parameters measured in the experiment. Three twin pairs are required to compare the three treatments and 3 replicates are necessary to produce the same statistical precision as the 29 cows per treatment in the original experiment. (Twin efficiency value of 10 x 3 cow replicates = 30 unrelated cows per treatment). Nine twin pairs (18 cows) would have replaced the 87 cows in the experiment, i.e. 69 less cows. Labour to manage and milk cows is about 5 minutes ($1.00) per cow per day and feed costs for the project were $2.25 per cow per day. Allowing also for interest (12%) on capital invested in these cows ($600 each), the saving by using 69 less cows would be approximately $61,500.

The establishment of viable twin herds for research purposes has been difficult due to the problem of obtaining sufficient sets of twins of adequate genetic merit and of similar breed and type. The development of techniques such as multiple ovulation, embryo splitting and non-surgical implanation means that genetically identical herds of high genetic merit within a single breed can now be established.

Embryo transfer in cattle is rapidly becoming a routine commercial procedure. Non-surgical implantation of fresh embryos produces a conception rate of about 60% and about 3 pregnancies per cow superovulated (Donaldson 1983). The production of monozygotic bovine twins by microsurgical division of embryos has been achieved (Bren et al. 1984, Williams et al. 1984) but conception rates were decreased to about 45%. It can be seen from Table 1 that as the technology of superovulation, embryo splitting and implantation further improves, the number of identical twin pairs per cow will increase. Sexing of embryos will also reduce the number of recipients required. The development of multiple splitting techniques will also allow more than two experimental comparisons to be made at the one time.

Table 1: Number of identical twin pairs per cow superovulated

Number of splittable embryos per cow	Conception rates after implantation								
	40%			50%			60%		
	Embryos split into			Embryos split into			Embryos split into		
	2	3	4	2	3	4	2	3	4
5	0.8	1.8	2.8	1.3	2.5	3.8	1.8	3.2	4.8
6	1.0	2.1	3.3	1.5	3.0	4.5	2.2	3.9	5.7
7	1.1	2.5	3.9	1.8	3.5	5.3	2.5	4.5	6.7

Recent developments in reproductive biology have offered new approaches for nutritional research with dairy cattle. Further developments in this rapidly developing field should, over the next decade, revolutionize the approaches that can be taken in nutritional research as large numbers of identical cattle of high genetic merit become available for research purposes. A program has commenced at the Northfield Research Centre to develop a herd containing genetically identical cows of high genetic merit.

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