THE JOURNAL OF AGRICULTURE
OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, Mayagüez Campus, for the publication of articles and research notes by staff members or others, dealing with scientific agriculture in Puerto Rico and elsewhere in the Caribbean Basin and Latin America.

VOL. 81 JULY AND OCTOBER 1997 No. 3-4

Comparison of Holstein, Charbray, and Zebu Bulls for beef production under rotational grazing I. Grazing performance and economic evaluation[1]

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J. Agric. Univ. P.R. 81(3-4):101-113 (1997)

ABSTRACT

Two grazing trials (GT1; GT2) were conducted over a period of three years, and effect of breed, season, and breed × season was observed on the grazing performance of 87 Holstein, Charbray, and Zebu (mostly Brahman) bulls. The Zebu and Charbray bulls exhibited higher ($P < 0.05$) average daily gains (0.60, 0.57 vs. 0.45 kg) and mean final weights (502.5, 478.4 vs. 438.9 kg) than the Holstein bulls. Overall, average daily gains (ADG) were similar ($P > 0.05$) during spring, summer, and fall but significantly higher than in the winter months ($P < 0.05$). Faltering ADG started in late autumn of GT1 and in late winter of grazing GT2, depending on when the cattle were started on test, and were the consequence of the combined effects of seasonal restraints on pasture growth and the need of greater dry matter intakes at higher stocking weights. The breed × season interaction was significant ($P < 0.05$). Holstein bulls had significantly lower ($P < 0.05$) ADG in summer and

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fall, but no significant difference was found among breeds in winter and spring. Net returns per animal after considering variable costs were $154.72, $134.49, and $77.47 for the Zebu, Charbray, and Holstein bulls, respectively. Costs not considered in the economic evaluation were fence and pasture depreciation, interest on investment, land cost, and overhead expenses.

Key words: dairy-beef, Holstein bulls, rotational grazing

RESUMEN

Comparación de toros Holando, Charbray y Cebú para producción de carne bajo pastoreo rotacional
I. Desempeño a pastoreo y evaluación económica

Ochenta y siete toros de las razas Holando, Charbray y Cebú (mayormente Brahman) se evaluaron bajo pastoreo rotacional en dos pruebas (P1 y P2) durante un período de tres años. Los toros Cebú y Charbray tuvieron ganancias diarias en peso (GDP; 0.60, 0.57 vs. 0.45 kg/día) y pesos vivos finales (502.5, 478.4 vs. 438.9 kg) significativamente mayores ($P < 0.05$) a los toros Holando. Durante las épocas de primavera, verano y otoño se obtuvieron GDP similares ($P > 0.05$) pero superiores a las logradas en invierno ($P < 0.05$). La GDP comenzó a disminuir al final del otoño en la P1 y al final del invierno en la P2, dependiendo del mes en que los animales comenzaron a pastorear. Este resultado se debió al efecto combinado de la época del año sobre el crecimiento de la pastura y a la necesidad de un mayor consumo de materia seca con el aumento en peso de los animales. La interacción de raza × época fue significativa ($P < 0.05$). Los toros Holando tuvieron GDP similares ($P > 0.05$) a las de los toros Cebú y Charbray en primavera e invierno pero significativamente menores ($P < 0.05$) durante el verano y otoño. Los ingresos netos por animal luego de considerar los costos variables fueron $154.72, $134.49, y $77.47 para los toros Cebú, Charbray y Holando, respectivamente. Para la determinación del ingreso neto por animal no se consideró la depreciación de las cercas y pasturas, el interés sobre la inversión, el costo de la tierra ni los costos indirectos.

INTRODUCTION

In 1994 the beef cattle industry of Puerto Rico produced only 28% of the beef consumed on the island. This industry has the potential to grow and capture a greater share of the island's beef market. To achieve this goal, modern production technology, marketing strategies, and business management skills have to be integrated into local beef farm operations.

The industry is confronted every year with a shortage of feeder calves[7] for cattle feeding. Local cow-calf operations can not meet the industry demand for calves because of high land prices that make it difficult for cattlemen to broaden their operations or to initiate new ones. Since the profitability of this segment of the industry does not justify the utilization of expensive land for beef production, an alternative

[7]The beef production unit used on the island is the bull; castration is not performed on beef calves.

to increase the availability of weaner calves is to use a portion of the dairy calf crop for dairy beef production.

Local dairy farms produce approximately 23,000 Holstein bull calves annually. Most of these calves are processed into beef before reaching standard slaughter weights and some are raised for veal. If half of this by-product of the dairy industry could be used for the production of dairy beef it would represent an increase of 15 to 20% in local beef production without augmenting the size or number of cow-calf operations on the island. Furthermore, if dairy calves can be reared economically and placed on the market at a lower price than feeder calves, beef production profit margins could also be increased by the reduction of the price differential between feeder and slaughter cattle. Raising Holstein bull calves for beef can create a market for dairy farmers who want to sell the bull calves, and for diversified producers who want to raise livestock for sale.

In Puerto Rico, cattlemen, cattle buyers, and beef packers discriminate against Holstein bulls for beef. As a consequence, market prices are on the average $0.17/kg lower for Holstein feeder bullocks and slaughter bulls. Beef producers argue that Holstein bulls gain less and have lower dressing percentages and yield of boneless retail cuts than bulls from beef breeds. However, Holstein purebred and crossbred steers have been used satisfactorily for many years as meat producing animals in Europe and in the United States (Anderson et al., 1978; Butterfield and Berg, 1974; Cole et al., 1963; García-de-Siles et al., 1977; Hallman, 1971; Truscott et al., 1976; Thonney et al., 1991; Wellington, 1971). Most of these studies evaluated the Holstein breed for beef production against British beef breeds, using the steer as the production unit in feedlot systems. Very little information is available that evaluates the performance of purebred Holstein bulls against heat tolerant beef breeds in tropical environments and grass-based feeding systems.

MATERIALS AND METHODS

The grazing trials were conducted at the Corozal Agricultural Experiment Substation of the College of Agriculture, University of Puerto Rico, between May 1991 and January 1995. This substation is located at an elevation of about 200 m in the central mountainous region of the island. Annual mean temperatures range between 17° and 31°C, and annual average rainfall varies between 1,524 and 2,034 mm. Twelve hectares of Stargrass (*Cynodon nlemfuensis Vanderyst var. nlemfuensis*), Paragrass (*Brachiaria purpurascens Nenr.*), and Caribgrass (*Eriochloa polystachya H.B.K.*) pastures were divided into three blocks of five paddocks each. The pastures were fertilized in May and in No-

vember with a 15-5-10 fertilizer at a rate of 898 kg/ha/yr (Antoni et al., 1992). During the first grazing trial (GT1) the stocking rate (SR) was 3.65 head/ha and was lowered to 3.40 head/ha at the start of the second trial (GT2). The rotational grazing schedule consisted of paddocks grazed for approximately three to five days with a 14- to 18-day rest period depending on paddock size, season of the year, and stocking weight.

Eighty-seven Holstein, Charbray, and Zebu (mostly Brahman) bulls were evaluated in two grazing trials under rotational grazing. The Holstein calves were raised on a feeding system similar to the one used for raising dairy replacements at the Gurabo Substation Dairy Farm. Zebu and Charbray bullocks, comparable in age and weight to the Holsteins, were purchased from local producers. Differences in mean liveweight at the start of the grazing trials were small ($P > 0.05$) among the three breed-groups (Table 1). Two or three days after arrival at the Corozal Substation the bulls were individually weighed, ear-tagged, and treated for internal and external parasites. The bullocks were then ranked by weight and randomly assigned to breed-treatment groups. Each breed-treatment group was then randomly assigned to graze rotationally in a complete randomized block design. Water and trace mineral/salt blocks were available in each paddock at all times. The bulls were individually weighed every 28 to 30 days after 14 to 16 hours without feed and water. The grazing trial ended when the bulls reached an average weight of 500 kg.

A partial budget with selected cost factors was prepared to evaluate the economic performance of the breeds. Data on labor usage and cost, cost of materials, and cattle purchasing and selling prices were collected to estimate the projected costs and returns. The net return determined under this procedure represents that portion of the total income that remains for the payment of the costs not considered here and for profit, after the deduction of the stated variable costs.

All dependent variables evaluated were analyzed by the Analysis of Covariance Procedure (SAS, 1987). Seasonal liveweight was used to adjust for different stocking weights at different seasons. The model included an overall mean and the main effects of year, breed, season, and their interactions. The Duncan Multiple Range Test was used to test differences among treatment means.

RESULTS AND DISCUSSION

Average daily gain and final weight

Zebu and Charbray bulls consistently exhibited significantly higher average daily gains (ADG) and final weights than the Holstein bulls

TABLE 1.—*Initial and final weights, average daily gains and age at the end of the trial of Holstein, Charbray and Zebu-type bulls.*

Breed	Number of animals	Initial weight	Final weight	ADG[1]	Average age at end of trial
		kg			(months)
Zebu	29	237.9a[2]	502.5a	0.600a	26
Charbray	29	235.7a	478.4a	0.571a	26
Holstein	29	244.2a	438.9b	0.454b	26

[1]ADG = Average daily gain.

[2]Means in the same column followed by different letters are significantly different ($P \leq 0.05$).

(Table 1). Differences among the three breeds showed that the Zebu and Charbray bulls gained 0.15 and 0.12 kg more daily ($P < 0.05$) and were 63.6 and 39.5 kg heavier ($P < 0.05$) than the Holstein bulls at the end of the grazing trials. At their present level of weight gain, the Holstein bulls would require three additional months of grazing to reach final weights similar to those of the Zebu and Charbray. In the present study comparisons were performed from a practical standpoint, in accordance with marketing criteria for cattle in Puerto Rico. For true comparisons among breeds of different mature weights, evaluations of rate of gain should be performed on the same segments of the growth curve to avoid differences in the composition of the weight gain.

Under feedlot conditions, Cole et al. (1963; 1964), García-de-Siles et al. (1977), and Thonney (1987) reported higher daily gains, off-feed weight, better feed efficiency and shorter time on feed for the Holstein steers than for British and Zebu type cattle. Callo et al. (1973) evaluated 8,412 growth records of 504 Holstein-Friesian (HF) pedigree bulls, and concluded that selection for high milk yield did not affect the potential for growth rate of HF males. If selection for high milk production has not affected the growth parameters of the Holstein bulls, the different performance of the Holsteins in this study could be caused by the grass-based feeding system and the tropical climate in which the bulls were evaluated, compared to feeding high energy diets in confinement or semi-confinement in a temperate environment.

Heat stress is known to have a greater detrimental effect on the performance of *Bos Taurus* than on *Bos Indicus* or *Bos Indicus* crossbred cattle (Hammond and Olson, 1994; Langbein and Nichelmann, 1993; Kamwanja et al., 1994). Environmental heat stress combined with the higher heat increment associated with the ingestion of fibrous feeds, and heat of voluntary grazing activity may have affected the grazing

performance of the Holstein bulls, limiting their dry matter intake. Jan and Nichelmann (1993) evaluated total grazing activity, standing and lying, and time spent in the sun and in the shade, and indicated that in the rainy season HF cows spend less time grazing and longer time in the shade than Cuban Siboney cows (5/8 HF × 3/8 Zebu). In addition, López et al. (1982) evaluated the performance of HF and HF × Zebu calves in the tropical environmental conditions of Cuba. A total of 190 calves were either fattened intensively indoors (IF) for 300 days, or grazed for 500 days. ADG for the HF, 3/4 HF, 5/8 HF and 1/4 HF calves were 0.94, 0.96, 0.94 and 0.88 kg in the IF system and 0.29, 0.37, 0.44 and 0.48 kg in the pasture system, respectively. They reported a significant ($P < 0.05$) genotype by feeding system interaction. HF calves fattened under grazing conditions were negatively affected by the low nutritional level to which they were exposed.

In this study nutritional level and environmental conditions may have affected the performance of the Holstein bulls. However, since in grass-based feeding systems the effects of environmental conditions on animal homeostasis and on forage quality and quantity are confounded and affect the nutritional level of the animal, it is difficult to determine which of the two factors has a greater influence on the growth parameters of Holstein bulls in the tropics.

Seasonal variations of average daily gains

Figures 1 and 2 show the monthly ADG variations of the Zebu, Charbray and Holstein bulls. The first group of bulls started on test in May 1991 (Figure 1) and the second group in November 1993 (Figure 2). The overall ADG for GT1 and GT2 was 0.54 and 0.63 kg/day for the Zebu-Charbray, and 0.41 and 0.52 kg/day for the Holstein bulls, respectively. The ADG of the Zebu-Charbray bulls was well below the overall ADG during late fall and winter in GT1 (0.42 kg/day November to March 92) and late winter in GT2 (0.14 kg/day March and April 94). The Holstein bulls showed a monthly pattern in weight gain similar to that of the other two breeds in GT2. In GT1, however, the Holsteins gained weight below their average for the grazing period from July to December 91 (0.29 vs 0.41 kg/day) and remained close to or above their average during January, February and March 92 (0.42 vs 0.41 kg/day; Figure 1).

The lower ADG reported in late fall and winter of GT1 and GT2 were the consequence of the combined effects of greater dry matter intakes at higher stocking weights (SW) and seasonal restraints on pasture growth (Figure 1, November SW = 1,144 kg/ha; Figure 2, March SW = 1,088 kg/ha). Total monthly precipitation and daylight

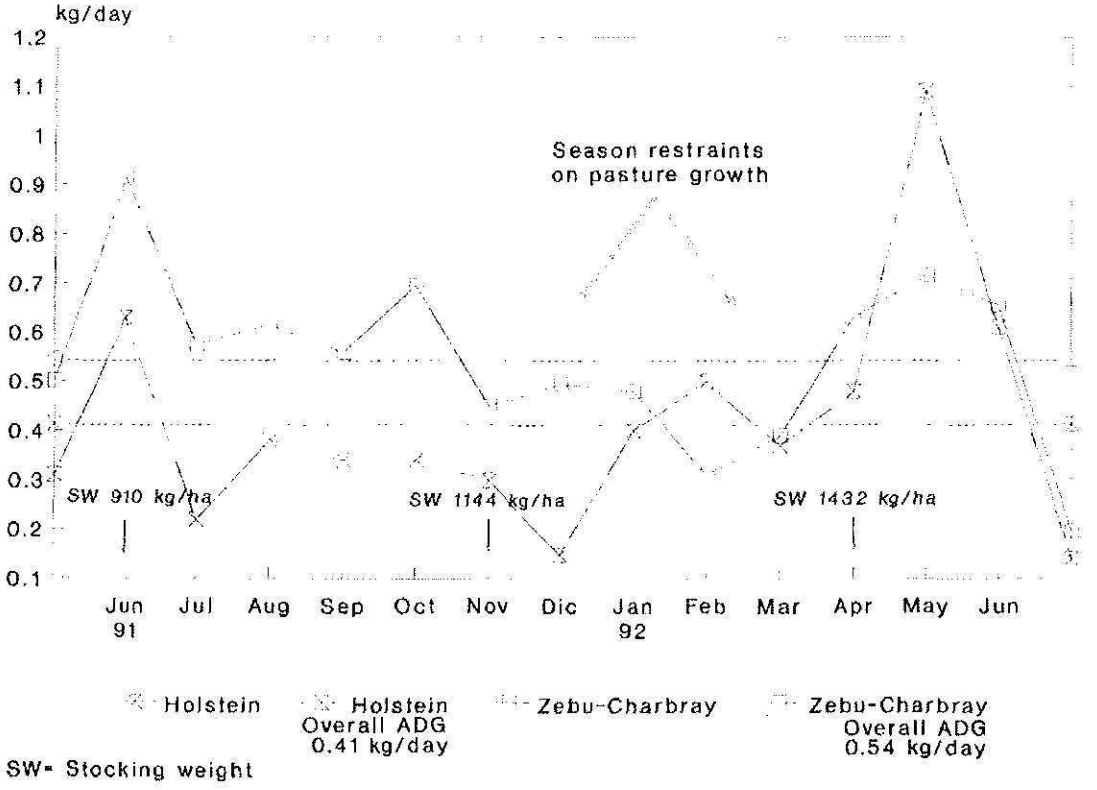


FIGURE 1. Monthly average daily gains of Holstein, Charbray, and Zebu bulls during the first grazing trial.

hours, and average maximum and minimum monthly temperatures at the Corozal Substation were lower in winter than in the rest of the year (Table 2). In conjunction, the reduction in pasture availability during these seasons may have decreased the grazing selectivity of the animals, thus affecting the quality of the diet. The fact that the ADG increased again above its average for the grazing period during spring of 92 and 94, even as the SW continued to increase (Figure 1, April SW = 1,432 kg/ha, Figure 2, May SW = 1,118 kg/ha), suggests that the main factor affecting weight gains from November through March was the seasonal restraints on pasture growth. Vincente-Chandler et al. (1974) found that cattle on intensively managed pastures had higher ADG from May to October and the lowest ADG during the cooler winter months with shorter days and less rainfall.

Overall, weight gains for the three breeds were significantly higher in spring, summer, and fall than in the winter months ($P < 0.05$; Figure 3). No significant differences ($P > 0.05$) were found for ADG among spring, summer, and fall seasons. The breed × season interaction was significant ($P < 0.05$; Figure 3). ADG of the Holstein bulls in summer and fall were significantly lower than the ADG of the Zebu and Charbray. Nevertheless, in spring and winter the difference among means

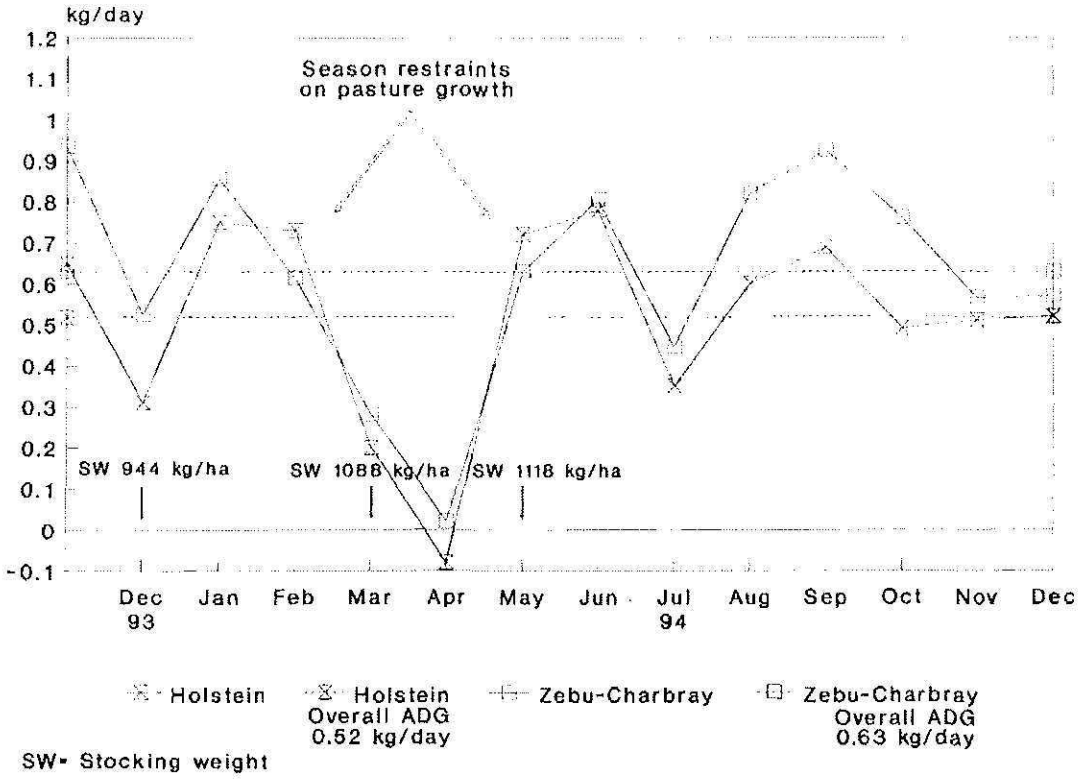


FIGURE 2. Monthly average daily gains of Holstein, Charbray and Zebu bulls during the second grazing trial.

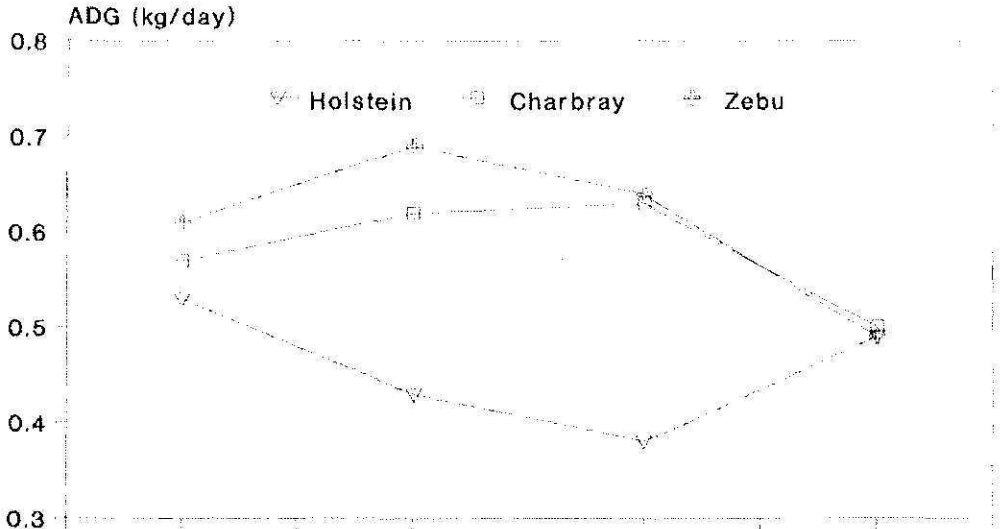
for the three breeds was not significant. The grazing performance improved in spring and winter for the Holsteins, and declined in winter for the Zebu and Charbray bulls. Differences in ADG between Zebu and Charbray bulls were not significant at any season.

These results suggest that the grazing performance of the Holstein bulls was more affected by the effects of season on heat stress (Jan and

TABLE 2.—*Climatic data collected from May 1991 through December 1994 at Corozal Experiment Substation.*

Season	Total monthly average precipitation cm	Average monthly maximum temperature °C	Average monthly minimum temperature °C	Daylight hours[1]
Winter	9.13	28.47	16.36	11.42
Spring	12.92	30.78	19.08	12.70
Summer	14.54	31.59	19.92	12.54
Fall	15.03	29.53	18.13	11.20

[1]Months of the year with the highest and lowest number of daylight hours are June (13.12), July (13.17); and December (11.04), January (11.11).



	Spring	Summer	Fall	Winter
Holstein	0.53	0.43 *	0.38 *	0.49
Charbray	0.57	0.62	0.63	0.5
Zebu	0.61	0.69	0.64	0.49
Means	0.58 a	0.58 a	0.55 a	0.49 b

a,b Means for the effect of season in the same row followed by different letters are significantly different (P<0.06).
* Means for the interaction of breed x season that are significantly different (P<0.05).

FIGURE 3. Seasonal average daily gains of Holstein, Charbray, and Zebu bulls under rotational grazing.

Nichelmann, 1993; Hammond and Olson, 1994) than by the seasonal restraints on pasture growth that normally reduce beef production in Puerto Rico during winter. Contrary to the Holsteins, the Zebu and Charbray bulls presented their best performance during spring, summer, and fall, and their worst during the winter months, when the lower temperature, less precipitation, and shorter days affect pasture availability (Vicente-Chandler et al., 1974). The reasons for this breed × season interaction, however, are not clear at this time.

Economic evaluation

Table 3 presents labor and material costs in the fattening of 45 animals in GT1 (479 grazing days) and 42 animals in GT2 (435 grazing days). The highest variable cost, aside from the cost of purchasing the animals, was pasture fertilization, which amounted to 62% of all variable costs. Fertilizer alone amounted to 50% of all variable costs. Labor costs due to weed control represented 10% of all costs. Within this factor, the higher cost was the herbicide application, which amounted to 7%. Pasture liming was another significant cost factor; it amounted to 6% of all variable costs even after being prorated through a six-year pe-

TABLE 3.—*Total labor and material costs in the two grazing trials.*

Description	Quantity	Price	Total
Fertilization[1]			
labor (man-hour)	405.4	$4.060	1,645.84
fertilizer (ton)	28.5	$231.000	6,583.80
Sub-total			$8,229.64
Animal care			
labor (man-hour)[2]	24.1	$4.060	98.02
medicines			
Antifungal hoof protection (ml)	60.0	$0.014	00.83
Topical antibacterial (ml)	2.0	$0.166	00.33
Antihelmintics	977.9	$0.448	438.34
Sub-total			$537.51
Weed control			
labor (man-hour)	241.0	$4.060	978.46
herbicides (ml)	39,331	$0.010	393.31
Sub-total			$1,371.77
Other activities			
fence maintenance (man-hour)	174.7	$4.060	709.14
grazing rotation (man-hour)	32.8	$4.060	132.97
water stations maintenance (man-hour)	123.8	$4.060	502.70
distribution of mineral/salt block (man-hour)	14.9	$4.060	60.63
liming (man-hour)[1]	140.4	$4.060	570.18
liming (ton)[1]	17.6	$11.000	194.07
trace mineral/salt blocks	56.0	$10.000	560.00
other material ($)			314.60
Sub-total			$3,044.26
Total labor and material costs			$13,183.19

[1]Cost and quantity in proportion to days on grazing; liming is performed every six years.

[2]Actual time spent was reduced by half because the animals were weighed at the same time.

riod. This practice was performed at the beginning of the second trial since periodical control of the soil acidity is recommended in the tropics. Cleaning and maintenance costs for fence repairs and water stations were higher than expected because of the experimental design, which required a large number of small paddocks with water stations. Total variable costs for both grazing trials amounted to $13,183.19 (Table 3), an average of $151.53 per bull. These costs are relatively high for the grazing operation in spite of excluding fence and pasture depreciation, interest on investment, land cost, and overhead expenses.

TABLE 4.—*Cost and returns over variable costs by breed per bull under rotational grazing.*

Description	Holstein	Charbray	Zebu
Expected gross income	$558.69	$679.88	$701.19
Animal purchase	$292.84	$351.17	$352.15
Variable costs[1]	$151.53	$151.53	$151.53
Interest on animal purchase	$29.25	$35.11	$35.19
Interest on variable costs	$7.59	$7.59	$7.59
Total expenses	$481.22	$545.39	$546.47
Expected net income	$77.47	$134.49	$154.72

[1]From Table 3.

Table 4 shows the expected gross and net income per animal over the cost factors presented earlier. Since the bulls were grazing together in the same pastures, the variable costs were assumed to be the same for the three breeds, except for the cost of the bulls and the interest cost associated with their purchase. Among breeds, the Zebu had the highest expected net income per animal ($154.72) over variable costs, followed by the Charbray ($134.49), and the Holstein bulls ($77.47). The difference in net income among breeds was mainly affected by the ADG of the animals and their buying and selling prices. The buying and selling prices of the Zebu and Charbray bulls were $1.55/kg and $1.40/kg of liveweight, respectively. The buying and selling prices of the Holstein bulls were estimated to be $1.27/kg at the market level. The lower ADG and selling price achieved by the Holstein bulls were the two factors responsible for their lowest net income per animal. The lower price at which the Holstein bullocks were purchased and the absence of a purchasing and selling price differential were not enough to compensate for the negative effect of these two factors on the net income.

Although not all cost factors are presented here, the small expected net income achieved by the animals under the present conditions indicates that optimal animal and management performance is essential for the economic viability of the industry. The importance of small differences in meat production potential among breeds is not readily apparent when the breeds are compared in terms of gross income. Nevertheless, these differences become well defined when seen in terms of the expected net income per bull.

CONCLUSION

Under our current practice of finishing intact males on pasture and beef market price structure, it would not be profitable to use Holstein bulls for beef production. However, since large numbers of Holstein bull calves are available every year and their use can significantly increase local beef production, it is necessary to evaluate the Holsteins under more intensive feeding systems to try to improve their biologic and economic efficiencies. Other possibilities include crossbreeding Holstein cows with bulls of local beef breeds, namely Brahman, Charbray, and Senepol, to produce dairy × beef crossbred calves for beef production. The success or failure of utilizing Holstein bulls for beef will depend on the cost of raising the bull calves, their performance on local feeding systems, cutting yields, and beef quality.

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