Rearing Dairy Heifers on Pastures Fertilized at Moderate Levels With or Without Supplemental Concentrates at Different Stages[1]

Paul F. Randel and Jaime Vélez-Santiago[2]

ABSTRACT

The experiment involved 3 successive phases in rearing Holstein heifers at Corozal on pastures of mixed grasses, fertilized annually with 168, 56 and 112 kg/ha of N, P_2O_5 and K_2O, respectively, in 3 applications. Mean initial age was 9 months and liveweight (LW) 167 kg. In phase 1 (91 days), 39 control animals stocked at 5/ha and not supplemented gained 0.41 kg daily, inferior ($P < 0.01$) to the gain of a like number supplemented with 2 kg daily of 14% crude protein concentrate (0.64 kg), 8.6 kg of concentrate per kg of extra gain over the control. In phase 2 (182 days), 32 animals stocked at 4/ha gained less ($P = 0.01$) per head than 24 stocked at 3/ha (0.53 vs. 0.59 kg daily), but total gain per ha was 16.4% greater for the former. During 259 days of phase 3, while 3 groups of 19 each remained intact, grazing at 3.75 animals/ha without supplementation (treatment 1) resulted in lower ($P = 0.01$) gain than treatments 2 and 3, involving concentrate supplementation at 2.5 or 4 kg daily beginning 200 or 125 days before expected parturition (0.57 vs. 0.64 and 0.62 kg, respectively), but supplementation increased gains over the control very inefficiently. Mean LW increased from 318 kg in all 3 groups to 485, 513 and 497 kg in treatments 1, 2 and 3, respectively. Only heifers of the latter 2 groups continued to receive concentrates after returning to their home farms in Cayey and Manatí until first calving. All animals received usual herd management postpartum. Mean 305-day first lactation milk production was 4292 kg in 18 control animals of phase 3, surpassing (not significantly, $P = 0.05$) productions of 3,771 and 3,869 kg by 16 and 17 former treatment 2 and treatment 3 animals, respectively. Stocking rates employed at each stage seemed suited to available pastures, and concentrate supplementation was unnecessary for rearing dairy heifers under these conditions.

INTRODUCTION

Extensive experimental data obtained over approximately 15 years, at locations of good year-round rainfall distribution in Puerto Rico, have led us to recommend that intensively-managed pastures be used under such conditions to supply the great majority of, or possibly all nutrients required for rearing replacement dairy heifers until first calving. Most previous studies employed fertilizer applications totaling not less than 336 kg of N, 112 kg of P_2O_5 and 224 kg of K_2O/ha in 4 equal portions annually, following a well known guideline for Puerto Rico (10). However, in view of drastic increases in fertilizer costs in recent years, there is renewed interest in reevaluating animal responses to lower levels of fertilization. Therefore, this experiment was based on pastures receiving less fertilizer input than the standard recommendation. Additional ob-

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[2] Animal Nutritionist, Lajas Substation and Agronomist, Corozal Substation, Agricultural Experiment Station, College of Agricultural Sciences, University of Puerto Rico, Rio Piedros, P.R.

jectives were to further test the feasibility of feeding concentrate supplements at different stages of growth, including possible postpartum carryover effects on animal performance in the milking herd, and to make further observations on different stocking rates in pasture.

MATERIALS AND METHODS

This experiment was conducted at the Corozal Research and Development Center of the University of Puerto Rico Agricultural Experiment Station from January 1980 to September 1981. It comprised 3 successive phases from 9 months of age until shortly before first parturition of replacement dairy heifers. The experimental treatments in phases 1 and 3 consisted of different schedules of supplemental concentrate feeding, whereas in phase 2 different stocking rates in pasture were tested.

PHASE 1

Seventy-eight 9-month-old Holstein heifers, ranging in initial liveweight (LW) from 136 to 203 kg were used; 4 were property of the institution and 74 were borrowed from the herds of two commercial dairies from Cayey and Manatí, which provided 48 and 26 animals, respectively. Two groups of 39 animals were formed, with nearly identical mean initial LW and similar distribution with respect to origin. One group was randomly assigned to each of two experimental treatments.

Treatment 1 involved grazing as sole ration in pastures predominantly of pangola (*Digitaria decumbens*), para (*Brachiaria mutica* Stapf) and guinea (*Panicum maximum*) grasses. Animals of each treatment grazed separate areas of 7.8 ha with a stocking rate of 5 heifers/ha divided into 6 equal paddocks, in 30 to 36-day cycles. Pastures were fertilized with 1.12 metric tons/ha annually of 15-5-10 analysis, equivalent to 168 kg of N, 56 kg of P_2O_5 and 112 kg of K_2O, in 3 equal portions applied in December, April and August. The pastures in question had been left unfertilized and grazed intensively for nearly a year before the experiment to exhaust residual fertilizer from higher applications in previous years. Treatment 2 involved grazing management as above, and also a supplement of 2 kg per head of a 14% crude protein (CP) commercial concentrate mixture, which was group-fed daily in a roofed enclosure.

Duration of this phase was from 24 January to 24 April (91 days). After initial weighing, animals were reweighed on 3 occasions following successive intervals of 29, 31 and 31 days. Data pertaining to LW response were subjected to analysis of variance applicable to a randomized design (9).

PHASE 2

Fifty-six of the heifers finishing phase 1 were divided into two new groups, one of 32 and the other of 24, as nearly alike as possible in mean

LW and each including an equal number of animals from each of the two former treatments. The larger and smaller groups constituted stocking rates of 4 and 3 heifers/ha, grazing the same paddocks as previously; these were designated treatments 1 and 2, respectively. Management of pastures was as described above; grazed herbage was the sole ration.

This phase commenced on 24 April and lasted for 182 days, until 23 October. Six intervals between successive weighings of the animals ranged in duration from 29 to 32 days. The analysis of variance to which LW response data were subjected included 2 factors: present treatment and previous (phase 1) treatment, and their interaction (9).

PHASE 3

Fifty-seven heifers were used in this final phase at Corozal, 55 of which had participated in both phases 1 and 2, 1 in phase 1 only, and 1 (owned by the institution) was new to the experiment. They were divided into 3 groups of 19 each, balanced as nearly as possible with respect to treatments received during phase 1; ratios of previously supplemented and nonsupplemented animals were 10:9, 10:9 and 9:9 in groups 1, 2 and 3, respectively. However, grouping for phase 3 could not accommodate close balancing with respect to phase 2 treatments, distribution of animals previously grazed at stocking rates of 4 and 3 heifers/ha being 8:11, 15:4 and 8:9, respectively. All possible combinations of previous treatments in phase 1 and 2 were represented in each phase 3 group, by numbers of animals ranging from 2 to 7 per combination.

All heifers grazed at a stocking rate of 3.75/ha in 4 paddocks of 1.3 ha per treatment, with a rotational cycle of 28 to 32 days. Treatment 1 included no supplementation; treatment 2 included feeding a 14% CP commercial concentrate at the rate of 2.5 kg per head daily beginning 200 days before the anticipated date of parturition; treatment 3 included 4 kg daily of the same concentrate beginning 125 days prepartum. Heifers were bred naturally at first observed estrus after reaching a minimum LW of 340 kg and rebred as needed until diagnosed pregnant by rectal palpation.

This phase lasted 315 days altogether, from 23 October 1980 to 3 September 1981, but heifers calving too soon to continue until the latter date completed either 259 days (until 9 July) or 287 days (until 6 August) of experimentation. All 57 animals were included in the first 9 weighing intervals, whereas 39 and 29 were weighed after the 10th and 11th intervals. To avoid possible complications due to transportation stress, near term heifers were returned to their home farms at least 2 weeks prior to expected calving. Analysis of variance of LW response data included 2 specific treatment comparisons: 1 vs. 2 + 3 and 2 vs. 3 (9).

Upon being returned, the 56 privately owned animals were distributed among 3 farms; 37 went to Montellano Farm in Cayey; 10 to Comercial

Manatí; and 9 to Monserrate Norte, both in Manatí. Respective numbers of heifers from phase 3 treatment groups 1, 2 and 3 at the 3 respective farms were as follows: 9, 16 and 12: 5, 2 and 3; 4, 1 and 4. The identifications of 2 of the 4 former treatment 3 heifers returned to Monserrate Norte were lost at the new location, thereby precluding their inclusion in the follow-up observations. The 18 control heifers from phase 3 continued without supplementation during the interim until first calving. Nineteen and 17 animals that had been in treatments 2 and 3, respectively, during phase 3 received 2.3 kg per head daily of a 14% CP concentrate in addition to grazing improved pastures until calving. Three former treatment 2 animals, all at Montellano, were also lost to the follow-up period; one that changed owners before calving, another that died of unknown reasons 6 days before the expected calving, and a third that died from the effects of delivering an oversized calf.

First parturitions of the remaining 51 animals occurred from 28 July 1981 to 13 March 1982; frequencies were as follows during the 9 successive calendar months: 1, 13, 15, 6, 4, 8, 2, 0 and 2. All but the last 4 calvings took place within a span of slightly less than 5 months. Postpartum all animals received the usual herd management at each farm. The feeding programs were based on grazing supplemented with high levels of concentrates. Pertinent performance data were recorded by the farm manager and compiled by the investigators until January 1983, when at least the first 305 days of all first lactations had been completed.

RESULTS AND DISCUSSION

PHASE 1

Means ± SE of initial LW of heifers assigned to treatments 1 and 2 were 166.6 ± 2.7 and 166.5 ± 2.8 kg, respectively. During the 3 successive weighing intervals of approximately 30 days each, treatment-1 heifers registered mean daily gains of 0.33, 0.49 and 0.40 kg. Slow growth during the 1st interval may have been due in part to excessive rainfall, which has been shown previously to be an adverse factor (4). A total of 194 mm of rain fell in February 1980; more moderate precipitations of 93 mm in March and 48 mm during the first 24 days of April coincided with somewhat better growth rates. Daily maximum and minimum ambient temperatures were 29.2° C and 18.3° C over-all, with only slight month to month variation. Heifers of smallest initial size were not at a greater relative disadvantage without supplementation than larger animals of the same treatment; eight animals weighing 150 kg or less at the start equalled the group mean (0.41 kg) in over-all daily gain (table 1).

Concentrate supplementation of 2 kg per head daily (treatment 2) had a marked effect on growth rate. During 3 successive weighing intervals these heifers gained 0.55, 0.82 and 0.54 kg daily, or an average of 0.64 kg for the whole growing period (table 1) which surpassed (P = 0.01) the daily weight gain of the unsupplemented control heifers. The difference (P = 0.01) in mean LW at termination of phase 1 in favor of treatment 2 was 21.1 kg (224.6 ± 3.9 vs. 203.5 ± 3.8 kg, table 1). In this study supplementation enhanced growth more than in most previous experiments with grazing dairy heifers in which higher rates of pasture fertilization were used, but not higher stocking rates (4). However, since 8.6 kg of concentrate was consumed by treatment-2 heifers for each additional kg of LW gain above that achieved with grazing alone, the economic efficacy of supplementation is questionable unless the additional increment in body size is of some long-term benefit.

TABLE 1.—*Liveweight responses and concentrate supplementation in phase 1*

	Treatments		
	1 Grazing only	2 Grazing + concentrates	Difference 2 − 1
Initial LW (kg)	166.6	166.5	−0.1
Final LW (kg)	203.5	224.6	21.1[1]
LW Gain			
total (kg)	36.9	58.1	21.2[1]
daily (kg)	0.41	0.64	0.23[1]
Concentrate consumption			
total (kg)	0	182	182
per unit of additional gain (kg/kg)	—	—	8.64

[1] Significant at P = 0.01.

PHASE 2

Mean LW at the start of the new groups assigned to treatments 1 and 2 (table 2) differed by only 1.7 kg (217.4 ± 4.5 vs. 219.1 ± 5.5 kg, respectively). At the end of phase 2, 182 days later, there was a 12.7 kg advantage for treatment 2 (313.1 ± 4.9 vs. 325.8 ± 7.0 kg), but this was not significant (P = 0.05). However, the difference between treatments in LW gain (table 2) of 11.0 kg total or 0.06 kg daily, was P = 0.01. Total LW increase per ha during this phase was 382.8 kg from 4 animals vs. 320.1 kg from 3 animals in treatments 1 and 2, respectively, representing a 16.4% advantage for the former. That higher stocking rate produced less rapid gain per animal but more total gain per unit of land is in accordance with relationships described by Mott (2). On balance, the 4/ha stocking rate was more advantageous, as it combined an adequate growth rate per animal (0.53 kg daily) with an appreciably greater yield of animal product per ha.

Effects of previous (phase 1) treatments on results in phase 2 can also be seen in table 2. Mean LW advantages of previously supplemented over nonsupplemented animals at the start of phase 2 were 25.3 and 30.4 kg in treatments 1 and 2, respectively. Among the former, effects of previous supplementation were partially compensated; the difference in question at the end of phase 2 was 18.1 kg. However, in treatment 2 the opposite trend was seen, the difference between former treatment groups increased to 35.6 kg upon completion of phase 2. The latter result was unexpected, since with a lower stocking rate in treatment 2, a greater degree of compensation by previously restricted heifers would seem logical. This inconsistency in compensatory growth was not enough to produce a significant (P = 0.05) interaction of present × previous treatment in either rate of gain or final LW in phase 2. On balance, the positive effect of supplemental feeding during phase 1 was maintained through phase 2.

TABLE 2.—*Liveweight responses in phase 2*

	Treatments		
	1 Stocking rate 4/ha	2 Stocking rate 3/ha	Difference 2 − 1
Initial LW (kg)	217.4	219.1	1.7
Supplemented in phase 1 (kg)	230.0	234.3	
Unsupplemented in phase 1 (kg)	204.7	203.9	
Final LW (kg)	313.1	325.8	12.7
Supplemented in phase 1 (kg)	322.1	343.6	
Unsupplemented in phase 1 (kg)	304.0	308.0	
Total gain (kg)	95.7	106.7	11.0[1]
Daily gain (kg)	0.53	0.59	0.06[1]
Supplemented in phase 1 (kg)	0.51	0.60	
Unsupplemented in phase 1 (kg)	0.55	0.57	

[1] Significant at P = 0.01.

However, pasture herbage alone was adequate as a ration for growing heifers in phase 2. Daily gains in LW registered in individual weighing intervals ranged as follows: treatment 1, 0.35 kg minimum in 4th to 0.73 kg maximum in 5th; treatment 2, 0.37 kg minimum in 5th to 0.77 kg maximum in 1st. Rainfall was abundant; a total of 976 mm was recorded during 182 days. June was the only month of limited precipitation (24 mm), whereas excesses occurred during several months, maximum was 255 mm in August. No consistent effect of rainfall pattern on LW gains could be detected. Daily maximum and minimum ambient temperatures averaged 32.3° C and 21.4° C during phase 2.

PHASE 3

In phase 3 effects of previous treatments, non-supplemented (NS) or supplemented (S) in phase 1 and stocking rate of 4 or 3 animals/ha in phase 2, on growth were small and unimportant. General mean for daily LW gain during the first 259 days (while the 3 groups remained intact) was 0.61 kg. Three of the four possible combinations of previous treatments, e.g. NS-4/ha, S-4/ha, and S-3/ha, were associated with nearly identical daily gains in phase 3 of 0.62, 0.63 and 0.62 kg, respectively; the

TABLE 3.—*Liveweight responses and concentrate supplementation during phase 3*

	Treatments		
	1 Grazing only	2 Grazing + 2.5 kg concn. daily from 200 days prepartum	3 Grazing + 4 kg concn. daily from 125 days prepartum
Initial LW (kg)	318.0	318.0	318.0
LW after 259 days (kg)	466.3	485.0	478.2
Final LW at Corozal (kg)	484.9	512.8	497.3
LW gain in 259 days[1]			
total (kg)	148.3	167.0	160.2
daily (kg)	0.57	0.64	0.62
LW gain including days beyond 259			
total (kg)	166.9	194.8	179.3
daily (kg)	0.57	0.66	0.62
Supplementation during 259 days			
supplemented days of total (%)	—	43.2	14.6
consumption per total day (kg)	—	1.08	0.58
Supplementation during entire experiment			
supplemented days of total (%)	—	50.0	17.2
consumption per total day (kg)	—	1.25	0.69
total consumption (kg)	—	6990	3784
per unit of additional gain (kg)	—	13.2	16.1

[1] Difference treatment 1 vs. treatments 2 + 3 significant at P = 0.01.

mean corresponding to the 4th combination, NS-3/ha, was slightly lower (0.58 kg). All heifers previously S in phase 1 gained 0.62 kg vs. 0.60 kg for NS; those grazed at 4/ha in phase 2 showed a mean of 0.62 kg vs. 0.60 kg for those grazed at 3/ha.

Heifers of treatment 1 (grazing alone) in phase 3 gained 0.57 kg daily over a period of 259 days (table 3). At a stocking rate of 3.75 animals/ha, this is equivalent to a total daily LW increase of 2.14 kg/ha. Interestingly, predicted LW gain/ha, corresponding to the level of fertilization in question (1.12 tons annually with 15% N), according to the quadratic regression equation relating these 2 variables of Vicente-Chandler et al. (11, fig. 32), is 767 kg per annum or 2.10 kg daily. Similar agreement with this predicted value was found both for treatment 1 in phase 2 (2.12 kg/ha), at a stocking rate of 4/ha, and for treatment 1 in phase 1 (2.05 kg/ha), at 5 animals/ha. These findings support the contention that suitable stocking rates were employed for the level of fertilizer applied. However, studies of longer duration are needed, including determination of long-term effects on the stand of pasture forage.

During successive weighing intervals of approximately 4 weeks duration in phase 3, slowest growth in treatment 1 (0.29 kg daily) occurred during the 2nd (from 22 November to 22 December). At this point a deterioration in the stand of desirable botanical species, with invasion by annual weeds, was evident. This point of minimum animal response had been preceeded by a 1st interval of 0.49 kg daily gain and was followed by rates of 0.58, 0.42 and 0.46 kg daily in 3rd, 4th and 5th intervals, up until 17 March. Thereafter, pasture quality improved markedly and daily gains of 0.70, 0.89, 0.75 and 0.58 kg were registered in the 4 succeeding intervals completing 259 days of phase 3. Rainfall totaled 259 mm during the 30 days prior to commencing phase 3, then declined to 49 mm during 1st weighing interval, the only period of relative moisture scarcity. Succeeding intervals coincided with rainfall ranging from 80 mm in the 9th to 373 mm in the 6th.

During the first 4 weighing intervals, concentrate supplementation scarcely began in treatment 2 and was nonexistent in treatment 3; thus animals of these treatments also had essentially a grazing-only alimentation. Mean gains by animals of these respective groups during the said weighing intervals were as follows: 1st, 0.36 and 0.56 kg; 2nd, 0.31 and 0.28 kg; 3rd, 0.47 and 0.49 kg; 4th, 0.39 and 0.64 kg. On balance, treatment group 3 heifers gained slightly faster than the controls over this 118-day period (0.49 vs. 0.44 kg), whereas those of group 2 grew more slowly (0.38 kg). In the case of treatment 3, supplementation was also zero during the 5th interval and barely began in the 6th. During the former, rate of gain for treatment 3 again surpassed that of the control (0.72 vs. 0.46 kg), but during the latter it was slightly inferior (0.64 vs. 0.70 kg).

With 8 heifers in treatment 2 receiving concentrates during all or part of the 5th interval, mean gain for the group was 0.56 kg daily. Thereafter, 15, 17 and 19 animals of this group were supplemented in 6th, 7th and 8th and 9th intervals. Corresponding growth rates increased to 0.71, 1.17, 1.09 and 0.76 kg. Concentrate supplementation in treatment 3 excluded eight animals altogether and was practiced on only 14.6% of the total animal-days while the group remained intact (table 3). It included 7 and 11 animals during 7th and 8th and 9th intervals, respectively. Corresponding daily gains averaged 0.78, 0.85 and 0.63 kg. Mean daily LW gain over 259 days was 0.64 and 0.62 kg in treatments 2 and 3, respectively (table 3). An advantage ($P < 0.01$) for treatments 2 and 3 combined over treatment 1 was found in this criterion. When observations made on incomplete groups of animals beyond 259 days of phase 3 are included, mean growth rate is altered only for treatment 2 (table 3). As in phase 1 of the present study and in previous experiments (3, 4, 5), supplementation produced little additional LW gain over that achieved with the grazing-only control (table 3).

There were discernible effects of treatments received previously, in phase 1 and 2, on LW after 259 days of phase 3. Mean LW over-all at this point was 476.5 kg (SD = 40.4 kg and CV = 8.5%). Twenty-nine heifers that had received supplementation in phase 1 began phase 3 with a 24.1 kg advantage in mean LW over 27 previously non-supplemented heifers (329.9 vs. 305.8 kg), within-group variability (SD) of the 2 respective groups differing little (30.1 vs. 28.0 kg). This mean difference increased by 4.6 kg during 259 days of phase 3 to 29.5 kg (491.2 vs. 461.7 kg), whereas variability increased more in the previously non-supplemented group, respective SD reaching 33.3 and 42.7 kg. The probable cause of this increasing advantage for previously supplemented animals was more advanced pregnancy. After 259 days of phase 3, 20 of 29 (69%) of the animals of the former group were in the last 90 days of pregnancy, whereas only 12 of 27 (44%) of the latter group was at that stage, when gestation has a measurable effect on maternal LW. Mean number of days pregnant at the point in question in previously supplemented and non-supplemented heifers was 196 and 158, respectively. Thus, supplementation during phase 1 decreased age at conception by slightly more than 1 month on average, but did so at a cost of 182 kg of concentrate per head. Supplementation in phase 3 was not applicable in this regard, as it began in treatments 2 and 3 subsequent to conception.

Thirty-one and 24 heifers grazed at 4 and 3 animals/ha in phase 2 differed on average by 12.4 kg in LW at the start of phase 3, but by only 6.5 kg 259 days later. Corresponding increases in SD were nearly the same within both groups (313.4 ± 28.3 vs. 325.8 ± 34.2 and 474.7 ± 37.8 vs. 481.2 ± 45.0, respectively). This decreasing mean difference might be interpreted as partial compensation by heifers previously under less favorable conditions, although the magnitude of the effect is too small to be of practical importance. On balance, suitability of the 4 animals/ha stocking rate in phase 2 is reconfirmed.

Mean LW for treatments 1, 2 and 3 were all 318.0 kg upon beginning phase 3, with SE of 6.7, 7.9 and 7.1 kg, respectively; corresponding figures 259 days later were 466.3 ± 7.9, 485.0 ± 9.6 and 478.2 ± 10.2 kg (table 3). However, effects of treatments in phase 3 on this criterion did not reach significance at P = 0.05. Mean final LW based on last weighings at Corozal showed somewhat greater differences in favor of treatment 2, of 27.9 and 15.5 kg over treatments 1 and 3, respectively (table 3).

FOLLOW-UP PHASE

Numbers of animals of former treatment groups 1, 2 and 3 that completed first lactations of 305 days or more in proportion to the total were 13/18, 6/16 and 14/17, respectively. Mean 305-day lactational milk productions, computed from once monthly milk weights, and extending incomplete records to standard length where appropriate (1), were 4282, 3771 and 3869 kg for the 3 former treatments, respectively. Corresponding SD and CV were 789, 1201 and 919 kg and 18.4, 31.8 and 23.8%. Thus the grazing only treatment of phase 3 was associated with both a higher mean and greater uniformity in this criterion than the treatments involving supplemental concentrates prepartum. Farm means ranked as follows: Monserrate Norte, 4512 kg; Montellano, 3956 kg; Comercial Manatí, 3708 kg. Neither former treatments at Corozal nor farm where 1st lactation was made, nor interaction of these two factors had significant effects (P = 0.05).

The present results, together with those of previous studies on Holstein heifers in humid regions of Puerto Rico (3, 5) and reports from Cuba on work with ¾ Holstein × ¼ Zebu (6, 8) or ½ Holstein × ½ Zebu heifers (7) in a climate of wet-dry seasons, form an inconsistent picture of the effect on postpartum lactational performance of feeding concentrates prepartum to animals reared on well managed tropical pastures.

At present it is not clear whether any real effect exists, independent of body size at calving. Theoretical mechanisms for such effects might include adaptations of the digestive tract, especially where high levels of concentrates are fed postpartum, or differing activities of diverse metabolic pathways, more or less favorable to lactation as opposed to body tissue synthesis, resulting from differences in products of digestion being absorbed.

Greater postpartum attrition rate among previously non-supplemented heifers was a concern in previous studies (3, 5), but not in the present case. Only 1 of 18 former treatment 1 animals was lost during first lactation because of accidental death; as of January 1983, 14 of 17 survivors had calved a second time, two were bred and pending pregnancy diagnosis, and one was a definite problem breeder. Of 16 former treatment 2 animals, 3 were sold after short first lactations because of low production. Lameness was an aggravating factor in 2 of these cases. Ten of the remaining 13 had calved for a second time, 2 had been diagnosed pregnant, and 1 was a reproductive problem case as of last observation. Among 17 former treatment 3 animals, 3 aborted during their second reproductive cycle, but by January 1983, 9 had calved again, 2 were diagnosed pregnant, two had been bred once or twice and were awaiting diagnosis, 3 bred 5 times or more without positive results, and 1 not rebred after aborting. Upon comparing combined data from treatments 2 and 3 (with prepartum concentrate supplementation) with the grazing-only control, we found that 15 of 33 (45%) of the former, and 8 of 18 (44%) of the latter animals began their second lactation in the herd after a cycle of normal length, not exceeding 13 months.

In phase 3 and after returning to home farms some slight evidence was found of a benefit from concentrate supplementation on the incidence of problems at first calving. Among 18 animals fed on grazing alone during these stages, there was 1 abortion plus 4 cases of dystocia, including 2 stillborn calves. Aside from 1 previously mentioned death at first calving, 30 of 33 remaining supplemented animals had uneventful parturitions and 32 of 33 calves were born live. Unfortunately, only 2 maternal LW after calving of non-supplemented animals were recorded (452 kg mean); thus there was no meaningful comparison with the 464 kg mean observed in 12 former treatment 2 and 3 animals. Nine first calves of non-supplemented and 20 of supplemented heifers had nearly alike birth weights of 37.2 and 36.8 kg, respectively.

Systematic follow-up observations on large numbers of both prepartum supplemented and non-supplemented heifers would be highly desirable for adequate assessment of this aspect of rearing replacement heifers. Nevertheless, experimental data thus far available support the conclusion that nearly all prepartum concentrate feeding can be eliminated without adverse consequences for dairy heifers on excellent tropical pastures.

RESUMEN

Este experimento abarcó 3 fases sucesivas en la crianza de novillas Holstein en Corozal, en pastos polifitos, abonados con 168, 56 y 112 kg anuales de N, P_2O_5, K_2O, respectivamente, en 3 repeticiones. La edad y el peso vivo (LW) medio iniciales fueron 9 meses y 167 kg. Durante la fase 1 (91 días), 39 animales testigo, pastando a 5 cabezas/ha y sin suplementación, arrojaron un aumento diario de peso de 0.41 kg, menor ($P < 0.01$) que el de otro grupo igual, suplementado con 2 kg diarios de alimento concentrado con 14% de proteína bruta (0.64 kg). Sin embargo, hubo un consumo exagerado de 8.6 kg de alimento concentrado por kg de aumento adicional al del testigo. Durante la fase 2 (182 días), 32 novillas pastadas a 4 cabezas/ha aumentaron menos ($P < 0.01$) por cabeza que 24 animales a 3 cabezas/ha (0.53 contra 0.59 kg diario), pero el aumento total por hectárea fue 16.4% mayor en las 32 novillas a 4 cabezas per hectárea.

Durante 259 días de la fase 3, mientras 3 grupos de 27 novillas se mantuvieron intactos, pastar solamente a 3.75 cabezas/ha (tratamiento 1) arrojó un aumento menor ($P < 0.01$) que los de los tratamientos 2 y 3, que incluyeron pienso concentrado a razón de 2.5 ó 4 kg diarios comenzando 200 ó 125 días antes del parto (0.57 contra 0.64 y 0.62 kg, respectivamente), pero la eficacia de la suplementación para inducir aumentos que rebasaran el del testigo fue muy baja. Durante 259 días el peso medio (LW) aumentó de 318 kg (en los 3 grupos) a 485, 513 y 497 kg en los tratamientos 1, 2 y 3, respectivamente. Los integrantes de estos dos últimos grupos siguieron recibiendo pienso concentrado luego de regresar a sus fincas de origen en Cayey y Manatí hasta el primer parto, luego del cual todos los animales se sometieron al cuido corriente del hato. La producción media de leche durante 305 días de la primera lactancia fue de 4,292 kg por 18 animales testigo de la fase 3, lo cual superó, pero no significativamente ($P > 0.05$) a las producciones de 3,771 y 3,869 kg de 16 y 17 animales previamente en los tratamientos 2 y 3, respectivamente. Se concluye que la densidad de apacentamiento utilizada fue la idónea en cada etapa, según la capacidad de los pastos, y que la suplementación con piensos concentrados fue innecesaria bajo estas condiciones.

LITERATURE CITED

1. McDaniel, B. T., R. H. Miller and E. L. Corley, 1965. DHIA Factors for projecting incomplete records to 305 days. Dairy-Herd-Improvement Letter, 41 (6).
2. Mott, G. O., 1960. Grazing pressure and the measurement of pasture production. Proc. 8th Int. Grassl. Cong., Reading, England, p. 606.
3. Randel, P. F. and N. Mendoza, 1983. Effects of concentrate supplementation to Holstein heifers grazed at a high stocking rate on intensively managed pastures from breeding age to parturition. J. Agric. Univ. P.R. 67 (4): 476–85.
4. ——, J. H. Sanfiorenzo, J. Vélez and I. Carlo, 1985. Evaluation of several stocking rates and programs of supplemental feeding for rearing replacement dairy heifers on intensively-managed pastures. Agric. Exp. Stn., Univ. P.R. Bull. 275.
5. —— and J. Vélez-Santiago, 1985. Effects of grazing alone as against three schedules of supplementation from breeding age to first parturition in Holstein heifers. J. Agric. Univ. P.R. 69 (1): 69–79.
6. Simón, L. y J. Batista, 1980. Efecto del nivel y la carga en el crecimiento y desarrollo de hembras F_2 de reemplazo. Pastos y Forrajes 3 (1): 137–46.
7. —— and I. Hernández, 1977. Effect of different feeding systems on calving age and milk production during the first lactation of dairy grazing heifers, Cuban J. Agric. Sci. 11 (2): 151–7.
8. —— y A. Perdomo, 1979. Efecto de tres sistemas de alimentación sobre el crecimiento de hembras bovinas en crecimiento, Pastos y Forrajes 2 (2): 265–72.
9. Snedecor, G. W., 1956. Statistical Methods, 5th ed, Iowa State College Press, Ames.
10. Vicente-Chandler, J., F. Abruña, R. Caro-Costas, J. Figarella, S. Silva and R. W. Pearson, 1974. Intensive grassland management in the humid tropics of Puerto Rico. Agric. Exp. Stn. Univ. P.R. Bull. 233.
11. ——, R. Caro-Costas, F. Abruña y S. Silva, 1983. Producción y utilización intensiva de las forrajeras en Puerto Rico. Esta. Exp. Agric. Univ. P.R. Bol. 271.