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## Effect of Four Levels of Concentrate Feeding on Milk Production by Holstein Cows Grazing Intensively Managed Tropical Grass Pastures<sup>1,2</sup>

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### INTRODUCTION

Feeding of dairy cows in Puerto Rico generally is based on fairly well-managed grass pastures, almost invariably supplemented by 1 pound or more of 20- to 24-percent protein concentrate per liter (2.2 pounds) of milk produced. About \$20 million worth of concentrated dairy feeds are imported yearly.

Numerous long-term grazing experiments conducted in Puerto Rico by Vicente-Chandler et al.<sup>4</sup> show that intensively managed, heavily fertilized pastures of improved grasses can carry over two head of growing cattle and can produce over 1,000 pounds of beef per acre yearly. The grazing cattle annually consumed about 14,000 pounds of dry matter per acre which contained 16 to 18 percent of crude protein throughout the year.

<sup>1</sup> Manuscript submitted to Editorial Board August 23, 1971.

<sup>2</sup> This paper covers investigations conducted cooperatively by the Soil and Water Conservation Research Division, Agricultural Research Service, USDA, and the Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico, Río Piedras, P.R.

Special appreciation is due Mr. Jorge González, who provided constant encouragement, as well as the land, fertilizer, labor and cows for this experiment. Without his unstinting help this research would not have been possible.

<sup>3</sup> Agronomist, cooperative between the Soil and Water Conservation Research Division, ARS, USDA, and the Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico; Project Leader-Soil Scientist, and Soil Scientist, Soil and Water Conservation Research Division, ARS, USDA, Río Piedras, P.R., respectively.

<sup>4</sup> Vicente-Chandler, J., Caro-Costas, R., Pearson, R. W., Abruña, F., Figarella, J., and Silva, S., *The Intensive Management of Tropical Forages in Puerto Rico*, Agr. Exp. Sta. Bull. 187, Mayagüez Campus, University of Puerto Rico, Río Piedras, P.R., 1964.

Caro and Vicente-Chandler<sup>5</sup> found that cows produced an average of 6,064 pounds of milk (25.2 pounds or 11.5 liters daily) over an 8-month lactation period on all-grass rations from steep pastures of intensively managed tropical grasses and that the cows maintained normal bodyweights throughout the experiment. The data suggests that no concentrate feed should be required for the first 10 liters or so of milk produced daily by cows on intensively managed, well-fertilized grass pastures.

The purpose of the experiment presently being reported was to determine the effect of feeding four levels of concentrate on milk production by Holstein cows grazing intensively managed tropical grass pastures over a full lactation period.

### MATERIALS AND METHODS

The experiment was carried out near Dorado on the North Coast of Puerto Rico where the average annual temperature is about 78° F., with a seasonal variation of less than 10°F. and daily temperatures rarely exceeding 90° F. Rainfall totalled about 80 inches yearly. The soils were deep, well-drained Toa clay loam and imperfectly drained Coloso clay.

All 48 cows in the experiment had continuous access to abundant high-quality forage. All grazed the same rotationally grazed Pangola and Star grass pastures which received 1 ton of 15-5-10 fertilizer per acre yearly in four equal applications. All pastures were provided with shade, water, salt, and ground bonemeal. One cow per acre was the rate of stocking.

The cows were milked twice daily. The milk produced by each cow in 1 day was weighed at 7-day intervals and samples were analyzed at this time for butterfat content. The cows were weighed monthly, were bred as required starting about 2 months after calving, and were dried when daily production dropped below 12 pounds of milk.

Twelve cows were assigned at random to each of the following levels (treatments) of concentrate feeding.

<i>Group of 12 cows each</i>	<i>Treatment: One pound of 20-percent protein concentrate fed per—</i>
1	1 liter (2.2 pounds) of milk produced
2	2 liters (4.4 pounds) of milk produced
3	3 liters (6.6 pounds) of milk produced
4	4 liters (8.8 pounds) of milk produced

The cows were fed half their daily ration of concentrates at each milking. The amount of concentrate fed daily to each cow was adjusted weekly on the basis of production during the previous week.

<sup>5</sup> Caro-Costas, R., and Vicente-Chandler, J., Milk production with all-grass rations from steep, intensively managed tropical grasses, *J. Agr. Univ. P.R.* 53(4): 253-58, 1969.

## RESULTS AND DISCUSSION

Neither total milk production nor length of lactation were affected significantly by feeding concentrates at the rate of 1 pound per 1, 2, or 3 liters of milk (table 1). Cows fed at these levels produced an average of 10,465 pounds (4,757 liters) of milk during an average lactation period of 279 days, with an average daily production of 17.1 liters. This production compares favorably with an average of 7,150 pounds per lactation for cows in Class A dairies in Puerto Rico.

However, further reduction in concentrate levels to 1 pound per 4 liters of milk sharply decreased milk production to 7,447 pounds of milk per lactation and length of lactation to 242 days (table 1).

The following tabulation shows average production for each group of 12

TABLE 1.—*The effect of four levels of concentrate feeding on milk produced by Holstein cows grazing heavily fertilized, intensively managed tropical grass pastures<sup>1</sup>*

One pound of 20-percent protein concentrate fed per—	Average length of lactation	Average daily production per cow		Average production per cow per lactation	Cost of concentrate per liter of milk	Average butterfat content of milk	
		Days	Pounds			Liters	Pounds
1 liter of milk	268 a <sup>2</sup>	36.3 a	16.5	9,728 a	5.00	2.9-3.2	3.0
2 liters of milk	280 a	38.5 a	17.5	10,781 a	2.50	2.9-3.2	3.0
3 liters of milk	288 a	37.8 a	17.2	10,886 a	1.66	3.3-3.9	3.5
4 liters of milk	242 b	30.8 b	14.0	7,447 b	1.25	3.1-3.6	3.3

<sup>1</sup> All values are averages for 12 cows in each treatment.

<sup>2</sup> Treatments with different letters differ significantly at the 1 percent level.

cows during the experiment compared to the previous lactation when all were fed concentrates at the rate of 1 pound per liter of milk.

Group of 12 cows each	Treatment: One pound of 20-percent protein concentrate fed per—	Experimental lactation Pounds	Previous lactation Pounds
1	1 liter of milk	9,728	10,461
2	2 liters of milk	10,781	9,974
3	3 liters of milk	10,886	10,865
4	4 liters of milk	7,447	11,051

There were no marked differences in production between both lactations for cows fed 1 pound of concentrate per 1, 2, and 3 liters of milk but cows receiving 1 pound of concentrate per 4 liters produced much less milk during the experiment than during the previous lactation.

Butterfat content of the milk tended to be higher with the lower concentrate rations, ranging from an average of 3.0 percent when 1 pound of con-

concentrate was fed per liter to 3.5 percent with the 1-pound-per-3-liter ration (table 1).

Concentrate levels did not affect calving interval which averaged 13.3 months for all treatments.

Milk production throughout the lactation (fig. 1) was not appreciably affected by feeding concentrates at the rate of 1 pound per 1, 2 or 3 liters of milk, but a further reduction of concentrate levels to 1 pound per 4 liters of milk caused a drop in milk production throughout the lactation period after the first month.

Bodyweight of the cows during the first 7 months of lactation increased by an average of 75 pounds when the cows were fed 1 pound of concentrate

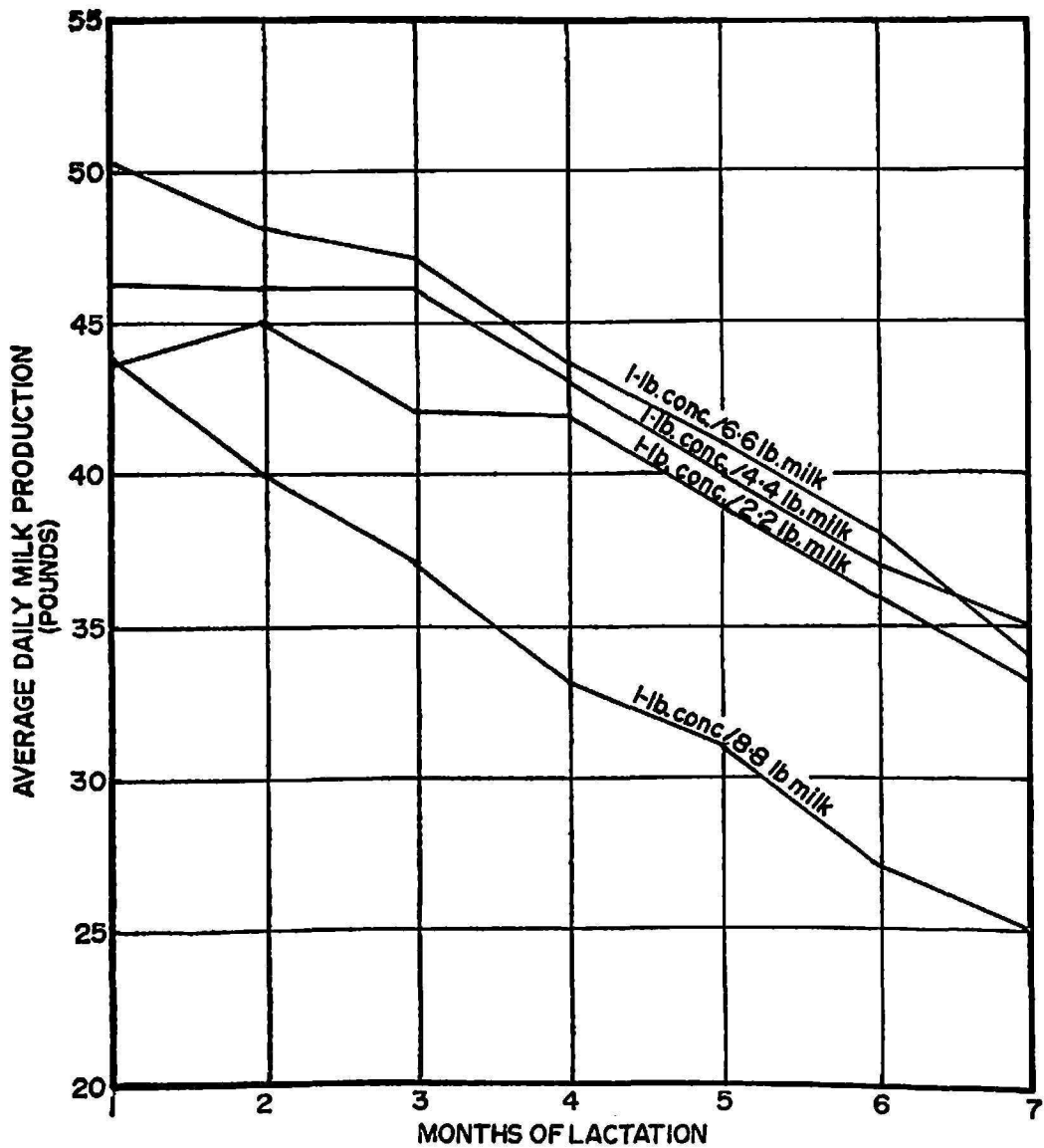


FIG. 1.—Effect of four levels of concentrate feeding on lactation curves of Holstein cows grazed on intensively managed tropical grass pastures. Values are averages of 12 cows per treatment.

per 2, 3, or 4 liters of milk and by 125 pounds when concentrate feeding was increased to 1 pound per liter. The cows ranged in weight from about 1,100 to 1,350 pounds at the end of the lactation period.

Reducing concentrate levels from the current standard ration of 1 pound per liter of milk to 1 pound per 3 liters reduced costs by more than 3 cents per liter or about \$160 per cow per lactation without affecting production.

The most economic level of concentrate feeding, 1 pound per 3 liters of milk, is roughly equivalent to feeding no concentrate for the first 10 liters or so of milk, then feeding 1 pound of concentrate for each additional liter produced. This confirms previous findings of Caro and Vicente-Chandler<sup>6</sup> that the first 10 liters or so of milk can be produced on an all-grass ration from intensively managed pastures. Cost of total digestible nutrients from such pastures is about 2 cents per pound compared to about 6 cents per pound for those from imported concentrate feeds.

The average lactation curve for the four highest yielding cows in each treatment is shown in figure 2. Lactation curves were similar for cows receiving 1 pound of concentrate per 1, 2, and 3 liters of milk. These cows produced an average of 13,570 pounds of milk during the lactation period while maintaining normal body weights. Production of cows receiving 1 pound of concentrate per 4 liters of milk dropped off after the first month and averaged only 10,480 pounds of milk during the lactation.

It is apparent that even with very high yielding cows, concentrate feeding can be reduced markedly from the standard practice of feeding 1 pound of concentrates per liter of milk. However, when cattle are grazed for more than 2 days at a time in each pasture, the grazing interval should be increased to about 21 and 28 days during seasons of fast and slow growth, respectively.

A cow producing 20 liters of milk daily and fed concentrates at the rate of 1 pound per liter would have to consume about 50 pounds of high quality green forage daily to meet its total digestible nutrient requirements. Such a cow fed concentrates at the rate of 1 pound per 3 liters of milk would have to consume over 100 pounds of forage. Therefore, cows fed a reduced concentrate diet must be provided with an abundance of good quality forage at all times so they may consume the required amounts. Heavy fertilization and intensive pasture management are essential if concentrate feeding is to be reduced.

#### SUMMARY

Holstein cows grazing with free access to intensively managed, heavily fertilized Star and Pangola grass pastures produced similar yields of milk

<sup>6</sup> Ibid.

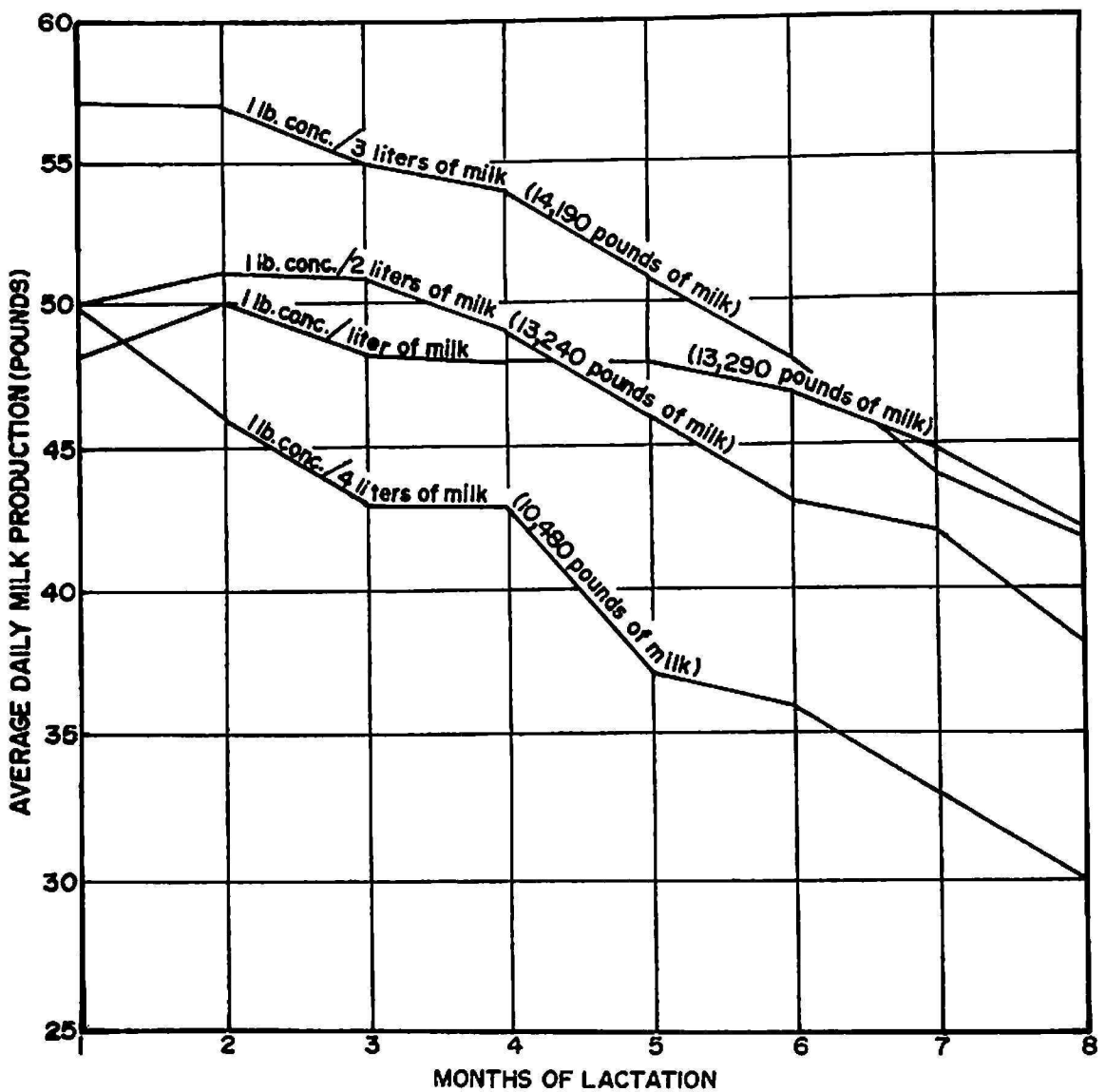


FIG. 2.—Effect of four levels of concentrate feeding on lactation curves of high-yielding Holstein cows grazing on intensively managed tropical grass pastures. Values are averages of the four highest yielding cows. Numbers in parentheses show average production per cow.

throughout a lactation when fed 20-percent protein concentrate at the rate of 1 pound per 1, 2, and 3 liters of milk produced daily. These cows produced an average of 10,465 pounds of milk during an average lactation period of 279 days, or an average of 17.1 liters daily. However, cows fed at the rate of 1 pound of concentrate per 4 liters of milk produced much less (7,447 pounds of milk per lactation).

**RESUMEN**

Se alimentaron 4 grupos de 12 vacas Holstein cada uno, a razón de 1 libra de alimento concentrado con un 20 por ciento de proteína por cada 1, 2, 3 y 4 litros de leche de producción diaria. Las vacas tenían acceso constante a pastos bien manejados

de yerba Pangola y yerba Estrella abonadas con una tonelada de la fórmula 15-5-10 por acre al año en cuatro aplicaciones iguales.

Las vacas que recibieron 1 libra de alimento concentrado por cada 1, 2 y 3 litros produjeron una cantidad similar de leche, con un promedio de 10,465 libras por período de lactancia de 279 días ó 17.1 litros diarios. Sin embargo, las que recibieron 1 libra de alimento por cada 4 litros de leche produjeron mucho menos leche (un promedio de 7,447 libras por lactancia).