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quence of the competition between the grass and the legume under grazing and/or differences in palatability which result in selective grazing by the steers, but also to the lack of knowledge about basic management strategies on the first year of establishment. It becomes clear that each combination of species requires a very specific management, i.e., each grass/legume association has to be evaluated as a separate unit.

The two replicated pastures of *S. capitata* 1405/*A. gayanus* produced an average daily gain of 678 g/animal/day with continuous stocking of 2.5 steers/ha from April to October (for 173 days); this mixture has been stable and well balanced.

In another set of replicated experiments the "protein bank" concept is studied, i.e., the use of small areas sown with a legume in pure stand to be used to supplement cattle grazing pure grass pastures. This concept appears to suit some legumes with management problems when used in mixed swards.

P. phaseoloides is used with *B. decumbens* or with native savanna. When the protein banks were not fenced, *P. phaseoloides* was soon overgrazed. In some cases, a long rest period with some fertilization was required for the legume to recover.

The experiment using fenced *P. phaseoloides* protein banks in conjunction with native savanna could be followed through for 11 months of experimental grazing (Table 47). Results so far indicate better animal gains in the low stocking rate compared to the high stocking rate used. At the end of this period (November), plant coverage and vigor continued to be satisfactory in both stocking mates used.

New pastures established during 1979 include 2 ha paddocks with *S. capitata* 1019 and *S. capitata* 1315 in mixtures with *A. gayanus*. Since the *S. capitata* 1019 is early flowering and 1315 intermediate, the effect of the difference in maturity on pasture productivity will be studied.

Table 48. Liveweight gains obtained with native savanna and Pueraria phaseoloides protein banks, at two stocking rates at Carimagua during 1979[1].

Stocking rate savanna + P. phaseoloides (ha/animal)	Liveweight gains (g/animal/day) Dry season	Rainy season	Total period (kg/animal)	(kg/ha)
1.8 + 0.2	10	486	119	60
3.8 + 0.2	170	551	152	38

1 Dry season, 59 days; rainy season, 245 days; total period = 342 days.

CATTLE PRODUCTION SYSTEMS (CARIMAGUA)

The Cattle Production Systems section (formerly called, Animal Management section) continued (a) the evaluation of existing beef production systems in Colombia, Brazil and Venezuela; (b) the evaluation of the strategic use of improved pastures in Colombia; (c) herd management experiments in Brasilia; and (d) management of test herds.

Evaluation of Beef Production Systems (ETES)

The data collection phase of the Beef Production Systems Evaluation Project (ETES, an interdisciplinary project carried out in conjunction with the Economics and Animal Health sections of the Tropical Pastures Program) has been concluded in the Colombian Llanos, is well advanced in the Brazilian Cerrado and has been reinitiated in the Northeastern Llanos of Venezuela.

Llanos Orientales of Colombia

In the previous year (CIAT Annual Report, 1978), emphasis was given to the inter-farm variation in herd structure and management, including availability of sown pastures. This year, emphasis was somewhat different; however, variation between farms in various items will again be presented, as well as aspects common to all farms.

The physiographic characteristics (Table 49) show that the dry savanna is the principal component of the

Table 49. Physiographic characteristics of 16 farms in the Eastern Plains of Colombia. (ETES Project.)

Farm No.	Total area (ha)	Dry savanna (ha)	Wet savanna (ha)	Hilly savanna (ha)	Forest (ha)
2	1083	839 (78)[1]	140 (13)	7 (0)	97 (9)
4	3052	2385 (78)	410 (13)	85 (3)	172 (6)
5	810	623 (77)	54 (7)	40 (5)	93 (11)
6	1605	1015 (61)	504 (33)	0 (0)	86 (6)
7	4932	4089 (83)	414 (8)	90 (2)	339 (7)
8	375	203 (54)	172 (46)	0 (0)	0 (0)
9	474	55 (12)	155 (32)	234 (50)	30 (6)
11	5252	2243 (43)	2052 (39)	877 (16)	80 (2)
12	4325	2982 (69)	583 (13)	710 (16)	50 (2)
13	1412	306 (22)	406 (29)	700 (49)	0 (0)
14	1701	751 (44)	540 (32)	410 (24)	0 (0)
15	3580	2986 (83)	505 (14)	0 (0)	89 (3)
17	2239	1805 (80)	248 (11)	186 (9)	0 (0)
18	8891	7835 (88)	621 (7)	70 (1)	365 (4)
19	3972	3119 (78)	545 (14)	200 (5)	108 (3)
20	2744	2174 (76)	379 (13)	50 (2)	141 (8)
Mean	2903	64	20	11	4
CV	77.0	35.8	62.5	144.8	83.7

1 Figures in parenthesis are percentages.

farms, followed by the wet savanna, the hilly savanna and forest areas. The proportion of the total area represented by dry savanna is less variable between farms than the proportion of the other physiographic units.

Soil fertility is also less variable between farms in the dry savanna than in the wet savanna (Figure 56, 57 and 58). Available soil P in the dry savanna was above 2 ppm in only four farms. In contrast, more than 2 ppm available soil P was found in the wet savanna portion of 13 farms, and more than 4 ppm in four farms. Al saturation in the dry savanna was above 80% in all but one farm. In the wet savanna it was below 80% in five farms, and below 60% in two farms. Soil pH in the dry savanna was less than 4.7 in all cases, whereas in the wet savanna the pH range was 4.2 to nearly 5.0.

The number of animal units (AU) per farm depended largely on available dry savanna (correlation between area of dry savanna and total AU = 0.85) and was practically independent of the availability of wet savanna (correlation between area of wet savanna and total AU = 0.23).

The overall average stocking rate was 5.9 ha/AU, with 3.9 ha of dry savanna and 1.2 ha of wet savanna available per AU. As expected, the availability of dry savanna/AU varied less between farms than the availability of wet savanna/AU (Table 50).

The herd structure (Table 51) shows that all farms are cowcalf and stocker operations with some minor fattening activity in farms 2, 12, 17 and 20.

Tables 52 and 53 contain information on animal management practices additional to the data presented in the previous report (CIAT Annual Report, 1978).

The main objectives of herd subdivision are to avoid interference of male animals with females, and to

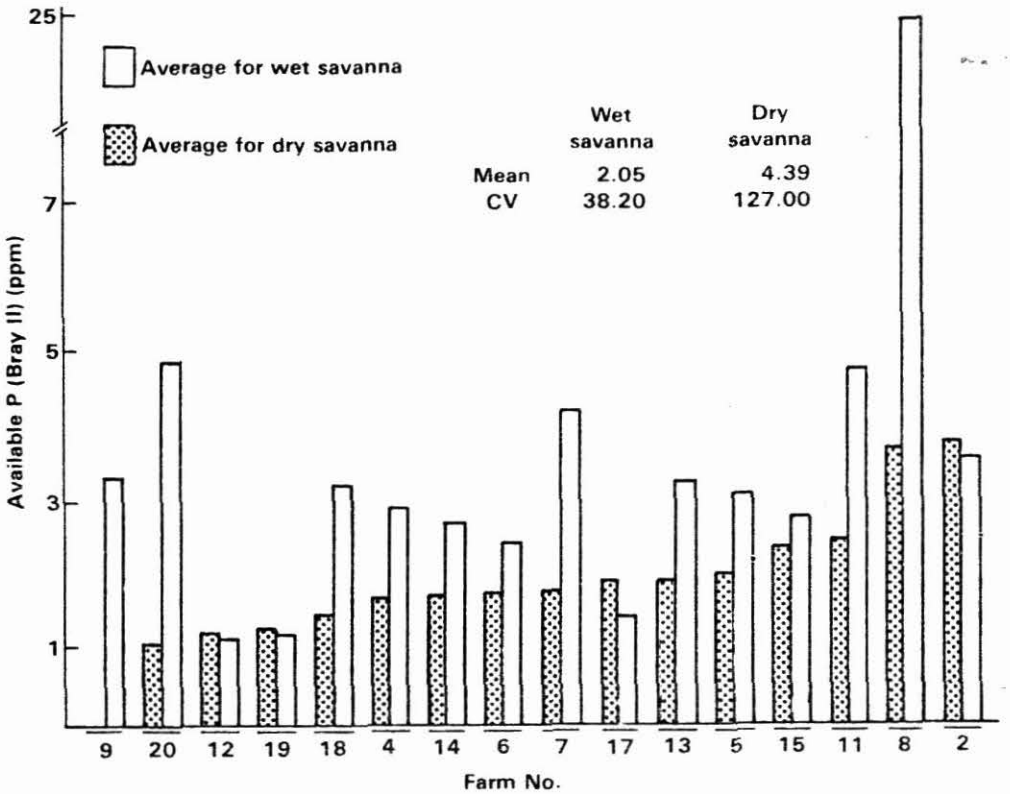

Figure 56. Available soil P in 16 farms of the Eastern Plains of Colombia (ETES Project).

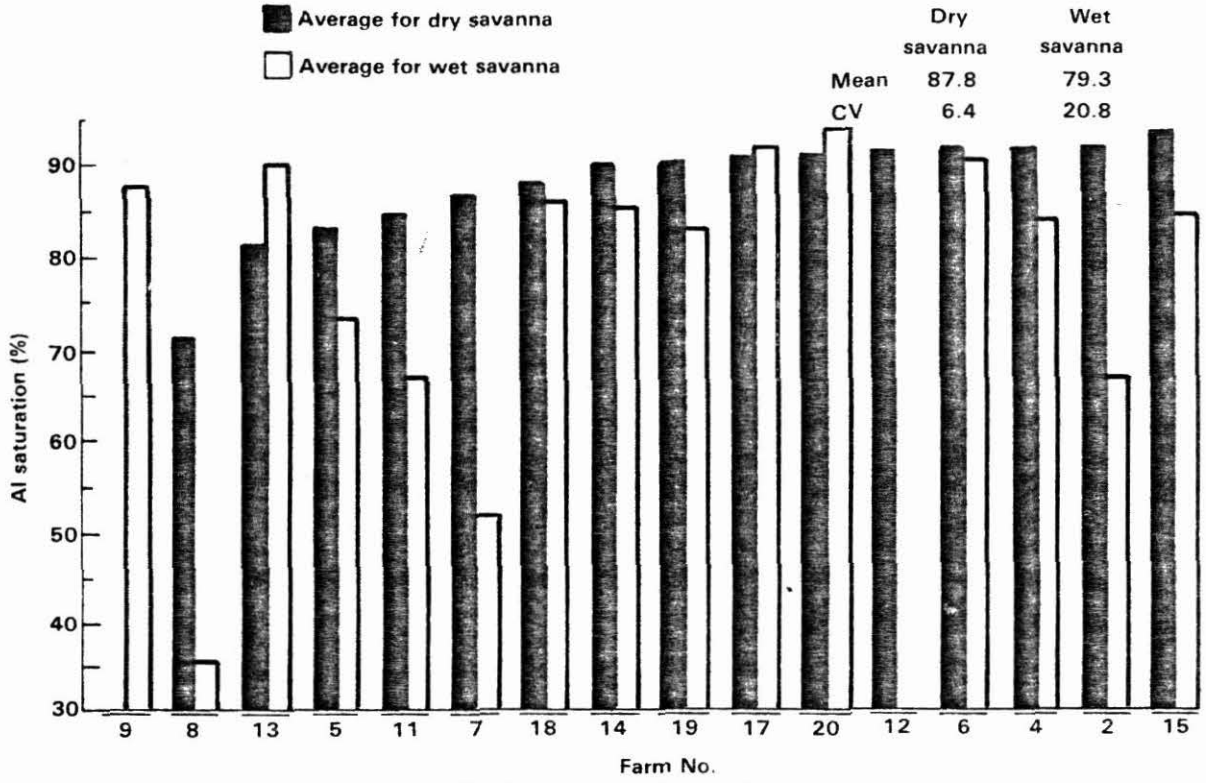

Figure 57. Al saturation in the soil of 16 farms of the Eastern Plains of Colombia (ETES Project).

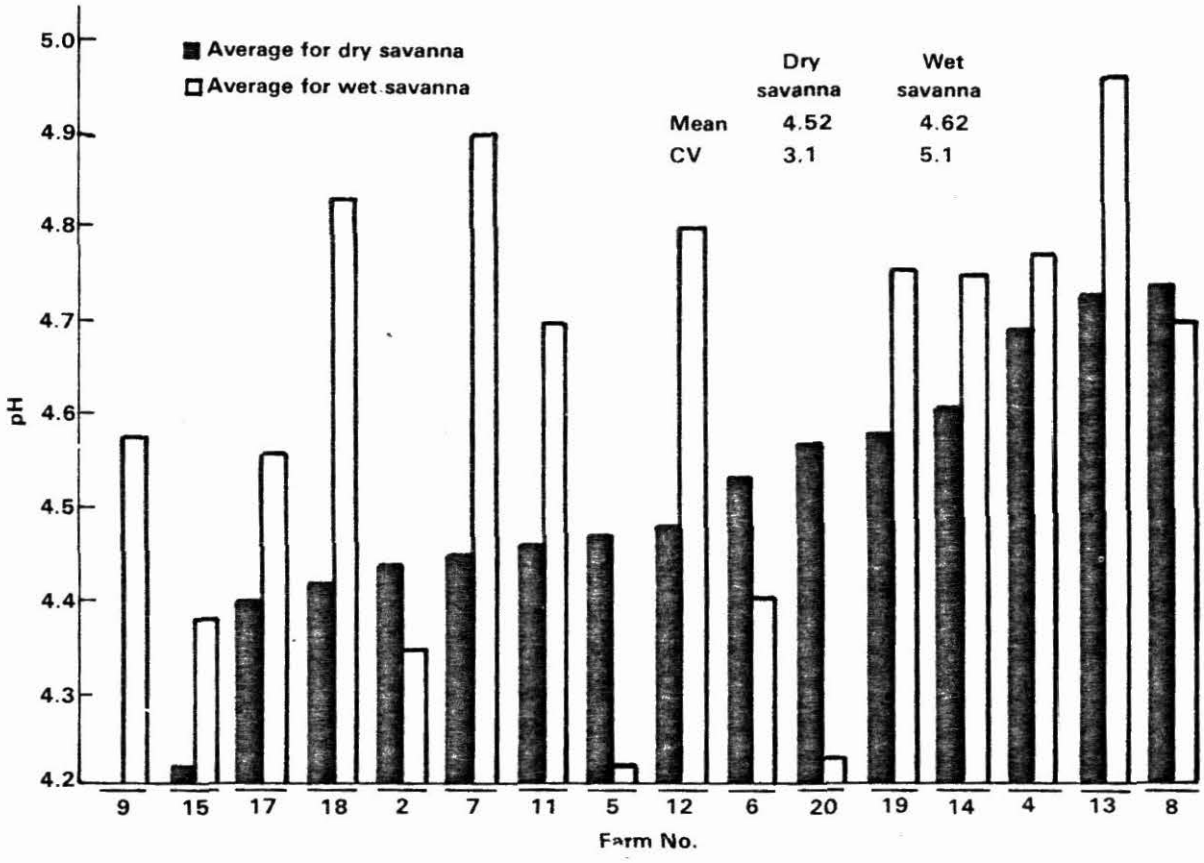

Figure 58. Soil pH in 16 farms of the Eastern Plains of Colombia (ETES Project).

adjust forage offer to the nutritional requirements of the stock. Only three farms practiced separation of animal categories in addition to the separation by sex (Table 52), although paddock availability does not appear to be limiting to more advanced practices of herd subdivision.

Mineral supplementation is difficult to evaluate in farm case studies. It is necessary to know not only the amount of mineral supplement, but also its quality, which animals receive it, and how often. In this study, only the amount of P supplement used by the farms was measured. The information was enough, however, to show that in general the level of supplementation is very low (Table 53). Only an average 46% of the level of supplementation recommended in Carimagua is used, and only three farms utilized 90-100% of the amount of P supplement used in Carimagua.

Disease control on the farms is also difficult to evaluate. No impact of vaccination against foot and mouth disease could be measured because no outbreaks occurred during the monitoring period, despite the large variation between farms in the use of vaccination (Table 53). Few farmers vaccinate against brucellosis but the prevalence of the disease in the Eastern Plains appears to be negligible. Blackleg is the only other infectious disease against which immunization is carried out by the farmers. No information on the incidence of the disease is available for the region and, on the other hand, only early mortality of calves (too early to be due to blackleg) could be recorded. Consequently, no relationship between vaccination against blackleg and productivity could be established.

Routine navel disinfection of calves is practiced on 7 of the 16 farms. The unweighted average of calf mortality in these seven farms was 4.3%, against 9.5% in the other nine farms. However, the high average mortality amongst farms without routine navel disinfection is due mainly to two farms with 20 and 28% calf mortality.

Ticks and gastro-intestinal parasites do not appear as major herd problems in the ETES farms (see Animal

Table 50. Mean stocking rates on 16 farms in the Eastern Plains of Colombia. (ETES Project.)

Farm No.	Stocking rate (ha/AU)	Available savanna (ha/AU) Dry	Wet
2	4.1	3.2	0.5
4	5.3	4.2	0.7
5	3.9	3.0	0.2
6	4.4	2.8	1.4
7	4.9	4.1	0.4
8	3.8	2.0	1.7
9	4.3	0.5	1.4
11	11.6	4.9	4.5
12	9.0	6.2	1.2
13	5.6	1.2	1.6
14	4.0	1.8	1.3
15	4.0	3.3	0.5
17	5.3	4.3	0.6
18	9.1	8.0	0.6
19	9.9	7.8	1.4
20	5.9	4.6	0.8
Mean	5.9	3.9	1.2
CV	42.4	53.8	85.6

Health section on page 107); however, there is still no clear explanation for this situation.

The main animal production parameters are presented in Table 54.

Conception rate was measured as the average annual conception rate of cows monitored during two years (actual monitoring was 18 months but pregnancy diagnoses by rectal palpation covered two complete years). The average for 15 farms was 49.8%, with a 15.5% CV and a range from 39 to 65%. These data confirm the low calving rates found in previous short term work in the Eastern Plains. Precise estimates per farm, however, require evaluation over two consecutive years because large yearly fluctuations can severely bias estimates obtained on particular farms in any single year. This variation must be expected with the low fertility levels that prevail in the region. The poor reliability of figures for a single year is illustrated by the fact that the calving rate estimates presented in the CIAT Annual Report, 1978 had a correlation of only 0.43 with the conception rates averaged over two years.

The cumulative conception rate of heifers up to three years of age also confirms previous observations on the advanced age at first conception. The pregnancy rate of heifers at three years of age is strongly correlated with the average annual conception rate of cows ($r = 0.88$) suggesting the presence of common causes for the fertility level of cows and heifers on individual farms.

Abortion rate was measured as the percentage of pregnancies detected by rectal palpation that did not lead to a calving or that ended in a recorded abortion. The abortion rate was high on average, but varied widely between farms. The very high abortion rate in about half of the farms indicates the need for further research on the causes of these losses.

Calf mortality was also high, particularly in two farms (Table 54). Calf mortality appears to have little relationship with abortion rate ($r = 0.21$) suggesting independent causes for the two types of losses, but the two farms with highest calf mortality also had high abortion rates. The low calf mortality found on some farms must be viewed with caution because under extensive grazing early calf deaths may be unnoticed. Besides, so far in Carimagua, it has been impossible to reduce calf losses below 5% despite improved management.

Annual weight gains of stockers were calculated by fitting regressions of weight on age through age categories of one year each, up to four years. With the exception of two farms, the annual weight gain per animal was well below the best results obtained on savanna in Carimagua (52.5 vs. approximately 90 kg/animal/year).

Farm annual liveweight production was estimated as follows:

$$(N \times C \times W) + \sum S \times G$$

where, N = number of cows; C = calving rate calculated from the average annual conception rate over two years, corrected for abortions and calf mortality; W = weight of one year old calves; S = number of stockers in the ith age category (1-2, 2-3, 3-4 years, and > 4 years); G = annual weight gains of stockers in the ith age category.

Table 51. Herd estructure in 16 farms in the Eastern Plains of Colombia[1] (ETES Project).

Farm No.	Cows	Bulls	Calves	Heifers (age in years) 1-2	2-3	3-4	Steers (age in years) 1-2	2-3	3-4	4	Culled cows
2	104	6	63	24	15	7	30	63	0	0	0
4	346	23	148	53	17	60	0	5	1	0	0
5	116	7	61	24	19	9	0	10	5	0	0
6	213	22	79	43	30	22	7	0	3	0	0
7	393	26	122	83	113	115	119	80	15	0	0
8	52	4	24	9	15	0	27	0	0	0	0
9	54	5	25	10	14	9	12	4	0	0	0
11	197	24	155	47	27	0	39	18	0	0	0
12	123	14	55	57	64	25	71	93	58	0	4
13	130	8	54	24	27	10	12	15	0	0	0
14	190	12	93	35	28	18	32	15	0	0	0
15	406	20	135	147	65	52	141	45	0	0	10
17	126	10	84	60	30	22	35	40	0	1	15
18	458	40	189	137	59	39	115	88	15	6	0
19	161	9	50	32	45	39	33	20	15	17	0
20	214	11	107	39	30	33	41	10	83	0	0
Total	3283	241	1444	824	598	460	714	506	195	24	29
					1882			1415			

1 **The number in each category is the average for the first two farm visits in October-November 1977 and April 1978.**

The annual liveweight production/AU on the farm is shown in Figures 59 and 60.

Farm production/AU varied from 34 to 129 kg/year, but when the top farm is excluded, the coefficient of variation in production is only 22%. Four farms produced less than 50 kg/AU/year, 10 farms produced between 50 and 70 kg/AU/year and only two farms produced more than 70 kg/AU/year.

Production/ha and production/AU were closely correlated (Figure 60). This indicates that farmers reached a remarkably close equilibrium between per animal and per ha output, despite the variation in farm production.

Much of the inter-farm variation in production appears to be related to the availability and fertility of wet savanna and, at a lesser extent, to the presence of sown pastures on the lower land. Sown pastures on the dry land do not contribute to explain inter-farm variation in production. This is shown by the following relationship:

$$Y = 29.71 + 3.50\ X_1 + 5.44\ X_2 + 0.03\ X_3 + 0.09\ X_4$$

where, Y = liveweight production/AU/year; X_1 = P (ppm) in wet savanna; X_2 = ha of wet savanna available/AU; X_3 = ha of sown pasture on dry land; X_4 = ha of sown pasture on wet land. The coefficient of determination for this model is 0.91; the partial regression coefficients for X_1, X_2 and X_4 are significant at the 1% level, and the regression coefficient for X_3 is not significant at the 5% level.

The main economic aspects of the ETES farms are the following:

Total investment per farm ranges from US$40,000-450,000; the average for the 16 farms is US$120,000 or $100/ha and $500/AU (Table 55).

The two most important investment items are cattle (43%) and land (39%). These two components make up over 70% of the total investment in all but one farm (farm 8) which has a larger investment in constructions, machinery and equipment than all other farms.

Table 52. Farm subdivision, herd subdivision and phosphorus supplementation in 16 farms, in the Eastern Plains of Colombia (ETES Project).

Farm No.	Farm subdivision (Paddocks/ 100 AU)	Herd subdivision[1]	Phosphorus supplementation[2]
2	3.4	2	24
4	1.7	5	77
5	4.8	2	24
6	2.7	4	3
7	2.1	4	91
8	11.0	3	51
9	0.9	2	5
11	2.4	6	95
12	2.9	2	55
13	0.4	2	25
14	1.4	2	100
15	1.0	1	62
17	1.4	3	50
18	1.4	2	33
19	1.5	2	13
20	1.3	3	33
Mean	2.5		46
CV	99.7		68.4

1 Herd subdivision scale: Males separated from females: At three years of age (1); at two years of age (2); at one year of age (3); heifers separated from cows (4); dry cows from lactating cows (5); cows in early lactation from cows in advanced lactation (6).

2 As percentage of phosphorus supplementation in Carimagua (1683 g/AU/year).

This farm also has the highest investment per animal unit.

Investments in constructions are mainly housing (37%), fences (32%) and corrals (20%). Small-sized equipment and tools, an old tractor and a vehicle constitute investments in machinery and equipment.

Farms are growing on the basis of increasing their cattle stock (Table 56). Some farms have increased their area in sown pastures during the observation period. Investments in constructions were either a building to house workers (farm 8) or chutes (farms 13 and 15). Three farms invested in machinery: farms 8 and 13 bought electric plants and farm 15 bought a used tractor.

A second possibility of growth, i.e., through purchasing land, is also taking place. Farm owners are buying other farms, usually in the Piedmont, with the purpose of fattening stockers from their farms in the savanna. Average new investments were US$9500 per farm, equivalent to a 4.5% annual growth rate.

Average farm income during 1978 was US$18,300 per year (Table 57). The main source of income was cattle sales, although 22% of sales were simply at the expense of reducing cattle inventories.

Income estimates on the basis of production is shown to provide a close average estimate of actual income, but correlation is very low on a per-farm basis with actual income. This fact confirms common knowledge that a one-year income flow should not be used as the basis for economic analysis of cattle farms where the production cycle comprises at least 3-4 years. Instead, production parameters obtained from these farms will be used for the economic analysis, with the aid of budgeting, simulation or programming techniques.

Average annual current expenditures in the ETES farms during 1978 were US$8000 per farm, with large differences between farms (Table 58). These expenditures consisted mainly of labor costs, administration and purchase of mineral supplements (despite the low level of supplementation).

Labor is mainly permanently hired cowboys. The larger survey of cattle farms in this region (see Economics section on page118) showed a somewhat different result in this respect with a large share of occasional laborers in the labor cost. Finally, purchases of other inputs, particularly fertilizer, were virtually nonexistent.

To summarize, cattle farms in the Colombian Llanos are cow-calf-stocker operations; fattening is of minor importance and essentially a speculative activity.

The production level, both per animal unit and per unit area, is low. The main limiting factor to a higher production is the low fertility of the dry savanna. There is little variation between farms in the quality of this main land resource which determines the total

Table 53. Animal health practices in 16 farms in the Eastern Plains of Colombia (ETES Project).

Farm No.	Vaccination against[1]			Control of[2]		Routine navel disinfection
	Foot & mouth disease	Blackleg	Brucellosis	Ticks	Endoparasites	
2	2.0	0.5	0.0	1.6	0.7	no
4	0.8	0.3	0.0	3.5	0.8	yes
5	3.2	1.0	0.0	0.0	0.4	yes
6	2.4	1.0	0.0	1.6	0.3	yes
7	0.1	0.5	0.0	1.5	1.0	yes
8	2.2	1.0	1.0	2.6	1.4	yes
9	4.5	1.0	0.0	1.0	0.7	no
11	2.7	0.5	0.0	4.0	1.0	yes
12	0.9	0.0	1.0	1.0	0.0	no
13	1.3	1.0	0.3	0.9	0.9	no
14	0.0	0.0	1.0	0.0	0.0	no
15	1.1	0.0	0.0	2.0	0.0	no
17	1.1	0.2	0.4	3.3	0.2	yes
18	0.9	1.0	0.0	1.0	0.6	no
19	0.0	0.0	0.0	3.5	0.1	no
20	2.0	1.0	0.0	5.5	0.5	no

1 Doses/animal to be vaccinated/year estimated from amount of vaccine consumed during the year.
2 Treatments/animal/year estimated from amount of drugs consumed during the year.

stocking rate of the farms. Differences in production between farms, therefore, originate principally from variation in the minor land component with frequently higher fertility, i.e., the wet savanna. Farms with larger proportions of more fertile low land produce more than farms with little wet savanna; this relative advantage is even further increased if pastures are sown on the better soil (which for this purpose must comply with another restriction: the low lands in the farms should not flood in the rainy season).

As suggested by the close relationship between production per unit area and production/AU, farmers apparently have succeeded in adjusting the stocking rate of their land to its natural production potential. This managerial aspect and the introduction of sown pastures to the more fertile areas, probably are the main management components of the prevailing farming system. Other management practices widely used in more advanced cattle production systems are either not applied at all, or are applied at a level of doubtful impact. Thus seasonal mating and weaning at a defined age are not practiced; herd subdivision is only applied at a low level; mineral supplementation, although clearly necessary, is inadequate; disease control appears to be haphazard and nonproductive animals are not culled systematically.

Improved management would increase production; particularly, adequate mineral supplementation could have an immediate response. The change, however, would probably not be dramatic as the major limitation is poor nutrition (responsible for the poor growth rate of the stock and, in all likelihood, for most of the low fertility of breeding females).

The means to substantially increase animal production, therefore, must be through the improvement of forage production on the dry savanna, along the lines proposed by the Tropical Pastures Program — grass/legume pastures adapted to the infertile savanna soils, to be used strategically and in conjunction with improved management.

A note of caution about improved management must be included: a severe limiting factor to any improve-

Table 54. Animal production parameters in 16 farms in the Eastern Plains of Colombia (ETES Project).

Farm No.	Conception rate of cows[1] (%)	Heifers pregnant at 3 years of age[2] (%)	Abortion rate[3] (%)	Calf mortality[4] (%)	Weight gain of stockers[5] (kg/animal/year)
2	56	53	18	28	53
4	*[6]	NA	NA	NA	*
5	41	29	6	8	41
6	57	74	16	7	47
7	51	NA	18	5	NA
8	65	100	3	0	141
9	50	62	15	20	48
11	56	NA	0	6	68
12	44	57	18	4	33
13	42	58	9	8	68
14	43	44	9	3	110
15	54	NA	4	1	NA
17	48	62	16	0	64
18	39	33	20	8	46
19	43	42	42	7	52
20	58	78	22	7	58
Mean	49.8	57.7	14.4	7.5	53.8
CV	15.5	34.7	71.1	99.6	46.9
				(excluding farm 8)	57.3
					34.4

1 Annual conception rate calculated from conceptions occurred during two years.
2 Cummulative conception rate up to three years of age.
3 Pregnancies ending in abortion x 100/total pregnancies occurred in one year.
4 Calves that died at one month of age or less/calves born in one year.
5 kg/animal/year estimated by regression of weight for age through age categories.
6 * = calving interval 23.5 month (n=116). No stockers present on this farm.
7 NA = information not available.

ment in management and to the adoption of more advanced technology will be the lack of managerial skill of farmers in the Eastern Plains region in general and of their administrators or farm managers in particular.

Cerrado of Central Brazil

Of the 15 farms initially selected, three were excluded from the project, two in Mato Grosso and one in Goiás. On the remaining farms data collection continued normally. Preliminary data analyses will be available in early 1980.

Northeastern Llanos of Venezuela

After inconveniences which delayed progress of the ETES Project in Venezuela, the final selection of 13 farms has been accomplished and the project is now in the early stages of on-farm data collection.

Characteristics of the farms surveyed in the pre-selection phase are presented in Tables 59 and 60 and data on the selected farms are shown in Table 61. Obvious differences with both the Colombian and Brazilian farms are the greater proportion of sown pastures, the higher stocking rate, the presence of

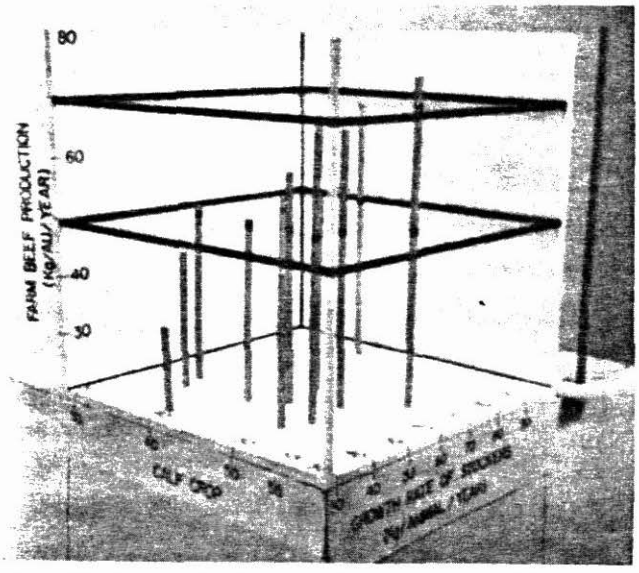

Figure 59. Farm production per animal per year to calving rate and growth rate of stockers.

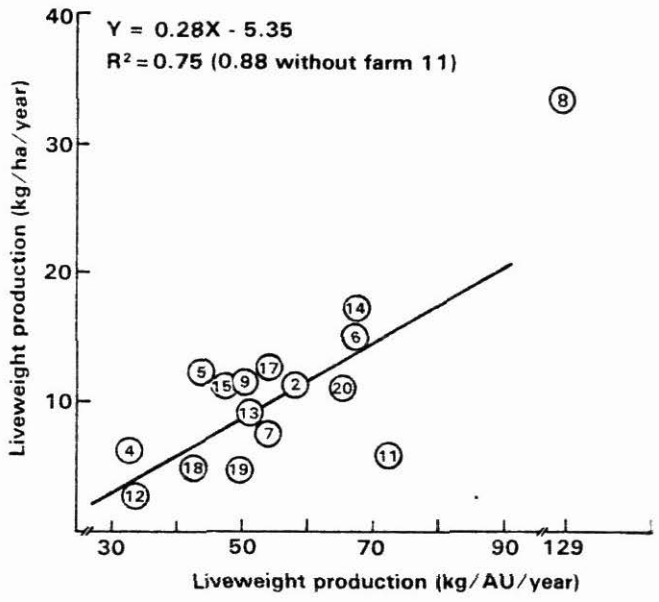

Figure 60. Liveweight production of cattle in 16 farms in the Eastern Plains of Colombia (ETES Project).

Table 55. Size and composition of total investment for 16 farms in the Eastern Plains of Colombia (ETES Project).

Farm No.	Land (%)	Cattle (%)	Sown pastures (%)	Installations and buildings (%)	Machinery and equipment (%)	Total investment (000 US$)[1]	Investment/ha (US$)	Investment/AU (US$)
2	40	34	10	8	8	163	150	620
4	55	35	0	7	3	322	100	560
5	43	35	10	12	0	109	1320	520
6	43	33	8	10	6	257	160	705
7	38	40	8	8	6	448	90	440
8	20	27	11	21	21	80	212	802
9	37	51	0	12	0	39	80	350
11	62	29	1	4	4	327	78	720
12	52	34	5	6	3	252	58	522
13	39	50	0	7	4	100	70	400
14	37	51	1	7	4	156	90	365
15	21	65	2	9	3	244	65	270
17	33	43	11	9	4	212	70	500
18	34	54	3	6	3	356	40	365
19	42	51	0	7	0	134	50	330
20	24	57	10	8	0	166	60	360
Avg.	39	43	5	9	4	210	95	490

1 1978 US$.

Table 56. New investments during 1978 for 16 farms in the Eastern Plains of Colombia (ETES Project).

Farm No.	New investments ('000 US$)[1]				
	Cattle[2]	Sown pastures	Installations and buildings	Machinery and equipment	Total new investment
2	10.1	5.0	0.0	0.0	15.1
4	16.5	0.0	0.0	0.0	16.5
5	7.2	0.0	0.0	0.0	7.2
6	28.7	0.0	0.0	0.0	28.7
7	- 7.1	8.4	0.0	0.0	1.3
8	15.3	7.9	0.4	1.7	25.3
9	6.9	0.0	0.0	0.0	6.9
11	-16.0	0.0	0.0	5.0	-11.0
12	27.9	4.0	0.0	0.0	31.9
13	5.5	0.0	0.0	3.3	8.8
14	-14.3	0.0	0.0	0.0	-14.3
15	30.0	3.6	0.0	3.8	37.4
17	-14.3	0.0	1.1	0.0	-13.2
18	29.7	2.8	1.1	0.0	33.6
19	-27.1	0.0	0.0	0.0	-27.1
20	3.7	0.6	0.0	0.0	4.3
Average					9.5

1 1978 US$.
2 Farms with negative investment in cattle show reduction in cattle inventory during the year due to sales.

fattening and dairy-ranching activities, the use of concentrates and the presence of crops. Thus, ETES Venezuela will be faced with a greater variety of cattle production systems and with more intensive entreprises than the other two ETES Projects.

ETES Project - Phase II

After the study of the prevailing cattle production systems in the first part of the ETES Project, a second phase will be devoted to the introduction of improved technology into some selected farms.

The objectives of the second phase are:

1. To evaluate the impact of grass/legume pastures developed by the Tropical Pastures Program on animal production and on net farm income. These pastures will be used strategically with the breeding herd, as a complement of the native savanna, in conjunction with improved animal management and animal health practices.

2. To study in detail the behavior of the improved grass/legume pastures under farm conditions, in terms of adaptation to the particular soil, disease and insect resistance, and productive persistence.

The second phase has been initiated on farm 4 in the Colombian Llanos.

The changes introduced so far include the sowing (July 1979) of the following improved pastures: (a) 25 ha of *Brachiaria decumbens* 606 in mixture with *Desmodium ovalifolium* 350; (b) 40 ha of *Andropogon gayanus* 621 in mixture with *Stylosanthes capitata* 1019; (c) 55 ha of *A. gayanus* 621 (49 ha in pure stand.

Table 57. Annual gross income for 16 farms in the Eastern Plains of Colombia (ETES Project).

Farm No.	Source of income ('000 US$)			Total gross income ('000 US$)	
	Cattle sales	Changes in inventory	Milk sales	Observed in 1978	Estimated according to production[1]
2	7.6	9.3	0.0	16.9	11.6
4	23.6	- 7.1	0.0	16.5	14.6
5	13.8	- 3.0	0.0	10.7	7.0
6	44.0	-26.8	0.0	17.1	18.6
7	58.9	-17.4	0.0	41.6	41.5
8	0.9	4.6	3.1	8.6	9.7
9	0.0	6.3	0.0	6.3	4.2
11	51.5	-16.0	0.0	35.5	25.1
12	27.8	- 5.6	0.0	22.2	12.3
13	2.8	5.5	0.0	8.3	9.8
14	24.0	-14.3	0.0	9.6	21.8
15	0.0	30.0	0.0	30.0	33.8
17	41.3	-21.2	0.0	20.1	17.4
18	28.0	11.9	0.0	47.9	32.3
19	28.0	-27.1	0.0	0.9	15.3
20	26.3	-13.1	0.0	13.1	23.1
Average	23.7	- 5.2	0.2	18.3	18.6

1 1978 US$.
2 Production measured in kg of liveweight/year at US$0.75/kg.

1 ha in mixture with *S. capitata* 1300 and 5 ha in mixture with *Zornia latifolia* 728); (d) 5 ha of *Pueraria phaseoloides* 9900.

The establishment of these pastures was satisfactory and the first grazing is about to begin.

Breeding Herds Management Systems

The effects of the strategic use of improved pastures and of the length of the mating season on the productivity of breeding herds is studied in this experiment at Carimagua.

The objectives and the experimental design were described in detail in previous reports (CIAT Annual Reports 1977 and 1978).

The experiment includes six herds of 54 cows each. Herds 1, 3 and 5 graze only on native savanna. Herds 2, 4 and 6 have access to improved pastures during 3.5 months in the late dry and/or early rainy season. Herds 1 and 2 mate all year round; the mating period for herds 3 and 4 extends from June until September (120 days) whereas herds 5 and 6 have a 90 day mating period between May and July.

The calving rate in 1979 calculated for all cows in each herd is presented in Figure 61. However, as some animals were pregnant during the mating season of 1978 or had calved shortly before the introduction of bulls of the herds, empty cows were classified as "able" if they had calved at least 90 days before the end of the mating season (arbitrarily, end of July for herds 1 and 2). The calving rate and the distribution of calvings in 1979 for these able cows is shown in Figure 62.

Comparing herds 1 with 2 and 5 with 6, it can be seen that the calving rate of able cows with no access to improved pastures in 1978 was higher than the calving rate of their counterparts that grazed only on

Table 58. Annual current expenditures for 16 farms in the Eastern Plains of Colombia (ETES Project).

Farm No.	Annual expenditures ('000 US$)[1]							
	Labor			Purchase of inputs				
	Occasional	Permanent	Administration	Mineral supplements	Drugs	Fertilizer	Others	Total
2	0.4	19.2	9.1	6.8	3.0	0.0	4.8	43
4	6.5	23.6	49.1	44.8	8.8	0.0	4.2	137
5	3.7	0.0	11.9	5.7	3.1	0.0	1.8	26
6	13.0	33.2	15.8	4.3	3.6	0.0	2.3	72
7	11.2	56.4	51.9	68.9	8.0	0.0	6.6	203
8	4.4	26.5	39.8	5.7	2.3	0.0	0.0	79
9	0.7	0.0	15.6	1.0	2.6	0.0	0.5	20
11	1.9	17.2	42.1	26.0	23.3	0.0	8.8	119
12	5.5	21.3	11.7	13.4	2.3	0.0	4.1	58
13	0.0	3.9	18.7	6.0	2.3	1.0	4.0	36
14	0.6	0.0	16.0	15.8	1.1	0.0	2.6	36
15	0.0	59.2	17.8	35.2	9.3	1.1	8.9	132
17	11.1	29.1	11.7	11.8	7.7	2.9	1.9	76
18	0.0	34.5	15.2	39.3	13.5	2.6	2.1	107
19	0.6	13.4	3.9	6.5	3.0	0.0	0.0	27
20	0.0	12.1	4.6	10.9	6.5	0.0	2.5	37
Average	3.7	21.9	20.9	18.9	6.2	0.5	3.5	76
Percentage	5	29	27	25	8	1	5	100

1 1978 US$.

Table 59. Characteristics of farms surveyed in the pre-selection phase in the Northeastern Llanos of Venezuela. ETES Project.

Stratum (ha)	n	Area (ha)	Area to sown pastures (ha)	Area to sown pastures (%)	Cows (No.)	Cows (%)	Stocking rate: Savanna pastures (ha/animal)	Stocking rate: Sown pastures (ha/animal)	Stocking rate: Savanna (ha/animal)
<500	9	224 (33)[1]	78 (82)	36 (84)	126 (61)	48 (40)	1.1 (68)	0.3 (71)	0.8 (98)
500-1000	21	699 (26)	236 (95)	34 (91)	160 (84)	40 (43)	2.2 (78)	0.6 (103)	1.6 (111)
1001-2000	10	1555 (21)	690 (71)	46 (72)	259 (68)	38 (58)	2.7 (84)	0.9 (77)	1.8 (137)
>2000	5	7000 (63)	352 (90)	9 (126)	603 (54)	43 (35)	5.7 (71)	0.3 (84)	5.4 (73)

1 Figures in parenthesis are coefficientes of variation (%).

Table 60. Other characteristics of farms surveyed in the pre-selection phase in the Northeastern Llanos of Venezuela (ETES Project).

Stratum (ha)	Use of mineral supplements (%)	Use of concentrates (%)	Dairy ranching[1] (%)	Fattening[1] (%)	Agricultural crops (ha)
< 500	50	63	56	22	22
500-1000	70	50	52	52[2]	33
1001-2000	90	40	40	40	60
> 2000	40	20	0	80	20

1 Plus cow-calf-stocker operation.
2 Two farms are exclusively fattening enterprises.

savanna. This effect, however, was not apparent in herd 4 which had practically the same calving rate as herd 3.

The shortening of the mating period from four to three months did not reduce the calving rate of cows with access to improved pastures (herd 6 vs. herd 4, Figure 62). In contrast, the shortening of the mating season for cows in savanna decreased the calving rate (herd 5 vs. herd 3). On the other hand, continuous mating should be compared with seasonal mating only at a more advanced stage of the experiment.

With regard to the possibility of maintaining a seasonal mating period, attention should be focused on the reconception rate of cows in early lactation. The reconception rate between 90 and 180 days post-parturition was 80% between 30 cows of herds with access to improved pastures. The reconception rate for 30 cows belonging to herds with access to savanna only was 40%.

Table 61. Characteristics of selected farms in the Northeastern Llanos of Venezuela (ETES Project).

Farm No.	Type of operation[1]	Area (ha)			Cattle		Stocking rate (ha/animal)	
		Savanna	Sown pastures	Crops	Total	Cows	Savanna	Sown pastures
1	C/R/F	165	650	0	855	390	0.2	0.8
2	C/R/D	200	470	0	500	240	0.4	0.9
3	C/R/F	100	600	0	300	60	0.2	2.0
4	C/R/D	180	70	0	350	150	0.5	0.2
5	C/R/F	400	250	0	1125	500	0.4	0.2
6	C/R/F	1600	300	100	1500	600	1.1	0.2
7	C/R/D	1775	125	0	300	200	5.9	0.4
8	C/R/D	600	600	0	1100	400	0.5	0.5
9	R	440	10	60	130	-	3.4	0.1
10	C/R	1180	20	0	300	150	3.9	0.1
11	C/R	890	80	30	500	300	1.8	0.1
12	C/R/D	400	50	50	350	200	1.1	0.1
13	C/R	550	50	0	250	120	2.2	0.2

1 C = cow-calf; R = raising; F = fattening; D = dairy-ranching.

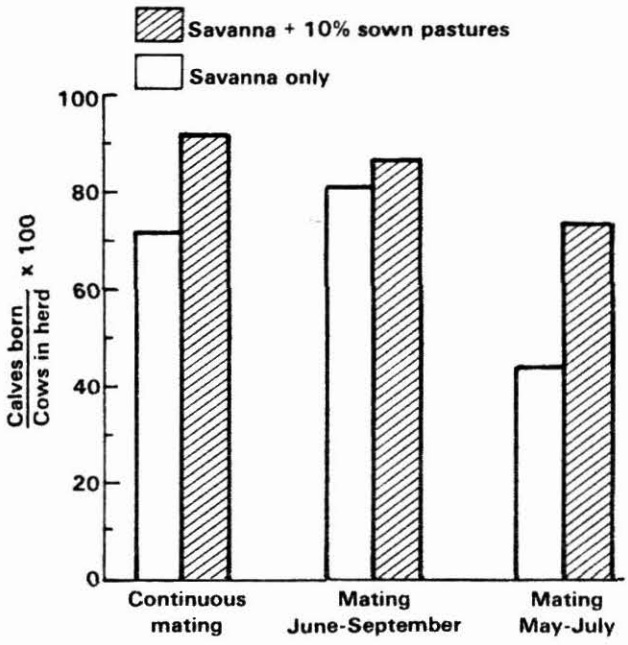

Figure 61. Effect of strategic use of sown pastures on calving rate during 1979 in the Breeding Herds Management Systems Experiment, Carimagua (calvings until September 30).

The reconception rate of cows on improved pastures is the required level for a seasonal mating system with high fertility. The reconception rate obtained on savanna only is too low for this purpose, but much higher than usual in the Llanos where cows normally almost never conceive while they are lactating. This suggests that the application of the management practices of herds 1, 3 and 5 to commercial herds in the Llanos might substantially increase fertility.

Pre-weaning mortality of calves was 8.4% in the herds that grazed on savanna only and 7.3% in those with access to improved pastures. This difference between grazing treatments was not statistically significant ($P<0.05$). The cause of death could not be determined in 53% of the cases; 32% of the losses were due to starvation (poor mothering ability of the dams), 10% to bone fractures and 5% to poliarthritis.

Calves born in 1978 were weaned at nine months of age. Weaning weight (Table 62) was increased due to access of the dams to improved pastures (168.1 vs. 158.8 kg). The period in which the calves were born had no effect on their weight at weaning and male calves were 11.3 kg heavier at weaning than females.

Body weight of cows at the bimonthly weighings is shown in Figure 63. During 1978, cows with access to improved pastures were always heavier than cows on savanna. From early 1979 onwards, however, cows on improved pastures lost weight progressively, particularly those in early lactation. This can be

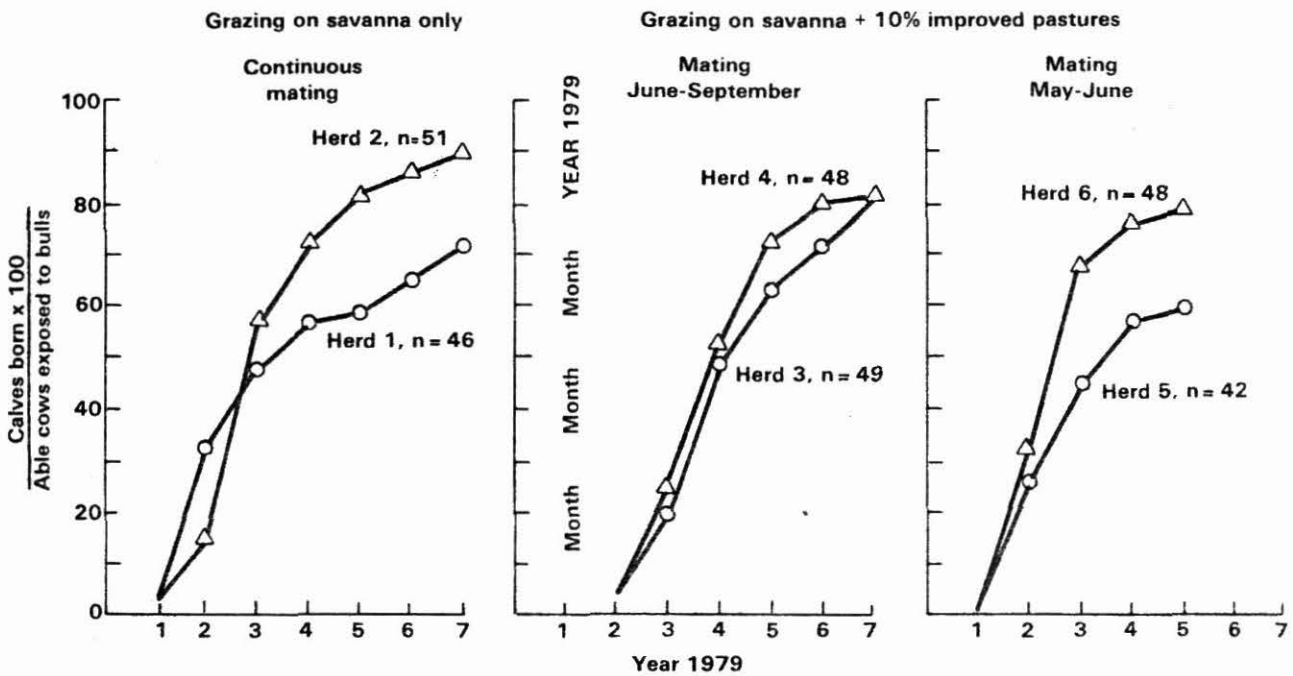

Figure 62. Accumulative calving percentage of cows classified as "able" during the mating periods of 1978.

Table 62. Effect of three variables on weaning weight of calves born in 1978 (ETES Project).

Variable		Weaning weight[1] (kg)
Strategic use of improved pastures ($P < 0.05$)		
Dams on savanna only		158.8 ± 3.0 (84)
Dams with access to improved pastures		168.1 ± 3.1 (77)
Sex		
Male calves		169.3 ± 3.1
Female calves		158.0 ± 2.9
Seasonal effect ($P > 0.05$)		
Born	Weaned	
January-March	October-December	161.6 ± 3.2 (70)
April-June	January-March	164.9 ± 3.6 (56)
July-September	April-June	163.9 ± 4.6 (35)

1 Weaned at nine months of age; mean weight ± standard error; figures in parenthesis are the number of observations.

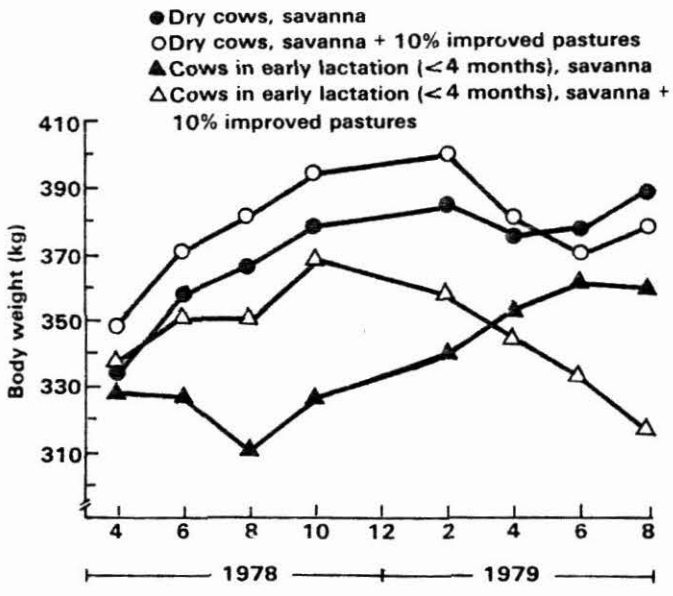

Figure 63. Effect of lactation status on body weight of cows on savanna only or on savanna + 10% improved pastures.

attributed to the facts that *S. guianensis* was severely attacked by anthracnose during the last trimester of 1978 and the *B. decumbens* paddocks were overstocked (as available area was reduced by 25% in order to sow additional legume pastures) and severely affected by a spittlebug (*Aneolamia varia, Zulia pubescens*) attack.

The utilization of improved pastures is shown in Figure 64. In addition to the programmed utilization, a paddock of *Melinis minutiflora* outside the experimental area was grazed (1.4 AU/ha) during July and August by herds 2 and 4. This was an attempt to overcome the emergency caused by the reduction of available *B. decumbens*.

Only preliminary information on the pregnancy rate for 1979 can be given at this stage. Pregnancy diagnoses were carried out in October when conceptions that occurred in late August and in September are still undetectable.

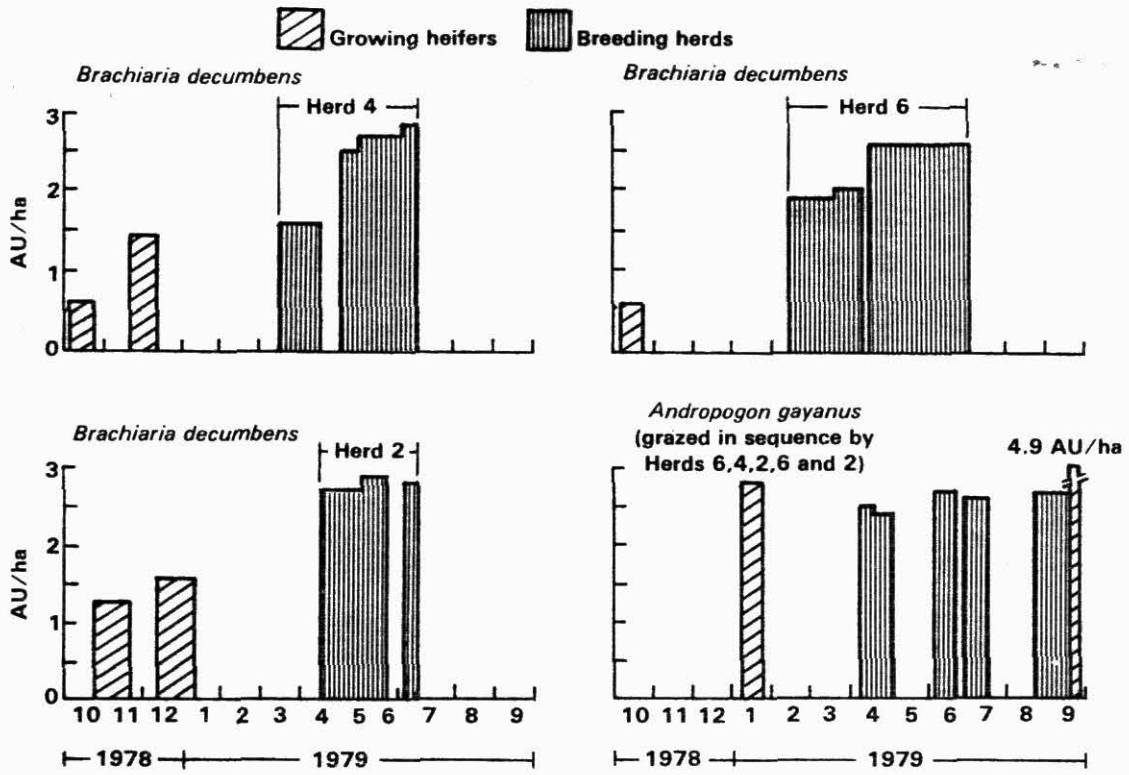

Figure 64. Utilization of improved pastures in the Breeding Herds Management Systems Experiment at Carimagua.

Herds 5 and 6 both had a 75% pregnancy rate. The average pregnancy rate for herds on savanna was only 58%. For herds with access to improved pastures the corresponding figure was 51%.

Compared to last year, fertility of cows on savanna plus improved pastures dropped, most likely as a consequence of the lower nutritional level achieved after the loss of the legume component in the pastures and grazing on *B. decumbens* attacked by spittlebugs.

The pregnancy rate of cows on savanna is only slightly lower than their previous calving rate. This difference, however, is likely to disappear when late conceptions (that were undetectable by rectal palpation in October) are computed.

The reduction in the conception rate of the cows on savanna plus improved pastures, compared to that obtained last year can be attributed mainly to the disappearance of the legume component of the pastures. This stresses the importance of the legume to obtain high pregnancy rates.

Test Herds

Size, management, and production objectives of these ICA-CIAT herds were described in the previous report (CIAT Annual Report, 1978).

The calving rate and the distribution of calving during the year are presented in Table 63. The calving rate in herds 1, 2 and 3 was slightly lower than in the previous year (53.9 vs. 58.2%). This difference is not statistically significant ($P>0.05$) and probably reflects chance fluctuations around a mean annual calving rate of approximately 55%.

In herds 4 and 5 the calving rate between October 1978 and September 1979 was 77.2%, 38.3 percentage points higher than the year before. Last year's calving rate was obtained for a mating period of only two months. This left many non-pregnant cows that conceived readily in the following mating season and consequently increased this year's calving rate.

Table 63. Distribution of calvings and calving rate in the ICA/CIAT Test Herds for the period October 1978-September 1979 at Carimagua.

Herds	Cows	October - December	January -March	April -June	July- September	Calving rate
1, 2 and 3	152	12	47	20	3	53.9
4 and 5	97	4	40	21	5	72.2

Calf mortality this year (5.9%) was practically similar to last year's (5.4%). Of the nine calves lost, two died from snake bite, one due to poliarthritis and another one after a bone fracture; cause of death could not be established for the remaining five calves.

The test herds provided 228 steers, 50 heifers, 9 cows and 9 bulls for other research projects at Carimagua. All these animals were transferred to different sections for other research work.

CATTLE PRODUCTION SYSTEMS (CERRADO)

Animal Management

Previous work at the CPAC, Brazil, has shown that a 3-month mating season is as good as the traditional continuous mating practice in terms of reproductive performance. Since seasonal mating facilitates animal and pasture management, continuous mating has been eliminated from experiments designed to test new management practices based on the strategic use of native and improved pastures at the CPAC.

In November, 1978, three breeding herds were put together from the existing females within the CPAC (Table 64). The females were assigned to herds according to weight, age, and reproductive status such that at the beginning of the mating season each herd

Table 64. Treatments used at the CPAC, Brazil, to study the effects of improved pasture, mating season and weaning age on reproduction in Zebu cows.

Herd	No. of cows	Pasture		Mating season (days)	Weaning age (days)
		Type	Grazing period (months)		
A	50	native	9	90 (Nov/Jan)	90
		improved	3		150
B	50	native	9	45 (Nov/Dec)	90
		improved	3	45 (Apr/May)	150
C	50	native	12	45 (Nov/Dec)	90
				45 (Apr/May)	150