THE UTILIZATION OF GRASSES, LEGUMES AND OTHER FORAGE CROPS FOR CATTLE FEEDING IN PUERTO RICO

I. Comparison of Guinea Grass, Pará Grass "Malojillo" and a mixture of Pará Grass and Tropical Kudzu as pasture crops

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INTRODUCTION

The success of the cattle industry in Puerto Rico is limited to a large extent by the lack of adequate sources of feed. Based on over 400,000 head of cattle, it is the second most important agricultural industry on the Island. In addition there are over 500,000 acres of cleared pasture land, which constitute about two fifths of the available arable land and whose efficient utilization is entirely dependent upon a well-managed cattle industry.

In Puerto Rico, the dairy cattle industry is somewhat regionalized. Intensive commercial milk production is mainly restricted to milk-shed areas sorrounding the urban centers. Dairy management is based on the use of Pará or "malojillo" (*Panicum purpurascens*) and Merker (Penninsetum purpureum, *var. Merkerii*) grasses cut for soilage with the supplemental feeding of mixed concentrate feeds.

Beef production is generally restricted to the grazing area of the southern coast and in reality is primarily a by-product of the production of workstock. Guinea grass is the prevailing pasture crop in this section.

In the mountainous areas cattle grazing is dependent upon miscellaneous grasses of low yield and little nutritive value.

Soil and climatic conditions on the Island are quite variable. In the north coastal region the rainfall is heavy and the soil is acid. In the south, the soil is alkaline and fertile, but its use is limited by a lack of adequate rainfall. The central portion of Puerto Rico has acid soils of low productivity and the climate is quite humid. The climate of the whole Island is characterized by periods of low rainfall in the winter and early spring and of abundant precipitation during the summer and fall. The dry period is much longer and more severe in the southern coastal region than in the other parts of the Island.

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Note: Mr. Juan Pastor Rodríguez, Associate Agronomist, was in full charge of the agronomic work required for this study.

The diet of the people of Puerto Rico is low in protein from animal sources. During 1944–45 [1] the per capita consumption of meat and fish, including imported products, was only 63 pounds. Twenty per cent of the 141 pounds of milk used per person was imported. For the same period, the per capita consumption of the United States was, on an average, 70 pounds of beef [7] and 440 of milk.[5]

Improved pasture and soilage crops should lower feed costs and increase the production of much-needed animal products, thus improving the diet of the Puerto Rican people to a considerable extent.

Literature Review

Information as to the best method of utilizing local grasses, legumes and other forage crops in the feeding of cattle in Puerto Rico is scant.

Axtmayer et al,[2, 3, 4] made studies on the nutritive value of some grasses and legumes grown at the Agricultural Experiment Station farm, which indicate that the grasses commonly used as forage crops are relatively low in protein content. Unpublished results obtained at the above-mentioned Station [9] have shown that when heifers were pastured on Guinea and Pará grasses they made better gains than when pastured on paspalum (*Paspalum hartwegianum*). Other results from the same project indicated that Merker and Elephant (*Pennisetum purpureum*) grass were not suitable for pasturing.

No experimental data have been published for Puerto Rico about the carrying capacity of any particular pasture previous to this work.

In the United States different methods of pasture evaluation were used until 1940, when a standard method was adopted by the Pasture Research Committee.[8]

Experimental

The forage grasses used in this grazing trial were: Pará grass, or malojillo (*Panicum purpurascens*), Guinea grass (*Panicum maximum*) and a mixture of Pará grass and tropical Kudzu (*Pueraria phaseoloides*).

Pará and Guinea grasses are common on the Island. Tropical Kudzu, a legume native to Malaya, was introduced to the Island by the Soil Conservation Service in 1940. Telford [10]

reported that Kudzu is best suited to the parts of the Island having at least 50 inches of rainfall per year.

At the start of the trial the condition of all the grasses and Kudzu was satisfactory. The plots of Para, Guinea and Para-Kudzu mixture had been planted three, two and one years prior to the start of the trial.

The grasses and the mixture were planted in three blocks of three one-acre plots; each plot planted to a different forage. Every plot was subdivided into three lots, each one-third of an acre in area. The fencing arrangement of the plots allowed the animals in each lot access to shade, water and mineral mixture, (ad lib.). The position of each crop within a block was selected at random. The soil of the experimental field was a well-drained Fajardo clay. In order to decrease the acidity of the soil, lime was added to each lot to bring its pH to 6.5, two years before this study was initiated. No other fertilizer was used at any time.

Nine pure native heifers were used. They were uniform in age, six to seven months old, but varied in weight.

The heifers were weighed for three consecutive days at the beginning of the trial and for three consecutive days every time they were moved from one lot to the next.

One heifer was put in the No. 1 lot of each respective grass plot and was moved from one lot to the next in their own plot when any one of the lots in the entire experiment was grazed out. They were taken out of the experiment when they were of breeding age, 18 to 19 months old.

All lots that had some good roughage left at the time of moving the animals to the next lots were clipped with a "machete" and the residue weighed. Before clipping, samples were taken for analysis. Sub-samples of grass from the middle and the four corners of the lot were taken and a composite sample made from them. Moisture in the samples was determined by drying to constant weight at 70°C. In the analyses of all of the samples the methods used were those given by the Association of Official Agricultural Chemists.[6]

Computation of total digestible nutrients produced by the different grasses and the carrying capacity was made according to the recommendations of the Pasture Research Committee of the American Dairy Science Association.[8]

Analysis of variance and covariance were done according to the methods given by Love.[11]

Results and Discussion

Due to seasonal effects, the experiment was divided in three periods which were marked by the following: First period, with the three grasses under trial; second period, without the Pará grass; and the third period, where an extra heifer was put in the Pará grass-Kudzu mixture.

Results of the three grazing periods are presented in Table 1.

Table No. 1

WEIGHT GAINS IN PER GROUP, MEAN GAIN PER ANIMAL AND LEAST SIGNIFICANT DIFFERENCES

Grasses	No. of heifers	Initial weights of groups	Weight of group at the end of periods	Gains of groups in pounds	Mean gain in weight in pounds per animal
First Period 12-11-45 to 3-28-46					
PK*	3	843.17	1,064.17	221.00	73.7
P	3	796.34	860.34	64.00	21.3
G	3	694.66	730.00	35.34	11.8
Least Significant Difference Between Means:					
At the 5 per cent level					28.14
At the 1 per cent level					46.68
Second Period 4-23-46 to 6-28-46					
PK	3	1,060.84	1,541.16	480.32	160.10
G	3	774.00	1,140.83	366.83	122.30
Least Significant Difference Between Means:					
At the 5 per cent level					143.12
Third Period 8-27-46 to 10-23-46					
PK	6	2,778.16	3,156.34	378.18	63.06
G	3	1,140.83	1,292.33	151.80	50.60
Least Significant Difference Between Means:					
At the 5 per cent level					104.65

*PK—Pará grass-Kudzu mixture.
P—Pará grass alone.
G—Guinea grass alone.

During the first period, the heifers on the mixture plots made significantly better gains than those on the other grasses, as shown in Table 7. A covariance analysis indicated that due to the higher initial weight of the animals in the mixture plots they gained 0.276 pounds more per pound of excess weight than the others. However, the gains were high enough to be significant even after making allowance for this. For the sec-

ond and third periods the gain differences were not high enough to be statistically significant.

At the end of the first period Pará grass was eliminated from the trial because it was severely affected by the drought. Indeed, even before starting the test, it was believed that the place was too high and dry for the Pará grass, which is best grown in low wet soils.

Drought did not seriously affect growth in the mixture plots. A very good mat was formed which could withstand close grazing and trampling and hold more of the moisture in the soil. The probable addition of nitrogen by the legume may have resulted in a better pasture.

Table 2 presents the chemical analyses of the different grasses, the mixture, and the plants from the mixture separately for the whole trial.

No samples were taken from plots that had very little roughage left or were completely grazed out. Samples of the grasses and the mixture were taken as explained before, all through the three periods, but the samples of Kudzu and Pará grass separated from Kudzu were taken in the third period. In all probability this is the explanation of the difference in moisture content and some other of the constituents in the analyses.

TABLE NO. 2

AVERAGE ANALYSES OF THE DIFFERENT GRASSES DURING THE WHOLE TRIAL IN PER CENT, DRY BASIS

Grasses	No. of samples	Moisture Per Cent	Ash Per Cent	Crude Protein Per Cent	Fat Per Cent	Fiber Per Cent	Nitrogen Free Extract Per Cent
Pará grass	9	77.93	8.56	4.91	1.18	33.83	51.53
Guinea grass	15	77.10	12.56	5.76	1.45	32.30	48.10
Pará grass and Kudzu	9	75.55	8.05	10.94	1.76	33.09	46.10
Kudzu alone*	12	77.50	8.14	17.34	2.02	34.21	38.27
Pará alone*	(12)	77.93	9.83	9.00	1.68	30.50	49.00

* Para grass or Kudzu separated from the mixture.

Kudzu is quite high in protein content and the Pará grass growing with it is higher in protein than when growing alone. The analysis of the mixture presents a more or less intermediate situation showing quite an improvement.

Guinea grass gave a much better analysis than Pará grass alone especially as regard minerals and protein.

The most interesting fact to be observed is the increase in protein content of the Pará grass in the mixture, as compared to the Pará grass growing alone.

The weights of the clippings and the dry matter in pounds for the whole trial are presented in Table 3. The weights of the samples taken for analysis were included.

TABLE No. 3

WEIGHT OF CLIPPINGS AND DRY MATTER YIELDS OF GRASSES; EXPERIMENTAL PLOTS

Grasses	Clippings, lbs.	Moisture Content Per Cent		Dry Matter, lbs.
First Period				
PK	25,382.82	(9 samples)	75.55	5,961.60
P	7,426.57	(9 samples)	77.93	1,639.04
G	9,391.94	(15 samples)	74.10	2,432.51
Second Period				
PK	13,572.73	(same as above)		3,318.53
G	540.52	(same as above)		139.99
Third Period				
PK	2,512.00	(same as above)		614.18
G	248.00	(same as above)		64.23

Larger amounts of forage were clipped from the mixture plots in all the three periods, even with two heifers in the third period.

The data in Table 3 together with the data in Table 1 were used for the calculation of total digestible nutrients and carrying capacity of the three grasses which are presented in Table 4.

The calculations were made according to the recommendations of the Pasture Research Committee of the A.D.S.A. and adapted to our problem. As growing heifers were used in this experiment, some error may have been introduced regarding the nutrient requirements per pound of gain in weight, but it is not felt that this source of error invalidates our conclusions regarding the evaluation of the grasses with respect to their nutritive value and carrying capacity.

The constants used have been as follows:

Standard cow-day = 16 pounds of total digestible nutrients

$$\text{Carrying capacity} = \frac{\text{Standard cow-days per acre}}{\text{Days in grazing season}}$$

Dry matter 72 per cent digestible

3.53 pounds of total digestible nutrients for every pound of gain in weight

The three periods are put together to facilitate comparison.

TABLE No. 4

CALCULATION OF TOTAL DIGESTIBLE NUTRIENTS AND CARRYING CAPACITY FOR THE THREE PERIODS OF THE EXPERIMENT

Items	First Period			Second Period		Third Period	
	PK	P	G	PK	G	PK	G
1. Days in periods	106	106	106	126	126	67	67
2. Number of heifers	3	3	3	3	3	6	3
3. Total cow-days (1) x (2)	318	318	318	378	378	402	201
4. Total initial weight in pounds	843.17	796.34	694.66	1,060.84	774.00	2,778.16	1,140.83
5. Total final weight in pounds	1,064.17	860.34	730.00	1,541.16	1,140.83	3,156.34	1,292.33
6. Ave. maintenance, lbs. $\frac{(4)+(5)}{2}$	953.67	828.34	712.33	1,301.00	957.42	2,967.25	1,217.08
7. Total weight-days (6) x (1)	101,089.02	87,804.04	75,506.98	163,926.00	120,634.92	198,805.75	81,544.36
8. TDN req. for maintenance, lbs. $\frac{(7) \times 7.925}{1000}$	801.13	695.85	598.39	1,299.11	956.03	1,575.54	646.24
9. Weight gain in pounds	221.00	64.00	35.34	480.32	366.83	378.18	151.50
10. TDN requirement for gain, lbs. (9) x 3.53	780.13	225.92	124.75	1,695.52	1,294.91	1,334.97	534.79
11. TDN requirements, lbs. (8) + (10)	1,581.26	921.77	723.14	2,994.63	2,250.94	2,910.51	1,181.03
12. TDN from residue, lbs	4,292.35	1,180.11	1,751.40	2,389.34	100.79	442.21	46.25
13. TDN yield of pasture, lbs. (11) + (12)	5,873.61	2,101.88	2,474.54	5,383.97	2,357.73	3,352.72	1,227.28
14. TDN yield per acre, lbs. $\frac{(13)}{\text{acreage}}$	1,957.87	700.63	824.85	1,794.66	783.91	1,117.57	409.09
15. Standard cow-days per acre $\frac{(14)}{(16)}$	122.36	43.79	51.55	112.17	48.99	69.84	25.57
16. Carrying capacity standard cow-days $\frac{(15)}{(1)}$	1.15	0.41	0.49	0.89	0.39	1.01	0.38

The results in Table 4 show the superiority of the mixture over Pará and guinea grasses in total digestible nutrients and carrying capacity. It more than doubles the yields of the other two separately. Guinea grass was similar to Pará in total digestible nutrients and carrying capacity, but was superior from the standpoint of drought resistance.

Taking all the results as a unit the carrying capacity for each grass under the conditions of the experiment were the following:

Mixture of Pará grass and Kudzu	1.02
Pará grass alone	0.41
Guinea grass alone	0.42

Analyses of the yields of total digestible nutrients per acre are presented in Table 5.

TABLE NO. 5

MEAN TOTAL DIGESTIBLE NUTRIENTS YIELDS PER ACRE AND LEAST SIGNIFICANT DIFFERENCES FOR THE GRASSES DURING THE THREE PERIODS

Grasses	TND mean yield in pounds per acre
First Period	
PK	1,957.67
P	700.00
G	842.36
LEAST SIGNIFICANT DIFFERENCES BETWEEN MEANS:	
At the five per cent level	196.49
At the one per cent level	325.87
Second Period	
PK	1,704.89
G	784.03
LEAST SIGNIFICANT DIFFERENCES BETWEEN MEANS:	
At the five per cent level	466.18
At the one per cent level	1,075.27
Third Period	
PK	1,117.65
G	409.47
LEAST SIGNIFICANT DIFFERENCES BETWEEN MEANS:	
At the five per cent level	296.05
At the one per cent level	682.84

The differences between the mean yield of total digestible nutrients per acre among the grasses were statistically significant at the one and five per cent levels for the first and third

periods and at the five per cent level for the second period, in favor of the Pará grass-Kudzu mixture, as shown in Table 6. These results agree with those obtained for carrying capacity.

Summary and Conclusions

Pará grass or "malojillo" (*Panicum purpurascens*), Guinea grass (*Panicum maximum*) and a mixture of Pará grass and tropical Kudzu (*Pueraria javanica*) were tested as pasture crops by rotational grazing of 1/3 acre plots with native heifers which were 6–7 months of age at the start of the trial.

At the time the heifers were changed from one lot to another, the uneaten portions of the forages were clipped, weighed, and samples secured for chemical analysis. Observations were also made on the ability of the crops to withstand drought, trampling, etc.

Pará and Guinea grasses were similar as measured by gains of the animals, yield and carrying capacity. The Pará grass suffered severely during one phase of the trial due to a drought which affected it unduly because the grass was planted on high, well-drained, soil in contrast to its natural habitat. Guinea grass was not affected by the drought. This resistance plus its other desirable qualities indicates that Guinea grass is suitable as a pasture crop in Puerto Rico.

The combination of Pará grass and Kudzu was found to give the best results in total digestible nutrients, gain in weight of the animals and carrying capacity. There was some evidence to indicate that the mixture benefited the nitrogen balance of the soil and assisted in the retention of precipitation. The Kudzu contained approximately 17 per cent crude protein and Pará grass of the mixture had a higher protein content than that grown alone.

The results of this study indicate that Kudzu is a highly desirable crop to use in conjunction with Pará grass for pasture purposes.

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