Tropical pasture establishment.
16. Economic considerations for pasture establishment

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Abstract

A budgeting approach is used to compare the costs associated with a range of pasture establishment methods. An assessment is made of the impact of factoring both new and second-hand equipment into the budgets. Benefits to be derived from pasture establishment options are considered in terms of principles and assessed within a framework of impacts on discounted cash flows. Consideration is given to some aspects of risk associated with pasture establishment.

Introduction

The profitability of livestock production is under continuing pressure from the dual forces of a chronic cost-price squeeze and limited productivity of many existing pastures. Apart from the option of acquiring more land to carry extra stock, a traditional management response to offsetting these forces is to use existing resources more intensively. Pasture establishment options, including the augmentation of existing pastures with legumes and/or improved grasses or the complete replacement of existing species, can provide such productivity gains.

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This paper examines the costs associated with some of the more traditional pasture establishment options as well as that of an emerging technology — band-seeding. Cost budgets are presented for a range of options, including the effect of factoring new or second-hand machinery into the calculations. Financial returns to pasture establishment will typically accrue over long periods and can vary substantially from case to case. For this reason, we consider the benefits to pasture establishment in terms of principles, particularly as these relate to the present value of cash flows[1]. Finally, we consider some aspects of risk which may play a significant role in managers' attitudes to undertaking long-term investments such as pasture establishment.

[1]See Appendix for an explanation of the discounting process.

Costs

Direct costs

Pasture establishment costs include a number of direct costs which vary according to the scale and intensity of the particular development plan. These costs are also influenced by the effective work-rate of machinery and the skill of its operators. Specific items include fuel and oil, filters, batteries, tyre wear, repairs to tractors and implements, seed and seed treatments, fertilisers and chemicals, and/or the cost of contractors when this option is selected (e.g. aerial spreading, contract ploughing).

Labour used for pasture development may represent a direct cost, as the hours of labour committed for a given establishment method will vary according to the number of individual operations involved and the work-rate associated with each operation. In a strict economic sense, labour input is costed at its *opportunity cost.*

This is the return that the labour would yield if applied to the next best alternative activity, either on or off the farm. It could be measured as either a wage rate or the change in gross margin in another enterprise that would arise from having the labour made available to it (e.g. Dillon and Hardaker 1980). However, including opportunity cost-based labour charges in pasture development budgets can present difficulties for practical farm managers. Many managers view their labour as an overhead cost to the enterprise or do not see off-farm employment as an option and, therefore, simply prefer to exclude it from their budgets. In cases where hired labour is used for pasture establishment work, the direct cost is the wage plus any other benefit paid.

Indirect costs

Pasture establishment costs also include a number of indirect or fixed costs that do not vary with the scale or intensity of development. These costs include depreciation on capital used for the development including machinery and fixed improvements, shelter and insurance for machinery, administration and organisation, and an opportunity interest charge on capital used for the project. This last cost item represents the lost opportunity associated with having funds, that could be used elsewhere, invested in machinery and other capital items associated with the pasture development project.

A model has been developed (Walsh *et al.* 1990) to calculate, on a per hectare basis, the direct, indirect and total costs of a range of pasture establishment methods. Input for the model includes data on tractor(s) and implement sizes, capital values and work-rates, effective working life and depreciation rates, fuel and oil consumption, labour and interest charges, seed, fertiliser and chemical application rates, and assumptions on repairs and maintenance, shelter and the other individual expense items listed above. The model was developed to provide static comparisons of different establishment options, so it was appropriate to include both direct and indirect costs. In a later section which covers benefits from pasture establishment, the model is modified to remove the indirect cost calculations (see footnote 2).

Representative establishment cost figures derived from the model are presented in Table 1 for the following commonly used pasture establishment methods in Queensland (Cook *et al.* 1993):

Table 1. Cost summary ($/ha) for a range of establishment options — New equipment.

	Offset disc + seed drill (ODSD)	Offset disc + drum seed. (ODDRx2)	Offset disc + drum seed. (ODDRx1)	Disc strip 33% (DS + f)	Band-seeder (BS)	Broadcast untilled (SS)	Aerial sowing (no fert.) (AS − f)	Aerial sowing (+ fert.) (AS + f)
(1) Seed-legumes	25	25	25	25	10	25	25	25
(2) Seed-grass	18	18	18					
(3) Fertiliser	33	33	33	11	11	33		33
(4) Herbicide					12			
(5) Labour	35	38	24	8	12	10		
(6) Implement (direct cost)	4	3	2	1	2	1		
(7) Tractor (direct cost)	20	22	14	5	7	5		
(8) Contract spreading							2	9
(9) Total direct cost	135	139	116	50	54	74	27	67
(10) Interest on capital	17	14	8	3	7	3		
(11) Implement (indirect cost)	19	12	7	2	9	1		
(12) Tractor (indirect cost)	9	10	6	2	3	3		
(13) Total indirect cost	45	36	21	7	19	7		
(14) Total cost	180	175	137	57	73	81	27	67
(15) Total direct cost (excl. labour)	100	101	92	42	42	64	27	67
(16) Total cost (excl. labour)	145	137	113	49	61	71	27	67
(17) Total cost (excl. lab/cap)	128	123	105	46	54	68	27	67

(a) fully cultivated seedbed: 2 passes with offset discs and a single pass with a combine seed drill (ODSD);
(b) fully cultivated seedbed: 2 passes with offset discs with an attached roller drum seeder (ODDRx2);
(c) roughly cultivated seedbed: a single pass with offset discs with an attached roller drum seeder (ODDRx1);
(d) roughly cultivated seedbed (disc strip): strips representing 33% of a paddock receive a single pass with offset discs with an attached roller drum seeder and a single pass with a fertiliser spreader across the whole paddock (DS + f);
(e) band-seeding; a single pass operation with a specialised machine that sows seed and fertiliser in furrows in the centre of 0.5 m bands which are sprayed with herbicide to control plant competition. The furrows are 1.5 m apart, so the method effectively treats 33% of the paddock (BS);
(f) surface-broadcast: a single pass ground application with a fertiliser spreader into untilled pasture (SS);
(g) surface-broadcast: aerial application *without* fertiliser into untilled pasture (AS-f); and
(h) surface-broadcast: aerial application *with* fertiliser into untilled pasture (AS + f).

With the exception of method (g), each of the options incorporates a fertiliser application (single superphosphate). Initial costings are based on the use of new equipment, and the effect of using second-hand machinery is examined in the following subsection. Assumptions covering rates of seed, fertiliser and chemical application used (where applicable) for the costings are detailed in Table 2.

The cost estimates in Table 1 are presented by the input categories described earlier. Total direct and indirect costs per hectare are presented in rows (9) and (13), and are summed to give total cost per hectare in row (14). The indirect costs for implements and tractors contain no allowance for opportunity costs for invested capital. That item is specifically contained in row (10).

The three aggregates presented in rows (15), (16) and (17) represent the total direct cost and total cost net of labour and labour and capital opportunity costs. These measures are included as they reflect the way that many practical farm managers and advisers assess machinery costs and other property development outlays.

The fully cultivated seedbed options (ODSD, ODDRx2) are the most expensive, reflecting the major inputs of machinery and labour associated with these methods. The rough seedbed technique involving only a single pass with an offset disc cultivator and attached roller drum seeder, with follow-up fertiliser application (ODDRx1), despite its image among some managers as a low-cost option (e.g. Partridge 1992), is relatively expensive because of the number of independent field operations that are involved.

The disc strip option (DS + f) attempts to further reduce the treatment cost by reducing both the area covered and number of machine passes. Of the ground-based methods, it has the lowest costs with direct and total cost estimates that are some 32–43% of those for the other ground-based options, although the absolute cost is still quite high. The reliability of this method is open to question (Cook *et al.* 1993).

Paradoxically, band-seeding, which has an image of being capital-demanding (e.g. Partridge 1992), is a relatively low-cost operation because

Table 2. Seed, fertiliser, and chemical inputs for a range of establishment options.

	Offset disc + seed drill (ODSD)	Offset disc + drum seed. (ODDRx2)	Offset disc + drum seed. (ODDRx1)	Disc strip 33% (DS + f)	Band-seeder (BS)	Broadcast untilled (SS)	Aerial sowing (no fert.) (AS − f)	Aerial sowing (+ fert.) (AS + f)
(1) Seed-legumes (kg/ha)								
Seca stylo	1.0	1.0	1.0	1.0	0.3	1.0	1.0	1.0
Fine-stem stylo	1.0	1.0	1.0	1.0	0.3	1.0	1.0	1.0
Wynn cassia	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5
(2) Seed-grass (kg/ha)								
Biloela buffel grass	2.0	2.0	2.0					
(3) Fertiliser (kg/ha)								
Superphosphate (9.6% P)	100.0	100.0	100.0	33.4	39.0	100.0		100.0
(4) Herbicide (l/ha)								
Glyphosate					1.0			

the capital costs associated with owning the implement are offset by the lower number of field operations which involve less machinery operating costs and labour. Moreover, while band-seeding (unlike the other methods compared) involves a chemical cost, the seed and fertiliser costs are significantly lower because only one-third of the total area covered is actually treated.

Of the surface-broadcast sowing techniques, the ground spreading option (SS), is conventionally considered to be a low-cost establishment method. However, when compared to band-seeding which is commonly assumed to be expensive, the higher fertiliser and seed costs coupled to similar operating costs put both options almost on par. For example, in the budgeted examples, the surface-seeding option is marginally more expensive than band-seeding.

The aerial-sowing application that incorporates no fertiliser (AS-f) involves the lowest cost outlays, explaining in large part its attractiveness to many landholders. When fertiliser is incorporated with the method (AS + f) the total outlay is similar to the lower cost, ground-based options of disc strip (DS + f) and band-seeding (BS). While the main advantage of the aerial-based techniques is their application for steep, timbered, and rocky terrain, their reliability in terms of seedling emergence and survival is an open question (Cook *et al.* 1993). This applies particularly to southern Queensland.

New vs second-hand equipment

All machinery costs included in the preceding section were based on machinery (including tractors) valued at *current replacement cost* (i.e. the cost of new equipment).

However, analyses based exclusively on new equipment values are open to criticism on the grounds that many managers will use older equipment, either already in their possession or acquired second-hand specifically for pasture development. To address this issue, the costings for each option listed in Table 1 have been recalculated for second-hand machinery. The

Table 3. Cost summary ($/ha) for a range of establishment options — Second-hand equipment.

	Offset disc + seed drill (ODSD)	Offset disc + drum seed. (ODDRx2)	Offset disc + drum seed. (ODDRx1)	Disc strip 33% (DS + f)	Band-seeder (BS)	Broadcast untilled (SS)	Aerial sowing (no fert.) (AS-f)	Aerial sowing (+ fert.) (AS + f)
(1) Seed-legumes	25	25	25	25	10	25	25	25
(2) Seed-grass	18	18	18					
(3) Fertiliser	33	33	33	11	11	33		33
(4) Herbicide					12			
(5) Labour	35	38	24	8	12	10		
(6) Implement (direct cost)	5	3	2	1	2	1		
(7) Tractor (direct cost)	21	23	15	5	7	6		
(8) Contract spreading							2	9
(9) Total direct cost	137	140	117	50	54	75	27	67
(10) Interest on capital	7	6	4	1	6	1		
(11) Implement (indirect cost)	9	6	3	1	9	1		
(12) Tractor (indirect cost)	5	6	3	1	2	1		
(13) Total indirect cost	21	18	10	3	17	3		
(14) Total cost	158	158	127	53	71	78	27	67
(15) Total direct cost (excl. labour)	102	102	93	42	42	66	27	67
(16) Total cost (excl. labour)	123	120	103	45	59	68	27	67
(17) Total cost (excl. lab/cap)	116	114	99	44	53	67	27	67
(18) Total direct cost (% new)	102	101	101	100	100	103	100	100
(19) Total indirect cost (% new)	47	50	48	43	89	43	100	100
(20) Total cost (% new)	88	90	93	93	97	96	100	100
(21) Total direct cost (excl. labour) (% new)	102	101	101	100	100	103	100	100
(22) Total cost (excl. labour) (% new)	85	88	91	92	97	96	100	100
(23) Total cost (excl. lab/cap) (% new)	91	93	94	96	98	99	100	100

exception to this assumption applies to the band-seeder, which, due to its novelty on the market, has an assumed value equivalent to the current new price. The revised costings are presented in Table 3.

Basing costs on second-hand machinery represents a compromise. Since most property owners would have machinery of mixed age, size, condition and effective salvage value, it is difficult to be too specific on what might represent a 'typical' suite — at least in a way that will meet universal acceptance.

For the present analyses, the following assumptions were applied:

(a) with the exception of the band-seeder, *all* equipment in each machinery suite (including the tractor) had 50% of its effective life left, and a salvage value of 33% of the current replacement cost; and
(b) a loading of 20% was placed on the repairs and maintenance assumptions for tractors and implements (other than the band-seeder).

The first assumption approximates to a value based on diminishing balance depreciation rates. The second assumption is consistent with the view that second-hand equipment can be expected to have higher maintenance costs than new equipment, if for no other reason than lack of warranties and general fatigue with such equipment (Fraser and Walsh 1992). These assumptions have the effect of incorporating two offsetting factors into the costings — lower indirect costs associated with the opportunity cost of capital and depreciation charges for second-hand equipment are to some extent offset by higher maintenance costs. The net effect is that the assumptions concerning second-hand equipment have not altered the relative cost ranking of the different establishment options (Tables 1 and 3).

Basing cost estimates on suites of second-hand equipment rather than new equipment has relatively little impact on the final assessment of pasture establishment costs (Table 3). This is consistent with the common observation in the machinery economics literature that the annual cost of operating farm machinery is relatively constant over the assumed life of most machinery items (e.g. Makeham and Malcolm 1984; Fraser and Walsh 1992). Decisions on whether to use new or second-hand equipment remain as much a function of marginal income tax rates and the episodic availability of investment allowances, as of machinery age and salvage values (Pollard and Obst 1978).

Other costs

The direct cost items, and to a lesser extent the indirect cost items, detailed in the preceding section are reasonably visible. They represent the up-front costs associated with the different pasture establishment options canvassed. However, other costs associated with pasture establishment options should also be taken into account. These are not always so visible and include:

(a) the cost of lost grazing opportunities when pastures are taken out of production (e.g. cultivated seedbeds), or when stocking rates must be lightened in cases where partial removal of species is involved (e.g. band-seeding and disc strip methods). In some instances, when delays of several years are possible, this cost can be substantial.
(b) the cost of additional livestock required when pasture establishment leads to higher aggregate carrying capacity. In the common instance where landholders retain home-bred animals as opposed to outside purchases, an opportunity is passed-up to sell those animals.
(c) the cost of associated non-livestock capital items including the provision of watering points, fencing and stock shelter.
(d) additional episodic outlays to maintain the productivity and stability of the treated pasture throughout its projected life. These include maintenance fertiliser, reseeding and/or chemical treatments.
(e) financing costs associated with pasture establishment where available cash reserves are insufficient to meet total capital outlays.
(f) income taxation considerations. Although these favour pasture development plans initially, higher future liabilities when associated returns from the development come on stream may offset previous taxation credits.
(g) the psychological cost of feeling committed to a management system that may be more intensive and capital-demanding than existing systems, or be seen to place a landholder in a position of increased exposure to financial risk. This can be an important consideration in the early years of a major pasture development program.

The incidence and impact of these costs, of course, depend on the nature, scale, and timing of individual pasture development projects. They are also influenced by the attitude to risk of individual landholders, which will vary from case to case. It is neither possible nor warranted to attempt to quantify these costs for typical scenarios. Individual managers will need to take account of them in their development planning.

Benefits

Reaping positive benefits is the ultimate target of pasture establishment programs. Benefits commonly attributed to pasture improvement include:
(a) increased quantity of forage per hectare;
(b) higher quality forage;
(c) availability of carry-over feed for maintaining stock in the dry season;
(d) more flexibility in choice of animal enterprises (e.g. fattening vs producing store animals);
(e) opportunities for improved livestock management; and
(f) increased property values.

Combined, these benefits commonly provide managers with the ability to carry more stock in any given season, improved rates of liveweight gain per head and access to more profitable market niches.

The economic value of pasture establishment options, as with any major investment, is ultimately determined by the relationship between funds outlaid (costs) and those returned from the investment (benefits). The principles for assessing the benefits of pasture development plans are relatively straightforward and conventionally based on capital budgeting techniques which employ discounting principles (e.g. Chisholm and Dillon 1971; Makeham and Malcolm 1984; MacLeod and Johnston 1990). Since pasture development investments are generally long-lived, the traditional procedure is to calculate for each year of an assumed project life, the net cash flow changes attributable to the development (through changes in stocking rate and per animal productivity). These annual cash flows are converted to a *net present value* (NPV) by applying discount factors and their sum compared to the initial development cost (see Appendix). If the NPV of the benefits exceeds the initial cost, the development is assumed to be worthwhile.

Unlike costs, which can be determined and represented with some degree of certainty by budgeting (as shown previously), quantifying the benefits attributable to a given pasture establishment option is difficult. This applies particularly to so-called *ex-ante* assessments which seek to assess the merit of a particular technique before it is carried out (e.g. band-seeding), and because the outcomes will vary considerably from case to case.

A common approach in the literature has been to draft a scenario for a given pasture development option (or suite of options) purported to represent a typical case and to provide an assessment of NPVs based on the set of assumptions underlying the chosen scenario (e.g. Wicksteed 1978, 1982; MacLeod *et al.* 1991). For many purposes, this approach is appropriate and can give a good guide to the economic feasibility of different pasture development options. However, to examine a broad range of options applicable over a wide regional base, selecting a comprehensive range of representative scenarios is extremely difficult.

A more appropriate approach is to explore a number of principles concerning the economic value of pasture development options that can be derived from understanding simple discounted cash flow analyses (MacLeod and Johnston 1990).

These are:
(a) the higher the initial development cost (and/or subsequent maintenance costs) the more substantial must be the ensuing productivity gains to warrant it;
(b) because discounting places least weight on distant sums and greatest weight on near-term sums, options whose benefits begin to accrue soon after expenditure is incurred are preferable to those that take a longer period to come to fruition, unless the subsequent productivity gains of the latter are particularly high;
(c) regardless of the discount rate chosen (within reason) options whose ensuing benefits are consistent and long-lived are preferable to those which are inconsistent and short-lived;
(d) the economic benefit to be derived from any project whose outcome is increased productivity is a function of *both* the pro-

ductivity gain and the value of the product; and

(e) the economic value of long-term pasture development projects is substantially affected by the availability of alternative investments that farm managers consider to be *both* profitable and attractive.

Principles (a), (b) and (c) are demonstrated in Tables 4a and 4b which show the NPV of discounted 15-year cash flows attributed to 2 levels of *additional* liveweight gain per hectare that might accrue subsequent to a pasture establishment exercise involving beef cattle. The first section (Table 4a) relates to a net response of 20 kg/ha and the second (Table 4b) to a net response of 40kg/ha, these being assumed to result from an increase in stocking rate, liveweight gain per animal or a combination of both. The calculations are based on a beef price of $1.25 per kg liveweight and a discount rate of 8%. The left hand margin of each table indicates the years taken from sowing (year 1) for any gain in productivity to commence. The top margin indicates the year in which the maximum assumed productivity gain is first achieved.

For example, an option with an assumed incremental gain of 20 kg/ha (Table 4a) that commences in the second year and is fully achieved by the fifth year would have an NPV before costs are deducted of $173/ha. Were the incremental gain from this example to increase to 40 kg/ha (Table 4b), the NPV would rise to $346/ha, and so on. The tables show that, for any assumed increase in liveweight gain, the longer the period taken to achieve it the lower is the NPV of that gain. The higher the gain for any given achievement period, the higher also is the NPV.

The tables can also be used to compare the *required* performance of an establishment option whose cost is known. For example, the fully cultivated seedbed options included in Table 1 (ODSD and ODDRx2), with total direct costs in the order of $135-$140/ha[2], would be economic

[2]The *indirect* costs of depreciation and interest charges are excluded from discounted cash flows. Depreciation is a notional charge and does not represent an actual cash flow. Interest opportunity charges are implicitly taken care of by the discount rate used to calculate the NPV (see Appendix).

Table 4. Net Present Value ($/ha) of 15-year cash flows by response in liveweight gain and time taken for response to commence and maximum response to occur.

(a) 20 kg/ha annual response.

Years to maximum response	1	2	3	4	5	6	7	8	9	10
Year response commences										
1	231	219	207	195	185	174	165	155	147	138
2		206	195	184	173	163	154	145	136	128
3			183	172	162	152	143	134	126	118
4				162	152	142	133	125	117	109
5					142	132	124	115	108	100

(b) 40 kg/ha annual response.

Years to maximum response	1	2	3	4	5	6	7	8	9	10
Year response commences										
1	462	437	413	391	369	349	329	311	293	276
2		412	389	367	346	326	307	289	272	256
3			366	344	324	305	286	269	252	236
4				323	303	284	266	249	233	218
5					283	265	248	231	215	200

even if the production gain was only an additional 20 kg/ha and it took more than 9 years to achieve it, assuming that the gain did not commence until the year after sowing. Other scenarios, including those *not* listed under the options in Table 1 can be considered against the table elements.

Principle (d) is demonstrated in Table 5, which is a two-way sensitivity table showing the impact of beef price and response in liveweight gain on the NPV of a discounted 15-year cash flow based on the productivity gain commencing the year following sowing and being fully realised 2 years later. The impact of lower beef prices can be offset by higher rates of liveweight gain and vice versa. For example, while an establishment method such as offset disc and seed drill (ODSD) with an estimated direct cost of $135/ha (Table 1) would not be economic at a beef price of $1.00/kg and liveweight response of 10 kg/ha, it would be economic at 90 cents/kg if the gain were raised by 30 kg/ha.

It must be noted that the foregoing statements are based on the assumption that the pasture establishment cost is the *only* outlay required and no allowance is made for other costs covered in the preceding section, including capital costs for fencing, water and other improvements that are often necessary to complete a pasture development project. Moreover, no allowance is made for taxation liabilities that might apply to the cash flows or concessions that would apply to the outlays. As these are very specific to individual cases and financial circumstances, they are difficult to include in representative examples. Therefore, the NPVs in the tables should be viewed as being indicative only and will approximate to the upper bounds for any specific case.

Finally, principle (e) is demonstrated in Table 6, which is a 2-way sensitivity table showing the impact of discount rates and response in liveweight gain on the same 15-year cash flow used above. Discount rates should be set to reflect the return on the next best alternative investment opportunity available to managers and are used to screen options to see whether they, in fact, can exceed that return. As discount rates (i.e. alternative returns) increase, the NPV of a given option will decline[3]. The impact of rising discount rates can be offset by productivity gains or increased beef prices, or any other factor which boosts the income-earning potential of a given pasture development option.

Risk

Many land managers are wary of undertaking pasture development programs, particularly those based on more capital-intensive establishment methods, because they see them as being subject to unacceptable risks. The main sources of risk arise through (a) below optimum establishment including total failure; (b) becoming locked into a requirement for ongoing expenses to maintain pasture productivity and stability throughout the life of the pasture; and (c) adverse movements in beef prices or production costs.

Accounting for these risks in a formal sense is difficult. Attitude to risk remains a personal thing for many managers as do their individual coping strategies. Practical suggestions in the farm management literature are to inflate costs and/or reduce the scale of potential benefits that might be applied to a given development proposal or to select a higher discount rate to reflect the risky nature of the investment (e.g. Makeham and Malcolm 1984; Workman 1984).

[3]When discount rates are set at the rate of return that might be earned on a competing investment outlay, an investment that yielded a lower return would have a negative NPV.

Table 5. Net Present Value ($/ha) of 15-year cash flows as affected by beef price and response in liveweight gain.

Liveweight response (kg/ha)	Beef price ($/kg liveweight)						
	0.90	1.00	1.10	1.20	1.30	1.40	1.50
10	66	73	81	88	95	103	110
20	132	147	162	176	191	206	220
30	198	220	242	264	286	308	330
40	264	294	323	352	382	411	440
50	330	367	404	440	477	514	551

Table 6. Net Present Value ($/ha) of 15-year cash flows by discount rate and response in liveweight gain.

Liveweight response (kg/ha)	Discount rate (%) 5.0	7.5	10.0	12.5	15.0
10	112	95	81	70	61
20	224	190	162	140	122
30	336	284	243	210	183
40	448	379	324	280	245
50	560	474	405	350	306

For example, the impact of establishment failure might be considered by assuming that replanting was necessary, thereby approximately doubling the cost estimates in Table 1 (e.g. MacLeod *et al.* 1991). The impact of poor establishment might also be examined using the cash flow figures similar to those of Tables 4a and 4b for scenarios that assume either lower rates of liveweight gain and/or longer time periods for the benefits to accrue. The impact of declining beef prices is shown in Table 5 and the effect of raising discount rates in Table 6.

Summary and Conclusions

While there is considerable scope for landholders to raise the productivity of their pastures and associated livestock enterprises through pasture improvement, the final decision on methods, extent and duration of pasture establishment programs will largely depend on the projected economic outcomes. Subject to some qualifications on the items to include, the cost of pasture establishment options is relatively easy to assess. Representative budgets have been presented. Benefits accruing to different options are less easy to quantify, being subject to individual circumstances, intended use of the pasture, and vagaries of climatic and market forces.

A number of important principles have been discussed concerning the benefits of pasture development, which relate to the timing, magnitude and duration of productivity gains arising from the pasture establishment method selected. The importance of considering the availability of alternative investment options, as reflected in appropriately set discount rates, and the influence of product prices have also been considered.

When these principles are considered against projected costs of alternative establishment methods, it may be timely to re-focus conventional thinking on what constitutes high or low-cost establishment techniques. Both initial establishment and ongoing maintenance costs should be considered relative to ensuing benefits which are a function of both production gains and prices, each with attached risk components. A more appropriate way of evaluating different establishment options is in terms of high or low *net* benefit which, in turn, should be assessed in terms of their contribution to whole-property development and management.

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Appendix — Discounting and calculation of Net Present Values

The present value of a future sum FV_n is that sum PV which, if invested at the present time at an interest rate i, would grow to FV_n by the end of an n year period. This can be represented by the formula:

$$PV = FV_n/(1 + i)^n$$

The interest rate i is commonly referred to as the *discount rate*.

The term *net present value* is used when the present value formula is applied to the difference between a flow of benefits and costs. This can be represented for a multi-period investment project commencing at the present time (year 0) and ending in year N, by the formula:

$$NPV = \sum_{n=0}^{N} (B_n - C_n)/(1 + i)^n$$

where: NPV = net present value.
B_n = benefit received in the nth year.
C_n = cost incurred in the nth year.
i = discount rate.

Manipulation of the NPV formula will provide two related investment appraisal measures, the *benefit-cost ratio* and *internal rate of return*, which are also used to rank alternative projects (Chisholm and Dillon 1971).