AN ECONOMIC EVALUATION OF PASTURE IMPROVEMENT ALTERNATIVES—COASTAL BURNETT FOOTHILLS

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ABSTRACT

Alternative pasture improvement systems in the Burnett coastal foothills are evaluated in this paper to provide guidelines for development priorities.

The most profitable pasture improvement systems are in previously cleared open native pasture. Both pasture improvement systems in this class of country, namely oversown legume into native pasture and ploughed and fully sown grass/legume pasture, in this analysis, yielded attractive internal rates of return of 12% and 19% respectively. The higher internal rate of return from ploughed and fully sown pastures appears possible despite the higher initial cost of establishment.

Under the present cost/price structure faced by beef producers, pasture improvement in virgin woodland is generally unattractive. This is especially so for contract poisoning of virgin timber to improve native pasture production. Where this investment is followed by the introduction of a legume the internal rate of return in this analysis was increased from a negative return to 6%.

Profitability of pasture improvement is highly sensitive to any change in beef prices and to the level of productivity achieved from pastures. With the long term outlook for beef prices fairly bright, pasture improvement of the large areas of previously cleared open native pasture in the Burnett coastal foothills appears to be a very worthwhile investment.

INTRODUCTION

The coastal Burnett foothills of south east Queensland constitute a strip of gently rolling to hilly country lying between the coastal ranges and the coastal lowlands. They extend from Rodd's Bay in the north to Tiaro in the south and vary in width from 25 to 55 km (Fox 1964).

The climate is sub tropical and the original vegetation was eucalypt forest. Much of the timbered area has been partially or wholly cleared to improve livestock production from native pasture which is dominated by *Heteropogon contortus* (Speargrass).

In recent years, tropical pastures have been established to increase stocking rates. Pastures established to date have been based predominantly on *Macroptilium atropurpureum* cv. Siratro and improved tropical grasses.

Pasture improvement alternatives in the coastal foothills are listed in Table 1. This paper applies an economic analysis to evaluate the profitability of these pasture improvement alternatives and to establish guidelines for pasture improvement programs.

ASSUMPTIONS

Livestock assumptions

The assumed animal production figures used in this analysis represent 'best estimates'. Evidence on which these estimates have been based has been drawn from C.S.I.R.O. grazing trials at Narayen (Tothill 1974) and Rodd's Bay (Shaw 1966-1973 unpublished). Data from grazing trials conducted by the Department of Primary Industries in Miriam Vale Shire have also been used (Bisset and Marlowe 1974).

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TABLE 1

Pasture improvement alternatives

Virgin woodland	Previously cleared native pasture
C—*Control*—unaltered woodland	C_1—*Control*—untreated open spear grass
K—*Trees killed*—by tordon injections	S.S.—*Direct seeded*—Siratro direct seeded with minimal cultivation into spear grass. 250 kg ha^{-1} super used and 125 kg ha^{-1} super annually.
K.S.—*Trees killed and direct seeded*—Siratro* direct seeded with minimal cultivation into native pasture. 250 kg ha^{-1} super used and 125 kg ha^{-1} super annually.	P.S.—*Ploughed and sown* to Siratro and improved grasses with 250 kg ha^{-1} super—annual application 125 kg ha^{-1} super.
C.P.S.—*Trees cleared, ploughed and sown* to Siratro and improved grasses with 250 kg ha^{-1} super—annual application 125 kg ha^{-1} super.	

The Rodd's Bay and Miriam Vale grazing trials were conducted on soils broadly similar to those occurring throughout the Burnett coastal foothills—solodic soils derived from granite. Rainfall at Rodd's Bay at 900 mm year^{-1}, is at the lowest extreme for the region with recorded rainfall for the Burnett coastal foothills up to 1 200 mm year^{-1} according to locality (Bisset and Marlowe 1974). Mean annual rainfall at Lowmead, the site of the Miriam Vale trials, is 1 100 mm.

The Narayen grazing trials are on a coarse sandy soil derived from granite and mean annual rainfall at the trial site is 710 mm year^{-1}.

Rodd's Bay results averaged over seven years have shown that weaner heifers stocked at 0.3 beasts ha^{-1} on native pasture have gained around 85 kg liveweight per year (28 kg ha^{-1}). Similarly weaner heifers stocked at an average of 1 beast ha^{-1} on native pasture and Townsville stylo (*Stylosanthes humilis*) with 125 kg ha^{-1} superphosphate per year, have gained 140 kg liveweight per year (140 kg ha^{-1}) after an initial pasture establishment phase of 2 to 3 years.

The early grazing trials at Lowmead used weaner steers at an average stocking rate of 0.9 beasts ha^{-1} on pastures of Siratro and scrobic (*Paspalum commersonii*). Although scrobic failed to persist the mean animal liveweight gain was 180 kg in 314 days (162 kg ha^{-1}). More recent trials conducted on this site (Nicol and Marlowe unpublished) measured livestock performance on native pasture (predominantly spear grass), sown pasture of Siratro and Rhodes grass (*Chloris gayana*) and the original trial pasture which had become predominantly Siratro and green couch (*Cyndon dactylon*). This trial was conducted during three years of above average rainfall, the mean from 1971 to 1973 being 1425 mm. At 0.6 beasts ha^{-1} on native pasture average liveweight gain per year was 110 kg (66 kg ha^{-1}). The sown Siratro and Rhodes grass pasture was stocked at 1.5 beasts ha^{-1}. Average liveweight gain was 186 kg per head per year (279 kg ha^{-1}). The Siratro-couch pasture was stocked at 1.45 beasts ha^{-1}. Liveweight gain per head per year was 170 kg (246 kg ha^{-1}). Superphosphate was applied to the improved pasture treatments.

The continuing experiment at Narayen with grazing steers has yielded useful data on animal performance from four alternative land use systems. Unimproved woodland, predominantly silver leaved ironbark stocked at 0.18 beasts ha^{-1} has yielded liveweight gains of around 75 kg per head per year (13 kg ha^{-1}). With the trees killed by tordon injection and the native pasture stocked at an average of 0.3 beasts ha^{-1} average liveweight gain over 3 years to 1975-76 has been 106 kg per

* The legume used in this analysis is Siratro. This is not intended to imply that Siratro is the legume most suited to all pasture improvement in the coastal foothills.

head per year (32 kg ha^{-1}). Similarly steers stocked at 0.67 beasts ha^{-1} on native pasture oversown with Siratro and fertilized with superphosphate gained 155 kg per year (104 kg ha^{-1}). Steers stocked at 0.85 beasts ha^{-1} on pasture fully cleared and sown to Siratro and buffel grass (*Cenchrus ciliaris*) with superphosphate applied gained 162 kg per head (134 kg ha^{-1}). A slower establishment phase for Siratro oversown native pasture also appears evident from this experiment.

There is little published information on the grading or finish of carcases from these grazing trials. In a grazing experiment similar to that described at Narayen (Mannetje, personal communication) steer carcases were graded from three pasture systems. At 2½ years of age the carcases of steers from native pasture stocked at 0.3 steers ha^{-1} were 190 kg and second and third grade. Carcases from stylo oversown pasture stocked at 0.8 steers ha^{-1} were 220 kg and graded first or second grade. The buffel and Siratro pastures stocked at 1 steer ha^{-1} produced first grade carcases of 260 kg.

Liveweight gains per head at both Narayen and Lowmead, within each pasture system, are very similar with the higher figures recorded at Lowmead. The results from both experiments have been averaged over a similar time period of above average rainfall. Liveweight gain per head from the native pasture and oversown pasture at Rodd's Bay is lower than that achieved on native pasture and oversown pasture at Narayen and Lowmead. The Rodd's Bay figures have been averaged over a longer period and include years of below average rainfall.

Recorded liveweight gains ha^{-1} show more variation between each experiment. These variations can be explained largely in terms of stocking rate, rainfall and the class of animals used over the time period of the experiments. The margin of increased liveweight gain ha^{-1} from fully sown pasture above that recorded on oversown pastures at both Narayen and Lowmead has been about 30 kg per year.

In making livestock assumptions for the Burnett coastal foothills in general the results from Lowmead have been regarded as above average while those from Rodd's Bay have been regarded as below average for the region.

Livestock assumptions are set out in Table 2.

TABLE 2

Livestock assumptions (figure rounded)

Alternative	Virgin woodland				Previously cleared speargrass		
	C	K	KS	CPS	C_1	SS	PS
Stocking rate (beasts ha^{-1})	0·12	0·35	1·0	1·15	0·35	1·0	1·15
Liveweight gain (kg steer^{-1} year^{-1})	80	103	160	175	103	160	175
Liveweight gain (kg ha^{-1} year^{-1})	10	36	160	200	36	160	200
Dressed weight gain (kg ha^{-1} year^{-1})	6	22	96	120	22	96	120
Dressed weight gain kg ha^{-1} over control	—	16	90	114	—	74	96
Percentage of turnoff 1st grade	—	Nil	70%	85%	—	70%	85%

The pasture systems are all assumed to be stocked with 2½ year store steers of approximately 280 kg liveweight. The cattle are assumed to be sold during the period February to May after twelve months grazing, whether finished or not. Store steers are assumed to be purchased or valued onto each pasture system at a price per kg which gives a zero market margin between fat cattle and stores. A two year establishment lag is assumed for oversown pasture before liveweight gains of 160 kg ha^{-1} are reached. No establishment lag is assumed for the other pasture improvement systems. Dressed weight carcase gain is assumed to be 60% of the liveweight change for the year.

Pasture Improvement Cost Assumptions

In estimating pasture improvement costs the following assumptions have been made:

(i) Both oversown pasture and fully sown pasture are established with 250 kg ha^{-1} superphosphate* followed by annual applications of 125 kg ha^{-1}. The price used for superphosphate is $72 per tonne bulk ex Bundaberg. The price used per tonne applied to pasture, is $85 per tonne after freight and spreading costs are included.

(ii) Siratro at 2 kg ha^{-1} at a price of $5.00 per kg is used to establish the oversown pasture.

(iii) Siratro at 1.5 kg ha^{-1} and 2 kg ha^{-1} of a mixture of setaria and Rhodes grass is assumed to be used in establishing the fully sown pastures. An average price of $9.00 per kg is used for the grass seed mixture.

(iv) No allowance is made for the existing capital investment or market value of land and improvements. Similarly for pasture improvement in previously cleared native pasture no allowance is made for the value of timber clearing which has been done in previous years. As these costs may be regarded as 'sunk' they are not relevant to any future pasture investment decisions.

(v) Expenditure on additional fencing and watering points is assumed to be $10 ha^{-1} for fully sown pastures. In making adjustments to this figure for other pasture systems, expenditure on fencing and particularly watering points per ha is assumed to increase at a diminishing rate as stocking rate increases. Similarly fencing costs are assumed to be higher in standing timber paddocks.

(vi) The additional investment in livestock for each pasture improvement system is calculated at $70 per head for 2½ year old steers.

(vii) Machinery operations have been combined whenever possible to minimise tractor workings.

(viii) Contract costs where available have been used or estimated for all machinery operations and timber poisoning. This has overcome the problem of arbitrary allocations of both labour costs and machinery overheads. Contract costs used in this analysis are shown in Table 3.

TABLE 3

Schedule of contract rates

Operation	kg ha^{-1}	Rate $$hr^{-1}$	$ ha^{-1}
Timber treatment (tordoning)	—	—	25
Pulling and windrowing timber	—	—	120
Disc cultivation and seeding in standing timber†	0·7	20	29
Disc cultivation and seeding in native pasture†	1·0	20	20
Disc ploughing in native pasture	1·4	20	14
Disc ploughing and seeding (second)	1·2	20	17

Capital costs of all pasture improvement alternatives are shown in Table 4.

THE ECONOMIC ANALYSIS

Analytical Approach

Estimated additional cash inflows (benefits) and outflows (costs) over the native pasture control, are estimated for each pasture improvement system. A planning horizon of 10 years has been assumed.

* Fertilizer application rates are assumed. It is not intended to imply that these are optimum rates in all situations.

† These contract rates have been estimated.

TABLE 4

Capital pasture improvement costs ($ha⁻¹)

Alternative	Virgin woodland C	K	KS	CPS	Previously cleared native pasture C_1	SS	PS
Poisoning timber		25	25				
Pull and windrow timber				120			
Disc. ploughing				14			41
Disc. cultivation and seeding			29	17		20	17
Seed			10	26		10	26
Fertilizer			21	21		21	21
Direct pasture improvement costs	—	25	85	198	—	51	78
Additional fencing and water		2	7	5		4	5
Additional livestock		20	62	72		42	52
Total		47	154	275		97	135

The stream of benefits from pasture improvement may extend beyond 10 years, however it is doubtful whether net benefits beyond this point would be recognized in any commercial situation, where pasture improvement is being considered as an investment alternative.

The investment analysis approach demonstrated by Firth *et al.* (1974) is used. Benefits and costs are budgeted over the 10 year project life and discounted to the present to enable the 'internal rate of return' (I.R.R.) to be calculated.

If benefits and costs bear a constant relationship to each other throughout the life of the pasture the I.R.R. derived is a real return (i.e. net of inflation). Production costs for beef producers in recent years, however, have increased at a greater rate, than prices. This has been indicated by a declining terms of trade (ratio of prices received to prices paid) for farmers in general. Without reliable estimates of future costs and prices this analysis is simplified by assuming a constant relationship between costs and benefits over the life of each pasture improvement system.

There is assumed to be no residual value at the end of each project life. This assumption is necessary because of the difficulty of calculating the added value to the land of each project at the end of the assumed 10 year life. The I.R.R. calculated is therefore not strictly comparable with other rates of return on capital, such as debenture earning rates, where assets are cashed at the end of the earning period.

Taxation has been omitted to simplify the analysis. The I.R.R. calculated, therefore, represents a rate of return before tax.

The same livestock production system of steer fattening is assumed for each pasture improvement system. Analysis of local data has shown this to be the most profitable use of improved pastures (Nicol and Wicksteed, unpublished).

Additional cash inflows

Additional cash inflows from pasture improvement are budgeted in Tables 5 and 6. In budgeting additional cash inflows the following assumptions have been made.

(i) The additional carcase yield from each pasture (from Table 2) is valued at \$0.51 kg^{-1} for first grade ox and \$0.45 kg^{-1} for second grade. These prices are average prices paid per kg dressed weight by central zone meatworks for the February to May period for 1976 and 1977*.

* Australian Meat Board—Weekly Market Notes for Livestock and Meat.

(ii) Liveweight gain ha^{-1} in the two establishment years assumed for oversown pasture is estimated at 130 kg ha^{-1} in year 1 and 145 kg ha^{-1} in year 2.

Additional cash costs

(i) Freight and slaughtering charges of $6.00 per beast are based on road freight to and slaughter at Maryborough export abattoir.
(ii) Fertilizer is usually applied biennially. This is assumed to be applied annually at 125 kg ha^{-1} to simplify the matching of cash inflows and outflows. Similarly maintenance poisoning of treated woodland, probably necessary every 5 to 10 years is apportioned at $2.50 ha^{-1} yr^{-1}.
(iii) Animal losses are assumed to be 1 percent per year for all pastures.
(iv) Animal health expenses are estimated at $2.00 per beast per year.
(v) Additional repairs and maintenance expenditure per year of fencing and watering points is estimated at 3 percent of capital cost.
(vi) It has been assumed that sufficient 'unused capacity' in property labour exists to handle the additional livestock.

Budget comparisons

Tables 5 and 6 set out the budgeted cash flows for each pasture improvement alternative.

TABLE 5

Additional cash flows ha^{-1} for three pasture improvement systems for virgin woodland

Alternative	K	KS			CPS
	Year 1-10 $	Year 1 $	Year 2 $	Year 3-10 $	Year 1-10 $
Gross income	7.20	35.40	39.87	44.28	5712.
Cash costs					
Freight and slaughter	1.68	5.28			6.18
Fertilizer	—	10.60			10.60
Timber regrowth poisoning	2.50	1.50			—
Animal health	0.56	1.76			2.06
Repairs and maintenance	0.06	0.21			0.15
Livestock losses	0.20	0.62			0.73
Cash costs	5.00	19.97	19.97	19.97	19.72
Cash surplus	2.20	15.43	19.90	24.31	37.40

TABLE 6

Additional cash flows ha^{-1} for two pasture improvement systems for previously cleared native pasture

Alternatives	SS			PS
	Year 1 $	Year 2 $	Year 3-10 $	Year 1-10 $
Gross income	27.54	31.95	36.42	48.12
Cash costs				
Freight and slaughtering	3.60			4.50
Fertilizer	10.60			10.60
Animal health	1.20			1.50
Repairs and maintenance	0.12			0.15
Livestock losses	0.42			0.53
Cash costs	16.00	16.00	16.00	17.28
Cash surplus	11.54	15.95	20. 42	30.84

Budget results

The above cash flow streams have been discounted over a 10 year planning horizon to calculate the I.R.R. for each investment alternative. The results are shown in Table 7.

TABLE 7

Calculated I.R.R. (%) for all pasture improvement systems

Alternative	K	KS	CPS	SS	PS
I.R.R.	—	6%	6%	12%	19%

Timber poisoning to improve native pasture production (K) shows a negative I.R.R. The I.R.R. calculated for both oversown pasture (KS) and cleared and fully sown pasture (CPS), in native woodland, are low at 6 percent.

The I.R.R. calculated for oversowing previously cleared native pasture (SS) is quite high at 12 percent. The I.R.R. for ploughed and fully sown pasture in previously cleared native pasture (PS) is the most promising at 19 percent. The investment in this type of pasture is therefore quite profitable despite the recent unfavourable changes in the cost/price structure faced by beef producers.

Sensitivity analysis

The most important variables in determining profitability are direct pasture improvement costs, productivity of pasture, beef prices and fertilizer prices. In Table 8, all variables have been separately increased by 10 percent to determine the sensitivity of I.R.R. to such changes.

The I.R.R. of all pasture improvement systems is most sensitive to changes in pasture productivity and beef prices. Conversely I.R.R. of all pasture improvement systems is relatively insensitive to changes in direct pasture improvement costs and to the level of fertilizer prices.

Sensitivity analyses conducted in other economic studies of pasture improvement projects have shown similar results (Firth *et al.* 1974, Evans 1975, Robinson and Sing 1975).

TABLE 8

Sensitivity of I.R.R. to a 10 percent increase in key variables (original I.R.R. is shown in brackets)

Alternatives	K	KS	CPS	SS	PS
Variables					
Direct pasture improvement cost	— (—)	5% (6%)	5% (6%)	11% (12%)	17% (19%)
Pasture productivity	— (—)	10% (6%)	9% (6%)	18% (12%)	23% (19%)
Beef prices	— (—)	10% (6%)	9% (6%)	18% (12%)	23% (19%)
Fertilizer costs	N.A.	5% (6%)	5% (6%)	11% (12%)	18% (19%)

Practical application

Several critical assumptions have been made in this paper. In considering the implications of the results obtained in this analysis, it may be useful to consider further the more important assumptions.

The assumption that all pasture improvement projects are carried out by independent contractors will in some cases overstate actual on property costs. Properties with fixed labour and machinery used mainly on grain or sugar cane growing, may have unused labour and machinery capacity at off peak times for use on pasture improvement work. The real incremental cost of pasture improvement programs in these situations could be much lower than the contract costs assumed.

Similarly graziers working with relatively inexpensive and improvized machinery can significantly reduce the cost of establishing oversown pastures. This is not possible to the same extent with ploughed and fully sown pastures where heavier and more specialized equipment is required.

Store steers have been valued at an assumed price per kg which gives a zero market margin between fat cattle and stores. In recent years depressed store cattle sales have enabled fatteners to purchase store cattle at a discount. This has resulted in some cases in a significant market margin between fat cattle and stores. Where this is possible the cash inflows used in this analysis will understate actual cash returns.

A further critical assumption used is that each project has a 10 year life and at the end of the 10 year life the project has no residual value. On commercial properties in the Burnett coastal foothills some improved tropical pastures established more than 10 years ago are still fully productive. There are some, however, which have required renewal at less than 10 years of age. In this respect, the assumption of nil residual value may be valid for pasture improvement projects in previously cleared native pasture. Pasture improvement projects in virgin woodland could be expected to have some residual value at the end of 10 years, provided timber regrowth has been controlled. The removal of timber could be expected to be reflected in added value to the land at the end of the 10 year project life. To this extent the I.R.R. calculated here for pasture improvement systems in virgin woodland could be understated.

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