CALF REARING BY MULTIPLE SUCKLING AND THE EFFECTS ON LACTATION PERFORMANCE OF THE COW

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SUMMARY

Experiments conducted in four successive seasons with identical twin Jersey cows or heifers and Friesian steer calves are reported.

Suckling by calves in early lactation stimulated milk production. An increased peak of lactation in suckled cows and heifers was indicated with the superiority in production over milked cows and heifers being maintained after weaning and throughout lactation. No significant difference in post-weaning milk production could be detected between cows suckled by calves twice daily and those suckled continuously. Cows suckled in early lactation did not gain as much body weight in lactation as milked cows.

The enhanced milk production of suckled cows appreciably reduced the apparent calf rearing cost. Good weight-for-age beef weaners were produced but continuously suckled calves were more variable in weaning weight than calves suckled twice-daily.

Problems and prospects of integrating efficient dairy and beef production, using nurse cow systems, are discussed.

DAIRY-BRED BEEF CALVES reared artificially by New Zealand farmers seldom achieve more than 1.0 lb liveweight gain per day during the first 2 to 3 months of life (Everitt *et al.*, 1969), or less than that recommended for successful rearing of Jersey heifer dairy replacements (McMeekan, 1964). This is of some concern, for poor growth in early life of beef animals can adversely affect lifetime performance (Wardrop, 1966; Lonsdale and Tayler, 1969; Everitt *et al.*, 1969) and carcass composition (Broadbent, 1969).

Improved growth rates in artificial rearing systems can be sought through use of more and better feeds; appreciable research effort is directed to this end (reviewed Everitt, 1970). At present prices of feedstuffs, in relation to returns on weaners and beef, these practices are generally expensive and uneconomic.

Nurse cows represent an alternative calf rearing technique. Feed intake of the suckling calves, and thus their

growth rate, can be modified by relating the number of calves to the expected milk production of the nurse cow, and by adjusting the length of the suckling period.

Multiple suckling is not, however, a modern practice. Ancient Greek literature notes the technique (see Amoroso and Jewel, 1963) and nurse cow rearing of calves is commonplace in European countries with a wide seasonal distribution of calving, providing the opportunity for suckling several batches of calves per nurse cow in each lactation. In New Zealand, with a restricted calving season for dairy cows, the possibility exists for multiple suckling in the early part of lactation, returning the cow to the milking herd after weaning.

From primitive times to the present day, various devices have been used to promote letdown of milk in dairy cows (Amoroso and Jewel, 1963). Suckling calves feature prominently in these techniques. Furthermore, as premilking artificial stimulation of the udder can increase butterfat production by as much as 25% over unstimulated cows (Phillips, 1960, 1965), it seems possible that suckling calves might also promote lactation performance and reduce the feed cost of calf rearing.

Nurse cow techniques may therefore offer opportunities for successful integration of efficient dairy and beef production and assist dairy farmers to diversify in times of need.

This paper reports experiments conducted in four successive seasons using identical twin Jersey cows and Friesian steer calves to examine some of the physiological and managerial principles involved in nurse cow systems of calf rearing.

EXPERIMENTAL

Trials were conducted in the 1966-7 (Trial 1), 1967-8 (Trial 2), 1968-9 (Trial 3) and 1969-70 (Trial 4) seasons.

TRIAL 1

Identical twin Jersey cows (six sets, 3 years old or more at calving) and heifers (five sets, 2 years old at calving) were used.

One member of each twin pair was chosen at random before calving to be milked by machine for the full lactation (referred to as "milked" cows or heifers). The other member of the twin set suckled calves for the first 10 weeks of lactation and then returned to the milking herd alongside her twin mate for the rest of lactation

("suckled" cows or heifers). Suckling calves ran with their foster mothers at all times.

Cows were fostered with three, and heifers two, Friesian steer calves each, but the number suckled varied owing to the "sharemilking" effect within a group of suckling cows and calves.

TRIAL 2

Twelve sets of identical twin Jersey cows and eleven sets of twin heifers were used. Suckled cows reared three, and heifers two, Friesian steer calves for seven weeks, with subsequent return of suckled cows and heifers to the milking herd.

TRIAL 3

Twenty-one sets of identical twin Jersey cows were used in a three-way split design. Twin set members were randomly allocated to a milked treatment, suckling three or suckling four Friesian steer calves for eight weeks, with return of suckled cows to the milking herd after weaning.

TRIAL 4

This trial compared the effects of continuous suckling three calves per cow — the calves running with foster dams at all times — with twice-daily suckling three calves per cow — the calves being kept separate from nurse cows except at suckling times. Fourteen sets of identical twin Jersey cows were used.

Twice-daily suckling calves had access to the cows at approximately 7 a.m. and 4 p.m. each day. Cows were held in a specially-built raceway and the calves let into the enclosure where they suckled the cows from each side for 20 minutes.

In addition, a group of 12 Friesian steer calves were artificially reared on whole milk, individual animal intake being regulated weekly so as to achieve a growth rate of 1.5 lb liveweight gain per day, simulating the growth rate of continuously suckled calves. Suckled and artificially reared calves were weaned at eight weeks of age.

MANAGEMENT OF CALVES

Calves in all trials were weighed on arrival for fostering ("arrival weight") when 4 to 5 days old; at weekly intervals thereafter until weaning; and again at 14 weeks of age.

Fostering techniques and management details were as reported by Everitt *et al.* (1968). Calves were castrated and dehorned at approximately three weeks of age, sprayed for lice at six weeks of age and drenched for internal parasites at weaning.

Management of Cows

Cows were milked by machine twice-daily with application of a pre-milking stimulus using warm water for washing. The stimulus requirement for letdown was estimated monthly for all cows. Stimulus level was increased stepwise through lactation, all cows being stimulated for 15 seconds until November 1, 30 seconds until January 1 and thereafter for 45 seconds.

Lactation terminated when daily milk production fell to a consistent level of a half-gallon of milk per day or had exceeded 305 days of lactation. Severe drought and lack of feed abbreviated lactation in Trial 4, all cows being dried off on February 27, 1970.

Body weights of cows and heifers were recorded weekly during the suckling period and fortnightly thereafter.

Oestrous periods were recorded and both milked and suckled cows were artificially inseminated.

Grazing Management

Three groups of stock were involved during the suckling period of all trials: a herd of milked cows (Trials 1 to 3 inclusive); a herd of nurse cows with calves and a herd of nurse heifers with calves (Trials 1 and 2); two herds of cows suckling 3 or 4 calves (Trial 3); two herds of suckling cows (continuous and twice-daily) and a group of twice-daily suckling calves (Trial 4).

Using two-acre paddocks, the groups in a trial interchanged grazing areas every two days on a planned rotation so as not to favour any one group.

Stocking rates over the suckling periods approximated a cow and calves per acre or a milked cow per acre. In the post-weaning period a stocking rate of 1.25 cows per acre was employed. As the suckling period coincided with the spring growth, abundant grass was available and hay to appetite was also offered.

Biometrical Procedures

Analyses of variance isolated between and within identical twin set variation, where appropriate. There was no

TABLE 1: MEAN GROWTH RATES OF CALVES

Trial	*Treatment*	*Arrival — Weaning*		*Weaning — 14 wks*		*Arrival — 14 wks*	
		lb/day	*diff. + s.e.*	*lb/day*	*diff. + s.e.*	*lb/day*	*diff + s.e.*
1	2 calves/heifer	1.52		1.06		1.39	
1966-67			0.19 + 0.15		0.35 ± 0.14		0.23 ± 0.12
	3 calves/cow	1.33		0.71		1.16	
2	2 calves/heifer	1.59		1.07		1.33	
1967-68			0.15 ± 0.08		0.05 ± 0.08		0.10 ± 0.05
	3 calves/cow	1.44		1.02		1.23	
3	3 calves/cow	1.47	***	1.06		1.28	**
1968-69			0.38 ± 0.05		— 0.07 ± 0.06		0.17 ± 0.05
	4 calves/cow	1.10		1.13		1.11	
	3 calves/cow twice daily	1.64		0.78		1.26	
	(1)		* 0.18 ± 0.08		— 0.07 ± 0.07		0.06 ± 0.04
4	3 calves/cow	1.46		0.84		1.21	
1969-70	continuous (2)		0.01 ± 0.08		— 0.05 ± 0.10		0.01 ± 0.06
	Bucket-fed	1.45	**	0.89		1.21	
	(3)		0.19 ± 0.06		— 0.11 ± 0.10		0.05 ± 0.06

Note:

s.e. = standard error of difference.

*** = $P < 0.001$; ** = $P < 0.01$; * = $P < 0.05$.

Trial 4: mean differences (1) Twice-daily — continuous suckling.
(2) Continuous suckling — bucket-fed.
(3) Twice-daily suckling — bucket-fed.

evidence of variation between cows within treatments being greater than between calves within cows, so that these were pooled for testing purposes.

Regression analyses examined relationships between cow and calf performance.

RESULTS

Calf Performance

Mean growth curves for calves in the four trials are shown in Fig. 1 and growth rates during three periods of interest are recorded in Table 1.

Good growth rates were achieved in these nurse-cow systems.

Pre-weaning growth rate differences between two calves suckled per heifer and three calves per cow (Trials 1 and 2) were not significant. In Trial 3, calves reared at three per cow grew significantly faster before weaning than those suckled at four per cow. Even at a suckling level of four calves per cow (Trial 3), calves grew at 1.10 lb liveweight gain per day up to weaning time.

Calves suckled twice-daily in Trial 4 grew significantly faster pre-weaning than calves suckled continuously or the bucket-fed calves. The latter group, as planned, grew at much the same rate as the continuously suckled calves. A total of 71.5 gallons of whole milk per head was fed to the bucket-fed calves over a period of 56 days, or 35.7 lb of butterfat at a fat test of 5%. This represents 0.44 lb butterfat per 1.0 lb liveweight gain.

Suckled calves received a small growth check at weaning in Trials 1 and 2 but regained their weaning weight in about two weeks (Fig. 1). A weaning check was not so apparent in Trials 3 and 4. All calves grew appreciably slower between weaning and 14 weeks of age than before weaning, with no significant differences between treatments within the four trials (Table 1).

Up to 14 weeks of age, growth rate differences were not significant, except that calves reared at three per cow in Trial 3 grew faster than those suckled at four per cow.

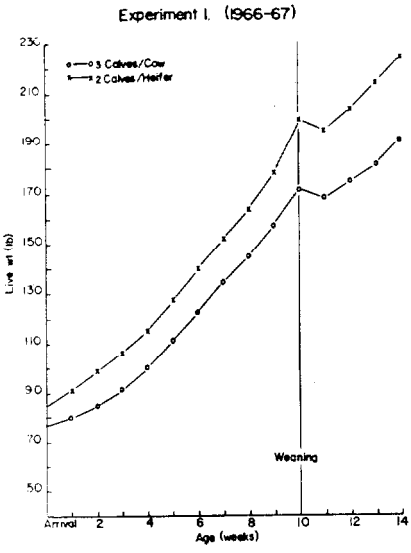
Average arrival, weaning and 14-week liveweights are recorded in Table 2. Figure 2 records the distributions of weaning weights in Trial 4.

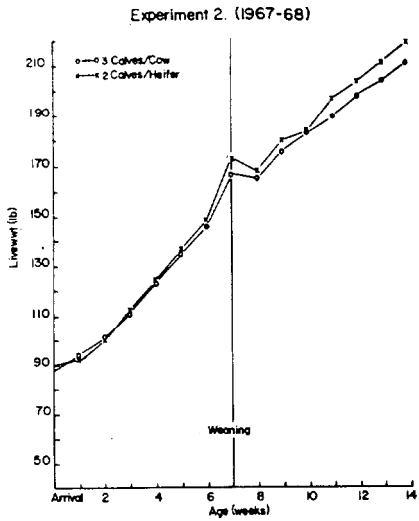
The smaller variation in weaning weight of artificially reared calves in Trial 4 reflects the controlled growth rate exerted through regulation of feed intake. Twice-daily suckling encouraged greater uniformity in calf weaning

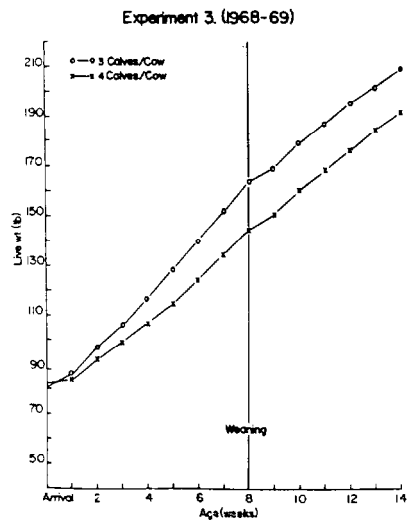
TABLE 2: MEAN LIVEWEIGHTS (lb ± s.d.) OF CALVES AT ARRIVAL, WEANING AND 14 WEEKS OF AGE

Trial	*Treatment*	*Weaning Age (wk)*	*Arrival*		*Weaning*		*14 Weeks*	
			No.	*Wt*	*No.*	*Wt*	*No.*	*Wt*
1	2 calves/heifer	10	10	86 ± 14.1	10	193 ± 36.7	10	223 ± 41.5
	3 calves/cow		18	77 ± 12.5	18	171 ± 31.4	18	191 ± 35.5
2	2 calves/heifer	7	22	90 ± 10.2	22	168 ± 14.9	22	221 ± 12.6
	3 calves/cow		36	88 ± 11.7	36	159 ± 19.2	30	210 ± 23.5
3	3 calves/cow	8	42	81 ± 12.4	42	164 ± 21.3	36	209 ± 25.6
	4 calves/cow		56	81 ± 12.1	56	142 ± 20.1	44	190 ± 22.2
4	3 calves/cow twice daily	8	42	82 ± 11.6	42	174 ± 18.1	41	207 ± 19.3
	3 calves/cow continuous		42	79 ± 9.9	42	161 ± 28.6	38	197 ± 26.0
	Bucket-fed		12	89 ± 7.2	12	170 ± 12.2	12	207 ± 18.7

Note: A number of calves were slaughtered for experimental purposes at weaning in Trials 3 and 4.







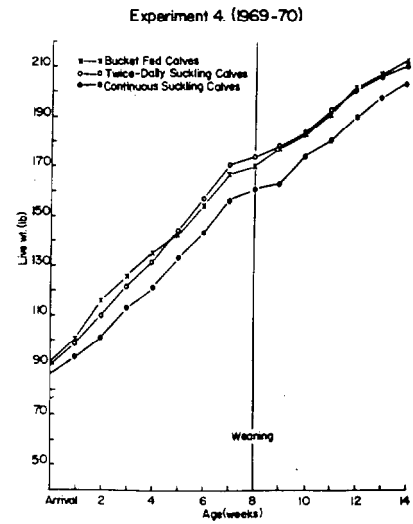


Fig. 1: Mean growth curves of calves.

weight than continuous suckling, the lightest calves under the latter system approaching a minimum weaning weight for Friesian steers. On the other hand, continuous suckling produced some relatively heavy weaners, reflecting the "share-milking" effect in a group of suckled cows and calves.

TABLE 3: CALF LIVEWEIGHT INCREASE PER COW (lb)

Trial	*Treatment*	*Total Calf Weaning Wt per Cow*	*Total Calf Live Wt Increase per Cow*	*Total Calf Live Wt Increase per Cow per Day*
1	2 calves/heifer	386	214	3.06
	3 calves/cow	513	282	4.03
2	2 calves/heifer	336	156	3.18
	3 calves/cow	477	243	4.96
3	3 calves/cow	492	249	4.45
	4 calves/cow	568	244	4.36
4	Continuous			
	3 calves/cow	483	246	4.39
	Twice-daily			
	3 calves/cow	522	276	4.93

Table 3 summarizes the calf liveweight increase per nurse cow recorded in these trials. The total weight of calf weaned compared favourably with the body weight of one single-suckled beef weaner weaned at 7 to 8 months of age, and provides a measure of the relative efficiency in two contrasting systems of beef production. On the assumption that 1 lb per day of calf liveweight gain is produced by 0.44 lb butterfat (Trial 4), then the 4.45 lb calf liveweight gain per cow per day recorded for cows continuously suckled by three calves in Trial 3 represents the equivalent of 1.95 lb butterfat per cow per day, or 109 lb butterfat over a suckling period of 56 days.

No clear relationships between calf growth and lactation performance of cows could be detected in these trials.

COW PERFORMANCE

Milk Production

Tables 4 to 7 summarize milk and butterfat production and days in milk for Trials 1 to 4, respectively. Mean lactation curves for Trials 1 to 3 are shown in Fig. 3.

Suckled cows and heifers produced more milk and butterfat in the post-weaning period than their milked mates in Trials 1 to 3 (Tables 4 to 6) although the response was not significant in all cases. The difference in

response to suckling 3 or 4 calves was not significant (Table 7).

This post-weaning increase in milk production of previously suckled animals did not compensate entirely for the loss of milk "in the bucket" suffered through early lactation suckling. Milked cows and heifers produced more salable butterfat than suckled cows over the whole lactation.

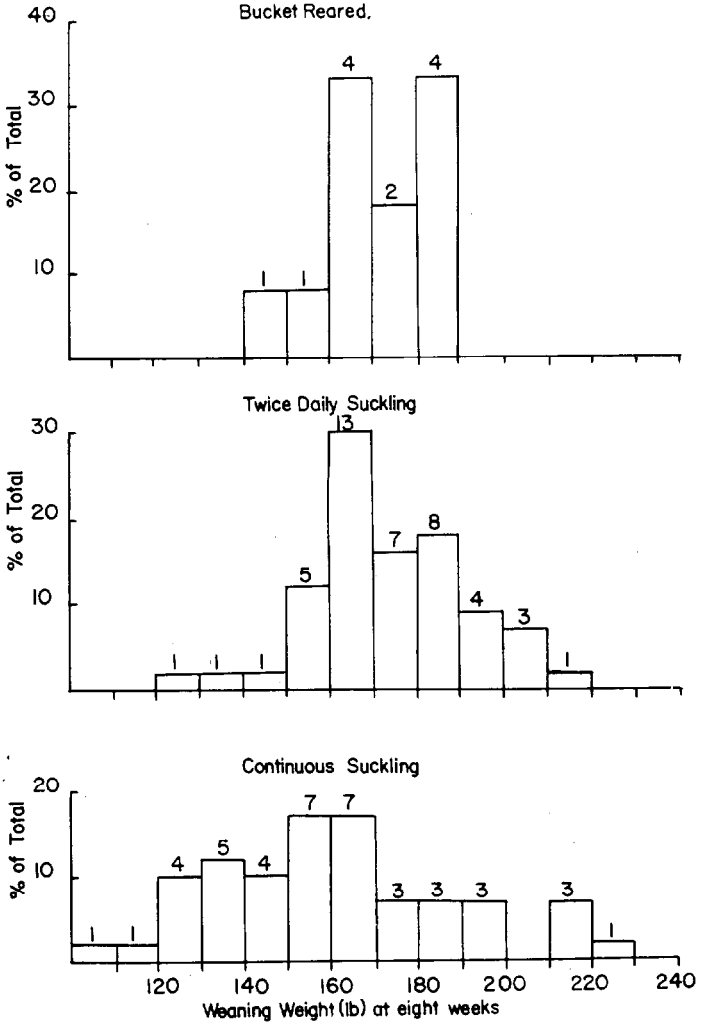


Fig. 2: Distribution of weaning weights of calves — Trial 4.

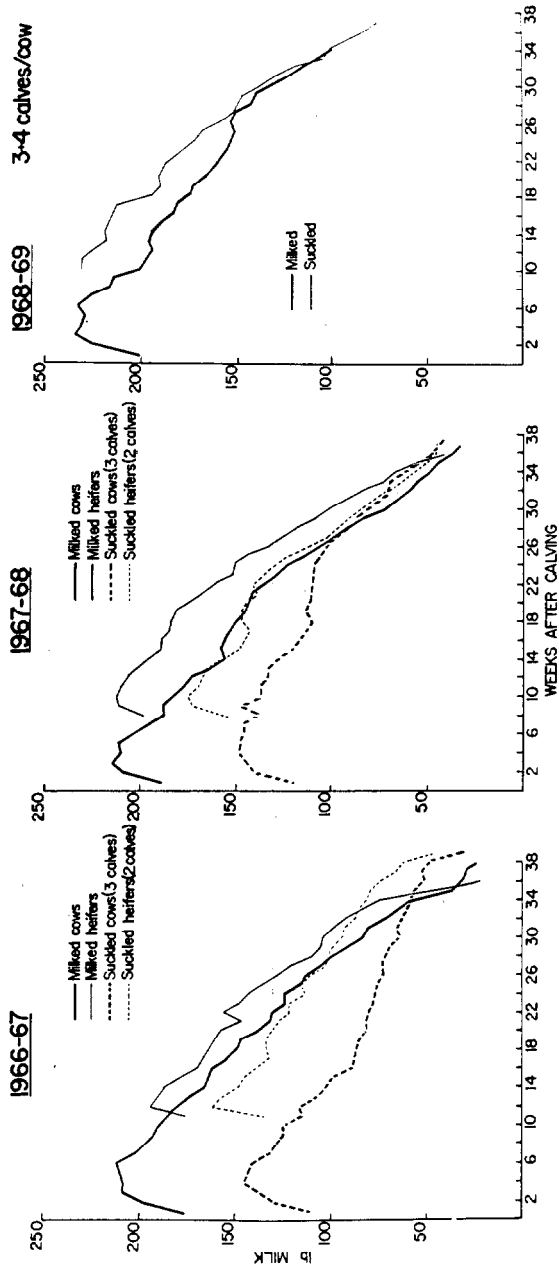


Fig. 3: Mean lactation curves of cows and heifers.

TABLE 4: LACTATION PERFORMANCE — TRIAL 1 (1966-7)

Period of Lactation	*Group and Mean Diff.*	*Heifers*			*Cows*		
		Milk lb	*Butterfat lb*	*Days Milked*	*Milk lb*	*Butterfat lb*	*Days Milked*
Pre-weaning	Milked	1,322	63	70	2,056	93	70
Post-weaning	Suckled	3,428	177	195	3,674	185	185
	Milked	2,365	116	*151*	3,224	156	188
	Difference	1,063	61	44	450	29	— 3
	± s.e.	± 512	± 34	± 34	± 323	± 16	± 11
Total	Suckled	3,428	177	195	3,674	185	185
	Milked	3,687	179	221	5,280	249	258
	Difference	259	— 2	— 26	— 1,606**	— 64*	— 73***
	± s.e.	± 616	± 37	± 34	± 379	± 19	± 11

TABLE 5: LACTATION PERFORMANCE — TRIAL 2 (1967-8)

Period of Lactation	*Group and Mean Diff.*	*Heifers*			*Cows*		
		Milk lb	*Butterfat lb*	*Days Milked*	*Milk lb*	*Butterfat lb*	*Days Milked*
Pre-weaning	Milked	953	49	49	1,418	63	49
Post-weaning	Suckled	3,817	199	216	4,512	221	214
	Milked	3,320	172	191	3,737	181	206
	Difference	496	26	25	775**	40**	8
	± s.e.	± 393	± 19	± 25	± 248	± 12	± 9
Total	Suckled	3,817	199	216	4,512	221	214
	Milked	4,273	221	240	5,155	244	255
	Difference	— 456	— 22	— 23	— 643*	— 23	— 42***
	± s.e.	± 500	± 25	± 25	± 263	± 12	± 9

TABLE 6: LACTATION PERFORMANCE — TRIAL 3 (1968-9)

Period of Lactation	*Group and Mean Diff.*	*Milk lb*	*Butterfat lb*	*Days Milked*
Pre-weaning	Milked	1,790	80	56
Post-weaning	Milked	4,690	227	223
	Differences ± s.e.			
	Suckled — milked	580* ± 230	30* ± 14	4 ± 6
	Suckled 4 calves — Suckled 3 calves	360 ± 260	22 ± 16	12 ± 7
Total	Milked	6,480	307	279
	Differences ± s.e.			
	Suckled — milked	1,260*** ± 260	— 51** ± 14	— 52*** ± 6
	Suckled 4 calves — Suckled 3 calves	330 ± 290	19 ± 16	12 ± 7

Milked cows in Trial 3 produced 80 lb butterfat in the first 56 days of lactation (Table 6). This result may be compared with an estimate of 109 lb butterfat produced by cows suckled by three calves in the same period of the trial — estimated from the milk intake and growth of the artificially reared calves in Trial 4. Figure 3 shows that the milk production of suckled cows and heifers immediately after weaning was less than that recorded for milked cows, subsequently improving to a level higher than milked cows for the rest of lactation.

The butterfat production after weaning in Trial 4 (Table 7) did not differ significantly between cows suckled twice daily and those continuously suckled.

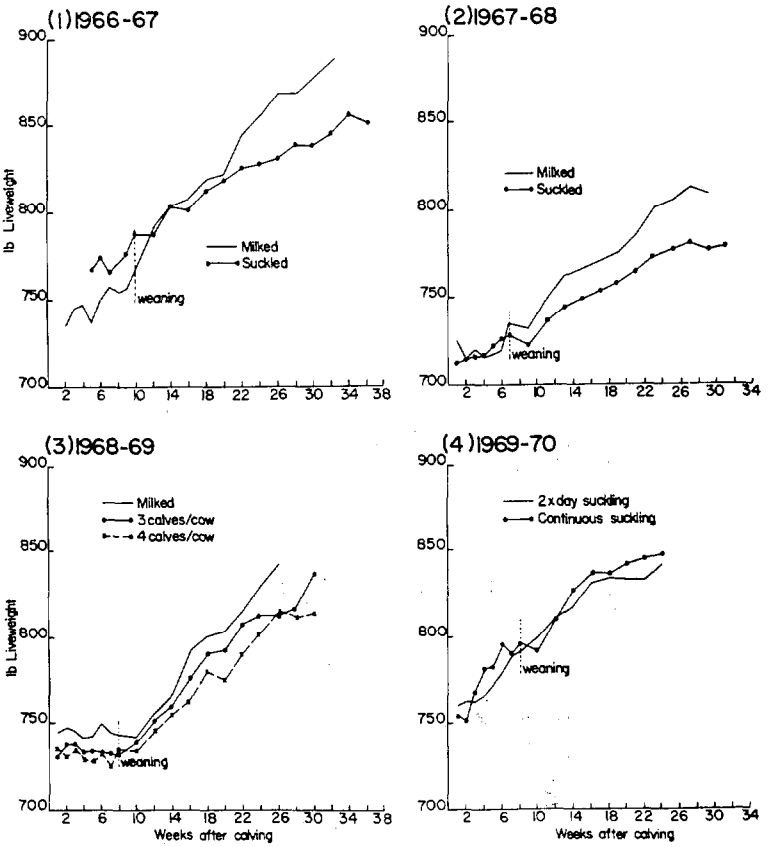


Fig. 4: Mean body weight curves of cows and heifers during lactation.

TABLE 7: POST-WEANING LACTATION PERFORMANCE — TRIAL 4 (1969-70)

Group and Mean Diff.	*Milk lb*	*Butterfat lb*	*Days Milked*
Twice-daily suckling	3,769	176	199
Continuous suckling	3,539	171	200
Difference ± s.e.	230 ± 280	5 ± 14	−1 ± 5

Fat test differences were small and not significant in all trials.

Suckled cows and heifers remained in milk longer than milked cows. In Trial 1, two out of six milked heifers dried off at 111 and 105 days of lactation but their suckled mates recorded lactation lengths of 284 and 150 days, respectively. In Trial 2, two out of 11 milked heifers dried off after 39 and 36 days, the lactation length of their suckled mates being 191 and 246 days, respectively.

The response to suckling in these trials was not significantly associated with the levels of milk production recorded.

Body Weights

Figure 4 records the mean body weights of suckled and milked cows. Suckled cows did not gain as much body weight during lactation as milked cows. This is consistent with a greater milk production of suckled cows over the lactation. In Trial 4, body weight gains in lactation of the two groups did not differ appreciably; neither did their butterfat production in the postweaning period.

DISCUSSION

The calf rearing period is of critical importance in the efficient production of beef from animals of dairy origin. Mortalities are greatest at this stage of life (Everitt and Evans, 1970) and the pre-weaning growth rate of calves appears to modify their ability to achieve potentiality for later growth.

Under commercial farming conditions, Everitt and Evans (1970) found that 7.8% of artificially reared calves died during the rearing period, compared with 0.9% mortality for multiple suckled calves. Moreover, Everitt *et al.* (1969), reporting the same trials, found that multiple suckled calves were appreciably heavier at weaning than artificially reared calves. Suckled calves in Trials 1 and 2 of this work were 40 lb and 20 lb, respectively, heavier

at 12 weeks of age than Friesian steer calves artificially reared on buttermilk powder diets (Everitt *et al.*, 1968). The small differences in calf live weights at 14 weeks of age indicate the flexibility in weaning age and weight without militating against later performance.

Trial 4 showed that to achieve the same growth rate as that for continuously suckled calves, it was necessary to feed the equivalent of 35.7 lb of butterfat to the artificially reared Friesian steer calves. At an opportunity cost of 32 cents per lb butterfat this represents a feed cost per calf of $11.42. Assuming a loss of salable butterfat of 40 lb owing to suckling in early lactation, the feed cost per suckled calf — when three calves were suckled per cow — approximates 13 lb butterfat, or $4.16 per calf. Continuously suckled calves were more variable in body weight at weaning than twice-daily suckled calves. The coefficient of variation of weaning weight at eight weeks of age for Friesian steer calves reared on milk replacer diets in other Ruakura trials (Everitt, unpubl.) was lower (8.2%), than the coefficient recorded for twice-daily suckled calves (10.4%) in the trials reported here.

Multiple suckling of cows alters reproductive behaviour by suppressing oestrus (Everitt *et al.*, 1968; Winks and Edgley, 1970) and delaying ovulation (Moller, 1970) although there is a rapid return to normality after weaning. These effects may be related to the degree of stress imposed by suckling and can be important if the cow is to be artificially inseminated during the suckling period. Methods of mothering-on suckling calves, involving the imprinting process (Kilgour, 1969; Crowley and Darby, 1970), and behavioural aspects of suckling calves and cows need more study.

Everitt *et al.* (1968) presented comparative budgets comparing artificial rearing with multiple suckling for calf rearing. They revealed favourable gross returns per cow used for rearing beef weaners in early lactation and subsequently milked for the rest of lactation. Financial advantages accruing from bringing a heifer into full milk production through suckling after calving, recorded in Trials 1 and 2, whereas her milked mate dried off early in lactation, were not estimated but could be important.

The reduced feed cost for suckled calves reflects the improvement in post-weaning lactation of suckled cows over cows milked by machine from the time of calving. Results of the four trials are consistent in showing a stimulating effect of suckling in early lactation although the degree of response was variable. The peak of the lacta-

tion curve appears to be increased appreciably in suckled cows with the superiority in production over milked cows being maintained throughout lactation (Fig. 3). Although the cows and heifers used in these trials were relatively low milk producers, it should be emphasized that the cows were given a high level of artificial stimulation before machine milking. It is not known if the greater milk production due to suckling is additive to that derived from pre-milking artificial stimulation. The lack of a marked difference in milk production between cows suckled twice-daily or continuously suggests that frequency in evacuation of the udder may not be so important as other physiological effects such as the stimulus of suckling itself, or improved udder health. Increased milk production of suckled cows at the expense of body weight gain during lactation (Fig. 4) agrees with Phillips' (1960, 1965) earlier observations associated with pre-milking artificial stimulation of cows and enhanced milk yield.

Corroborative evidence for an increase in milk yield due to calf suckling is provided in a brief report from Ireland (Walsh, 1969). Cows suckled twice daily by four calves per cow in the first 100 days of lactation produced 3,891 lb milk, while milked cows produced 3,427 lb — a difference in favour of suckling of 11%. All animals were machine milked between the 100th and 230th days of lactation when the previously suckled cows produced 3,181 lb of milk and the milked cows 2,975 lb. Thereafter, until the end of lactation, the early lactation treatments were repeated; suckled cows produced 472 lb milk compared with 366 lb milk produced by milked cows. These Irish results suggest that stimulation of milk yield is much greater during periods of suckling, especially in late lactation, than the residual effects after suckling.

From a managerial point of view twice-daily suckling offers some advantages over running calves continuously with foster cows, and as the calves are less variable in weaning weight, it seems likely that the former method will be more acceptable in practice.

Various systems of integrating dairy and beef production, employing suckling techniques, are now under study (Stephens, 1969; Campbell and Clayton, 1970; Smith, 1970). These trials indicate that a new management philosophy and technology is demanded, and more than one season is needed to acquire and successfully apply the different and additional managerial skills. Kaiser (1970) comments from his Australian studies that the

production from dairy cows rearing three beef calves for twelve weeks, and then milked, offered similar financial returns, considering both labour and prevailing product prices, to a return from milk production only.

The relative emphasis placed on milk or weaner beef production, and their integration, will be determined by the relativity of product prices, the availability of labour and milking shed resources, the size of the farm and herd, and the degree of managerial skill available. The trials reported here reveal some interesting principles of animal production but further research is needed to define the physiological details and refine the managerial techniques.

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