# AN ECONOMIC EVALUATION OF DRYLAND PASTURE IMPROVEMENT STRATEGIES FOR BEEF CATTLE PRODUCTION IN TROPICAL QUEENSLAND

by

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## ABSTRACT

Twelve dryland pasture improvement strategies developed by the CSIRO were evaluated to determine their economic viability for adoption by graziers in the Thuringowa area of North Queensland. Five of the twelve strategies were profitable under current economic conditions and for typical open woodland establishment conditions. The Sabi grass-legume mix, the native grass-legume mix and the Rhodes grass-legume mix stocked at the high rate of 1.25 beasts/ha were the most profitable. The other profitable strategies were - the Sabi grass-legume mix and the native grass-legume mix stocked at the moderate level of 0.95 beast/ha.

Three strategies involving the annual application of 100 kg of nitrogen fertilizer per ha on the three grasses (native, Sabi and Rhodes) instead of the legume mix, were the most unprofitable and resulted in severe economic losses under diverse economic conditions. Three low level stocking rate strategies (0.65 beast/ha) containing the legume mix plus one of the three grasses were assessed as unprofitable under current economic conditions. The other unprofitable strategy was the Rhodes grass-legume mix strategy stocked at 0.95 beast/ha.

The key economic variables affecting the profitability of pasture improvement strategies were the interest rate, finished and store cattle prices. Modest adverse changes in these three economic variables led to the most promising strategies becoming unprofitable.

# INTRODUCTION

Beef production is a major economic activity in Australia; it is one of the three major sources of foreign exchange generated by the agricultural sector (Stoeckel and Miller, 1982). Tropical northern Australia, which includes the area of the study, is a principal beef producing region in Australia. (Tropical northern Australia lies above the Tropic of Capricorn and has an annual rainfall above 500 mm).

The majority of beef production in the tropical north is based on grazing pastures, predominantly native grasses. Because these native pastures commonly have inadequate nitrogen, phosphorus and other essential mineral elements, and have a low digestibility both in the dry and wet seasons, improved dryland pastures provide an opportunity for significantly higher liveweight gains.

Over the past four decades, extensive research into the development of improved pastures in Australia has been carried out by the CSIRO and other governmental organizations (t'Mannetyje, 1984). Despite this fact, the adoption of improved dryland pastures by graziers has generally been slow and has probably not been commensurate with the high level of public investment in research and extension. Out of the 165 million hectares of pastures in Queensland, sown pastures amount to only about 5 million hectares (3%); the remaining 160 million hectares are native grasses (Gramshaw and Walker, 1988). Moreover, the sown pastures have been mainly established in the more fertile subtropical parts of the State.

The economic viability of improved pastures is the principal factor of interest to graziers who are considering introducing these pastures into their commercial beef cattle operations. This economic viability will vary with changing climatic and market conditions. Climatic changes can be very severe in the dryland areas of northern Australia because of the high variability of rainfall and frequent occurrence of drought. In addition, since a considerable amount of the beef produced in this region is exported, prices received by beef producers are subjected to world market instability over which Australian graziers have little control. Thus, changes in profitability under varying climatic and market conditions will influence greatly the adoption decisions of graziers concerned about income risk and business survival.

The key variables affecting the profitability of improved pastures in tropical and subtropical Australia have been identified by several economic studies (Firth et al., 1974; Evans, 1975; Robinson and Sing, 1975; Wicksteed, 1983). The major variables were interest rate, finished and store cattle prices and establishment costs of improved pastures. Pulsford (1980) also demonstrated that the 60% decline in the fertilized pasture area in tropical and subtropical Queensland in the mid-1970's was the result of increases in fertilizer prices and the collapse of beef prices.

Comparisons of the economic viability of native and improved pasture alternatives in tropical and subtropical Australia have also been undertaken. Mitchell (1986) reported that the strategy of supplementing steers grazing on native pastures was more profitable than supplementing steers on improved Verano pastures. Wicksteed (1978) established that legume oversown into native pasture, and ploughed and fully sown grass legume pasture established on previously cleared open native pasture, were profitable but became unprofitable when established under certain virgin open woodland conditions.

While such studies give substantial information on the economic viability of improved pastures in tropical northern Australia, there are several issues which are not well addressed by this literature. First, the effect of the grazier's planning horizon on long-term profits has largely been neglected because of the fixed term planning horizon commonly used by economists (e.g. 10 years). The grazier's planning horizon essentially determines the level of his short-term profits. However, long-term profits are critically dependent on the maintenance of a sustainable resource base which allows for the timely replacement of pastures in order to avoid land degradation. The sensitivity of profits to different planning horizons is therefore an important issue in the light of current concerns about land degradation and ecologically sustainable production (Mott, 1986; Kirby and Blyth, 1987).

Secondly, the experimental data used in many economic analyses has generally been collected for short periods of time, such as one season or two years. These data might not provide accurate estimates of profitability, especially so under changing climatic conditions. The use of longer time series data from continuous grazing experiments is necessary to capture the effect of weather variability (e.g., drought at certain periods) on profits.

Finally, economic evaluations of pasture improvement systems need to take into account the new risky economic environment which now characterises Australia. As mentioned above, the problem of slow adoption of improved pastures, documented by authors such as Robinson and Sing over a decade ago, continues in the 1980's despite the increased availability of these pastures. New economic studies are thus needed to help shape the agenda of biological scientists involved in the development of new tropical pasture systems and to ensure that increasingly scarce public research and extension resources are efficiently used.

The economic evaluation of pasture management strategies presented here is based on long-term production data from a continuous grazing experiment. It measures the sensitivity of the profitability of these strategies to changes in the planning horizon and the economic environment of graziers. The specific objective of the study was to determine the profitability of twelve dryland pasture improvement strategies which involved introduced and native pastures. These strategies were developed by CSIRO at the Lansdown Research Station in North Queensland from 1977 to 1987.

In what follows, the procedures and methods used in the study are first reported. Our results are then summarized and discussed in the last section of the paper.

## EXPERIMENTAL DESIGN AND SOURCES OF DATA

The experiment at the Lansdown Pasture Research Station, 50 km south of Townsville, Queensland, consisted of twelve pasture treatments incorporated in a randomised complete block design with two replicates for the legume based treatments and only single replicates for the nitrogen-fertilized grass treatments. The twelve treatments are described in Table 1.

[TABLE 1 HERE]

The native pasture area chosen for the experiment has been cleared and was carrying a pasture which was dominated by speargrass (*Heteropogon contortus*), Kangaroo grass (*Themeda triandra*), giant speargrass (*Heteropogon tritiserus*) and *Bothriochloa* species.

The pastures were established in January 1977 by burning and discing the native pasture, oversowing with the seed mixtures and applying an initial level of superphosphate at 100 kg/ha. During the establishment phase, all twelve pasture treatments were grazed at the same stocking rate, commencing in November 1977. This stocking rate was approximately

0.9 steer/ha. From July 1979, three stocking rates were imposed - 0.65; 0.95 and 1.25 steers/ha. Steers were introduced as weaners and remained on the experiment for two years. They were replaced every second June/July by a new batch of weaner steers and liveweight gains were recorded monthly. The nitrogen fertilized grass pastures were stocked at 1.25 steers per ha. They received 100 kg/N/ha/yr in two equal applications in Spring and Autumn.

The summer rains in the last six years of the experiment (1981-1987) were below the average of the entire ten-year period. In addition, severe droughts occurred in some years. These factors led to considerable stress on the high stocking rate treatments leading to the removal of the cattle from the paddocks for several weeks in some years. The effect of summer rains on the performance of the cattle is well documented in the Annual Reports of the CSIRO Division of Tropical Crops and Pastures from 1979/80 to 1986/87.

## PASTURE IMPROVEMENT ASSUMPTIONS

In order to analyse the economic viability of this experiment, we used a set of assumptions regarding the grazier's property, pasture establishment and maintenance and livestock. Each assumption reflected the CSIRO experimental conditions and/or actual grazing conditions in the study area.

### The Grazier's Property

Graziers with extensive grazing properties testing new pasture developments will generally use a relatively small 200 hectare paddock for this testing. We thus evaluated the economic viability of the CSIRO trials on the basis of a typical 200 ha paddock.

We assumed that the area to be established with pasture was covered with virgin open woodland, which is generally the case in this region. Such an area would need to be cleared, fenced and ploughed before the improved pastures could be sown. Further, a bore and water tank would need to be installed before the cattle could be grazed. The property's existing infrastructure was assumed to be sufficient to cope with the extra livestock involved. This would actually be the case for an extensive cattle property handling the extra 135 to 250 beasts for the 200 hectare development assumed in this study.

**Pasture Establishment**

Clearing and fencing costs for the 200 hectare paddock were estimated using contractors' rates in the area. Clearing cost was $66.12/ha and fencing cost was $1,200 per kilometre respectively. One discing, costing $15.85 per ha, was carried out to reduce competition from the native pastures and to prepare seed beds for the introduced pastures.

The cost of bore drilling and finding water at a depth of 33 metres was estimated using local contractors' rates ($1200). The hardware purchased for this water point was assumed to be a 1100 gallons/hour jet pump costing $700 and a 5,500 gallon tank for water storage costing $2,345.

The initial aerial application of all fertilizers and seeds for all twelve treatments cost $45/tonne. The Sabi and Rhodes grasses were both sown at the rate of 2 kg/ha. However the legume mix was sown at a rate of 3 kg/ha. The cost of the Sabi, Rhodes and the legume mix seeds were $9.85, $11.60 and $4.30 per kg respectively. The cost of unimproved pasture land in the area was estimated as $84.66 per hectare on the basis of information provided by the Staff of Valuer Generals' Departments in Brisbane and Townsville.

**Pasture Maintenance**

All treatments were fertilized every second year with 100 kg/ha of superphosphate at a cost of $195 tonne plus $10/tonne for freight charges. The three treatments involving the application of nitrogen fertilizer instead of the legume mix received an additional 100 kg of nitrogen every year. The nitrogen was in the form of urea costing $15.50 per 50 kg bag.

Weeds, consisting of Chinee apple tree and rubber vine were controlled by spraying with 2,4,5-T using a 20 KW tractor. The associated labour cost was estimated assuming that it took one man-day to treat ten hectares. The cost of weed control was $12.17/ha and the weed control was repeated every four years.

Livestock

The initial weight of store cattle was assumed to be 150 kg liveweight to reflect experimental conditions. The final dressed weight was estimated at 55% of the final liveweight (obtained from the CSIRO trials) at the end of two-year grazing periods. Deaths were assumed to be 5% of the number of cattle at the end of each two-year grazing period. The price of store cattle was assumed to be $150 per beast.

Annual veterinary and health costs involving tick, buffalo and worm treatments were estimated to be $3.38/beast. Livestock transport costs to the Townsville abattoirs were evaluated assuming that a representative property was about 50 kilometres from Townsville. Sales commission was estimated to be 5% of gross revenue. An extra casual labour requirement of 20 man-days per year was assumed for the handling, animal health care and other miscellaneous labour items for the 200 hectare enterprise.

ECONOMIC ANALYSIS

The methodology we used in our economic analysis is that of investment analysis of agricultural projects. Benefits and costs occurring over the lifespan of each grazing strategy were identified and valued (Brown, 1979; Gittinger, 1982). The net present value and the equivalent annuity of each of the twelve strategies were then derived.

The net present value of a project is defined as the sum of the present value of each year's net benefit (i.e., benefit minus cost). The present value refers to the current value of income to be received in the future. Present values are obtained by discounting future income values using the opportunity cost of capital. An annuity is the annual lump sum of money which, if invested each year for the life of the project at the opportunity cost of capital, would accumulate to a value equivalent to the net present value.

The planning horizon was initially assumed to be ten years. The net present value of a pasture management strategy over the life of the project is therefore denoted as:

$$NPV_i = \sum_{t=0}^{10} \frac{Rit - Cit}{(1 + r)^t}$$

where $NPV_i$ is the net present value of income from strategy i; Rit is the gross return of strategy i at the end of time t; Cit is the total cost of strategy i at time t, and r is the discount rate reflecting the opportunity cost of capital.

The establishment of the pastures occurred ten months before the grazing by the animals (year zero). The animals were then grazed for five approximately two-year periods (from year 1 to 10). Thus, gross returns were received only at the end of year 2, 4, 6, 8 and 10 through the sales of the cattle. However, costs were incurred every year of the project. The biennial application of superphosphate fertilizer occurred in year 0, 2, 4, 6 and 8, while the weed control occurred in year 4 and 8. The store cattle were purchased at the beginning of year 1, 3, 5, 7 and 9.

The gross returns in year 10, that is at the end of the experimental period, were adjusted to include the terminal or the salvage value of the unused fixed assets (i.e., the water tank, land, fencing and the bore). The pastures and the water pump were assumed to have no salvage value left at the end of ten years of grazing. Ten years' remaining value was assumed for the water tank, 20 years' remaining value for fencing and the bore and 89 years' remaining value for the unimproved land at the end of the project[1].

The annuity (Ai) corresponding to the net present (NPVi) value of pasture improvement strategy i was calculated using the formula reported in Drynan (1981):

$$Ai = \frac{NPVi\ (1+r)^{10}}{[(1+r)^{11} - 1]}$$

The net present values of the twelve pasture management strategies were initially derived for a set of fixed economic conditions. These present values were then re-estimated for changes in the values of key economic parameters. The parameters varied were the discount rate, finished cattle price, store cattle price, finished cattle price, establishment cost of the pastures and the planning period of the grazier.

The opportunity cost of capital, or discount rate, was initially assumed to be 14.5%. This discount rate was derived by assuming a 17% nominal bank interest rate (16% overdraft rate plus 1% commission and extra bank charges) minus inflation, which was 7.3% in Australia during 1987/88. This resulted in a real interest rate of 9.7%. An additional 4.8% was added, as a risk discount, to reflect the relatively high degree of risk taking in dryland beef cattle production. The 4.8% risk discount was approximately 50% of the real interest rate. (A summary of measures for addressing risk in project appraisal is reported in Pouliquen, 1970

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1 The lifespan of the pastures, pump, water tank, fencing, bore and the unimproved land was [illegible]

and Anderson *et al*., 1977). The Commonwealth Banking Corporation overdraft rate and bank charges were used in these computations, as well as the assumption that 100% of the funds were borrowed.

Taxation was omitted in this study to simplify the economic analysis. Contract costs were used for all machinery and labour operations. This resolved the problem of arbitrary allocation of labour and machinery costs. All costs were taken into account, except for management costs. Hence, the net present value computed was a return to management, the uncosted resource.

The data regarding the costs of pasture establishment and maintenance were collected from a variety of sources and are documented in Fraser (1987). These sources included officials of the Queensland Department of Primary Industries, agricultural contractors, stock and station agents, local graziers, manager and scientists from the Lansdown Research Station. The prices of finished cattle were obtained from several abattoirs in Townsville.

## RESULTS

Tables 2 to 7 provide information about the net present value of the twelve pasture improvement strategies under diverse economic conditions. The results we derived using base economic conditions are discussed first.

### Base Analysis Results

Average 1987 economic conditions were used in the base analysis, with a discount rate of 14.5%, store cattle price of $150, and the other cost and price assumptions mentioned above. The net present value and equivalent annuity for the twelve pasture improvement strategies are listed in Table 2.

[TABLE 2 HERE]

The most profitable strategy was the Sabi grass-legume mix stocked at 1.25 beasts/ha (S, L, 1.25) followed by the native grass-legume mix and the Rhodes grass-legume mix both at the 1.25 beasts/ha stocking rate (N, L, 1.25 and R.L, 1.25). Two other strategies at the 0.95 beast/ha stocking rate (S, L, 0.95 and N, L, 0.95) were profitable. All the other strategies including the three 0.65 beast/ha strategies were unprofitable under current economic conditions.

Table 2 also shows that very high losses are associated with the three strategies involving the application of nitrogen fertilizer at 100 kg N/ha/year instead of the legume mix (S, F, 1.25; R, F, 1.25 and N, F. 1.25). This is because of the high cost of the annual nitrogen fertilizer application. In addition, with the N, F, 1.25 strategy, the native grass pasture broke down to weeds following a drought. Not surprisingly, this strategy was the most unprofitable.

## Sensitivity Analysis

Sensitivity analysis was then conducted to test the effect of modest changes in key economic parameters on the profitability of the pasture improvement strategies. The parameters we varied were the discount rate, store cattle price, finished cattle price, the establishment cost of the pasture and the planning horizon of the grazier.

### Changes in discount rate

The discount rate was varied from 5% to 20%. All strategies were unprofitable at the 20% discount rate, as shown in Table 3. However, all the pasture strategies, except for the three nitrogen-fertilized strategies stocked at the 1.25 beasts/ha, were profitable at both 5% and 10% discount rates.[2]

[TABLE 3 HERE]

The internal rate of return (IRR), i.e. the discount rate at which the net present value of a pasture improvement strategy was zero, was also calculated. The IRR of the two most profitable strategies, the sabi grass-legume mix (S, L, 1.25) and native pasture-legume mix (N, L, 1.25), were 19.4% and 19.6% respectively.

## Changes in store cattle price

Table 4 shows how the net present value of the twelve pasture improvement strategies varies with changes in store cattle prices from $100 to $200/beast.

[TABLE 4 HERE]

At the price of $200, all the twelve strategies were unprofitable. An increase in the current store price of about 22% (to $183/beast) led to the most promising strategy (S, L, 1.25) becoming unprofitable. The net present values of all strategies improved with declining store prices, as expected. At a low price of $100, all the strategies were profitable except the three nitrogen-fertilized strategies stocked at the 1.25 beasts/ha.

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2 Since the 10% discount rate reflected the real interest rate without the risk discount, these results were applicable to graziers least concerned about income variability or risk in beef production (i.e., who were risk-neutral). This might be

## Changes in finished cattle prices

Variations in the net present value of the twelve strategies with changes in finished cattle prices are summarized in Table 5.

[TABLE 5 HERE]

A [illegible]1% decline in current finished cattle prices led to all the twelve strategies becoming unprofitable. However, profitability improved with increasing prices. All strategies became profitable when current prices were increased by 10%, with the exception of the three nitrogen-fertilized grass strategies stocked at the 1.25 beasts/ha.

## Changes in establishment cost of pastures

Changes in net present values due to fluctuations in the establishment cost of pastures are presented in Table 6. The establishment cost of the pastures denotes the sum of the costs of clearing, discing, fertilizers, seeds and aerial application of seeds and fertilizers.

[TABLE 6 HERE]

The three most promising strategies, S, L, 1.25 and N, [illegible], 1.25 and R, L, 1.25 were still profitable with a 50% increase in pasture establishment costs. However a decline in establishment cost by one-third resulted in all the pasture strategies becoming profitable except the three nitrogen-fertilized strategies and the Rhodes grass-legume mix stocked at 0.65 beast/ha.

### Changes in the planning horizon of the grazier

The planning horizon of the grazier was equated in this study with the lifespan of the improved pastures. This horizon was initially assumed to be 10 year long, following similar studies in dryland areas of Queensland (Wicksteed, 1978 and Robinson and Sing, 1975). This ten-year planning horizon was further warranted by the fact that the pasture improvement strategies ~~stocked at the 1.25 beasts/ha~~ at the high stocking rate (1.25 beasts/ha) showed signs of severe stress during the ten-year grazing period especially in the last two years[3].

Table 7 shows how the net present value of the twelve improvement strategies varied with changes in the planning horizon from 10 to 40 years.

[TABLE 7 HERE]

There were five profitable strategies for the base planning horizon 10 years. This number increased to seven for 20 to 40 year long planning horizons. The additional strategies were S, L, 0.65 and N, L, 0.65.

## CONCLUSIONS

The economic analysis we undertook in this study indicates that the majority of the twelve pasture improvement strategies tested by CSIRO were unprofitable under current economic conditions. The three most profitable strategies were the Sabi grass-legume mix, the native grass-legume mix and the Rhodes grass-legume mix all at the 1.25 beasts/ha

3 Jones (1987) reported that the 1985-87 period (the last two years of the experiment) was exceptionally dry such that the available forage declined to less than 500 kg/ha on the six 1.25 beasts/ha stocking rate treatments. The cattle were thus

stocking rate. These strategies had modest economic stability since they would become unprofitable with an increase of 5% or a decrease of 11%, in current interest rate and finished cattle price respectively.

All strategies involving the 0.65 beast/ha stocking rates were unprofitable. However, two 0.95 beast/ha strategies involving the Sabi grass-legume mix and the native grass-legume mix were profitable under current economic conditions. The three nitrogen-fertilized pasture strategies resulted in the highest economic losses under diverse economic conditions because of the high cost of the annual application of nitrogen. In general, at the same stocking rate and with the legume mixture, the Sabi and native grass strategies were much more profitable than those involving the Rhodes grass.

The most profitable pasture improvement strategies had the highest stocking rate (1.25 beasts/ha). This is because the fixed costs including the establishment costs of these improved pastures were so high that profits were only generated by strategies which had a high output level. We noted that the long-term sustainability of these high stocking rate strategies may be doubtful given that signs of pasture stress were observed during the ten-year grazing period. In addition, our analysis of the profitability of the improved pastures for a range of planning horizons suggests that an overestimation of the resilience of introduced pastures by graziers would lead to an exaggeration of profits and an unrealistic view of the long-term economic potential of these pastures.

While the pasture improvement strategies led to sizeable gains in biological productivity when compared with the existing native grasses, the production costs involved were very high. The cautious adoption of the most promising of these improved pastures by graziers in the area is likely to reflect their modest economic potential and the risk attitudes of the graziers. On the basis of our results, we endorse the recent call from Gramshaw and Walker (1988, p.101) for a stronger emphasis to be put on the research and development of low cost pasture technologies in dryland tropical areas.

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TABLE 2: Net present value and annuity of pasture improvement strategies

| Strategy (a) | Net Present Value $ | Annuity $ | Ranking (b) |
|---|---|---|---|
| S,L,0.65 | -2824 | -462 | 6 |
| S,L,0.95 | 10847 | 1774 | 4 |
| S,L,1.25 | 20579 | 3365 | 1 |
| S,F,1.25 | -49899 | -8159 | 10 |
| R,L,0.65 | -10897 | -1782 | 9 |
| R,L,0.95 | -6487 | -1061 | 8 |
| R,L,1.25 | 1468[illegible] | 2402 | 3 |
| R,F,1.25 | -63487 | -10381 | 11 |
| N,L,0.65 | -3087 | -505 | 7 |
| N,L,0.95 | 7412 | 1212 | 5 |
| N,L,1.25 | 19692 | 3220 | 2 |
| N,F,1.25 | -83719 | -13689 | 12 |

(a) The key for this column is provided by Table 1

(b) Ranking of the strategies in terms of profitability

TABLE 1: CSIRO dryland pasture improvement treatments

| Key | Grass type (a) | Legume mix (b) or N fertilizer (c) | Stocking rates (beasts/ha) |
|---|---|---|---|
| S,L,0.65 | Sabi | Legume mix | 0.65 |
| S,L,0.95 | Sabi | Legume mix | 0.95 |
| S,L,1.25 | Sabi | Legume mix | 1.25 |
| S,F,1.25 | Sabi | Nitrogen fertilizer | 1.25 |
| R,L,0.65 | Rhodes | Legume mix | 0.65 |
| R,L,0.95 | Rhodes | Legume mix | 0.95 |
| R,L,1.25 | Rhodes | Legume mix | 1.25 |
| R,F,1.25 | Rhodes | Nitrogen fertilizer | 1.25 |
| N,L,0.65 | Native | Legume mix | 0.65 |
| N,L,0.95 | Native | Legume mix | 0.95 |
| N,L,1.25 | Native | Legume mix | 1.25 |
| N,F,1.25 | Native | Nitrogen fertilizer | 1.25 |

(a) The scientific names of these grasses are as follows:
Sabi grass - Urochloa mosambiciensis cv. Nixon,
Rhodes grass - Chloris gayana cv. Callide,
Native grasses - include Themeda triandra, Heteropogon contortus, and several Dicanthium and Bothriochloa species.

(b) The legume mix consisted of Stylosanthes hamata, Stylosanthes viscosa, and Macroptilium atropurpureum cv. Siratro.

(c) Nitrogen fertilizer was applied at a rate of 100 kg N/ha/year.

TABLE 2: Net present value and annuity of pasture improvement strategies

| Strategy (a) | Net Present Value ($) | Annuity ($) | Ranking (b) |
|---|---|---|---|
| S,L,1.25 | 20579 | 3365 | 1 |
| N,L,1.25 | 19692 | 3220 | 2 |
| R,L,1.25 | 14689 | 2402 | 3 |
| S,L,0.95 | 10847 | 1774 | 4 |
| N,L,0.95 | 7412 | 1212 | 5 |
| S,L,0.65 | -2824 | -462 | 6 |
| N,L,0.65 | -3087 | -505 | 7 |
| R,L,0.95 | -6487 | -1061 | 8 |
| R,L,0.65 | -10897 | -1782 | 9 |
| S,F,1.25 | -49899 | -8159 | 10 |
| R,F,1.25 | -63487 | -10381 | 11 |
| N,F,1.25 | -83719 | -13689 | 12 |

(a) The key for this column is provided in Table 1

(b) Ranking of the strategies in terms of profitability

TABLE 3: Net present value, in dollars, of pasture improvement strategies with changes in the discount rate

| Strategy (a) | Discount rate (% per annum) 5 | 10 | 14.5(b) | 20 |
|---|---|---|---|---|
| S,L,0.65 | 45686 | 15519 | -2824 | -18165 |
| S,L,0.95 | 72264 | 34069 | 10847 | -8559 |
| S,L,1.25 | 94223 | 48353 | 20579 | -2491 |
| S,F,1.25 | -16333 | -37810 | -49899 | -59082 |
| R,L,0.65 | 29705 | 4498 | -10897 | -23848 |
| R,L,0.95 | 42156 | 11833 | -6487 | -21691 |
| R,L,1.25 | 81389 | 39948 | 14689 | -6437 |
| R,F,1.25 | -39107 | -54933 | -63487 | -69661 |
| N,L,0.65 | 40250 | 13358 | -3087 | -16931 |
| N,L,0.95 | 61775 | 28012 | 7412 | -9860 |
| N,L,1.25 | 85230 | 44606 | 19692 | -1270 |
| N,F,1.25 | -81419 | -83543 | -83719 | -82838 |

(a) The key for this column is provided by Table 1.

(b) Represents the base economic conditions.

TABLE 4: Net present value, in dollars, of pasture improvement strategies with changes in store cattle prices

| Strategy (a) | Store cattle prices (dollars per beast) | | | | |
|---|---|---|---|---|---|
| | 100 | 125 | 150(b) | 175 | 200 |
| S,L,0.65 | 17110 | 7143 | -2824 | -12791 | -22758 |
| S,L,0.95 | 36354 | 23600 | 10847 | -1906 | -14660 |
| S,L,1.25 | 51658 | 36118 | 20579 | 5039 | -10501 |
| S,F,1.25 | -18819 | -34359 | -49899 | -65438 | -80978 |
| R,L,0.65 | 9038 | -929 | -10897 | -20863 | -30831 |
| R,L,0.95 | 19020 | 6266 | -6487 | -19240 | -31993 |
| R,L,1.25 | 45768 | 30228 | 14689 | -851 | -16390 |
| R,F,1.25 | -32408 | -47947 | -63487 | -79026 | -94566 |
| N,L,0.65 | 16848 | 6880 | -3087 | -13054 | -23021 |
| N,L,0.95 | 32918 | 20165 | 7412 | -5342 | -18095 |
| N,L,1.25 | 50771 | 35231 | 19692 | 4152 | -11387 |
| N,F,1.25 | -52640 | -68180 | -83719 | -99259 | -114799 |

(a) The key for this column is provided by Table 1.

(b) Represents the base economic conditions.

TABLE 5: Net present value, in dollars, of pasture improvement strategies with changes in finished cattle prices

| Strategy (a) | Change in finished cattle prices (%) | | | | |
|---|---|---|---|---|---|
| | -11 | -5 | 0(b) | 5 | 10 |
| S,L,0.65 | -17652 | -9655 | -2824 | 4007 | 10839 |
| S,L,0.95 | -7789 | 2376 | 10847 | 19318 | 27789 |
| S,L,1.25 | -1232 | 10665 | 20579 | 30492 | 40406 |
| S,F,1.25 | -71223 | -59592 | -49899 | -40206 | -30513 |
| R,L,0.65 | -25114 | -17359 | -10897 | -4434 | 2029 |
| R,L,0.95 | -23293 | -14126 | -6487 | 1153 | 8792 |
| R,L,1.25 | -6551 | 5034 | 14689 | 24343 | 33997 |
| R,F,1.25 | -83677 | -72664 | -63487 | -54309 | -45131 |
| N,L,0.65 | -17651 | -9707 | -3087 | 3534 | 10154 |
| N,L,0.95 | -10411 | -690 | 7412 | 15513 | 23615 |
| N,L,1.25 | -1586 | 10020 | 19692 | 29363 | 39035 |
| N,F,1.25 | -100888 | -91524 | -83719 | -75915 | -68111 |

(a) The key for this column is provided by Table 1.

(b) Represents the base economic conditions.

TABLE 6: Net present value, in dollars, of pasture improvement strategies with changes in the establishment cost of pastures

| Strategy (a) | Change in the establishment cost of pastures (%) | | | |
|---|---|---|---|---|
| | -33 | 0(b) | 25 | 50 |
| S,L,0.65 | 6549 | -2824 | -9854 | -16883 |
| S,L,0.95 | 20220 | 10847 | 3817 | -3212 |
| S,L,1.25 | 29951 | 20579 | 13549 | 6519 |
| S,F,1.25 | -41395 | -49899 | -56277 | -62655 |
| R,L,0.65 | -1290 | -10897 | -18101 | -25306 |
| R,L,0.95 | 3119 | -6487 | -13692 | -20896 |
| R,L,1.25 | 24295 | 14689 | 7484 | 279 |
| R,F,1.25 | -53889 | -63487 | -70685 | -77883 |
| N,L,0.65 | 4967 | -3087 | -9127 | -15167 |
| N,L,0.95 | 15465 | 7412 | 1372 | -4669 |
| N,L,1.25 | 27745 | 19692 | 13651 | 7611 |
| N,F,1.25 | -76535 | -83719 | -89108 | -94496 |

(a) The key for this column is provided by Table 1.

(b) Represents the base economic conditions.

TABLE 7: Net present value, in dollars, of pasture improvement strategies with changes in the planning horizon

| Strategy (a) | Planning horizon in years (b) | | | |
|---|---|---|---|---|
| | 10(c) | 20 | 30 | 40 |
| S,L,0.65 | -2824 | 806 | 2016 | 2621 |
| S,L,0.95 | 10847 | 14477 | 15687 | 16292 |
| S,L,1.25 | 20579 | 24209 | 25419 | 26024 |
| S,F,1.25 | -49899 | -46605 | -45507 | -44958 |
| R,L,0.65 | -10897 | -7176 | -5936 | -5316 |
| R,L,0.95 | -6487 | -2766 | -1526 | -906 |
| R,L,1.25 | 14689 | 18409 | 19649 | 20269 |
| R,F,1.25 | -63487 | -59770 | -58531 | -57911 |
| N,L,0.65 | -3087 | 33 | 1072 | 1592 |
| N,L,0.95 | 7412 | 10531 | 11571 | 12090 |
| N,L,1.25 | 19692 | 22811 | 23850 | 243[illegible] |
| N,F,1.25 | -83719 | -80937 | -80009 | -79546 |

(a) The key for this column is provided by Table 1.

(b) The planning horizon of the grazier is equal to the lifespan of the pastures, as perceived by the grazier.

(c) Represents the base economic conditions.