

SOME PROBLEMS ASSOCIATED WITH ARTIFICIAL INSEMINATION OF BEEF CATTLE

D. R. LAMOND* and A. TAKKEN*

Summary

In October, 1964, beef cows were divided into three groups. One group was run with bulls for four months (group 1); another group was kept free of bulls and was observed daily for six weeks and cows detected in oestrus were inseminated using chilled semen (group 2); and the third group was given progestagens to synchronise ovarian cycles and the cows were inseminated after treatment and again at the next observed oestrus (group 3). Bulls were put with groups 2 and 3 in mid-December.

The percentages pregnant two months after removal of the bulls were 59.2% (group 1), 39.4% (group 2) and 68.1% (group 3), but after correction for differences between groups in lactation status and body condition, the figures were 53.7%, 47.1% and 54.3%. On the basis of relative costs per pregnancy, Group 2 was inferior to the other two because few cows were detected in oestrus and labour costs were high. The paper discusses problems associated with management and identification of cattle, collection of semen and detection of oestrus.

I. INTRODUCTION

It is generally believed that the major practical limitations to artificial insemination of beef cattle in Australia are handling large groups of cattle and detecting oestrus. An experiment was carried out in central Queensland to investigate these problems in some detail. The basis of the experimental design was comparison of a natural mating system with two systems employing artificial insemination followed by natural mating.

II. MATERIALS AND, METHODS

(a) Animals

A herd of over 430 Hereford and Hereford x -Brahman heifers and cows was available on a property 30 miles north-west of Bundaberg, central Queensland.

TABLE 1
Number of cattle in each class on November 26, 1964

	Age		Lactation			Body Condition		
	2 and 3 yr	4 yr and older	Wet	Dry	Poor	Store	Forward- Store	Fat
Group 1	68	79	64	83	64	66	15	2
Group 2	42	98	82	58	50	54	32	4
Group 3	74	63	39	98	36	69	22	4

*C.S.I.R.O., Division of Animal Physiology, Cunningham Laboratory, Mill Road, St. Lucia, Queensland.

TABLE 2
Number of cattle in each class on April 29, 1965

	Pregnancy		Lactation			Body Condition		
	Pregnant	Empty	Wet	Dry	Poor	Store	Forward Store	Fat
Group 1	87(79)*	60	31	116	22	43	58	24
Group 2	56(67)	88	92	50	27	67	10	38
Group 3	94(76)	44	47	93	17	33	33	55

*Adjusted totals used for comparative purposes in Table 3 (see text for details).

land. The property was partly cleared, but no pasture improvement had been undertaken. The area is predominantly summer-rainfall, average 40 inches (100 cm) per year, and the predominant grass is spear grass (*Heteropogon* spp.). Due to the nature of the terrain, it was not always possible to muster all cattle on any one occasion (Tables 1 and 2). The cattle were ear-tagged (with plastic Disc Self-Piercing Cattle Tags-Leader Products, Melbourne) and divided into three groups on October 19, 1964, the groups being roughly balanced for age, body condition, lactation status and breed type. Approximately 43% of the total had calves 0-3 months of age. The bulls used for collection of semen were stud Brahman and those joined with the herds were $\frac{5}{8}$ to $\frac{7}{8}$ Brahman.

(b) Treatments

The cattle in Group 1 were allotted to a paddock of 3230 acres, and six bulls were joined with them on November 4. The bulls were removed on March 3, 1965. The cattle were mustered on November 26 and age, breed type, body condition and whether lactating were recorded. Similar records were obtained at this time for Groups 2 and 3. The results are shown in Table 1.

The cattle in Group 2 were put in a paddock of 113 acres on November 4. During week days, for the next six weeks, they were mustered soon after daylight into yards and observed for signs of oestrus. Cows seen to stand for other cows were considered oestrus and were kept in the yards and inseminated later in the morning by either a research officer or a trained farm hand. Two stockmen rode through the paddock in the late afternoon and brought any cows seen in oestrus into the yard. These cows were inseminated next morning. The cattle were not observed from midday Saturday until Monday morning. At weekends and after completion of inseminations, they were given access to a paddock of 506 acres. On December 16, the cows were joined with four bulls and given continuous access to the two paddocks.

The cows in Group 3 were each injected intramuscularly (I/M) with 30 mg of CAP (Chlormadinone-Ely Lilly) on October 19. This treatment will suppress ovarian cycles for 10-12 days (Lamond & Bindon, unpublished data). They were then each given 50 mg of progesterone in oil I/M on October 29 and 31, and again on November 2. All cows in the group were inseminated on November 7 and 8. From November 26 to December 1 inclusive, the herd was examined daily for signs of oestrus. Cows in oestrus were inseminated. Four Brahman bulls were joined with the group on December 16. The cattle were run

in a paddock of 226 acres during periods of injection and observation; at other times they had access to a paddock of 1400 acres.

The cows in Groups 2 and 3 were examined for pregnancy on January 20, 1965. The bulls were removed on March 3. Cattle in all three groups were examined for pregnancy on April 29, 1965.

(c) Management

A record was kept of all labour and other costs that could reasonably be charged to each of the three groups. One aim of the experiment was to obtain the relative costs per pregnancy for the three systems and to include this in evaluating the systems. The size of the paddocks varied but, according to the manager, the stocking rates were normal for each paddock.

(d) Collection Of Semen

Ejaculation was induced using a Watson Transtimulator Mk3c (Watson 1964). Collections were made before 9 a.m. at least three days per week. The semen was examined for volume, motility, density and colour. The total number of sperm collected was estimated and a smear was taken for estimation of percentage alive. The semen was diluted with 1 to 3 parts by volume of egg yolk-citrate diluent. Diluted semen was chilled and used within 36 hr of collection. Handling of semen took place in a mobile laboratory.

Collection was attempted from 10 bulls. Volumes ranged from 3.5 to 16 ml. On occasions it was necessary to bring in a number of bulls before semen was obtained because some bulls lay down in the crush and others would not enter it. Quality of semen was generally satisfactory (motility > 3 ; count $> 20 \times 10^6$ per ml; per cent alive > 70).

III. RESULTS

(a) Group 1

The majority of cattle were in poor and store condition in November, but by the end of April more than half were forward-store or fat (Tables 1 and 2). About half the cows that had calves in November had weaned them five months later. There was a heavy loss of ear-tags, only 47 of the original 147 remaining. On examination on April 29, 87 (59.2%) were pregnant. The proportion pregnant in each classification of body condition and lactation status is shown in Figure 1. The average body condition of the group (score 1 for poor; 2 for store; 3 for forward-store; 4 for fat) in April was 2.6.

(b) Group 2

The majority of cattle were in poor or store condition in November, and a higher proportion than in the other two groups had young calves. There was no evidence that cows had weaned their calves at the second examination when 39.4% were pregnant. The average body condition at the end of April was 2.4.

A total of 29 cattle was detected in oestrus once and of these, seven returned to oestrus, five at intervals of 16 to 21 days and the other two at intervals of 7 and 9 days. On the basis of the results of the examinations for pregnancy

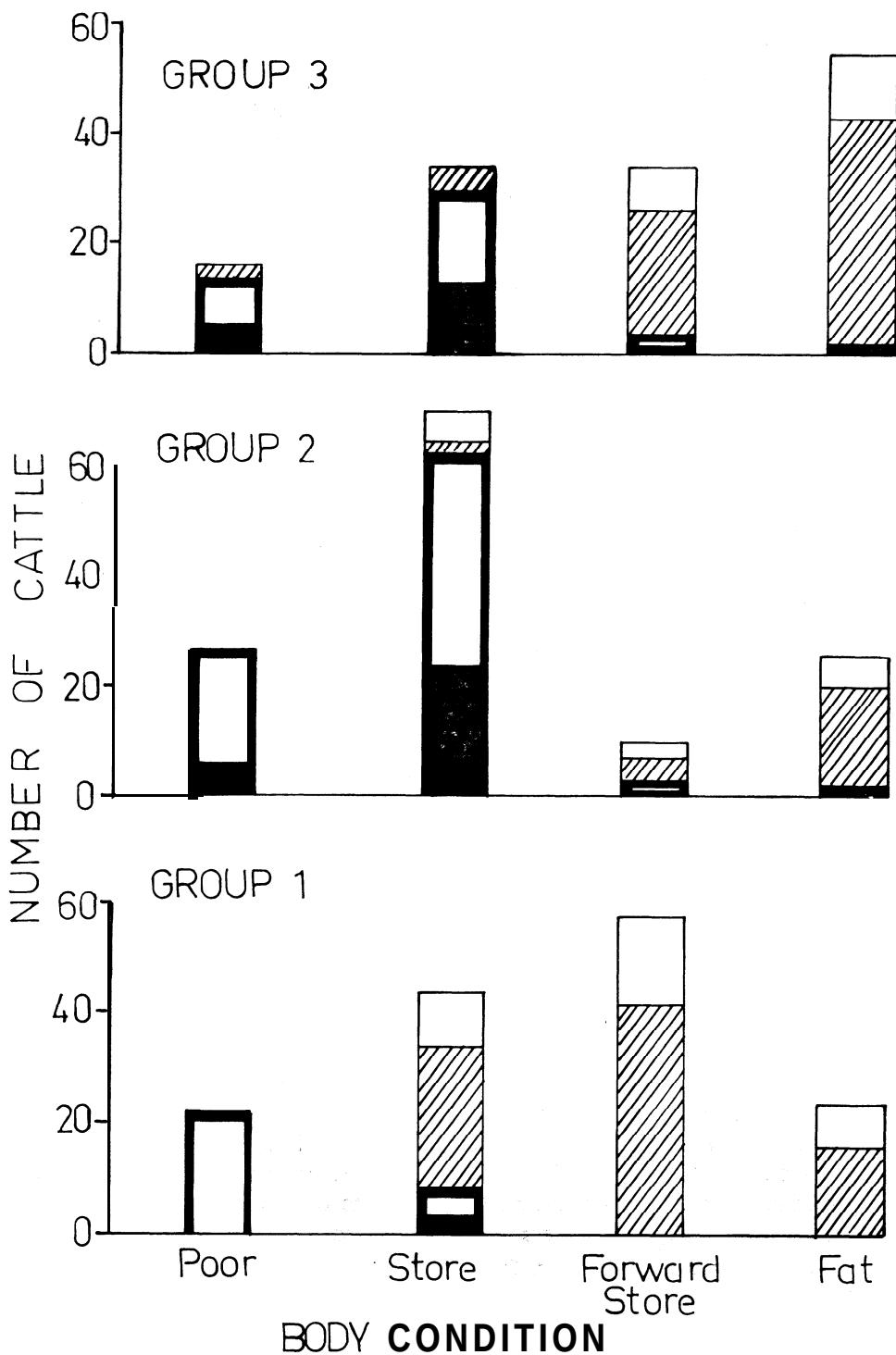


Fig. 1.-Number of cattle in each clasification of body condition x lactation status x pregnancy for the three groups.

□ — Non-lactating, empty
 ▨ — Non-lactating, pregnant
 ■ — Lactating, empty
 ▩ — Lactating, pregnant

on January 20, 1965, 10 of 22 held to the first insemination and 5 of 7 to the second, giving a total of 15 pregnancies. Oestrus was detected in only 3 of 82 wet cows and 26 of 58 dry cows. A few of these cattle had lost tags by mid-January but by April 29, 60 of a total of 140 had lost them.

(c) Group 3

Although most of the cows in the group were in poor to store condition at the start of the experiment, fewer had young calves compared with the other two groups. This was related to the higher proportion of young cattle in the group. The average body condition on April 29 was 2.9, and the proportion pregnant was highest of the three groups (68.1%). The wet cows had lower pregnancy rates than the dry cows in the group and also were in poorer condition. A total of 84 of 137 had ear tags remaining on April 29.

Complete records were available for 110 cows for the period up to January 20. Of these, 27 were detected in oestrus 17-21 days after the mass insemination on November 7 and 8, and were again inseminated, and 13 were pregnant on January 20, 1965. The remaining 83 cows and heifers were examined also on January 20 and 15 were pregnant.

Thus there were 28 cattle pregnant after the two periods of inseminations. This represented 13.6% (15 out of 110) to the first insemination and 48.1% (13 out of 27) to the returns. These figures and those for Group 2 are considered minimum as doubtfuls were not included, though on the basis of normal variation in uterine size and shape over the period 2 to 3 months of gestation (Lamond and Vendargon 1963; Edwards 1965), some of these were probably due to the treatment insemination.

(d) Comparison between groups—fertility

The average fertility for the herd was similar to that observed in similar herds in northern Australia (Lamond, unpublished data), in that wet, poor cows had the lowest proportion pregnant, that wet cows tended to be in poorer condition than dry cows, and that cattle in forward store and fat condition had high pregnancy rates. In order to reduce the bias in pregnancy rate due to differences between the three groups in lactation status and condition, it was decided to adjust the results on the basis of each group being comparable as to lactation status and body condition. In May 1964, 1056 cows (including many of those used in the present experiment) from the general herd, owned and managed by the same personnel, were examined for pregnancy and classified as to lactation status and body condition. It was decided that the proportion pregnant in each class could be considered a reasonable standard with which to equate the three experimental groups. Consequently, coefficients were determined and adjustments made using the result of the general herd in the previous year as the basis. These assumed pregnancy rates are shown in Table 2 and were used in the calculations in the following section.

(e) Comparison between groups--economics

The economic factors taken into account in comparing the three systems are set out below. The purpose was to show the relative position of the three systems

TABLE 3

**Cost schedule for four systems of breeding including one hypothetical case
(see text)**

<i>Group</i>	\$	<i>Group 2</i>	\$
6 bulls at \$32	192	4 bulls at \$32	128
		140 hr at 80 cents	112
		60 days at \$6	360
		Veterinarian	100
		Equipment	60
			760
		Less 15 calves at \$10	150
			610
No. cows pregnant	79	No. of cows pregnant	67
Cost per pregnancy	\$2.43	Cost per pregnancy	\$9.10
		Added value of A.I. calves to equate cost to Group 1	\$39.81
<i>Group 3</i>	\$	<i>Group 4</i>	\$
4 bulls at \$32	128	3 bulls at \$32	96
70 hr at 80 cents	56	300 ampoules of semen	300
20 days at \$6	120	Labour	100
Veterinarian	100	Hormones	140
Equipment	60	Veterinarian	100
Hormones	75		
			736
	539		
Less 28 calves at \$10	280	Less 56 calves at \$10	560
	259		176
No. cows pregnant	76	No. cows pregnant	100
Cost per pregnancy	\$3.41	Cost per pregnancy	\$1.76
Added value of A.I. calves to equate costs to Group 1	\$12.65	Added value of A.I. calves to equate costs to Group 1	\$8.80

and compare them with an hypothetical system. The costs per pregnancy therefore did not include figures that might reasonably have been attributed equally to all systems, such as cost of cows, maintenance of improvements, managerial allowance.

It was assumed that each bull was valued at \$240 and that he had a working life of 5 **years** and a resale value of \$80. Cost per bull per year therefore was \$32. The index chosen for comparison between groups was cost per pregnancy (adjusted figures) at April 29, 1965.

(i) Group 1

As set out in Table 3, the figure was \$2.43 for Group 1.

(ii) Group 2

Approximately 140 manhours at 80 cents per hour were occupied in collecting, diluting, transporting, inseminating, and cleaning the equipment. There were 60 man-hours at \$6 per day involved in mustering the herd for detection of oestrus. Four bulls were run with the group. A C.S.I.R.O. officer supervised the semen collecting, handling and inseminations. For the purpose of comparison, an arbitrary figure of \$100 for veterinarian fee for testing the bulls, advice and supervision was allowed.

A mobile laboratory was used but a figure of \$60 per year could normally be allowed for depreciation and cost of material for handling of semen. On the credit side a figure was allowed for the added value of calves as it was assumed that the quality of the bulls used in this programme exceeded that of the herd bulls. **No** cost was attributed to the semen obtained from the stud bulls because they were already on the property and were being used for stud purposes. The figure chosen was \$10 per calf. On this basis the cost per pregnancy in Group 2 was \$9.10. An additional figure was calculated for the values by which the A.T. calves would have to exceed the other calves in order to equate the cost of the method with Group 1.

(iii) Group 3

The time required for handling semen and mustering was less than for Group 2. An additional cost compared with Group 2 was hormones, valued at **50** cents per cow. The cost per pregnancy was estimated at \$3.41.

(iv) Group 4 (hypothetical case)

In order to show the position if it were possible to obtain 40% pregnancy rate after synchronization (and putting out 13% bulls afterwards), an additional comparison is included. It was assumed possible to buy ampoules of proven beef bull semen at \$1.00 per ampoule and to inseminate each cow on two successive days. It was assumed that the veterinarian would carry out the inseminations as well as supervise. The cost of hormones for synchronization has been assumed at \$1.00 per cow. Assuming 100 calves for the service from A.I. and bulls, the figure per pregnancy was \$1.76. The assumed herd size was 140.

It is evident that, in comparing the systems, the major factors are relative value of A.I. calves compared with calves by herd bulls; and balance between some kind of synchronization which is required to reduce labour costs and to eliminate the need for detection of oestrus, and fertility of synchronized ovulation.

IV. DISCUSSION

Better balance between groups at the start of the experiment would have been desirable. Numerous practical considerations raised by the manager, such as keeping mates together and mothering-up calves, precluded this. Fortunately a method was available for correcting pregnancy rates to a uniform basis for statistical purposes. In any event, co-operating with management always presents difficulties in field experiments.

As a general rule the principles we employ in designing experiments on private properties include :

-ask simple practical questions for which a high level of precision is not required;

--allow a wide margin for safety in selecting group size; use simple balanced designs so that loss of information, uncontrolled confounding and effects of abnormal environmental occurrences such as drought and loss of identification are not likely to lead to serious bias.

An example of unexpected loss of information was the loss of ear tags. The same make of tags had proved successful in the previous year on other properties, giving approximately 5% loss per annum. The difference in tag losses between Group 1 and the others was probably due to factors associated with the lower stock carrying capacity of the paddock.

Many cows in Group 1 weaned their calves sooner than cows in the other groups. It seems reasonable to assume that this was another result connected with the kind of conditions the group experienced.

Detection of oestrus in non-lactating cows was only fair and in lactating cows was negligible. These results and experience of others under similar conditions (Donaldson 1962; Rollinson 1962; Lamond, Little and Holmes 1964) indicate the need for a system of synchronization of ovulation and insemination at an assumed time of oestrus, in circumstances where A.I. is required. The analyses of the costs involved in the systems, as shown in Table 3, point to the advantages that would follow even a moderately successful method of synchronization.

Our experiences and results indicate that there need be no serious obstacles to collection and handling of semen under conditions likely to be met in northern Australia.

V. ACKNOWLEDGMENTS

We are most grateful to Mr. Charles Young, Fairymead, Bundaberg and his stock manager, Mr. Ken Coombe, for provision of facilities and assistance.

VI. REFERENCES

- DONALDSON, L. E. (1962). Some Observations on the fertility of beef cattle in north Queensland. *Australian Veterinary Journal* **38**: 447.
- EDWARDS, M. J. (1965). Observations of the anatomy of the reproductive organs of cows. *New Zealand Veterinary Journal* **13**: 25.
- LAMOND, D. R., and VENDARGON, X. (1963). Rectal examination of cattle during early pregnancy, *Australian Veterinary Journal* **39** : 93.
- LAMOND, D. R., LITTLE, D. A., and HOLMES, J. G. H. (1964). Observations on oestrus and ovulation in beef heifers in central Queensland. *Proceedings of the Australian Society of Animal Production* **5**: 37.
- ROLLINSON, D. H. L. (1962). Physiology of reproduction in domestic animals with special reference to African conditions. *Bulletin Epizootic Diseases of Africa* **10** 137.
- WATSON, J. W. (1964). Field collection and evaluation of semen from bulls using electroejaculation. *Australian Veterinary Journal* **40**: 183.