Use of Dairy Cow Culls for Rearing Dairy Replacements for Beef[1]

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ABSTRACT

The use of culled cows on grazing to rear dairy heifers is viable, but rearing beef heifers or steers may be marginal.

Data on 132 calves (73 males and 59 females), from birth to 18 months, were obtained from January 1973 to November 1977. The calves were the progeny of purebred Holstein sires and purebred Holstein or grade Holstein cows from the Corozal Agricultural Experiment Substation of the University of Puerto Rico. The herd consisted of 43 cows, culled because of health disorders or delayed breeding, and 19 heifers from low-producing dams. Two Holstein bulls were kept with the herd to rebreed as early as possible following parturition. The calves remained with their dams until weaning at 4 months. They were placed on separate pastures until 18 months old. The male calves were castrated at 6 months. The animals were subjected to exclusive grazing of mixed grasses: Pangola, Guinea, and Pará. These were fertilized with 2240 kg of a 15-5-10 analysis per ha per year in 4 equal applications and were managed under rotation at a stocking rate of 2.5 cows or 5 young animals per ha.

The F-values due to fitting year and sex effects were significant (P .05) in all age groups. Year effects were greater in the middle age groups (8 to 14 months). Sex effects were fewer at birth (5.3%) but accounted for 10 to 13% of the variation in weight after 4 months. At 4 months, males averaged 10.1 kg heavier than females, but this difference increased only by about 8.0 kg by 18 months. The correlation between weights at parturition and at weaning was high (+0.92), suggesting little or no interaction effect of calf sex, calving season or cow age on body weight changes from parturition to weaning. Overall mean calving interval was 348 ± 73.1 days; this interval is attributed to the rapid rate of rebreeding and the few cows culled for sterility. The mean calf daily gains were 1.12, 0.27, and 0.56 kg from 0 to 4, 4 to 10, and 10 to 18 months of age, respectively, suggesting that the heifers could be bred by 17 months. With mean daily gains of 0.52 to 0.54 kg after 18 months, expected calving age would be around 28 months with a mean weight above 480 kg.

INTRODUCTION

Dairy cull cows constitute the principal source of slaughter animals in Puerto Rico. González-Villafañe (4) showed that 50% of the cattle sacrificed in the regional slaughterhouses of Puerto Rico are dairy cull cows. Bulls and heifers constitute 30% and 17% of the remaining cattle slaughtered, respectively. Local beef production represented only 40% of the total consumption in 1977–78, which was 60 million kg. Of primary

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concern to the local beef industry are the possible economic advantages which may result if dairy cull cows are used in a cow-calf enterprise.

The principal asset of any beef enterprise is the availability of good-quality pastures. Vicente-Chandler et al. (11) reported no significant differences in liveweights of 88 recently weaned bulls of 8 different breeds and crosses fed exclusively on 36 ha of steep grasslands in the humid mountains of Puerto Rico for a 1-year period. Holstein bulls gained 193 kg per head per year versus 210 kg for Red Polled bulls. Carlo et al. (1) determined that bulls and heifers from crosses of pure or grade Holstein cows with Brahman bulls were superior to Holstein-Angus and Holstein-Charolaise crosses.

Carlo and Vélez (3) showed that dairy cull cows can rear satisfactorily both their own and an adopted calf to 8 months of age on pasture alone. Mean calving interval between the first and second calf crops was 416 days. They also reported as uneconomical limited concentrate feeding (1.8 kg per head per day) to 4-month-weaned calves on pasture from 4 to 8 months.

The purpose of this study was to evaluate the effect of early weaning (4 months) on the future performance of steers and heifers on pasture alone. The relation of early weaning to the reproductive performance of cows and heifers was also evaluated.

MATERIALS AND METHODS

The study was conducted at the Corozal Agricultural Substation from January 1973 to November 1977. The mean annual temperature was 24.6° C, ranging from 26.5° C in July to 22.4° C in January. The mean monthly rainfall was 13.6 cm, with a range from 4.4 cm in June to 24.6 cm in October.

There were 62 cows, principally of the Holstein breed, with 137 parturitions from January 1973 through May 1976. Five of the pregnancies were terminated by abortion or by death of the calf after birth. Data on 132 calves (73 males and 59 females), progeny of purebred Holstein sires, were used in the analysis, including body weights from birth to 18 months of age.

Initially, the herd consisted of 34 cows, culled from dairy herds because of health disorders or delayed breeding, and of 19 heifers from low-producing dams. Forty-five percent of the herd was pregnant from 2 to 8 months, in January 1973. Nine additional cull cows were added later. The cows ranged in age from 2.5 to 10.0 years.

Two Holstein bulls were kept with the herd continuously in order to attain rebreeding as early as possible following parturition. The cows were examined for pregnancy between 195 and 205 days post-partum. Those not pregnant for at least 46 days were removed from the herd. The

mean number of cows for the years 1973 through 1976 was 40, 52, 42 and 52, respectively. The cows were weighed when they entered the herd, the day following each parturition and at the time of calf-weaning.

The calves were with their dams continuously until weaning. They were then placed on separate pastures and remained there until 18 months of age. The male calves were castrated at 6 months of age. Periodically, all calves were treated for the control of endo- and ecto-parasites. Although the females reached puberty prior to 18 months, they were not bred so that growth rate would not be confused with pregnancy. The calves were weighed at birth and at weaning (4 months), followed by weighing at bi-monthly intervals up to 18 months.

The basic statistical model used was:

$$Y_{ijk} = \mu + a_i + s_j + e_{ijk}$$

where,

y_{ijk} = weight for a given animal in the i^{th} year and the j^{th} sex
μ = effect common to all animals
a_i = effect of the i^{th} year (1973, 74, 75, 76)
s_j = effect of the j^{th} sex, male or female
e_{ijk} = random error, $E(e) = 0$, $Var(e) = \sigma^2$

Normal equations (10) were set up for the different ages and solved, with the necessary constraints. Additive adjustment factors were used to correct all weights. Assuming a normally distributed error term, the analysis of variance (10) for fitting the model in each group was calculated.

Season effects were not included due to disproportionate distribution. Of the 137 calvings, 81 occurred during the 4 months from January through April, with 56 spread over the other 8 months, ranging from 2 in July to 13 in November. Gestation number was deleted from the analysis due to confounding with year effects. This was because the majority of the cows had sequential calvings in 2 or more years. Mean calvings per cow were 2.1.

The animals were subjected to exclusive grazing on improved mixed grasses: Pangola (*Digitaria decumbens*), Guinea (*Panicum maximum*), and Pará (*Brachiaria purpurascens* (Raddi) Hnr.). These were fertilized with 2,240 kg of a 15-5-10 analysis per ha per year, in four equal applications at trimonthly intervals. The soil was limed at the same rate in a single application when necessary to maintain the pH at 5.5 or higher. The pastures were managed under rotation, at a stocking rate of 2.5 cows or 5 young animals (227 kg each) per ha. Mineral supplement and water were available at all times in the pasture.

Simple correlations were calculated among all calf-age body weight groups, between calf weight and dam weight the day following parturition (calving), and between dam weight at weaning and calf weight.

RESULTS AND DISCUSSION

YEAR AND SEX EFFECTS

Table 1 presents the unadjusted means for body weight at various ages of all records, by sexes and by year. The *F*-values due to fitting year and sex effects were significant ($P < .05$ or $P < .01$) over all age groups (table 2). The year effects were larger in the middle age groups (8 to 14 months), accounting for 10–12% of the variation. Up to 6 months of age and at 16 or 18 months, the year variance was only 6%.

Variation of weight among years is illustrated by the deviations from the base year, 1973, in fig. 1. The estimates in kg are in table 3. At least two factors were identified as contributing to year differences. The stocking rate for the cows was regulated to 2.5 per ha, but it was not possible to control the young stock closely. In 1973, all the calves were young. From mid-1974 to the end of 1975, there was a wide range in size of the heifers and steers, thereby reducing diet selection even though numbers per ha remained stable. By 1976, stocking rate was lower. Rainfall during 1974 and 1975 was below average (13), decreasing the quantity of forage available.

The higher growth rate up to weaning during the last 3 years was attributed to the cows having higher body weights at the time of parturition. Prior to their calving for the first time in the experiment, the cows were accustomed to other feeding regimes. Health disturbances, such as mastitis or foot problems, were less frequent in second and later calvings.

Sex effects were the least at birth (5.3%) but accounted for 10–13% of the variation in weight after 4 months. Males were the highest in rate of gain from birth to 4 months (fig. 2). At 4 months, males averaged 10.1 kg heavier than females but this difference increased only by about 8.0 kg by 18 months (table 3). After weaning (6–10 months), the males had a greater depression in growth rate than females probably because of the effect of castration. After recovery from castration and past 12 months, the males made compensatory gains.

Even though the magnitude of the simple correlations among weights at various ages was similar for both sexes, correlations for females were slightly higher after 10 months. The higher correlations for females indicate that their growth rates were more uniform than those for males.

EFFECT OF DAM WEIGHT

The mean body weight of all cows when they entered the study was 489.4 ± 72.2 kg. The high standard deviation was attributed mainly to the wide variation in cow ages. Mean cow weights at time of parturition was 546.0 ± 53.1 kg and at time of weaning was 524.9 ± 57.5 kg, indicating

TABLE 1.—*Means and standard deviations for body weight (kg) of Holsteins by sex and years at 9 ages*

	Number of records	Birth	Age (mo)							
			4	6	8	10	12	14	16	18
			Unadjusted Means (All records)							
Overall	132									
Mean		39.3	173.9	188.9	203.4	222.6	248.6	283.4	320.7	356.8
S.D.		5.4	19.9	21.3	23.4	26.9	30.3	32.6	34.9	35.9
			Sexes							
Male	*73*									
Mean		*40.2*	*181.8*	*199.9*	*214.2*	*233.9*	*261.2*	*297.3*	*335.9*	373.1
S.D.		*5.4*	*19.9*	*18.6*	*21.8*	*26.6*	*30.8*	*32.9*	*35.0*	34.7
Female	*59*									
Mean		*38.3*	*164.0*	*175.3*	*190.1*	*208.6*	*233.0*	*266.2*	*301.8*	336.7
S.D.		*5.1*	*14.9*	*16.1*	*18.2*	*20.1*	*21.3*	*22.8*	*23.8*	25.8
			Years							
1973	29									
Mean		37.2	168.1	191.7	216.0	243.6	270.2	304.0	337.6	371.7
S.D.		5.1	19.0	21.2	26.3	32.2	36.9	39.0	43.2	46.0
1974	44									
Mean		39.8	173.0	188.4	201.1	217.0	245.4	280.7	317.3	352.2
S.D.		5.4	19.9	22.1	22.6	22.2	26.4	28.2	32.5	32.4
1975	40									
Mean		40.2	179.0	189.7	200.4	216.6	238.7	274.4	314.3	350.0
S.D.		5.8	20.6	20.7	20.0	20.8	23.62	27.0	25.6	28.2
1976	19									
Mean		39.7	174.0	184.1	196.0	216.3	244.0	277.3	316.1	359.3
S.D.		4.0	18.2	21.6	22.4	25.3	26.2	31.7	37.3	36.4

TABLE 2.—*Analysis of variance for fitting the model:* $Y_{ijk} = \mu + a_i + s_j + e_{ijk}$ *to body weights at various ages*

Age	MSR[1]	MSE[2]	*F*-values
Birth	423.0	130.0	3.31*[3]
4 mo	17739.6	1417.9	12.51**[4]
6 mo	24170.7	1514.7	15.96**
8 mo	26209.9	1935.4	13.54**
10 mo	38473.1	2421.4	15.88**
12 mo	46022.1	3158.3	14.57**
14 mo	50023.2	3754.8	13.32**
16 mo	52395.1	4433.8	11.82**
18 mo	59785.3	4570.0	13.08**

[1] MSR = Corrected mean squares for fitting the model (d.f.4).
[2] MSE = Error mean square (d.f. 127).
[3] Significant at the 5-percent level.
[4] Significant at the 1-percent level.

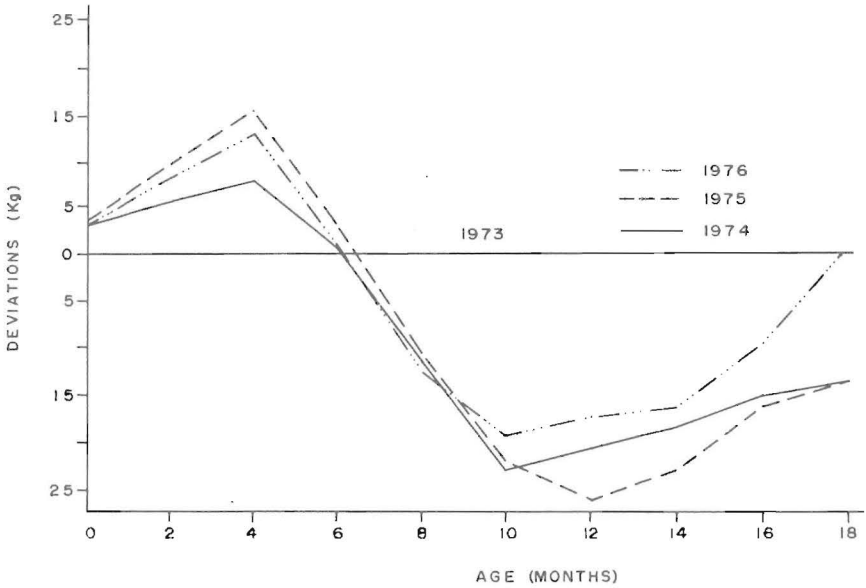

FIG. 1.—Estimated deviations (kg) for year effects in relation to year one (1973).

that the majority of the cows continued to lose weight throughout the suckling period.

Table 4 shows that the correlation between weights at parturition and at weaning was high (+.92); this fact suggests little or no interaction effect of calf sex, calving season or cow age on body weight changes from parturition to weaning. There were positive nonsignificant estimates of

TABLE 3.—*Estimated values (kg) for the effects of year and sex on body weight at various ages*

Estimated functions	Birth	Ages (mo)							
		4	6	8	10	12	14	16	18
Year [1]									
a_1	−2.4	−9.1	−1.3	8.4	16.1	16.0	14.6	10.3	6.8
a_2	.5	−1.1	−.8	−2.9	−6.8	−4.8	−4.2	−4.9	−7.0
a_3	1.1	6.3	2.2	−2.0	−5.9	−9.9	−8.4	−5.7	−6.9
a_4	.8	3.9	−.1	−3.5	3.2	1.3	−2.0	.3	7.1
Sex [2]									
s_1	1.2	10.1	12.4	11.1	11.1	12.5	14.1	16.1	17.9
s_2	−1.2	−10.1	−12.4	−11.1	−11.1	−12.5	−14.1	−16.1	−17.9
$\bar{x}$ [3]	39.1	172.3	187.4	202.4	222.4	248.5	282.9	320.0	356.8

[1] a_1 to a_4 correspond to years 1973 through 1976.
[2] s_1 = male; s_2 = female.
[3] $\bar{X}$ = overall mean.

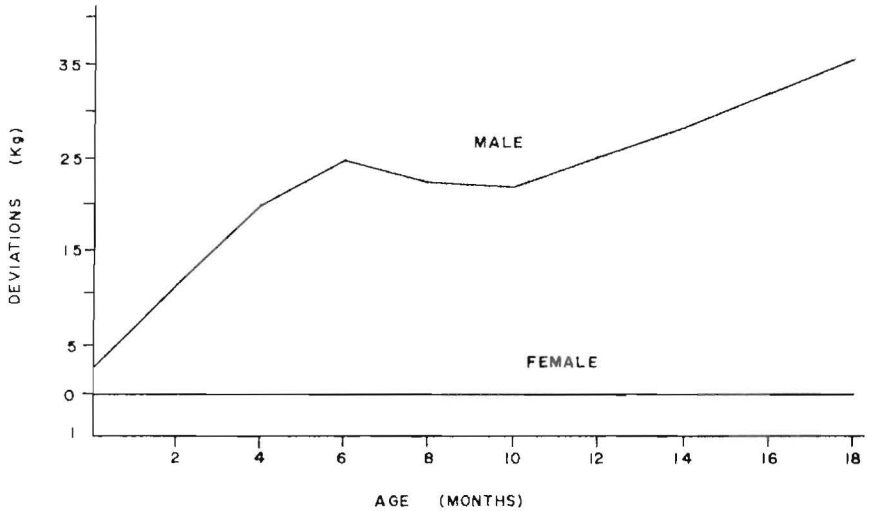

FIG. 2.—Estimated deviations (kg) for males in relation to females.

correlation between cow weights at both parturition and weaning and calf weights up to 6 months. After the calves reached 8 months, the correlations between dam weights and calf weights were slightly negative and mostly nonsignificant (tables 4 and 5). Dam weight was not significantly correlated with offspring weight at any time. The magnitude of the cow-calf weight correlations shows that under grazing conditions and early weaning, maternal effects of offspring development may be low. This conclusion is supported by the correlations between calf weights at less than 6 months of age with weights at later ages (table 5).

TABLE 4.—*Overall simple correlations for body weights*

	Cow weight[1]	Birth	Age (mo)							
			4	6	8	10	12	14	16	18
Cow weight										
Parturition[2]	.92**[3]	.10	.12	.02	−.05	−.12	−.12	−.20*[4]	−.18*	−.11
Weaning[1]		.09	.11	.02	−.09	−.15	−.15	−.23**	−.18*	−.12
Calf										
Birth			.67**	.58**	.40**	.33**	.36**	.34**	.35**	.30**
4 mo				.85**	.60**	.45**	.38**	.39**	.43**	.40**
6 mo					.82**	.69**	.63**	.60**	.61**	.58**
8 mo						.91**	.78**	.68**	.67**	.66**
10 mo							.89**	.79**	.75**	.73**
12 mo								.90**	.84**	.81**
14 mo									.95**	.85**
16 mo										.93**

[1] Weight of dam at weaning.

[2] Weight of dam one day after parturition.

[3] Significant at the 1-percent level.

[4] Significant at the 5-percent level.

CALVING INTERVAL

The overall mean calving interval was 348.0 ± 73.1 days. The interval following first parturition was 354.0 ± 45.3 days while the mean for subsequent calvings was 340.0 ± 87.8 days. The interval between first and late parturitions was attributed to the number of first calf heifers. The 348-day calving interval was 59 days less than for lactating cows at the Gurabo Agricultural Substation grazed at the same stocking rate (13). The period from parturition to first estrus at the Gurabo Substation was 67 days. In this study, the cows were required to be pregnant by 80 days postpartum; thus the onset of estrus was earlier than that observed at the Gurabo Substation.

TABLE 5.—*Simple correlations for body weights by sexes*

	Age (mo)							
	4	6	8	10	12	14	16	18
				Male				
Birth	.69**[1]	.61**	.37**	.26**	.26**	.31**	.34**	.26**
4 mo		.80**	.44**	.24**	.13	.19**	.25**	.20**
6 mo			.73**	.56**	.47**	.46**	.46**	.41**
8 mo				.88**	.70**	.57**	.54**	.54**
10 mo					.86**	.74**	.68**	.68**
12 mo						.88**	.79**	.76**
14 mo							.95**	.82**
16 mo								.90**
				Female				
Birth	.66**	.56**	.37**	.34**	.42**	.30**	.25**	.24**
4 mo		.84**	.57**	.46**	.46**	.28**	.32**	.28**
6 mo			.78**	.64**	.57**	.44**	.47**	.41**
8 mo				.90**	.76**	.61**	.60**	.52**
10 mo					.86**	.70**	.68**	.59**
12 mo						.86**	.80**	.71**
14 mo							.89**	.77**
16 mo								.90**

[1] Significant at the 1-percent level.

McDowell and Leining (6) pointed out that calving interval for Holsteins in tropical areas was longer than for temperate areas. This was principally due to the stress of the hot climate, which depressed appetite during the early stages of lactation, resulting in prolonged periods of body weight loss. The authors concluded that conception rate was low until the cows had either stabilized body weight or were in a gaining state. The performance of the cows in this study tends to refute the weight loss hypothesis, with reservations. The cows may not have been under as much stress as at the Gurabo Substation, since the calf did not remove as much milk as would have occurred in the normal milking processes. Also,

bulls were present continuously in this study while observations for estrus were made twice daily at the Gurabo study and breeding was by artificial insemination.

Several reports, such as those of Kaiser (5), McDowell and Leining (6) and Winks and Edgley (12), indicated that suckling per se may cause a delay in the onset of estrus. Kaiser (5) found that cows grazing tropical grass pastures, and being milked, averaged 34 days from parturition to first estrus; cows suckling one or more calves up to 12 weeks averaged 93 to 98 days to first estrus depending on the number of calves suckled. Kaiser (5) concluded that suckled cows rarely showed estrus until their calves were weaned at 4 months. Carlo and Vélez (3) reported a mean calving interval of 395 days when Holstein-type cows conceived approximately 125 days before the calves were weaned. These authors concluded that the delay in rebreeding was caused more by weight loss of the cows, resulting from higher milk production in feeding 2 calves rather than possible hormonal imbalances affecting the reproductive processes caused by suckling. The rapid rate of rebreeding and the small number of cows culled for sterility in the present study do not support a rebreeding inhibitor from suckling.

EXPECTATIONS FROM USE OF CULL DAIRY COWS

The estimated growth curve for Holstein calves (sexes combined) from birth to 18 months under the regime used are plotted in fig. 3. Up to 4 months, the mean daily gain (MDG) was 1.12 kg, which is approximately twice the rate obtained for calves hand-fed on dairy farms. This illustrated that Holstein calves can utilize large volumes of milk. From 4 to 10 months, MDG was lower than expected (.27 kg). In previous trials at the Corozal Substation, Holsteins weighing 170 kg when placed on grazing alone gained at a rate of .45 kg or higher during the first month (13). These animals were 7 to 8 months of age, indicating that the previous feeding system (soilage and concentrate) may be a factor in the utilization of pastures. From 10 to 18 months MDG was .56 kg, slightly higher than in some of the previous studies at the Corozal and Isabela Substations (2, 7).

Using 325 kg as the minimum desired weight for breeding Holsteins, the heifers could have been bred by 17 months (table 1). Bred at the first estrus following 17 months with 1.34 services per conception (7), the heifer would be expected to conceive at approximately 18.5 months. With MDG of .52 to .54 kg after 18 months, expected calving age would be around 28 months with a mean weight above 480 kg, which was the acceptable level set for Holstein heifers in Puerto Rico (7).

Yazman et al. (14) determined that the cost per cow per year on pastures similar to those in the current trial (fertilizer, lime, labor for

application, and interest on investment) was $200.00. The value for the slaughtering of heifers weaned at 4 months weighing 164 kg would be considerably less than $200.00. But $200.00 per heifer is similar to the estimated cost ($196.00) of rearing Holstein heifers from birth to 6 months (mean weight 160 kg) on a sample of DHIA farms in Puerto Rico (9). The barn-rearing cost included feed (milk, calf-starter, growing ration, and forage), interest on capital investment, prorated cost of equipment, and cost of medications but not labor. The labor costs and treatment for health disorders would be considerably lower on the nurse cow system,

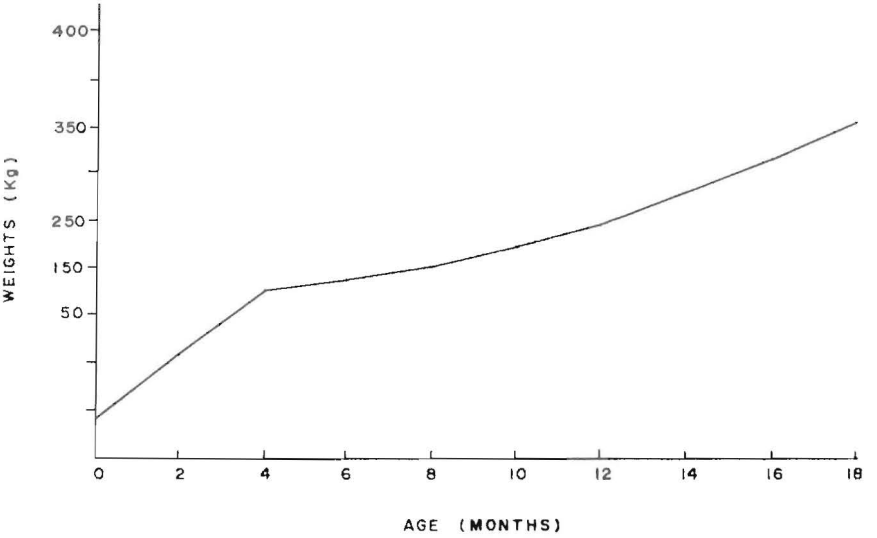

FIG. 3.—Estimated body weights ($\mu + \bar{a} + \bar{s}$) for Holsteins in a Puerto Rico environment from birth to 18 months of age.

and so would mortality losses. The conclusion is that the use of culled cows on grazing to rear dairy heifers is viable.

Is the system economically viable for rearing male calves for beef? If sold at weaning (182 kg), the value per kg must exceed $1.00 in order to break even on the $200.00 cost for the dam; therefore, it is not an attractive business. Selling the males at 18 months (375 kg) would still not be attractive as price per kg liveweight must be $.90 to cover dam cost and cost of grazing for the male. The estimated cost per kg of carrying the males to 450 kg weight at approximately 22 months of age would be $.78, which approximates market value. If the male calves had been castrated shortly after birth or left intact, expected mean weight would have been 400 kg at 18 months and 450 kg at 20 months. The conclusion is that using cull dairy cows on highly-fertilized pastures to

rear beef heifers or steers may be marginal. The opinions expressed on the use of cull dairy cows are similar to those expressed by Mullen (8) from experiences in Australia.

A cow depreciation cost was not included because it was assumed that there would be higher values when the cows were sold after two or more calvings. This assumption is based on the estimated weight of the cows at time of entering the herd (490 kg) and at time of sale (550 kg). The additional value of the cows would likely cover trucking cost and the small losses from an occasional death among the cows.

RESUMEN

Se utilizaron los datos de peso vivo de 132 becerros (73 machos y 59 hembras) desde el nacimiento hasta los 18 meses de edad, desde enero de 1973 hasta noviembre de 1977. Los becerros, progenie de toros Holstein y de vacas Holstein puras o cruzadas, se obtuvieron de la Subestación Experimental Agrícola de Corozal de la Universidad de Puerto Rico. El hato consistió de 43 vacas, desechadas de la vaquería debido a desórdenes de salud y a cruzamientos tardíos y de 19 novillas, hijas de vacas de baja producción lechera. Dos toros Holstein se mantuvieron todo el tiempo en el hato para cruzamiento tan pronto fuese posible luego del parto. Los becerros permanecieron con las madres hasta el destete a los 4 meses de edad y luego en pastos separados hasta los 18 meses de edad. Los becerros se castraron a los 6 meses de edad. Los animales utilizaron pastos exclusivamente de gramíneas mixtas: Pangola, Guinea y Pará. Los pastos se abonaron a razón de 2240 kg de un análisis 15-5-10 por ha y año en cuatro aplicaciones iguales. El apacentamiento se realizó a razón de 2.5 vacas o 5 animales jóvenes por ha.

Los valores *F* debidos a efectos de año y de sexo fueron significativos ($P < .05$) para todas las edades. Los efectos de año fueron mayores para los grupos de mediana edad (8 a 14 meses). Los efectos de sexo fueron los menores al nacimiento (5.3%), pero explicaron del 10 al 13% de la variación de peso después de los 4 meses. A los 4 meses, los machos alcanzaron un peso medio de 10.1 kg más que las hembras, pero esta diferencia aumentó solamente en 8.0 kg a los 18 meses. La correlación entre los peso al parto y al destete fue alta (+0.92), sugiriendo poco o ningún efecto de interacción de sexo, época de nacimiento o edad de la vaca en cambios de peso al nacer hasta el destete. El intervalo medio entre partos fue de 348 ± 73.1 días, siendo responsable de ésto la tasa rápida de cruzamientos y el limitado número de vacas descartadas o eliminadas por esterilidad. Las ganancias diarias medias de los becerros fue de 1.12, 0.27 y 0.56 kg de 0 a 4, 4 a 10 y 10 a 18 meses de edad, respectivamente, sugiriendo que las novillas se pueden cruzar a los 17

meses. Con ganancias diarias medias de 0.52 a 0.54 kg después de los 18 meses, la edad probable al parto sería alrededor de los 28 meses, con un peso medio de alrededor de 480 kg. Se concluye que el uso en pastoreo de vacas desechadas de vaquerías es viable para la crianza de novillas lecheras, pero para novillas y toros castrados de carne puede ser marginal.

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