Pelleted Maize Plants as a Forage Extender for Dairy Heifers on Improved Pastures in Puerto Rico[1]

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ABSTRACT

A study to determine the effects of a high quality roughage supplement on heifer groth rate was conducted at the Corozal Substation. Sixteen dairy heifers, averaging 190 kg, were subjected to a 43-day adjustment period to grazing of heavily fertilized Pangola grass (*Digitaria decumbens*). They were then assigned in equal number to either grazing of Pangola grass alone or grazing supplemented with 2.27 kg per day of dehidrated wholeplant maize (*Zea mays*) pellets. Grazing was at the rate of five head per ha, each treatment being rotated among four assigned pastures of 0.40 ha each. Both groups were rotated to new pastures simultaneously and weighed at 5- to 7-day intervals. The trial was terminated when body weights averaged 320 kg. During the early weeks, supplementation of pasture with maize pellets proved detrimental to weight gains as heifers grazing alone gained more rapidly than heifers on grass supplemented with maize pellets. This discrepancy was due primarily to maturation of herbage in the pastures grazed by the latter heifers.

Later in the trial the pellets were advantageous when pasture growth was inhibited by drought. Mean daily gain at 302 days was .29 and .44 kg for heifers on grazing only and on grazing and maize forage pellets, respectively.

Pastures were sampled before and after grazing by clipping six quadrats of 0.84 m^2 each. Differences between before and after yields were significant. Treatments, sampling before and after grazing, cycles, and pastures within treatments showed significant differences. Cycle × sampling before and after grazing was the only interaction of significance, indicating the effect of the drought on intake of forage.

The study showed that high-quality maize pellets are advantageous as feed for heifers on pasture, except when pastures are lush, plentiful and high in nutritive value.

INTRODUCTION

In Puerto Rico, many dairy replacement heifers are reared in confinement up to 150–200 kg body weight. Thereafter, they are fed almost entirely on pasture. It is possible, on grazing alone, to obtain Holstein heifers weighing over 480 kg and calves at 28 to 30 mo of age (1,8). Even

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with improved grass species and heavy fertilization, many dairy farmers still find the rearing of dairy replacements too expensive and prefer to import heifers from the continental United States. Land prices continue to rise, and there are problems which are due to seasonal variation in pasture yield and quality. Supplemental feeding of animals on pasture is the logical solution to variation in pasture quantity and quality and/or more intensive land use. However, results to date have not been encouraging. Carlo and Vélez (1) showed slightly higher gains for heifers (2.9 to 5.0 per ha) fed 2 kg per head daily of ground maize than for heifers either on grazing alone or receiving various amounts of a bulky feed plus pasture. They concluded that it was probably not economically feasible to use maize when feed and labor were considered, even though heifers receiving maize freshened 2 months earlier.

The objective of this study was to determine the utilization of a high-quality maize pellet for heifers on pasture and its effect on quantity and quality of pasture grass consumed. Pellets made from maize plants were used because in Puerto Rico it is technically feasible to dehydrate and pellet hybrid forage sorghum; these similar pellets (4) from forage sorghums would be only slightly lower in quality than maize pellets from the continental United States.

MATERIALS AND METHODS

The experiment was conducted at the Corozal Substation with 16 dairy replacement heifers, 7 to 9 mo of age, weighing 180 to 205 kg. It lasted approximately 9 mo, from May 25, 1976 to March 23, 1977. It was temporarily interrupted for 30 days from October 11 to November 12, 1976, for pasture recovery because of drought.

The heifers were reared on drylot and were placed on fertilized Pangolagrass (*Digitaria decumbens*) pastures. After a 43-day adjustment period to grazing, the heifers were assigned by weight pairs to two treatment groups. Each group was assigned to four pastures of .40 ha each. The heifers had free access to water and mineralized salt. Medication was given periodically when internal parasites were suspected.

One group (T_1) was allowed only grazing while the second group (T_2) was permitted free choice of grazing, plus 2.27 kg per head daily of maize forage pellets as a supplement. The pellets were placed in a trough in the pasture early each morning. Both groups were carried at a stocking rate of 5 head per ha. The trial was terminated when the heifers weighed at least 320 kg.

Fertilizer (15-5-10) was applied to the pastures at the rate of 2240 kg per ha per year, divided into equal applications of 560 kg every 3 mo. Lime was applied only once to reduce soil acidity.

Both groups were rotated to new pastures simultaneously and weighed

at 5- to 7-day intervals. Frequency of rotation was determined by the condition of the pastures.

Each pasture was sampled before and after grazing by being clipped to within 5 cm from the ground. Samples from six quadrats of 0.84 m^2 each per pasture were weighed and subsampled for dry matter (DM). Care was taken not to place the quadrats over areas recently sampled or fouled. After grazing, samples were obtained from areas adjacent to those sampled before grazing.

When the heifers showed signs of estrus, they were placed overnight in an adjacent pasture with a bull, and service dates were recorded. At the close of the experiment, in order to characterize body scale, heart girth, height at the withers and length from the withers to the pin bones were measured.

TABLE 1.—*Monthly 1976–77 rainfall versus the 1962–76 average at the Corozal Substation*

Month	1976–77	1962–76
	Cm	
May	7.8	17.7
June	3.5	8.8
July	3.4	11.3
August	9.6	15.1
September	13.1	16.0
October	37.8	24.2
November	5.6	19.9
December	9.0	18.7
January	12.2	12.9
February	2.0	9.8
March	4.9	11.3
Total	108.9	165.7
Mean	9.9	15.1

RESULTS AND DISCUSSION

Table 1 shows the rainfall pattern throughout the study, as compared to similar data recorded during the years 1962 to 1976. Rainfall from May to September and from November to December 1976 was 54% and 38%, respectively, of mean for a 15-year period (1962 to 1976). During the 9-mo period, rainfall was 66% of the mean for 15 years. Neither the animals nor the pastures for the T_1 heifers would have recovered normally from the drought, if the experiment had not been temporarily discontinued. The pastures grazed by the T_2 heifers would probably have recovered satisfactorily without interrupting the experiment.

It was expected that the experiment would quantify the extent to which a high-quality forage supplement could substitute for grazing, but some of the assumptions may not have been entirely valid, namely, that before and after pasture sampling would measure the quantity and quality of pasture consumed; and that regrowth after a grazing period would be equal in quantity and quality for both experimental groups. In order for the first assumption to hold, grass lost by trampling and fouling must equal the amount of new pasture growth during the grazing period. Variations in measurement of pasture yields were larger than expected. There is no doubt that a source of variation in sampling was caused by

TABLE 2.—*Mean body weight and mean daily gain of heifers on pasture alone (T_1) and on pasture plus 2.27 kg daily of maize forage pellets (T_2)*

Trial period[1]	Mean body weight		Cumulative mean daily gain	
Days			*Kg*	
	T_1	T_2	T_1	T_2
0	233	230	—	—
28	243	236	.38	.24
55	250	248	.33	.34
81	249	258	.20	.35
105	258	270	.24	.38
125	247	269	.11	.31
139[2]	246	270	.10	.29
170	259	288	.16	.34
197	274	301	.21	.36
225	285	320	.24	.40
248	298[3]	333	.26	.41
266	313[3]	349	.30	.45
279	322[3]	354	.32	.44
293	320[3]	360	.30	.44
302	321[3]	362	.29	.44

[1] Days correspond to the end of each grazing cycle.
[2] Trial discontinued for 30 days.
[3] Seven animals per treatment, instead of eight.

the amount of stubble remaining after cutting. The second assumption fails to consider genetic and physiologic limitations to plant growth. In spite of the limitations, some significant results were obtained.

The acceptability of pellets by animals on lush pasture is not a limiting factor, since all pellets offered were consumed rapidly. Heifers receiving pellets benefited by greater gains in weight (table 2). The supplemented heifers were also slightly taller (height at withers) and in body length (withers to pins) (table 3). This group was significantly better in condition or fatness as indicated by the higher values for heart girth (table 3). The latter observations coincide with findings from previous trials in Puerto

Rico (1,8). Six of the T_2 heifers were pregnant at the end of the trial, while in the group on grazing alone (T_1) there were only two pregnancies.

The relationship between animal performance and pasture data was difficult to establish, primarily because of sampling variation of the pastures. For example, it was not clear at the beginning of the experiment why heifers on grazing alone (T_1) gained more than the heifers receiving supplement (T_2) (table 2). The T_2 group no doubt had a lower total DM intake because they were consuming pellets which were highly palatable and not grazing pasture because it was less palatable. A more logical explanation would be in the additive and substitutive properties of the supplement to pasture. Maize pellets were substituting for pasture, allowing the herbage in the pastures grazed by the T_2 group to become more mature than that of the other pastures. Thus, the digestible DM intake of both maize pellets and pasture for the T_2 group was less than the digestible DM intake of the T_1 group. After the first cycle of pasture rotation, it was clear that more herbage remained after grazing in T_2

TABLE 3.—*Body dimensions of heifers on grazing alone (T_1) and on grazing plus 2.27 kg daily maize forage pellets (T_2)*

Body dimensions	T_1	T_2
	Cm	
Heart girth	713 ± 44.0[1]	793 ± 58.0
Height at withers	121.5 ± 2.5	123.8 ± 2.5
Length from shoulder to pins	119.8 ± 2.7	125.4 ± 2.2

[1] Standard deviation.

pastures than in those of T_1. This was as expected, but the amount of subsequent pasture regrowth was much less for T_2 pastures than for T_1 pastures. Consequently, T_2 pastures became more mature and, as a result, lower in quality.

The weight gain of the two groups was reversed when a drought period slowed pasture growth (table 2). During the drought period, the pastures grazed by the T_2 heifers had more plant material before and after grazing than the other pastures. Therefore, it is clear why heifers receiving supplemental forage made more rapid gains during the drought period than heifers on grazing alone.

Pastures were rotated more rapidly during the low rainfall period (table 1) for the benefit of the heifers on grazing alone. The result was beneficial to the heifers, but the period of pasture regrowth was shortened. When the drought period ended, the pastures did not recover as they would have in longer rotations. During the pasture recovery period, all heifers were put on lush pastures and pellets were discontinued for the T_2 group. If the experiment had not been discontinued, and the pastures for T_2 had

been returned to 7-day rotations, the heifers and pastures for group T_2 would probably have recovered satisfactorily. This experience shows that in a long dry season, pastures alone may not support satisfactory gains when the stocking rate is 5 heifers per ha. Caro-Costas et al. (2) reported a carrying capacity of 6.25 animals per ha on Pangolagrass pastures at Orocovis, Puerto Rico, but this was a mean for variable stocking rates (put and take experiments) throughout the year. Also, the mean monthly rainfall at Orocovis during the 2 years of the study was more than normal and never below 100 mm per mo.

Differences between samples from the pastures taken before and after grazing were significant, indicating that the amount of herbage consumed and trampled exceeded the regrowth during the grazing period. Cycle variation was most likely due to precipitation whereas pasture variation was probably due to weeds. Interactions with treatment or pastures within treatments were not significant.

Previous studies at Corozal (1), comparing grazing alone versus grazing plus supplementary feeding of molasses, ground maize, or a bulky concentrate, did not present a significant advantage in growth rate of Holstein heifers except during the period December–March, when the yields of pastures are approximately half that of the other months (6). These observations coupled with the present trial, show that the advantage of any form of supplement is highest when pastures are low in quantity and quality. Further studies are needed to compare high quality forage supplements and concentrates when pastures will not support at least a .5 kg mean daily weight gain for heifers. However, in order to measure the substitution rate of pelleted forages and pasture, stocking rates (5, 7 or 10 heifers per ha) should be held constant. The grass sward should be maintained in a uniform condition by varying the amount of pellets fed. This uniformity avoids the problems of maintaining put-and-take animals in the same condition as tester animals, and calculations can still be made on the relative contribution of pasture and pellets.

It was expected that supplementary feeding of a high quality pelleted forage would reduce pasture intake. For this reason a wide range was desired in order to measure the joint contribution of pasture and pellets to animal intake; thus the level of 2.27 kg per head daily for T_2 was chosen. It was also expected that the increase of total DM intake per animal from pasture and pellets would be due to more rapid digestion and passage of the pelleted forage (3). It was not possible to determine the effect of pellets on DM intake because of the confounding of treatment differences in pasture digestibility and failure to measure pasture intake. Nevertheless, heifers receiving pellets should have responded with higher gains than those observed when pastures were high in digestibility. The reasons for smaller gains than expected for heifers with pellet supplemen-

tation were probably related to DM intake. In a trial with lactating cows at the Gurabo Substation, there was significant negative regression of milk yield on estimated pasture digestibility for cows receiving 2.27 kg of maize forage pellets per head daily (5). It was suggested that the digestible DM intake was less for the pastures high in digestibility because the volume of grazed tropical grasses in the rumen might be negatively related to digestibility. If this were the case, the effects of maize forage pellets were not adequately explained. The possibility existed that the fiber-mat filter in the rumen was made even finer by the pelleted fiber particles, thus reducing passage of broken down pasture grass fiber (7). Further studies are needed with tropical grasses to verify this theory. It is likely that pasture intake is not reduced as much with concentrate feeding as with pelleted forages. While concentrates may be more beneficial to animal gains than pelleted forages, the desired intent of extending pastures may be more difficult to obtain with concentrates. The relative economic importance of animal gains and pasture conditions in various seasons also needs consideration.

CONCLUSIONS

Dehydrated, whole-plant maize pellets have both additive and substitutive properties when used as a supplement to Pangolagrass pasture. A high-quality pelleted forage can be used successfully in a system of raising dairy replacement heifers on pasture with some limitations. When pastures are lush and plentiful, there is no advantage to supplementing with pellets. In fact, the feeding of pellets at this time may be to the detriment of both pastures and animals because use of the pasture is delayed, resulting in the grasses becoming more mature and less digestible. A pasture extender, by definition, should be used when pastures are short and low in quality. Pellets at this time reduce pasture intake thus preventing over-grazing of the grass stands.

The method of before and after sampling of pastures used in this experiment resulted in too much variation in yield and quality estimates to justify the time and effort required. Visual observations, while more subjective, resulted in more satisfactory assessment of pasture conditions. Pluck sampling, combined with visual assessment, in determining pasture quantity and quality has been shown to be satisfactory in previous experiments (5).

Because of difficulty in estimating DM intake and failure to consider plant physiological responses to differing grazing intensities, this study was not able to quantify the extent to which pellets can substitute for pasture. It is suggested that stocking rates be fixed for different treatments and that pellet feeding be varied to maintain uniform pasture conditions.

Further studies should be conducted to determine whether a preliminary period of adjustment to grazing is necessary to maintain the optimum weight gains and for rumen development in young heifers. Whether high-quality forage or concentrate supplements are better at this time should be determined. More research is needed on bulk density, rumen fill, rate of digestion and rate of passage of tropical grasses in order to answer some of the questions raised.

RESUMEN

Un estudio para determinar el efecto de un pienso suplementario de alta calidad sobre la tasa de crecimiento de novillas lecheras se realizó en la Subestación de Corozal.

Dieciséis novillas con un peso medio de 190 kg se sometieron previamente a un apacentamiento de pasto Pangola (*Digitaria decumbens*), abonado intensamente, por un período de 43 días, al cabo del cual se asignaron en grupos iguales a pacer el pasto Pangola solo (T_1) o a pacerlo suplementado con 2.27 kg diarios de bolas hechas de la planta íntegra de maíz (T_2).

El apacentamiento se realizó a razón de cinco novillas por ha, alternándose cada tratamiento entre cuatro cercados de .40 ha cada uno. La rotación de los animales en ambos tratamientos se realizó simultáneamente. Estos se pesaron a intervalos de 5 a 7 días. El estudio se completó cuando los animales alcanzaron 320 kg de peso medio.

Durante las primeras semanas, la suplementación con las bolas de maíz demostró ser detrimental a la ganancia de peso, ya que la ganancia en las novillas en T_1 fue mayor que la de las en T_2 a causa de la madurez excesiva del pasto en T_2. Más adelante, las bolas fueron ventajosas, al agostarse los pastos durante la época de sequía. La ganancia media por día a los 302 días fue de .29 y .44 kg para las novillas en T_1 y T_2, respectivamente.

Se tomaron muestras de los pastos antes and después del apacentamiento cortándose 6 cuadros de 0.84 m^2 cada uno en cada ocasión. Las diferencias entre los redimientos del pasto antes y después del apacentamiento fueron significativas. Los tratamientos, el muestreo antes y después del apacentamiento, los ciclos y los pastos arrojaron diferencias significativas. La única interacción significativa fue la de ciclo con muestreo antes y después del apacentamiento, indicando el efecto de las sequías en el consumo del forraje.

El estudio demostró que los forrajes de alta calidad en bolas fueron provechosos, cuando se suplieron a las novillas apacentadas en pastos que no eran suculentos ni abundantes. Se deben utilizar las bolas de maíz cuando el crecimiento de los pastos es pobre y de calidad inferior para así reducir el apacentamiento excesivo.

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