ECONOMIC EVALUATION OF LAND USE ALTERNATIVES FOR THE SOUTHERN WALLUM REGION, QUEENSLAND

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ABSTRACT

An economic appraisal of alternative possibilities for land use of the South Wallum area of Queensland was carried out from the public point of view. The realistic alternatives in terms of technical feasibility and market prospects were considered to be beef and forestry. Three types of beef enterprises and two forestry alternatives were evaluated using discounted cash flow analysis. Given the underlying assumptions and the criteria used it was found that a 40 year pulp-timber rotation was most profitable, closely followed by a beef breeding and yearling marketing alternative where replacements for the breeding herd are bought on the store market. Beef fattening of stores was superior to a 20 year pulp rotation, while beef breeding and yearling marketing with the maintenance of a breeding herd was the least profitable.

Product price levels would have to increase for all alternatives by 5-10%, all other assumptions remaining unchanged, before the ranking in profitability would change in favour of beef alternatives. However, if all product prices fell, beef would become relatively more unprofitable than forestry.

INTRODUCTION

Evaluation of alternative investment projects is necessary because a nation has scarce resources with which to achieve competing ends. Resources should therefore be put to best use in terms of achieving objectives. In the case of a project such as Wallum development the scarce resources are investment capital, labour and the land itself. The objective may be to increase net national income by as much as possible.

Faced with such a problem the economist evaluates alternatives on the basis of recognized investment criteria. However, this is not to say that eventually the choice is necessarily made on economic criteria alone. Nevertheless, the economist's approach does make clear the financial implications of development alternatives and the cost or loss involved to the individual or the nation of adopting a course of action which may not always be the best from the economic point of view. The objective of this paper is to apply the economist's approach to the development of the Southern Wallum region of Queensland. The region presents perhaps the last large scale opportunity in Australia to plan development of a previously useless area so that the nation benefits most. Some economic aspects of Wallum development have been studied by Moore (1967), Adams and Fox (1968) and McGuire (1968).

The part of the coastal lowland belt in Queensland that extends from Brisbane to Baffle Creek (north of Bundaberg) is known as the Wallum. The portion between Caboolture and the Mary River is the subject of this study and is called the Southern Wallum (S.W.). Coaldrake (1961) described the ecosystems of the Queensland Wallum. It is assumed here that agricultural development is feasible mainly on the heath downs and swamps, the low rolling ridges, the rolling hills and the true coastal plain. The yearly overall rainfall is around 40 inches but in some areas in the south it may rise to 65 inches. Temperatures throughout the year generally are mild although heavy frosts may occur. From an agricultural point of view the strength and pattern of wind can be ignored except for the possible effect of cyclones in the coastal lowlands on exotic forests. Coaldrake suggested that severe mechanical damage may occur once in twenty years. Such a prospect has been incorporated into this analysis by assuming conservative timber yields.

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On the basis of estimates of Coaldrake (1961) and McGuire (1968), study of Queensland Government maps and limited field surveys it is assumed that S.W. has a total area of 793000 acres suitable for development. This excludes Fraser Island and the Teewah sandhills. Roads and scenic areas account for 57000 acres leaving a net area of 736000 acres, the figure used in this study. This latter consists of 382000 acres of State and private forest, 72000 acres reserves, 63000 acres unoccupied Crown land and 219000 acres in private hands. The 219000 acres includes the commercial farming areas. About 16000 acres is in crops (11000 sugar cane, 5000 citrus, pineapples, bananas, other fruit and vegetables); another 40000 is not used for farming and the remainder carries about 15000 dairy cattle and 9000 beef cattle. There are precedents for resuming such land for large scale development. Economic viability and political considerations may dictate such a policy. In any case as far as this study is concerned the critical factor is the ranking of the alternatives considered.

S.W. consists of two distinct types of country, timbered and heathy. Coaldrake (personal communication) estimates the latter at 20% of the total and this figure has been used in development costs.

Realistic production possibilities on S.W. in the future are limited by what is technically possible to produce, and equally important, find remunerative markets for. These criteria were used to assess a normal range of agricultural and horticultural crops, types of livestock enterprises and forestry. The feasible alternatives considered are:

Forestry
Beef production
Sheep and wool production.

Properly, these alternatives should be considered both from the public point of view and on an individual farm basis. Such studies were carried out, but are too extensive to report here. It is considered that a comparison of the forestry and beef alternatives from the public point of view would be of most interest. A separate publication which presents the other aspects not discussed in this paper is available from the senior author.

METHOD OF ANALYSIS

The theoretical basis for economic evaluation

Measures used

Three measures are commonly used to decide among investment projects. These are payback period, average per cent return on capital invested and present worth. The relative merits of such measures have been well discussed in investment literature —for example Bierman and Smidt (1960) and Merrett and Sykes (1966). Briefly, present worth is the correct measure to use when the objective is profit maximization. It considers the full duration of the project and takes proper account of changes in costs and returns over time. All costs and returns are reduced to sums that are directly comparable at a common point in time. This is accomplished by using the discounting formula,

$$PW = \frac{S}{(1 + i)^n}$$

where PW = present worth,

S = value of a lump sum at a point in the future,

i = the rate of discount expressed as a fraction,

n = the number of years in the future at which S accrues.

To calculate and compare present worth say for forestry and beef, returns and costs for each particular year must be estimated. Assume development is completed in ten years. Present worth of the costs up to this point is calculated using the following relationship:

$$C_a = \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \dots + \frac{C_{10}}{(1+i)^{10}} = \sum_{j=1}^{n} \frac{C_j}{(1+i)^j}$$

Similarly the present worth of returns up to year 10 is given by:

$$V_a = \frac{V_1}{(1+i)^1} + \frac{V_2}{(1+i)^2} + \dots + \frac{V_{10}}{(1+i)^{10}} = \sum_{j=1}^{n} \frac{V_j}{(1+i)^j}$$

where C_a = present worth of costs up to year 10
V_a = present worth of returns up to year 10
i = the interest rate expressed as a fraction (the selection of an appropriate interest rate will be discussed later)
C_j = the costs occurring in year j
V_j = the returns occurring in year j
n = the number of years considered (in this case 10).

The present worth of the project up to year 10 is $V_a - C_a$. After year 10, when the net return is assumed to become stable, these calculations could be continued in the same way, but where the income stream continues into perpetuity the formula (capitalization formula) giving the present worth of the costs and return reduces to,

$$C_b = \frac{c}{i} \quad \text{and} \quad V_b = \frac{v}{i}$$

where C_b = present worth of a constant stream of costs at the beginning of year 11
c = the cost in any of the years 11 to infinity, this being constant
i = the interest rate expressed as a fraction
V_b = present worth of a constant stream of returns at the beginning of year 11
v = the return in any of the years 11 to infinity, this begin constant.

However, the two present worth figures obtained for both costs and returns are not yet comparable because they hold for different points in time. To arrive at a single figure the capitalized figures must be discounted back to the beginning of year one and combined with V_a and C_a. Thus, the present worth of the whole project is:

$$\text{Present worth} = V - C = (V_a - C_a) + \frac{V_b - C_b}{(1+i)^{10}}$$

If $V - C > 0$ a particular project is economically viable, if $V - C = 0$ the project will just break even and if $V - C < 0$, the project is not economically viable. Where $V - C = 0$, this means that if, say, the interest rate was 6% the investor could borrow all money at 6% and just break even. If $V - C > 0$, the investor would make a surplus when borrowing, or would prefer this project to an alternative returning 6%. Where alternatives compete, as in the study reported here, each alternative is analyzed and the one giving highest present worth is then selected. In practice V and C are usually manipulated to give a number of other measures which together with present worth provide a more comprehensive basis for choice as outlined by Lutz and Lutz (1961). In the study reported here the other measures estimated are the cost-benefit ratio, the land expectation value and the internal rate of return.

The *cost-benefit ratio* which indicates the return per dollar of outlay is calculated by dividing V by C. Here, if $V/C > 1$, the project will produce a surplus, if $V/C = 1$, the project will break even and if $V/C < 1$, the project is not economically viable. However, this measure gives no indication of the absolute value of the project and should be used in conjunction with V—C.

The *land expectation value* is V—C divided by the number of acres in the project. Survey costs and any land rates and rents are not included in estimating V—C. Thus the land expectation value is the amount per acre that the land could be purchased for on a freehold basis for the project to break even.

The *internal rate of return* is the discount rate necessary to make the present worth of a project equal to zero. It is the theoretically correct dynamic counterpart of the percent return on capital and is determined by setting the equation for present worth equal to zero and solving for i. If a particular project had an internal rate of return of, say, 10% and capital could be borrowed for 6%, then a surplus would accrue. If an alternative investment yielded 6%, then the project being considered would be more profitable. However this measure has a number of shortcomings as pointed out by Lutz and Lutz (1961).

In summary, the measures considered most useful are present worth (V—C) and the cost benefit ratio (V/C). Land expectation value has intuitive appeal. Internal rate of return has also been calculated as it is probably of general interest.

Evaluation from the public point of view

Costs that have to be met by the nation as a whole in developing a block of land are different from those faced by individuals, each developing part of the block. The major differences are taxation (including subsidies) and road making. The individual must assess returns after paying tax whereas from the national point of view taxation is a transfer payment and not a cost. Producer subsidies (freight concessions, fertilizer subsidies) lower individual producer costs but the nation cannot give such concessions to itself (in effect). The nation must find funds for road making within the area and these will only fractionally come from individual farmer's rates and petrol tax. Housing is another transfer payment because if houses are not built within the area they must be built elsewhere.

The interest rate

The interest rate used has a marked effect on the result obtained. For this reason the alternatives were evaluated using a number of discount rates. A rate of 6%, approximately that received on development bonds, is considered most appropriate.

Allowing for uncertainty

Uncertainty arises in this study because research results have to be interpreted at the commercial farm level and the period that costs and prices have to be projected forward is long. Rather than attempt to quantify the latter, 1969 costs and returns are assumed throughout and improvements in technology are assumed to have similar effects on returns for all alternatives. However a number of graphs are included which summarize the profitability of beef and forestry under a number of different price regimes based on the 1969 data. This enables the reader to choose his own assumptions and learn of their consequences.

THE DEVELOPMENT PROGRAMMES

Beef

Alternatives

Three alternatives were chosen for evaluation. These represent a range of possibilities rather than the advocacy of particular systems.

(1) *Fattening* based on purchase of 2-2½ year old stores in backward to store condition weighing about 600 lb liveweight. These are then fattened on improved pasture and sold within one year of purchase. Liveweight gains of 350 lb per animal are assumed. Mortality rate is taken as 2%.

(2) *Breeding A* based on breeding and selling yearling beef and maintaining a breeding herd. Also, up to 100 store cattle are purchased and fattened each year depending on seasonal conditions. It is considered that a "buffer herd" of this type is

realistic. Breeding cows are culled at 8% per year. These cull cows and cast for age cows (culled after the 6th calf is weaned) are sold immediately as tinners. Stock mortality, excluding bulls is 2% per year. Calving percentage (calves weaned/cows mated) is 85% and 3% bulls are used, which have a working life of 7 years.

(3) *Breeding B* based on breeding and selling yearling beef but purchasing 2 year old breeders on the store market, of which 18% are culled in the first year and 8% thereafter. These cull cows are spayed and fattened. Assumptions concerning cast for age cows, mortalities, calving, and bulls are the same as for breeding A. A "buffer herd" is also kept.

For beef it is assumed that the state would orient development around the living area concept. Accordingly average property size is taken as the area required to support enough livestock to keep two full time labour units fully occupied.

For *fattening* it is considered that 1000 head would be reasonable and 1500 head the upper limit. The latter figure has been used. Based on experimental and other data this means a property size of 1900 acres. For S.W. this permits 387 properties.

For *breeding A* it is assumed that two labour units are sufficient for 500 breeding cows and 80 to 100 stores as a buffer herd. This means a property size of 1020 acres or 721 properties for S.W. as a whole.

For *breeding B* because breeder replacements are bought rather than bred total stock equivalents carried are lower and average property size is 950 acres to give a total for S.W. of 774 properties.

For all these units a four year development programme has been assumed with the total area under pasture by the end of year 4. The four year period was chosen as it was considered that the two man labour unit could handle fencing, building of yards and the increasing stock work over the four year period, but that labour for these jobs would be limiting over a more rapid development period. As a further check to assess whether a 4 year development programme was reasonable an example was worked through in which all development was completed at the end of year 1. It was found that the differing rates of development did not significantly alter the overall profitability.

Productivity and price data

Carrying capacity is assumed to be 1 mature beast per 4 acres of sown pasture in year 1 rising to 1 beast per 1.25 acres in year 7, when the pasture is assumed to reach its full carrying capacity. A liveweight gain of 350 lb per animal per year is assumed. The above data are based on research of C.S.I.R.O. (1967, 1968, 1969), T. R. Evans (personal communication) and C. H. Allen (personal communication), but adjusted to allow for commercial farm yields being lower than experimental yields as indicated by Davidson and Martin (1965) and W. Moore (personal communication).

The 1969 average Brisbane saleyard price for 1st and 2nd quality export ox was \$26 per 100 lb dressed weight (D.W.) (Anon. 1970) and this figure has been used except that a premium of \$3 per 100 lb D.W. has been added for yearling beef sold. Stores purchased for fattening are assumed to cost \$13 per 100 lb L.W. (dressing at 50%), due to continuing strong demand for lighter cattle.

Constant costs at the 1969 level are assumed over the development period. This is normal in such studies due to the difficulty of forecasting cost trends in the future. Costs estimates are not discussed in detail here but are summarized in Table 2 and are available from the senior author.

Results for beef

Due to space limitations results are presented in summary form here. Data for years 6 to 10 inclusive and budget supporting details for all alternatives are available from the senior author in sea parate publication.

TABLE 1

Physical Development Programme for Breeding A, Breeding B and Fattening Alternatives—South Wallum (selected years)

Year	1			2			3			4			5			11		
Activity	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening
ACRES																		
Clearing Timber	86520	27090	26288	216300	193500	174096	144200	154800	174096	72100	139320	147014						
Heath	144200	147060	147014															
Drainage	144200	147060	147014															
Fertilizer Establishment Timber	144200	85140	85114	216300	193500		144200	154800		72100	139320							
Heath	144200	147060	147014															
Maintenance	0	0	0	288400	232200	232128	504700	425700	406224	648900	595980	580320	721000	719820	727334	721000	719820	727334
Cultivation and Sowing	288400	232200	232128	216300	193500	174096	144200	154800	174096	72100	139320	147014						
MILES																		
Roads Internal	721	774	387															
External	170	170	120	100	100	60	50	50	10									
Fencing	3605	3870	2708	2163	2322	1934	2163	2322	1934	1442	1161	1548						
UNITS																		
Machinery	721	774	387															
Bores and Dams	721	774	387	721	774	774	721	774	774	1442	1548	387						
Buildings	721	774	387															
Yards	721	774	387															
NUMBERS																		
Stock Purchases																		
Bulls	2163	1548		721	1548		1442	1548		721	1548			2322		2163	1548	
Cows	0	42570		28840	48762		35329	51858		12257	65790		4326	55728			90558	
Stores	7210	0	34819	14420		81245	21630		171388	28640		280488	36050		483600	64890	30960	580032
Yearlings	62721																	
TOTAL	72094	44118	34819	43981	50310	81245	58401	53406	171388	41618	67338	280488	40376	58050	483600	67503	123066	580320
Stock Sales																		
Bulls																2163	1548	
Cows				7931			8652			11538			12978			69216	43344	
Stores			34045	7210	7740	79697	14420	11610	167906	21630	15480	275072	28840	20214	473928	63448	68886	568714
Yearlings					27864		36771	58050		47586	88236		59122	123066		188181	291024	
TOTAL			34045	15141	35604	79697	59483	69660	167906	80754	103716	275072	100940	143190	473928	323008	404802	568714

NOTES:
1. Acres cleared do not sum to 736000 because 10% is assumed already cleared.
2. Total acreage for each type of hypothetical property is not the same and does not sum to 736000 acres, because of different invididual property sizes and allowances for non productive purposes.

Table 1 includes details of the physical development programme for S.W. as a whole under the breeding and fattening alternatives.

Ten per cent of the area is assumed already cleared (as in the forestry alternative). The remainder is cleared and grassed in four years at the rate indicated. Subsequently, stock carrying capacity increases to a maximum in year ten and is stable thereafter. Years six to ten merely reflect this build up and are omitted from Table 1. From year 11 onwards the breeding A and B alternatives respectively require purchase of approximately 65000 and 31000 stores per year, compared with 580000 for the fattening alternative. Annual turnoff is also massive reaching around 323000 for breeding A, 405000 for breeding B, and 570000 for the fattening alternative in year 11 and subsequently.

External road making is a cost that has to be met in the public development case. It is true that external roads bring other benefits which perhaps should be offset against their cost. However such benefits are very difficult to quantify. Here, the approach has been to charge the full cost to beef or forestry. A compromise could be to charge part of the cost.

Table 2 summarizes capital requirements and cost and income flows associated with the development programme of Table 1.

In year 1 the major capital expense for breeding B and for the fattening alternative is for fertilizer. This makes up 16% and 21% of total expense respectively. Because of the nature of breeding A, stock purchases are the largest single cost in year 1. These account for 17% of total expenditure followed by 16% for fertilizer. Other main year 1 expenses are for external roads (breeding A 13%, breeding B 15%, fattening 20%) and for cultivation and pasture establishment (breeding A 11%, breeding B 10%, fattening 13%). Capital costs for machinery and buildings are also relatively high.

By the end of year 4 when development operations have been completed the single largest expense for breeding A and B has been for fertilizer. This is around $30 million for each alternative representing 23% of total expenditure. Over the same period stock purchases are the largest expense for the breeding alternative, making up 31% of the total. The next largest items for all alternatives are clearing and drainage closely followed by cultivation and pasture establishment. Total expenditure over the 4 year development period is $136 million for breeding A and B and $142 million for the fattening alternative.

For all alternatives income has built up substantially by about year 8. Income stabilizes in year 11 at $33 million for breeding A and $43 million for breeding B. The fattening alternative has a considerably higher stable income of $70 million because all stock are turned over. This necessitates more stock being bought as indicated under expenditure.

Two items dominate recurrent expenditure. These are the cost of maintenance fertilizer and cattle purchases. When stability has been reached in year 11 maintenance fertilizer costs are 28% of total expenditure for breeding A, 24% for breeding B and 11% for fattening. In the same year cattle purchases comprise 69% of total expenditure for the fattening alternative, 26% for breeding A and 35% for breeding B. If commission on cattle purchases and sales and cartage in and out are added to the actual cost of the cattle themselves this sum represents 82% of total expenditure for the fattening alternative, 38% for breeding A, and 48% for breeding B.

The wage of management allowed to the owner is the next largest expense. If labour costs are added to this figure total wage costs amount to 19% of total expenditure for breeding A, 17% for breeding B and 4% for fattening.

For breeding A income exceeds expenditure by $8.6 million in year 11 but a cumulative undiscounted deficit of $119.7 million has been incurred over the period. Breeding B has a higher net income of $13.7 million in year 11 and a cumulative deficit of $106.2 million. Fattening has the lowest net income of $5.1 million but also the lowest deficit of $48.2 million. The cumulative peak deficits for breeding A and B are $142 million and $126 million respectively and occur in year 8. Fattening has a peak deficit of $74 million in year 4.

TABLE 2

Costs and Returns ($000's) for Breeding A, Breeding B, and Fattening Alternatives—South Wallum (selected years)

Year	1			2			3			4			5			11		
Activity	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening	Breeding A	Breeding B	Fattening
INCOME	0	0	4294	1565	3887	9843	6114	7570	20736	8292	11252	33971	10411	15523	58530	32755	43424	70236
EXPENDITURE																		
Clearing	2697	914	892	6489	5805	5223	4326	4644	5223	2163	4180	4410						
Drainage	505	519	515															
Fertilizer*	7931	6664	6662	7859	6617	6325	8463	7817	8066	8147	8809	9184	7210	7198	7273	7210	7198	7273
Cultivation and Past. Estab.	5191	4179	4179	3894	3483	3134	2595	2787	3134	1298	2508	2646						
Roads	216	232	116															
Machinery	3966	4257	2128															
Buildings	3389	3638	1819															
Fencing and Yds.	1773	1904	1199	555	596	470	555	596	470	368	310	379						
Water	1082	1161	580	1082	1161	696	1082	1161	1161	2163	2322	116						
Stock Purchases	8068	4249	2716	3807	4729	6337	5307	4977	13368	3641	6060	21878	3151	5743	37721	6359	10410	45265
Cartage	433	310	310	375	449	743	577	542	1548	591	759	2538	598	898	4333	1515	2090	5200
Animal Health	79	85	54	202	170	124	288	255	255	368	356	422	448	426	727	865	867	870
Commissions	0	0	172	65	155	394	245	303	829	332	450	1359	418	621	2341	1312	1737	2809
Labour (Mgtmt.)	2884	3096	1548	2884	3096	1548	2884	3096	1548	2884	3096	1548	2884	3096	1548	2884	3096	1548
Labour (Other)	1803	1935	967	1803	1935	967	1803	1935	967	1803	1935	967	1803	1935	967	1803	1935	967
Repairs and Maintenance	793	851	426	793	851	426	793	851	426	793	851	426	793	851	426	793	851	426
Fuel and Oil	216	232	116	216	232	116	216	232	116	216	232	116	216	232	116	216	232	116
Vehicle Exp.	361	387	193	361	387	193	361	387	193	361	387	193	361	387	193	361	387	193
Other Fixed Expenses	360	387	193	360	387	193	360	387	193	360	387	193	360	387	193	360	387	193
Sinking Fund																461	495	248
External Roads	6200	6200	6200	2000	2000	1200	500	500	100									
TOTAL EXPENDITURE	47947	41200	30985	32745	32053	28089	30256	30470	37597	25488	32642	46375	18242	21774	55838	24139	29685	65108
Cash Flow	−47947	−41200	−26691	−31180	−28166	−18246	−24142	−22900	−16861	−17196	−21390	−12404	−7831	−6251	2692	8616	13739	5128
Cumulative Cash Flow	−47947	−41200	−26691	−79127	−69366	−44937	−103269	−92266	−61798	−120465	−113656	−74202	−128296	−119907	−71510	−119680	−106168	−66382

* Subsidy not allowed for

Forestry

Alternatives

The forestry proposal assessed is the development of the whole plantable region of 736000 acres as a sustained yield softwood forest using slash pine (*Pinus elliottii* var. *elliottii*). On the basis of discussions with Queensland Department of Forestry 10% of this area is assumed taken up with firebreaks and roads. Two development possibilities have been examined:

40 year pulp-timber rotation
20 year pulp only rotation.

A critical factor in such an analysis is the haulage distance from the forest to the milling centre. As well, cost of processing (and hence price that can be paid for logs) is a function of the size of the pulp or saw mill. Taking these factors into account saw milling centres have been hypothesized at Gympie, Maryborough and Caboolture and pulp mills at Gympie and Petrie. S.W. was then divided into 10 sub-regions (A to J) such that the boundaries of these sub-regions were set at 10 mile radius intervals from the appropriate processing centre. The log flows that ensued approximately maximized stumpage value at any point in S.W. as a whole. The fact that within region mills have been hypothesized for forestry while all cattle are transported to Brisbane does not bias the comparison, because log prices are based on ruling Brisbane timber prices less transport costs from the forest site as explained in the next section. The processing locations and sub-regions are included in Figure 1.

Log flows are as follows:

Pulp from sub-regions A, B, C, D goes to Petrie, timber to Caboolture. Pulp from sub-region E goes to Gympie, timber to Caboolture. Pulp and timber from sub-regions F, G, H goes to Gympie. Pulp from sub-regions I and J goes to Gympie, timber to Maryborough.

For the 40 year pulp-timber rotation one fortieth is planted annually until development is complete in year 40 and thereafter replantings take place to maintain a sustained yield forest. A similar assumption is made for the 20 year rotation.

Taking account of Australia's future needs for softwood timber and pulp and of F.A.O. (1966) world demand predictions it is considered that production could be disposed of at satisfactory prices on the domestic and foreign markets.

Productivity and price data

A single yield table has been used for each alternative. These were formulated in conjunction with the Queensland Forestry Department and represent an average situation for S.W. as a whole. (In technical terms the yield table approximates a site index of 75 ft).

Table 3 includes yield data at the hypothesized average quality site.

Compared with normal yield tables the number of thinnings has been reduced so that volume per acre at each thinning increases and allows large scale (and hence low cost) logging operations.

TABLE 3

*Slash pine net yield (cu. ft/ac) for average Wallum**

	20 year pulp rotation			40 year pulp sawlog rotation				
Year after planting	11	15	20	11	18	26	33	40
Pulp	750	1170	2250	750	500	250	250	250
Sawlog	—	—	—	—	—	1000	500	3900

* Approximates 75′ site index
Pulp volumes are to 3″ diameter under bark (d.u.b.), small end.
Log volumes are to 6″ (d.u.b.), small end.

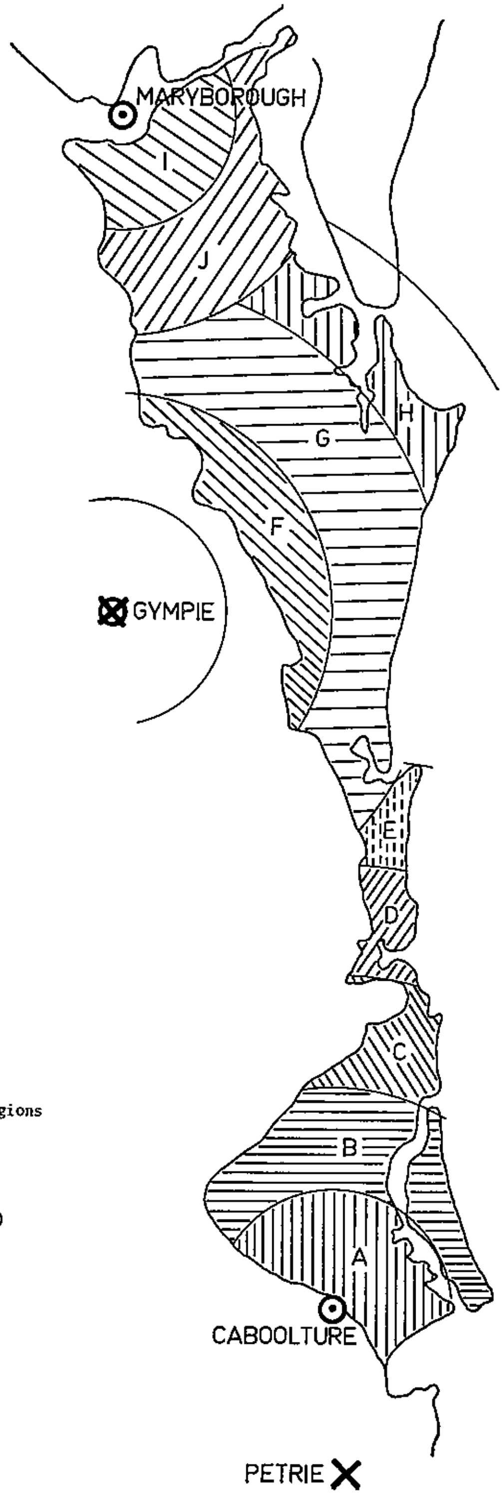


FIGURE 1

Location of Forest Regions

Milling Centres ⊙
Pulp Centres ✕

Prices assumed for felled logs at the forest site (known as derived stumpage values) were estimated by a "shadow pricing" technique. This involves selecting an appropriate price from the nearest viable competitive market and deducting all costs incurred between the forest site and this market. (As far as this study is concerned it also has to be the market location for beef in order to be able to make valid comparison). Weintraub (1959) discusses the rationale of the "shadow pricing" technique.

This approach was used because stumpage values set by most public authorities do not necessarily reflect the true value of the timber to the community. As Hanson and Leslie (1965) indicate such values are usually a compromise between a number of aims including raising government revenue, recovering costs of growing or replacing timber sold, or stimulating or stabilizing the industry.

The appropriate competitive market for thinnings is taken to be the Brisbane wholesale market for rough sawn dry, unsorted, ungraded exotics. Based on this market in 1969 an average price of $11.00 per 100 super ft for 1st timber thinnings and $12.00 per 100 super ft for 2nd timber thinnings is assumed.

As no large sales of pruned slash pine have been made on the Brisbane wholesale market the sale of comparable timber (*P. radiata*) on the Adelaide market in 1969 is taken as a base. A price of $15.00 per 100 super ft dry at Brisbane is assumed.

A mill door log value is derived from these prices by subtracting freight costs to Brisbane and drying, dipping and milling costs at the mill. Further deductions for percentage recovery, haulage costs and cutting and snigging costs gives the derived stumpage value for each sub-region. Milling costs are those derived by Hall (personal communication) from cost studies of large scale milling at Mt. Gambier, South Australia. Haulage costs were obtained from unpublished data of N.S.W. Forestry Department. Cutting and snigging costs, based on efficient operation were supplied by the Queensland Forestry Department.

The pulp price used is based on prices paid in Queensland and other comparable areas in 1969. Stumpage values range from 16.7 cents per cubic ft at zero distance from the mill to 5.0 cents 50 miles from mill.

Results for forestry

The results of the forestry alternatives are summarized in Tables 4 and 5. Data for years not included in Table 5 and supporting calculations are available in a separate publication from the senior author.

Table 4 includes details of the 10 sub-regions. The total gross plantable area of 736000 acres corresponds with the area used in the beef alternatives. The per cent of each sub-region assumed cleared was estimated from aerial photographs and is taken into account in clearing costs. Processing centres (and distances) for each region are listed. Finally, timber and pulp shadow prices are given for each sub-region. These differ mainly because of different haulage distances to the relevant processing centre.

Table 5 summarizes development costs for the 20 year pulp rotation and the 40 year pulp timber rotation respectively. For both alternatives the major initial costs are for purchase of plant and machinery and vehicles, temporary accommodation for workers and housing for plant, and for clearing land in preparation for planting. The machinery item comprises 34% of outlays in year 1 for the pulp alternative and 45% for the pulp-timber rotation.

For the pulp alternative, as development proceeds, clearing and planting costs remain major expense items. Recurring direct costs (maintenance of plant, equipment and buildings, road building, fire breaks etc.) and costs of caring for trees, increase in importance as the forest increases in size. By year 20 maintenance costs have become the major expense (41%). Revenue flows commence in year 11 and stabilize at $11.6 million in year 20. This represents a gross return of $15.76 per acre. Although year 21 shows a net return of $6.66 million ($9.05 per acre) a cumulative deficit of $52.8 million has been incurred. A peak deficit of $64.7 million is incurred in year 19.

TABLE 4

South Wallum Forestry Subregions and Shadow Prices

Subregion	Gross Plantable Area (Ac)	Already Cleared %	Timber Destination	Haulage Distance (miles	Timber Base Shadow Prices 1st thins (cents per cubic ft.)	2nd thins	clear fell	Pulp Destination	Haulage Distance (miles)	Pulp Base Shadow Price (cts. per c.ft.
A	77100	0–10	Caboolture	10	36.6	42.8	69.5	Petrie	20	10.7
B	108000	10–20	Caboolture	20	34.4	40.6	67.3	Petrie	30	8.8
C	35100	30–40	Caboolture	30	32.2	38.4	65.1	Petrie	40	6.9
D	24300	60–70	Caboolture	40	30.0	36.2	62.9	Petrie	50	5.0
E	14700	20–30	Caboolture	50	27.8	34.0	60.7	Gympie	40	6.9
F	85800	10–20	Gympie	20	31.3	37.5	63.9	Gympie	20	10.7
G	228300	10–20	Gympie	30	29.1	35.3	61.7	Gympie	30	8.8
H	41800	0–10	Gympie	40	26.9	33.1	59.5	Gympie	40	6.9
I	51800	0–10	Maryborough	10	31.7	38.0	64.2	Gympie	50	5.0
J	69100	0–10	Maryborough	20	29.5	35.8	62.0	Gympie	40	6.9
TOTAL	736000									

Note: Average percent already cleared 10%

TABLE 5

Costs and Returns ($000's) of Pulp (20 Yr) and Pulp-Timber (40 Yr) Alternatives—South Wallum (selected years)

	Year 1		Year 2		Year 11		Year 12		Year 20		Year 21		Year 41
Cost Item	Pulp	Pulp-Timb.	Pulp	Pulp-Timb.	Pulp	Pulp-Timb.	Pulp	Pulp-Timb.	Pulp	Pulp-Timb.	Pulp	Pu.p-Timb.	Pulp-Timb.
Building and Structures	1114	1114									28		28
Machinery and Vehicle Purchase	2340	2340											
Surveys	294	147	294	147	294	147	294	147	294	147		147	
Clearing	1031	515	1031	515	1031	515	1031	515	1031	515		515	
External Roads and Firebreaks	371	186	371	186	371	186	371	186	371	186		186	
Planting: Stocks	371	186	371	186	371	186	371	186	371	186	371	186	186
Operations	371	186	371	186	371	186	371	186	371	186	371	186	186
Fertilizer*	236	118	236	118	236	118	236	118	236	118	236	118	118
Preplant Hormone	371	186	371	186	371	186	371	186	371	186	371	186	186
Annual Recurring Direct Costs	132	66	265	132	1457	729	1590	795	2650	1325	2650	1391	2650
2nd Year Manual Tend			212	106	212	106	212	106	212	106	212	106	106
4th Year Manual Tend and Spray					265	133	265	133	265	133	265	133	133
8th Year Manual Tend					212	106	212	106	212	106	212	106	106
Prune to 8 ft.						199		199		199		199	199
Prune to 14 ft.						212		212		212		212	212
Prune to 21 ft.								159		159		159	159
Machinery Replacement					1590	1590					239	1590	239
Total Cost Flow	6631	5044	3522	1762	6781	4599	5324	3234	6384	3764	4955	5420	4508
Total Revenue Flow					2089	1044	2089	1044	11613	1741	11613	1741	52274
Cumulative Cash Flow	-6631	-5044	-10153	-6806	-50862	-29390	-54097	-31580	-59514	-49976	-52856	-53655	88294

* Subsidy not allowed for

A similar cost pattern emerges for the 40 year pulp-timber rotation. From year 2 onwards planting costs are the most important until year 11 when direct costs exceed them. Cost of caring for the increasing area under trees levels out at $0.9 million in year 12 and in that year accounts for 28 % of total costs. In year 41 and thereafter recurring direct costs account for 58.9 % of annual expenditure. Care of existing trees and replanting costs make up most of the remainder. Cost flows have more or less stabilized by year 12 and fluctuations thereafter are a function of machinery replacement which occurs in a cyclical pattern. Revenue flows commence in year 11 and step up in years 18, 26, 33 and 40 (an undiscounted peak deficit of $63 million occurs in year 25). In year 41 total revenue is $52.3 million or $71.0 per acre. Net revenue is $47.8 million ($64.9 per acre). At the end of year 40 there is a cumulative surplus of $40.5 million.

RESULTS

Table 6 includes values of the economic criteria for the alternatives discussed here.

TABLE 6

Values of economic criteria for S.W. alternatives, public viewpoint

Alternative	V–C ($ million)	V/C	I.R.R. (%)	L.E.V. ($ per ac.)
Beef breeding A	–36.7	.9	4.6	–50
Beef breeding B	43.7	1.1	7.6	59
Beef fattening	–1.2	1.0	5.9	– 2
20 year pulp rotation S.W. average	–6.3	.9	5.5	– 9
40 year pulp-timber rotation Region A	8.1*	2.3	9.1	105
40 year pulp-timber rotation Region H	2.8*	1.8	8.1	66
40 year pulp-timber rotation S.W. average	61.7	2.0	8.6	84

V–C Present worth I.R.R. Internal rate of return
V/C Benefit-cost ratio L.E.V. Land expectation value
Interest rate assumed is 6 %.
* Not comparable with other V–C values as single region only.

The preferred criteria are present value (V—C) and V/C taken together. The former is a measure of the value of the investment while the latter indicates the relative magnitude of the income and cost streams. It is suggested that either criterion alone does not give as good a basis for decision as both together. Land expectation value per acre is simply present worth (with land survey costs and rates excluded) divided by the total number of acres. It indicates the maximum sum that can be paid for land and still allow the project to break even. Land expectation value and internal rate of return are probably intuitively more familiar concepts.

These criteria have been worked out on 1969 costs and prices and using livestock and timber yields which the authors judge realistic. However as controversy is likely to surround this judgment additional estimates are presented in Figures 2 and 3 which allow a comparison of the alternatives assuming product prices change. Improvements in technology, changes in cost and altering the discount rate can be investigated using the same technique.

Figure 2 indicates changes in L.E.V. (and thus V—C) associated with changes in product prices while Figure 3 relates changes in I.R.R. to changes in price. L.E.V. and I.R.R. plotted against changes in costs would give mirror images of Figures 2 and 3. In both figures the 20 year pulp alternative is not included because it is less viable than pulp-timber over the entire range of price changes. For the 40 year pulp-timber rotation only Regions A and H are considered as these are the most and least profitable Regions respectively.

FIGURE 2

Changes in Land Expectation Value Associated with Changes in Product Price

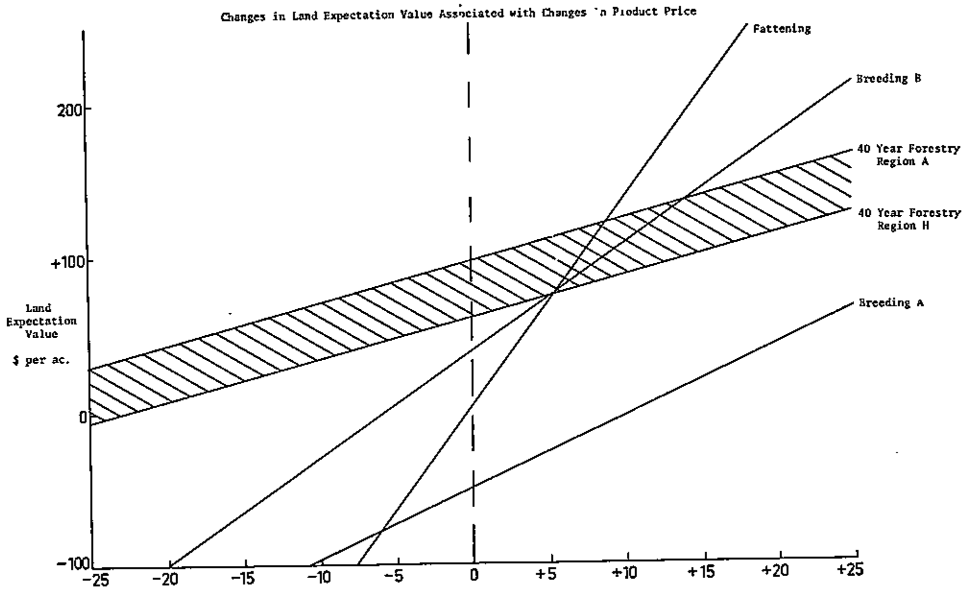
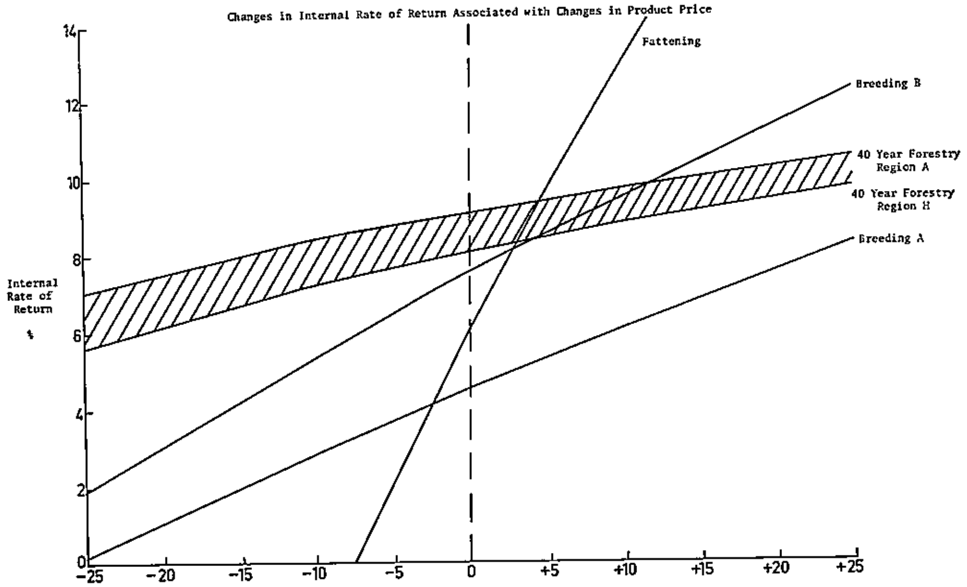


FIGURE 3

Changes in Internal Rate of Return Associated with Changes in Product Price



DISCUSSION

Tables 2 and 5 present the financial consequences of the beef and forestry alternatives respectively. However, different time periods are involved for each. Accordingly these data cannot be manipulated and valid comparisons made except through use of discounting techniques which equalize time flows of future costs and revenues including those accruing after full development or production has been reached. Thus only Table 6 and Figures 2 and 3 are relevant for comparison and assessment.

Under the assumptions made, Table 6 indicates that the 40 year pulp-timber rotation is superior to all other alternatives, closely followed by beef breeding B. Beef fattening is preferable to the 20 year pulp alternative. Beef breeding A ranks last. The 40 year pulp-timber and beef breeding B alternatives have a positive present worth and accordingly a positive land expectation value. Beef fattening more or less breaks even at the 6% interest rate assumed but the pulp alternative and breeding A would only do so if the interest rate fell to 5.5% and 4.6% respectively.

Using land expectation value as the criterion Figure 2 indicates that if all product prices rose by 5% beef fattening and beef breeding B would be as profitable as 40 year forestry in Region H. However, product prices would have to rise by 9% and 14% before fattening and breeding B respectively became as profitable as 40 year forestry in Region A. Alternatively if prices for pulp and timber remained constant prices for beef would need to increase by about 7% for beef fattening to become competitive with forestry in Region A, but only by about 4% if the comparison was with Region H. (For breeding B the required price increases are 9% when compared with forestry in Region A and 3% when compared with Region H.) Breeding A does not become competitive with forestry within the range of prices indicated. If pulp and timber prices remained constant around a 25-30% increase in beef prices would be required for breeding A to be comparable with forestry. If all product prices fell beef would become relatively more unprofitable for a given price change than would forestry. Figure 3 which uses internal rate of return as the criterion leads to similar conclusions.

Overall, beef is more sensitive to price changes than forestry. Thus as prices rise beef becomes relatively more profitable than forestry but as prices fall it then becomes relatively more unprofitable. Essentially this is a reflection of the longer term nature of forestry and the consequently greater effect of the interest rate on annual costs and returns. Hence the forestry lines are flatter (more horizontal) than the beef lines. The fattening line is the steepest because revenues accrue earliest here.

Livestock production experts may consider that the assumptions made about animal performance and prices do not well reflect future possibilities. Examples here could be stock mortalities and the assumption that pastures do not reach their maximum carrying capacity until year 7 rather than say year 3 or 4. Forestry interests could counter with similar arguments. Certainly the subject is a controversial one.

Charging the full cost of external roads to each of the alternatives and not allowing fertilizer subsidies are accepted assumptions in cost benefit analyses investigating the public point of view.

A possibility for improving the economic viability of the beef alternatives is to base development on larger units. However discussion of Table 5 indicated that cost of maintenance fertilizer and costs associated with cattle (buying in, transport and commission) dominated recurring expenditure. Such items do not vary per acre so there is little possibility of significant economies by increasing size of unit. Further, it is not clear that the government is planning to abandon its long held "living area" concept in land development.

The relative location and number of mills and beef slaughter plants does not influence the outcome of the study because product prices are those on the nearest common competitive market (Brisbane) less transport costs from "farm gate" for beef and from "stump" for timber.

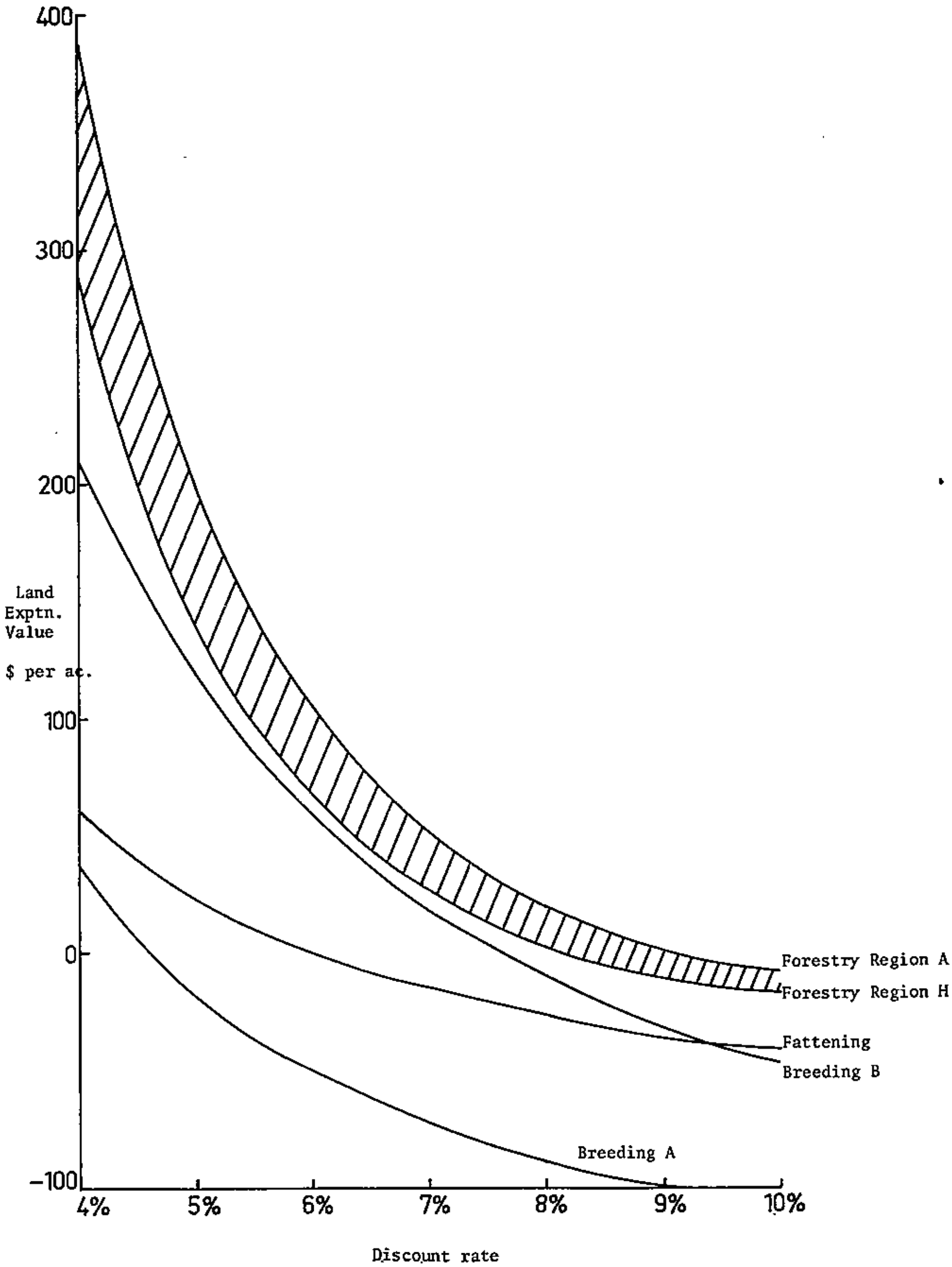
As indicated earlier the discount rate assumed does have a marked effect on economic viability. Figure 4 which relates changes in discount rate to L.E.V. illustrates this point.

Because of its longer term nature forestry is more sensitive to changes in the discount rate at relatively low rates. However it is also evident that the relative ranking of alternatives is not affected by such changes.

Finally, it is sometimes suggested that as forestry is a long term investment and sometimes assumed more inflexible than beef, part of the area be devoted to forestry (for example Region A) and the remainder to beef. This is an example of hedging

FIGURE 4

Changes in Land Expectation Value Associated with Changes in Discount Rate.-



against future uncertainties but involves a cost in the sense that returns from the total area might then not be as high as possible. A somewhat similar argument is that since large areas of land lie idle in the forestry alternative, net national gain could be improved further by introducing beef enterprises on the less favoured areas until such time as forestry requires the land. Such alternatives have merits and some difficulties, but are outside the focus of this paper.

It is concluded that if policy makers and their advisors find the assumptions made here acceptable, then economic criteria dictate that development should be for forestry if the nation is to benefit most, although beef breeding B is a close alternative. It remains for readers to study all assumptions carefully, form their own judgments and then assess relative profitability using Figures 2 and 3. The author's best guess is that prices assumed for beef are too optimistic for the future.

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