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Economics

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During 1981 the Economics Section concentrated its efforts on:

- Economics of the use of alternative fertilizer sources for improved pastures in the Llanos Orientales of Colombia.
- Comparative advantages of alternative forms and uses of improved pastures in the Llanos Orientales.
- Continuation of the economic analysis of cattle farms, particularly in Brazil and Colombia (ETES Project).
- Initiation of a monitoring study of six dual-purpose (beef and milk) farms in the Central Provinces of Panama.

Economics of Alternative Fertilizer Sources Use for Improved Pastures in the Llanos Orientales of Colombia

Fertilization is a major cost factor in CIAT's pasture technology, involving 42% (Col$2580) of the pasture establishment costs per hectare and 75% (Col$1260) of the annual maintenance costs. A number of alternative sources of mineral nutrients are presently available on the Colombian market (Table 1). Additional sources could be developed from locally available raw materials.

A linear programming model was developed to minimize per-hectare costs of complying with nutrient requirements determined by the Soils and Plant Nutrition Section (Table 2). All nutrient sources used (Table 1) were assumed to have the same agronomic efficiency. Activities considered in the model include the purchase of different nutrient sources at Bogota and transportation to the Carimagua location in the Llanos Orientales. Cost of on-farm storage and distribution are not considered due to very small differences among possible alternatives.

In this analysis, average fertilizer requirements per-hectare for establishment are used (22 kg P, 33.20 kg K, 100 kg Ca, 20 kg Mg and 20 kg S). Main results indicate that:

1. A combination of basic slag and rock phosphate provides the most economic phosphorus supply (Table 3).

2. At present prices, magnesium subcarbonate is the most efficient magnesium source, followed very closely by Sulpomag and both forms of magnesium oxide.

3. Rising transportation costs do not have a substantial impact on the optimal combination of fertilizer sources. At levels 100% above the present ones, basic slag use is reduced to 1/3 of the original level and rock phosphate use is expanded accordingly. Magnesium subcarbonate is then substituted by a more concentrated source, magnesium oxide.

Table 1. Fertilizer nutrient content and price[1] CIF Bogotá[2] (July 1981).

Fertilizer	Nutrient content					Price/ton	
	P	K	Ca	Mg	S	Col$	US$[3]
	%						
Basic slag	6.60	0	37	1	0	2,400	44.02
Simple superphoshate	8.80	0	20	0	12	22,000	403.52
Triple superphoshate	19.80	0	14	0	0	23,230	426.08
Potassium chloride	0	49.80	0	0	0	16,560	303.74
Potassium sulphate	0	41.50	0	0	18	22,000	403.52
Sulfur flower	0	0	0	0	85	18,000	330.15
Gypsum	0	0	29	0	20	3,600	66.03
Calcitic lime	0	0	30	0	0	2,500	45.85
Dolomitic lime	0	0	37	8	0	3,600	66.03
Huila rock phosphate	9.68	0	40	0.5	0	4,600	84.37
Pesca rock phosphate	8.80	0	21	0	0	3,000	55.02
Magnesium sulphate[4]	0	0	0	10	13	28,800	528.24
Magnesium carbonate[4]	0	0	0	24	0	11,550	211.84
Magnesium oxide 70[4]	0	0	0	42	0	22,000	403.52
Magnesium oxide 60[4]	0	0	0	36	0	18.800	344.82
Magnesium subcarbonate[4]	0	0	0	16	0	6,100	111.88
Sulpomag	0	18.26	0	11	22	16,000	293.47

[1] Bagged
[2] Transport Bogotá-Carimagua: Col$2500/ton
[3] Exchange rate July 15, US$1 = Col$54.52
[4] Prices quoted by Magnesios Bolivalle Ltda., July 1981 plus freight Medellín-Bogotá: Col$1600/ton

Table 2. Recommended fertilization levels for establishment and maintenance of promising species (kg/ha).

Species	Establishment (kg/ha)					Maintenance (kg/ha/year)				
	P	K	Mg	S	Ca	P	K	Mg	S	Ca
Andropogon gayanus	22	33.20	20	15	100	6.60	33.20	5	7.5	50
Stylosanthes capitata	22	33.20	20	20	100	6.60	33.20	5	10	50
Pueraria phaseoloides	22	33.20	20	20	100	8.80	33.20	10	10	50

Sources: Spain, J. "Actualización de Recomendaciones Generales, Establecimiento y Mantenimiento de Pastos", internal document, CIAT, August 1980.
Salinas, J.G. Personal communication, July 27, 1981.

Table 3. Optimal fertilization strategy for pasture establishment in Carimagua (base solution).

Nutrient	Required level (kg/ha)	Shadow price[1] of the restriction (Col$/kg)
Phosphorus	50	26.3
Potassium	40	31.8
Calcium	100	1.1
Magnesium	20	53.8
Sulfur	20	24.1
Fertilizers	**Required level**	**Marginal cost of introducing fertilizers not included in the optimal strategy**
Basic slag	223.5	-
Simple superphosphate	0	16.10
Triple superphosphate	0	13.70
Magnesium carbonate	0	1.20
Potassium chloride	66.7	-
Potassium sulphate	0	4.20
Magnesium sulphate	0	22.80
Sulfur flower	23.5	-
Gypsum	0	0.95
Calcitic lime	0	4.66
Dolomitic lime	0	1.39
Huila rock phosphate	0	0.59
Pesca rock phosphate	82.4	-
Magnesium oxide 70	0	1.90
Magnesium oxide 60	0	2.00
Magnesium subcarbonate	111.0	-
Sulpomag	0	0.28
Cost (Col$/ha) $4.259		
Total weight (kg/ha) 507.1		

[1] Amount by which total cost per hectare would decrease if 1 kg less of the nutrient were required per hectare.

4. Given the acidity of the soils in the area, the use of more expensive soluble phosphorus sources such as triple superphosphate is not economic. If short-term solubility of rock phosphates were considered too low for a given crop or pasture, the use of basic slag would be expanded.

5. Basic slag is expected to be scarce in Colombia in coming years. Rock phosphates will then substitute for basic slag causing only a minor cost increase. Rock phosphates will substitute basic slag completely if its price rises by 31% or more.

6. Partial acidulation increases the water and citrate solubility of rock phosphates. On very acid soils partial rock acidulation is not economically worthwhile for the establishment of pastures. If certain levels of short-term phosphate solubility are required, they could be achieved more economically by increasing the use of basic slag. The attractiveness of partial rock acidulation is probably higher for crops requiring higher levels of solubility, particularly on less acid soils and if the price of basic slag increases substantially.

7. The potential value of cement dust (a presently unused by-product of the cement industry) as a source of potassium and calcium was evaluated. Available data suggested a content of 6.4% potassium oxide and 31% of calcium. Under these conditions cement dust would only be competitive if basic slag is unavailable and if supplied CIF Bogotá at a price below Col$0.90 per kg. Cement dust supplying calcium and potassium displaces potassium chloride and basic slag in the formula due to the calcium content of the latter. The required phosphorus is in this case supplied by rock phosphates. Due to the low potassium concentration of cement dust, its competitiveness is very sensitive to transport cost changes. Availability of cement dust with a higher potassium oxide concentration (24%) is reported in the literature. This cement dust would be competitive at prices up to Col$5.32 per kg. If basic slag were unavailable, this type of cement dust would be included in optimal fertilizer mixtures up to a price of Col$5.84 per kg CIF Bogotá.

8. The high shadow price of the magnesium and potassium restrictions (Table 3) indicates that the fertilizer cost per hectare is very sensitive to the required level of these nutrients. Therefore, better knowledge of the response surface to magnesium and potassium would be very valuable to assess profitable usage levels.

These conclusions suggest the need to evaluate fertilizer response functions. Classical response surface studies for perennial pastures are very expensive and difficult to undertake. Nevertheless, some more points of the surface, selected as "best bets", particularly with lower levels of these expensive nutrients should be evaluated in the near future.

Fertilizers being such a crucial element of the technological package involving improved pastures, further research is needed on the supply-demand situation on Latin American markets. FAO data (Table 4) show a substantial regional deficit, particularly for potash fertilizers.

Table 4. Fertilizer production and consumption, Brazil, Colombia and Mexico 1979/80[1]. (Thousand metric tons: N-P-K.)

Country	N		P		K	
	Production	Consumption	Production	Consumption	Production	Consumption
Brazil	288	783	574.66	737.44	0	900.55
Colombia	57	151	20.24	32.12	0	58.10
Mexico	642	826	99.88	112.20	0	50.63

[1] Preliminary data, fertilizer year July 1-June 30.

Source: FAO: Current Fertilizer Situation and Outlook, Rome, June 1981.

The limited number of domestic fertilizer suppliers in most Latin American countries suggests that research on market structure and pricing policy may be rewarding as market prices probably differ from those maximizing national welfare. Research in this area is being planned in collaboration with the International Fertilizer Development Center (IFDC).

Comparative Advantages of Alternative Forms and Uses of Improved Pastures in the Llanos Orientales

As the program is promoting materials to Categories IV and V of the germplasm selection strategy, a number of these become candidates for eventual release by the national institutions (ICA in Colombia). This release has to be accompanied by information to potential adopters of the merits and drawbacks of each material. Among other information, the appropriate use of specific material in production systems must be assessed. Economics play a major role in this context.

Using the linear programming technique, a first attempt was made at comparing broad groups of improved pasture alternatives of varying degrees of intensity, as well as alternative uses of forage under the conditions of the Llanos Orientales of Colombia.

Table 5 presents the pasture establishment costs and Table 6 gives the technical parameters assumed to be achieved. Data are based on CIAT experimental results, information obtained through the ETES Project and educated guesses. Results therefore have to be considered preliminary and subject to substantial changes as additional information is generated by the program and the model is further disaggregated.

Table 5. Pasture establishment costs[1] (one hectare).

Cost item	Grass Units	Grass Col$	Legume Units	Legume Col$	Legume/grass association Units	Legume/grass association Col$
Seed: (kg)						
Brachiaria decumbens	1.2	1560				
Andropogon gayanus					2.5	1000
Stylosanthes capitata			5	3250	2.5	1625
Fertilizer: (kg)						
Basic slag	300	1080	330	1188	330	1188
Sulpomag	100	1500	100	1500	100	1500
Land preparation: (frequency)						
Harrowing	2	1700	2	1700	2	1700
Seeding	1	300	1	300	1	300
Total cost (Col$)	-	6140	-	7938	-	7313

[1] Maintenance costs: for all types of improved pastures an annual fertilization with 100 kg of Basic slag and 60 kg of Sulpomag at a cost of Col$1600 per hectare per year (including application cost) is assumed.

Table 7a presents the beef production levels achieved, 7b the gross margins per hectare, animal unit, and kg of beef produced for the cow-calf + fattening alternative. Table 8 shows the investment and profitability of alternative systems. The most outstanding features of this comparison are:

- the differences in ranking of forage alternatives when compared on the basis of hectares or animal units indicate that optimal strategies will depend on the relative scarcity of these factors;

- the similarity of per-animal unit investment of all alternatives;

- the rather low profitability of production alternatives based on the exclusive use of improved pastures under the conditions prevailing in the Llanos Orientales[1];

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[1] Specialized fattening oeprations were not included as the model was expected to reflect the potential of the region, which cannot be thought of as net importer of feeders, due to the higher fattening potential of the other regions.

Table 6. Technical coefficients assumed for each production system.

Coefficient	Fodder base				
	Native pasture	Native pasture plus mineral supplementation	Grass pasture	Native pasture plus protein bank	Legume/grass association
Stocking rate (AU/ha)	0.2	0.2	2.0	0.25	1.3
Adult mortality rate (%)	4	4	4	4	4
Weaning rate (%)	45	55	65	70	75
Age at first mating (%)					
24-35 months	-	10	72	82	92
36-48 months	64	54	100	100	100
>48 months	100	100	-	-	-
Liveweight (kg)					
At mating	260	270	290	290	290
At weaning	150	160	170	180	190
Weight gains steers (kg/head per year)	70	80	110	120	200
Milk production (litres/cow/[1] per year)	-	-	400	400	400

[1] Lactating cows only.

Table 7a. Beef output by forage production system (kg/year)[1].

Forage system	Production per ha			Production per AU		
	Cow-calf operation	Fattening operation	Cow-calf + fattening operation	Cow-calf operation	Fattening operation	Cow-calf + fattening operation
Native pasture	9	14	10	45	70	48
Native pasture + minerals	10	16	12	51	80	57
Improved grass pasture, exclusive use[2]	141	220	164	70	110	82
Grass/legume pasture, exclusive use[3]	109	256	150	85	200	117
Protein bank, strategic use[3]	18	29	21	77	120	89
Grass/legume pasture, strategic use	12	-	14	60	-	68

Table 7b. Gross margin by forage production system (cow-calf + fattening operation) (Col$)

Forage system	ha	AU	kg
Native pasture	236	1178	25.54
Native pasture + minerals	243	1215	21.31
Improved grass pasture, exclusive use[2]	1494	747	9.10
Grass/legume pasture, exclusive use[3]	937	732	6.25
Protein bank, strategic use[3]	366	1522	17.10
Grass/legume pasture, strategic use	293	1467	21.57

[1] Fattening refers only to the production of 3-year-old steers, presently fattened outside the impact region, for the alternatives with native pastures only and for the option with mineral supplementation.

[2] Productive life of pasture: 10 years; stocking rate: 2.0 AU/ha.

[3] Productive life of pasture: 6 years; stocking rate: 1.28 AU/ha.

Table 8a. Marginal investment per hectare, animal unit and kg of beef per annum produced by production systems[1] (Col$).

System	ha	AU	kg	Land investment[2] (%)
Native pasture	2,754	13,770	286	36
Native pasture + minerals	3,034	15,170	266	33
Improved grass pasture, exclusive use[3]	27,000	13,500	164	4
Grass/legume pasture, exclusive use[4]	21,284	16,846	140	5
Protein bank, strategic use[4]	4,001	16,644	187	25
Grass/legume pasture, strategic use[5]	2,837	14,185	208	35

Table 8b. Marginal profitability of alternative production systems[1] (% return).

System	Improved pastures (% total area)	Cow-calf operation	Cow-calf + fattening operation	Cow-calf + milking
Native pasture	0	8.4	8.6	-
Native pasture + minerals	0	6.4	8.0	-
Improved grass pasture, exclusive use[3]	100.0	3.6	5.5	13.3
Grass/legume pasture, exclusive use[4]	100.0	-0.8	4.5	8.5
Protein bank, strategic use[4]	5.0	7.4	9.1	15.8
Grass/legume pasture, strategic use[5]	1.8	9.5	10.4	-

1 In this context marginal refers to the investment and profitability of buying an additional hectare and using it in one of the systems described, given an already existing farm with its fixed costs. A land price of Col$1000/ha is assumed.
2 As share of total investment.
3 Productive life of pasture: 10 years; Stocking rate: 2.0 AU/ha.
4 Productive life of pasture: 6 years; Stocking rate: 1.28 AU/ha.
5 Used for early weaning of calves and fattening of cull-cows and steers.

- in spite of the adverse economic frame, the strategic use of improved pastures to supplement rather than replace low-cost native pastures to solve specific bottlenecks such as weaning of calves, fattening of cull-cows or steers is an economic proposition;

- feeding improved pastures to milking cows of local breeds is an attractive option even though very low production levels are assumed.

Table 9 presents the linear programming solution for a farm with Col$20 million-own capital. Traditionally used native pastures are the most efficient way to produce calves. Only as land becomes more scarce (more than Col$2000/ha) does fattening of on-farm produced store cattle on improved pastures become profitable. This preliminary analysis neglects the changes in relative prices and technical coefficients generally concommitant with the rise in land prices, but it does point towards the tendency to be expected.

Pasture persistence has a substantial influence on the profitability of improved pastures (Figure 1), particularly when investment is higher (legume and grass/legume mixtures). Furthermore, Figure 1 depicts the changes in competitiveness of alternative pasture improvement techniques due to changing land prices (all other coefficients constant).

A similar analysis was performed to evaluate the potential of producing milk with cows fed improved pastures within dual-purpose systems (Figure 2). Milking leads to a substantial increase in profitability of all types of improved pastures.

<u>It is concluded that:</u>

- Total substitution of native pasture with improved pasture is not economic at the present price structure. Strategic use of improved pastures to solve specific bottlenecks may be very worthwhile, but further research is necessary to improve the efficiency of its use, if adoption in extensive cow-calf operations of the Llanos Orientales is aimed at.

- On the short run the use of larger areas of improved pastures will mainly occur at locations closer to the market, and this forage will in most cases be fed to fattening steers.

- Dual-purpose (beef and milk) systems seem to be another promising option, particularly for smaller farms. Similar production systems operate under commercial conditions at a great distance from the market in the Paraguayan and Bolivian Chaco. More in-depth research is needed to evaluate their potential in the Llanos Orientales of Colombia.

Table 9. Optimal organization of a beef ranch with a total equity of Col$20 million[1].

	Land price (Col$/ha)		
	0	1000	2000
Land use (ha):			
Native pasture	11,523	9,831	4,966
Grass/legume pasture	-	-	76
Stock numbers:			
Cows	1,047	893	451
Calves	494	421	213
Heifers: 1-3 years	460	392	197
3-4 years	216	184	93
>4 years	78	66	33
Steers: 1-2 years	235	200	101
2-3 years[2]	-	-	97
Sales (head):			
Cows	178	151	76
Heifers	6	5	3
Steers 2 years old	226	192	-
Fat steers[2]	-	-	93
Own capital (4% interest opportunity cost)	20.000,000	20.000,000	20.000,000
Borrowed capital (7% interest)	-	6.888,994	-
Total gross margin (Col$)	1.839,861	968,809	443,434

1 Technical coefficients of Tables 5 and 6.
2 Steers reared on native pastures till the age of 2 years, finished on grass/legume pastures.

Further Activities

- An economic assessment of the marginal profitability of feeding mineral supplements in traditional beef production systems in the Llanos Orientales region was undertaken. The main results were: 4-8 years of negative marginal cashflow and internal rates of return between 8% and 20% p.a. to the phosphorus source used.

- The field phase of the monitoring project (ETES) in Brazil has been completed. In Venezuela the last surveys are being undertaken. The comparative study of all three ETES sites (Colombia, Brazil, and Venezuela) is expected to be completed in 1982.

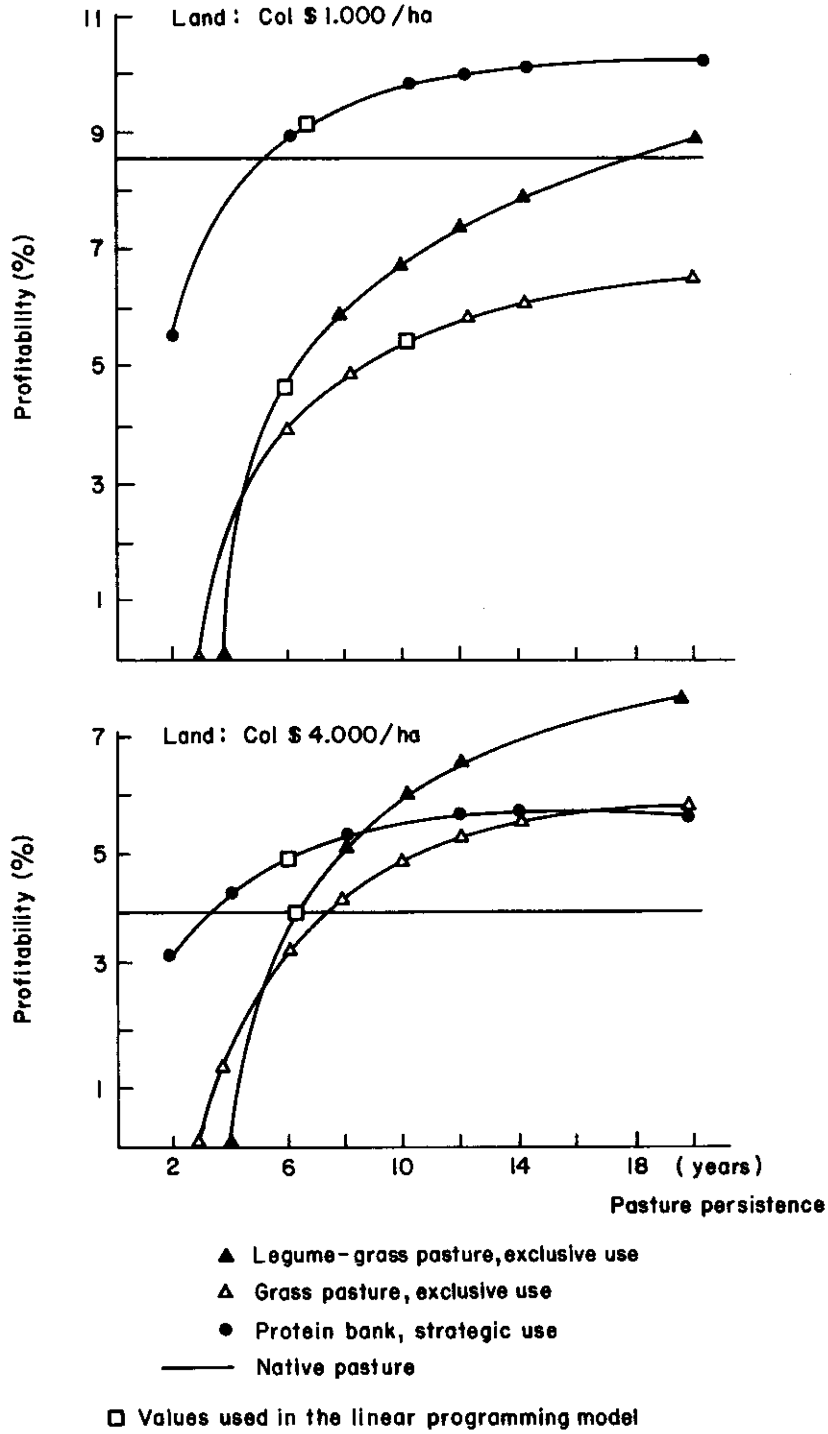

Figure 1. Effect of pasture persistence on the profitability of beef production (cow-calf + fattening operation) at two land price levels. (No mixed strategies, such as running a cow-calf operation on natural pastures and fattening on improved pastures are included here for the sake of simplicity.)

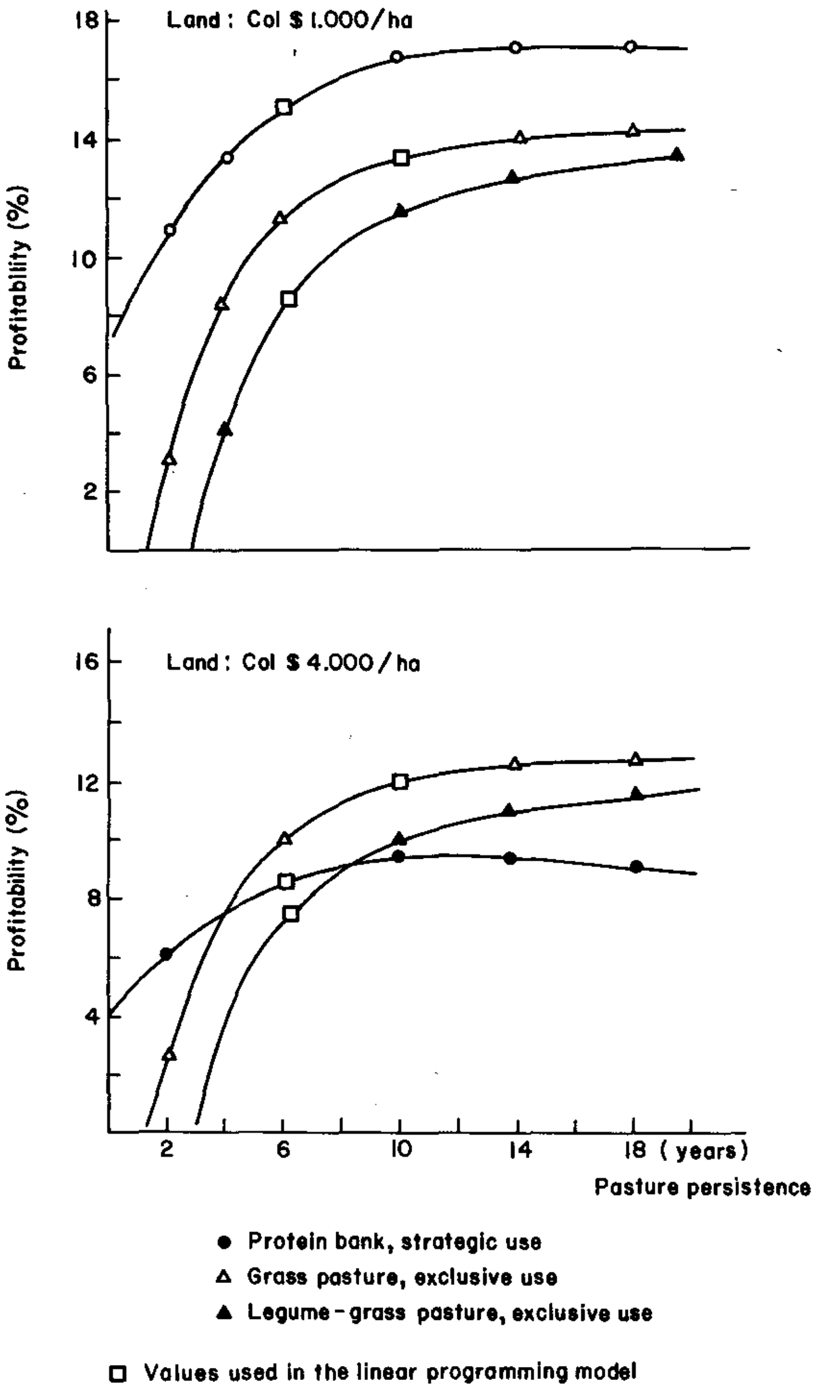

Figure 2. Effect of pasture persistence on profitability of dual-purpose systems (cow-calf operation + milking) at two land price levels.

- A similar monitoring project of dual purpose (beef and milk) farms was started in cooperation with the Banco Nacional de Panama in the Central Provinces of Panama in 1981. This special project undertaken in collaboration with the Technical University of Berlin and funded by the German government through GTZ, includes the posting of a post-doctoral fellow in Panama. The foreseen one-year continuous recording of biotechnical and economic data will be completed in May 1982. A report is expected to be completed by October 1982.

- In cooperation with FAO, a study on the potential to increase beef production in Latin America and its constraints, with particular emphasis on pasture improvement technology for the tropical lowlands, is well under way.

It can be concluded that, due to the increasing availability of detailed biotechnical research and monitoring information, the research approach of the Economics Section is gradually shifting from an emphasis on ex-ante simulation of the potential impact of pastures based on assumed values for these parameters, to an increasingly ex-post analysis of actual performance of grasses and legumes and whole production systems. At the same time research is expanding into production systems of different levels of intensity of resource use to help the program exploit the whole potential of the germplasm being developed.