BIO-ECONOMIC ANALYSIS OF RANCH IMPROVEMENT SCHEMES AND MANAGEMENT STRATEGIES FOR BEEF PRODUCTION IN THE CERRADO REGION.

By

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1. INTRODUCTION

Traditionally Mato Grosso, and the Cerrado region in general, has been the producer of weaned calves or thin steers to be fattened in more fertile areas closer to the large consuming centres. This situation has been, and still is, changing with the advent of improved pastures, the creation of local slaughtering facilities and the improvement of road transport.

If markedly increased production is to be obtained from the traditional cattle raising areas of the Cerrado, the existing vegetation must be improved or replaced. This concept is generally agreed by producers, extensionists and research workers, since the increase in production that can be expected from the management of native pasture alone is small.

Over the past few years there has been an increasing tendency for the replacement of Cerrado type vegetation by improved grass pastures either directly or following a short sequence of cash cropping, mainly rice. The point has therefore been reached where research must provide guidelines for the economic development of this area and, at the same time, identify areas where future research should be concentrated.

The work presented here is a first attempt, using computer simulation, to bring together some of the factors in an extremely complex bio-socioeconomic system which would be virtually impossible to study as a whole using conventional field experimentation.

The model to be described does require modification to make it more relevant to actual commercial conditions but, even in its present state, the broad outline of the results of managerial decisions can be determined and thus future investigations can be narrowed down to the most promising systems.

The background information on which the model was based has been derived from surveys previously carried out, Condepe (1969), Mattana Saturnino et al (1977), research results and from the experience of producers and extension personnel. The assumptions made in building the model were presented to a meeting of other producers and extensionists and modifications were made as a result of the discussions.

The main objectives of this study were to determine the impact of the introduction of improved pasture on the bio-economic efficiency of a traditional cow - calf system and also to estimate how changes in herd management would interact with systems in which improved pasture played an increasing part.

2. DESCRIPTION OF THE MODEL

As a starting point a 4.000 ha ranch of Cerrado type vegetation was assumed all of which was grazable and sub-divided into four sections of approximately equal size. It was further assumed that the ranch was situated 250 km from a city, where the owner lived, and that he visited the ranch twice a month travelling by pick-up.

The ranch was equipped with a mainhouse and other housing for workers. There was also assumed to be a corral and natural watering points. The existing traditional production system of the sale of weaned calves and culled heifers and cows formed the basis on which improvement was to be made.

Improvement in the feed supply was achieved by the sowing of improved pasture (Brachiaria decumbens) after clearing trees and preparing the soil by conventional means. As is normal no fertilizer costs were included. When stocking rate increased, due to greater availability of feed, other facilities and services, such as fencing, corrals, houses, vaccines, salt, and labour, were appropriately increased.

Estimates of the carrying capacity of native pasture throughout the year were obtained from farmer experience, and that for Brachiaria from experimental results. The values used, in animal units (A.U.), were as follows:

	J	F	M	A	M	J	J	A	S	O	N	D
Native	0.40	0.40	0.40	0.35	0.30	0.25	0.25	0.20	0.20	0.25	0.30	0.35
Brachiaria	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0

The animal equivalents used in the calculations were the following: Cow or steer over 3 years old = 1 A.U., Bull = 1.2 A.U., Suckling calf = 0.2 A.U., Weaned calf = 0.4 A.U., Heifer or Steer 1 to 2 years old = 0.6 A.U., Heifers or steers 2 to 3 years old = 0.9 A.U.

2.1. Productivity of Traditional System

Average figures for the production indices of a typical Cerrado region were used as follows:

Age at first calving	4 years
Calving rate	50%

(This 50% is made up of 58% for all cows except 2nd calvers who were credited with 20%. Since approximately 20% of cows are 2nd calvers, this gives an average of 50%).

Culling rate of heifers	5%
Culling rate of 12 year old cows	100%
Culling rate of bulls	20%
Culling rate of other cows	(variable according to availability of pasture)

Death rates, which were not altered in the improved system, were the following: Suckling calves 15%, Weaned to 1 year 1%, Animals 1-2 years old 5%, Heifers 2-3 yrs. 3%, Adult cows 2%, Steers 2-3 years 1.5%, Steers over 3 years 1.0%, Bulls 2.0%.

2.2. Improved Systems

It was assumed that only in improved systems, where Brachiaria (or another species) was sown, would it be possible to produce fat animals and this only when the area of Brachiaria was sufficient to allow the maintaince of these animals on the cultivated pasture throughout the year. If this were not possible they were sold as thin steers for fattening.

The effect of Brachiaria on animal production was taken to be (a) if heifers of one and two years old had access to Brachiaria the first calving in the next year occurred at 3 years instead of 4; (b) if cows after 1st calving had access to Brachiaria the birth rates of 2nd calvers was raised from 20% to 50%; (c) Adult cows with access to Brachiaria increased birth rates from 58% to 70%; (d) growing animals of 1-2 years with access to Brachiaria gained 140 kg/animal/year, 2-3 years old, 110 kg/animal/year while fattening animals over 3 years old, who always have access to the best pasture available, 120 kg/animal/year.

A constraint was placed on the use of the Brachiaria according to the management strategy selected. The management strategies used with their respective priorities are given below.

Strategy I. Sale of weaned calves

Priority	1. Old cows for fattening
for	2. Cows after first calving
Brachiaria	3. Heifers of 1-2 years
	4. Other breeding cows.

Strategy II. Sale of steers at 21 months

Priority	1. Weaned male calves
for	2. Steers of 1-2 years
Brachiaria	3. As for Strategy 1

Strategy III. Sale of thin steers at 33 months

Priority	1. Weaned male calves
for	2. Steers 1-2 years
Brachiaria	3. Steers 2-3 years
	4. As for Strategy I

Strategy IV. Sale of fat steers at 45 months

Priority	1. Weaned males calves
for	2. Steers 1-2 years
Brachiaria	3. Steers 2-3 years
	4. Steers 3-4 years
	5. As for Strategy I.

The number of each class of animals that had access to the Brachiaria depended on the area sown which was set at 5, 10, 20 or 40% of the total ranch area. Any animals in the fattening process that could not be accomodated on the Brachiaria were sold. In the case of females, in the rearing or breeding phase, these were returned to the native pasture. The total carrying capacity of the ranch was determined (as it would be in practice) by the A.U. capacity of the pastures. A.U. requirements were adjusted by selling animals (usually breeding cows) that were in excess of the carrying capacity.

Further management strategies tested in the model refer to the use to be made of the extra pasture as it became available during the ranch improvement programme. Several possibilities existed: (a) breeding cows were purchased to take up the increased carrying capacity and until animal numbers stabilised; (b) the breeding herd was allowed to increase naturally by retention of females; (c) natural increase of breeding animals and purchase of one year old steers for fattening to take up the initial increase in carrying capacity.

Within these three systems the effect of buying (or not) old cows for fattening during the wet season was also tested. These animals were assumed to gain 90 kg liveweight in a six month period (November - April).

When calculating the number of animals to be purchased (breeding cows or young steers) the total carrying capacity of the ranch during the month of least pasture production was always taken as a maximum. The number to be purchased was further reduced by a correction factor that takes into account the age of selling males and the percentage of improved pasture to avoid unreal fluctuations in animal numbers in the years immediately following the formation of improved pasture. In the case of old cows for fattening, which were to be only on the ranch during the six month wet season, 90% of the excess carrying capacity in November was used as the basis for calculating how many could be bought.

It was assumed that all births took place during the month of August.

2.3. Costs and Returns

The costs and prices used were calculated according to those existing in July 1978. At this time there had been an upswing in cattle prices so that the results presented may be taken to represent a mid-point between the low and high values associated with the well documented five-six year cattle price cycles, Venturoli et al (1978).

In calculating net incomes, depreciation was allowed as follows: Buildings and fences 3% per year, pickup truck 25% per year, Corral 2.5% per year and horses 10% per year.

Total value of assets was considered as (1) value of all animals; (2) value of land (including fences, buildings and corrals); (3) horses and (4) pickup.

In the improved systems the cost of establishing the Brachiaria pasture was all assigned to the first year. In practice this would probably be spread over three years and so, in this first analysis, cash flow problems have appeared where they may not necessarily be important. In future analyses of the most promising systems this defect will be corrected.

3. MODEL OUTPUT

The model was programmed in FORTRAN and could be considered a dynamic, deterministic mathematical model. The time step used was one month and data relevant to

the physical output of the ranch, including A.U. of pasture both available and required, were printed monthly. In addition, economic data on gross revenue from sales, costs and net profit were calculated.

Each year the following data were provided: (1) Gross revenue from each class of animal and percentage contribution to gross revenue; (2) Total gross revenue; (3) Variable costs and percentage contribution to total variable costs; (4) Total costs; (5) Net profit; (6) Capital invested; (7) Birth rate; (8) Age of cows at 1st calving.

The programme was run to cover 10 years and the following information was then printed: (1) Area of ranch; (2) Area of sown pasture; (3) Management strategies used; (4) Number of animals sold and purchased each year; (5) Percentage contribution each year to gross revenue of the different classes of animals; (6) Gross revenue, costs, net profit and capital invested each year and means over 10 years; (7) Additional income and costs, and annual cash flow as a result of the investment; (8) Annual production of liveweight and 10 year mean; (9) Net present value (NPV), and Internal Rate of Return (IRR) of the investment; (10) Discount rate which was set at 10%.

4. PRELIMINARY RESULTS

As a first approximation of the investment possibilities only the Internal rate of return (IRR) and Net present value (NPV) will be considered. Cash flows and borrowing requirements will be presented at a later stage when modifications, presently being made to the model, are completed. These modifications should not substantially alter the conclusions drawn in this first paper.

4.1. Opportunist Buying

In Table 1 a summary of the complete results referring to IRR and NPV are presented. The major effect in all managements and at all levels of sown pasture was the purchase or not of old cows for fattening. This strategy can obviously not be applicable over a large region since, to buy, somebody must be willing to sell and very quickly a shortage of available animals would appear. However the immediate change of doubtful investments into highly lucrative ones, when old cows are fattened, does show the favourable balance that exists for the producer who can buy cattle for rapid fattening compared to the breeder and rearer. It is also an indicator of the more effective use of wet season grass production which, under other managements, would be under utilized due to the need to hold animal numbers down to the carrying capacity of the dry season. In other words this strategy makes greater use of the investment in cultivated pasture.

This point is further emphasised when both IRR and NPV are compared within any management that includes the purchase of old cows for fattening. As the age of selling males increases the investment criteria decrease. This is because as more

Table 7. Investment analysis of improvements to a 4000 ha ranch where increasing amounts of Cerrado are sown to cultivated pasture and varying management strategies applied. Calculations over a ten year period with a 10% discount rate assumed.

		Age of selling males (months)	Percentage of Ranch sown to cultivated pasture							
			5		10		20		40	
			IRR*	NPV*	IRR	NPV	IRR	NPV	IRR	NPV
Natural increase of herd by retention of females	No Old cows bought	9	6.7	-134	2.0	-557	0.0	-1,558	0.0	-4,691
		21	6.4	-155	3.7	-504	0.0	-1,516	0.0	-4,335
		33	4.2	-240	1.4	-676	1.9	-1,733	0.3	-4,342
		45	9.0	- 48	10.4	35	5.3	- 822	0.0	-3,233
	Old cows bought for fattening	9	24.7	1,199	24.0	2,272	22.4	3,607	20.8	5,810
		21	20.5	762	22.0	1,833	21.5	3,363	20.3	5,592
		33	18.1	519	19.6	1,378	20.2	2,915	19.4	5,065
		45	19.6	651	22.5	1,877	22.1	3,653	20.5	5,841
Purchase of breeding cows until herd stabilised	No Old cows bought	9	7.9	- 67	4.4	-443	2.5	-1,214	0.0	-3,192
		21	6.7	-141	5.2	-400	1.8	-1,305	0.3	-3,071
		33	4.7	-223	2.4	-616	0.0	-1,569	0.0	-3,455
		45	9.1	- 44	11.0	106	6.5	- 625	3.8	-2,161
	Old cows bought for fattening	9	24.8	1,247	24.2	2,404	20.8	3,219	18.2	4,437
		21	20.4	762	22.2	1,926	20.1	2,996	18.2	4,462
		33	17.9	513	19.7	1,421	19.4	2,755	17.6	4,107
		45	19.5	636	22.8	1,944	21.7	3,598	19.6	5,466
Natural increase of herd plus purchase of one year old males for fattening until herd stabilised	No Old cows bought	-	-	-	-	-	-	-	-	-
		21	6.9	-134	6.3	-317	2.1	-1,277	0.0	-3,504
		33	4.5	-230	5.0	-431	0.0	-1,685	0.0	-3,911
		45	9.4	- 29	11.7	172	8.1	- 357	4.8	-1,810
	Old cows bought for fattening	-	-	-	-	-	-	-	-	-
		21	19.9	710	21.2	1,733	18.9	2,936	19.5	5,264
		33	17.3	468	18.9	1,275	18.3	2,411	17.6	4,132
		45	19.3	616	21.9	1,755	21.5	3,504	20.4	6,102

* IRR = Internal rate of return

* NPV = Net present value in Cr$ 1,000

males are retained for sale at a later age fewer old cows can be purchased thereby indicating that, even compared to the rearing and fattening of steers, opportunist buying is a more attractive investment.

Such ativity while ensuring the production of fat cows for market does not result in any improvement in the basic process of producing weaned calves, unless the extra profits gained are used to improve ranch productivity. There is however an important point to be considered in the provision of credit to the producer in the process of improving his pastures. Credit is only normally given for the establishment of pastures, fencing, etc., and the purchase of animals is excluded. It would seem from the results in Table 1 that if some money were made available for purchase of fattening animals the initially difficult period of ranch imorovement could be more attractive.

4.2. Herd Increase Strategies

In contrast to the effect of opportunist buying the overall strategies of allowing natural herd increase, buying breeding cows or buying one year old males in conjunction with natural increase had little influence on the investment criteria. Further analyses will have to be made to determine the effect of buying breeding cows on the cash flow position. It may be that the period of indebtedness could be significantly reduced by this strategy.

4.3. Area Sown to Cultivated Pasture

Excluding the alternative of buying old cows the effect of increasing the area sown to cultivated pasture was very marked. At 20 and 40% cultivated pasture the NPV was always negative. This finding is similar to that of Torres et al (1977) who suggested that the economic optimum was approximately 5%.

Within the 5% and 10% levels some interaction existed with age of selling males. At the 10% level the only apparently viable investment occurred when males were retained until 45 months and sold fat; while at 5% the criteria just failed to reach the critical levels. The poorest strategy was the sale of males at 33 months due to the capital involved and lack of a compensating price increase. This tendency was repeated in all management strategies.

These effects can be more clearly appreciated in Table 2.

These results indicate that a producer, following the traditional system of selling weaners and thin cast cows, who sows five, or more, percent of cultivated pasture must attempt to fatten animals if his investment is to prove viable. Exploration below the 5% level has not yet been made, but on a 4000 ha property, 5%, or 200 ha, is not a large area to be improved.

This may indicate that a cheaper pasture improvement method would have to be employed where only breeding and sale of weaned calves was practised. This could be the over sowing of suitable cerrado with Hyparrhenia rufa or Brachiaria decumbens and research is needed to quantify the outcome of these methods.

TABLE 2. Effect of area sown to cultivated pasture and age of selling males on the IRR and NPV. Means of all management strategies but excluding buying of old cows.

Age of Selling males (months)	% Cultivated Pasture							
	5		10		20		40	
	IRR	NPV	IRR	NPV	IRR	NPV	IRR	NPV
9	7.3	-111	3.5	-500	1.3	-1436	NEG.	-3942
21	6.7	-143	5.1	-407	1.3	-1366	NEG.	-3637
33	4.5	-231	2.9	-574	0.6	-1669	NEG.	-3569
45	9.2	-40	11.0	102	6.6	-601	2.9	-2403

If, as these results indicate, no more than 10% of ranch area should be improved, this has important implications for soil fertility research related to pasture establishment. For instance soils which are not the most important (in area) may have properties which lend themselves to ease of establishment and low cost maintenance of grass or grass-legume pastures. This possibility must be borne in mind when selecting soils for study.

4.4. Age and weight of selling steers

A sensitivity test was run to examine the effects of an increased rate of animal gain and earlier age of slaughter on the returns from the investment. The two situation visualised were as follows:

(1) Weaning wt. 140 kg, 21 months 280 kg, 33 months 420 kg

(2) Weaning wt. 140 kg, 21 months 280 kg, 33 months 390 kg, 45 months 510 kg.

The rate of gain and selling weight in (2) is what was considered normal by local producers. No extra costs were added for the slightly more rapid gain demanded by (1) and, in fact, such gains have been exceeded under experimental conditions on unfertilized B. decumbens pastures. The results are presented in Table 3.

Once again the model was not sensitive to the decision of buying breeding cows or allowing a natural increase, and also 20 and 40% of cultivated pasture was a poor investment.

The great impact of a more rapid growth rate and earlier sale came when only 5% of pasture was available, doubling the IRR and changing a negative NPV to markedly positive. The explanation of this lies in the amount of cultivated pasture available. When only 5% was sown (200 ha) there was insufficient carrying capacity to permit all males to be fattened at 45 months and many had to be sold at 33 months at a lighter weight and less price. This did not occur when 10% (400 ha) of cultivated pasture was available and all males were sold fat at 45 months. This result indicates the importance of achieving a high rate of gain per animal when only a restricted area of pasture is available to allow slaughter at 33 months and 420 kg.

TABLE 3. Effect of age and weight at slaughter of fat steers on IRR and NPV when varying areas are sown to cultivated pasture, and under natural herd increase or buying breeding cows.

Wt. and age at slaughter	Herd Strategy	PERCENTAGE CULTIVATED PASTURE							
		5		10		20		40	
		IRR	NPV	IRR	NPV	IRR	NPV	IRR	NPV
45 Months 510 kg	Natural Increase	9.0	-48	10.4	35	5.3	-822	NEG.	-3,233
	Buying Cows	9.1	-44	11.0	101	6.5	-626	3.8	-2,167
33 Months 420 kg	Natural Increase	18.5	444	11.2	115	5.6	-738	NEG.	-3,198
	Buying Cows	18.9	470	12.1	204	7.0	-527	4.4	-1,913

Research should determine the conditions (stocking rate, pasture type, etc.) under which a high rate of gain is assured.

5. PHYSICAL PRODUCTIVITY

In addition to investment criteria the model has provided a first estimate of the increases in productivity that could be expected as a result of introducing cultivated pastures and altering management strategies. The yardstick chosen was Kilograms of liveweight produced (sold) per hectare per year. In the case of animals bought in for fattening only the weight gain achieved on the ranch was taken into account. All figures given are means of 10 years.

5.1. Effects of Sown Pasture and Management

In Table 4 actual and relative liveweight production resulting from the various management alternatives are shown.

Quite small areas of cultivated pasture had considerable impact on liveweight production, but at these levels (5 and 10%) changing the management strategy had less effect on output than at higher levels of cultivated pasture. However, it should be remembered that, as investment projects, neither the 20% or 40% levels of cultivated pasture were viable.

TABLE 4. Liveweight gain/ha/year resulting from management alternatives averaged over ages of selling males but excluding purchase of old cows for fattening (Means of 10 years)

% Cultivated Pasture	Natural Growth of herd		Purchase of Breeding cows		Nat.Growth of herd + purchase of 1 year old steers.		Mean	
	kg/ha	relative*	kg/ha	relative	kg/ha	relative	kg/ha	relative
5	14	127	14	127	15	136	14	127
10	16	145	17	154	18	164	17	154
20	19	173	21	191	22	200	21	191
40	20	182	28	254	30	272	26	236

*Traditional system 11 kg/ha = 100

5.2. Birth Rate and Age at First Calving

On raches where animal categories are separated, management could favour replacement heifers to ensure earlier calving or breeding cows to increase birth rate. The effects of these decisions on liveweight production are given in Table 5.

TABLE 5. Liveweight production per hectare per year resulting from changes in birth rate and age at first calving. (Means of 10 years).

Birth Rate %	Age at 1st calving			
	4 years		3 years	
	kg/ha	Relative*	kg/ha	Relative*
50	11	100	13	118
55	12	109	15	136
60	13	118	16	145

* 11 kg/ha = 100

A 10% increase in birth rate (1st calving four years) was equivalent to reducing 1st calving to three years (50% birth rate). Therefore starting from a traditional ranch (50% birth rate and four year calving) it would be indifferent which class of animal had access to improved pasture. Chudleigh (1977) estimated that the economic effect of this decision would also be similar. The marked increase in productivity obtainable by combining earlier calving with a higher birth rate is obvious.

5.3. Age of Selling Steers

Within the 10% level of cultivated pasture it was seen (Table 2) that a viable

ages of selling steers on physical output is shown in Table 6.

TABLE 6. Liveweight production per hectare per year, at 10% cultivated pasture, as affected by age of selling steers. (Means of 10 years). Considering a natural herd increase and without buying old cows for fattening.

	Age of selling steers (Months)			
	9	21	33	45
kg/ha/year	14	16	17	18
Relative*	127	145	154	164

* Traditional system 11 kg/ha = 100

Where sufficient cultivated pasture is available (and no cash flow problems) to allow the fattening of steers until 45 months a 64% increase in liveweight production over the traditional system is possible. Although of considerable practical interest the 27% increase obtained when weaned calves were sold was shown not to represent an economic investment,

6. GENERAL CONSIDERATIONS

It would appear that investment in cultivated pasture as a means of increasing the productivity of a traditional ranch selling weaned calves cannot be recommended under the cost-price structure assumed in this study. This was apparent at all levels of cultivated pasture and the situation became progressively worse as the area sown increased. This would suggest that improvements in the breeding phase must come through improved herd management (controlled breeding period, disease prevention , supplements, etc.) rather than the use of cultivated pasture established by conventional methods. If a cheap reliable method can be found to improve native pasture, then an economic increase of productivity in the breeding phase may be possible by this method. There are of course several alternatives that have not yet been tested in the model which could influence breeding cow performance. For example the use of a very restricted area of cultivated pasture for early weaned calves, or increased attention after calving to reduce the high calf mortality rate. These and other factors could easily be tested once a reasonable quantitative estimate of their effects and costs, under Cerrado conditions, are available.

In the case where large amounts of cultivated pasture are sown, typified by the 40% level assumed in the model, the continuance of a policy of breeding, rearing and fattening the animals produced on the ranch did not give a viable investment at a 10% discount rate (Table 1). But, when old cows were bought in for fattening, the

economic outcome was very attractive. Although not tested in the model, the buying of advanced store cattle for fattening should have a similar effect.

This fattening process on cultivated pastures while adding value to the beef industries total output does little for the basic breeding phase which provides the raw material (calves) for all other processes. The creation of more cultivated pastures may of course create a greater demand for weaned calves with a consequent price increase thereby stimulating investment in the breeding phase. It is however more likely that increased calf production will come from horizontal expansion into new areas of cheaper land rather than increased productivity via cultivated pastures. Also, in an inflationary situation, the expected increase in land values is a deterrent to investment in, and improvement of, already cleared areas.

It can however be asked why large areas of Brachiaria are being sown in the Cerrado? There could be several answer to this question. A producer may have excess cash on hand and will invest it in pasture improvement although this may not be the best economic decision. It is however a safe investment which will increase the value of the land. However, as land values rise, the continuance of a breeding system comes under increasing economic pressure.

A great deal of speculation could be indulged in over these points without reaching any firm conclusions and it would be wise to await the further analysis of cash flow and credit requirements before expanding on this theme. What is obviously required is an assessment of producers' attitudes to investment, credit, risk, inflation and short and long term trends in the beef industry.

Some research guidelines that have emerged from this study are as follows: (1) Improvement in reproductive efficiency of the breeding cow should be looked for by techniques other than the use of cultivated pasture with special emphasis on calf mortality; (2) Rapid liveweight gain per animal in the fattening process will be more important than per hectare production when only small amounts of sown pasture are available; (3) Since reducing age at first calving by one year is equivalent (in physical and economic terms) to a 10% increase in calving rate research might be more rewarded by concentrating on birth rate which could conceivable be raised by more than 10%; (4) Agronomic studies should concentrate on finding reliable cheap methods of increasing the productivity of native pastures; (5) Soil fertility work should determine on which soils nutrient deficiences can be corrected most easily without regard to the extent of these soils in the Cerrado region since probably only small areas will be used for cultivated pastures in beef production systems; (6) Socio-economic studies should ascertain producers reaction to short and long term investment risks and strategies.

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