THE EFFECT OF LAND CLEARING REGULATIONS ON THE RATE OF FARM DEVELOPMENT — A CASE STUDY

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During the last ten years Government policy in Western Australia has been to encourage land clearing as new technology has made this increasingly possible in large areas of the state. The fact that during this period an average of three quarters of a million acres of land have been cleared annually by farmers (in W.A.) indicates that there are considerable economic incentives for farmers and new settlers to use this technology. The state's Land Act, backed by a policy of throwing open new lands for selection, has encouraged growth.

Land clearing, presumably, has not been a goal in itself, but rather a means to greater income for individual farmers and the state. It should be by the income goal, rather than the number of acres cleared for production, that the value of the state's land legislation should be judged. Legislation designed to bring about rapid economic growth in one technological environment, may inhibit the rate of growth in another. This looms as a particular problem in Western Australia as new techniques are increasing the stocking rate potential in many areas and also increasing the rate at which new land can be brought into full production.

It is the purpose of this article to examine the economic cost of certain provisions of the Western Australian Land Act[1] as applied to the Esperance region, where it is now feasible to farm at much heavier stocking rates and come to production more rapidly than was thought possible at the time when regulations were formulated. It is not intended as a criticism of administration, nor are any proposals for improvement made.

Section 47 of the Land Act of Western Australia outlines requirements attached to the conditional purchasing of grazing land. Two of these are that a maximum of 2,500 acres can be allotted to any one person, and that the lessee must make certain improvements to the property within a prescribed time or forfeit the lease. In the Esperance region the latter requirement is that in each of the first four years a minimum of 10 per cent of the cultivable area has to be cleared, and by the end of six years this 40 per cent of the farm must be laid down to pasture or cereal crop.

The purpose of these requirements is to ensure that land is developed by bona fide settlers, and that development will take place at a rapid rate. Yet settlers come with different capital backings, and it is not clear to what extent the regulations help or hinder the attainment of optimal economic development rates. These considerations become real

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[1] Western Australia, *Land Act 1933-1956;* reprinted 1958.

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production parameters for farmers, however, and it should be possible to establish their potential economic cost to farmers and the state by comparing optimal plans with and without these restraints.

This has been done for a 2,000 acre property on the Esperance Downs under a wide range of possible starting capital positions. There is obviously nothing definitive about this study. For one thing a limited number of farming activities has been selected. For another only a single criterion for optimal development has been considered, and that largely dictated by the capacity of computing facilities available. Thirdly, no consideration has been taken of the manner in which starting capital becomes available. In general the relationships considered are taken to be as favourable to the farmer as good management suggests. Examples of this are stocking rates on the high side of the mode and no interest charge on starting capital. In consequence the actual cost of the regulations may well be greater than is suggested. For such reasons, however, the optimal plans selected should not be taken as recommendations for action. For this purpose more conservative situations should be considered, and also a longer planning period.

Optimal plans for a range of starting capital levels were estimated by a "dated-statics" linear programming model with characteristics of types used by many workers, especially Stewart and Thornton.[2] Development (clearing, pasture establishment, and stocking) is financed from starting capital and income generated within the plan, the surplus of both above living expenditure in any year being transferred to the next year at the compound interest rate of 3 per cent. The objective function maximised is the revenue transferred from the tenth to eleventh year of the plan.

The choice of a maximising principle for this type of programme is difficult. No single criterion is most appropriate for all situations but the general type chosen, i.e., maximization of accumulated net revenue, seems as useful as any other. The main difficulty lies in choosing the planning period over which this figure is maximized. The period chosen will have a definite effect on the optimum plans. A ten year period was chosen for the following reasons:

1. Computer capacity made ten years the upper limit for the type of matrix used.
2. The regulations specify a four to six year clearing and pasturing period. A further four or five years allows even the last sown pastures to approach full production. Hence ten years is roughly the minimum period which allows a fair comparison between the different methods of development.
3. Ten years seems to be a suitable planning horizon for a farmer who is developing a new property.

"Intensive" and "Extensive" Development

It is assumed that all clearing is done by contract at the prevailing rates and that the farmer has two alternative methods for developing his property—an "intensive" method and an "extensive" method. The former involves greater capital expenditure per acre on clover seed and fertilizer than the latter, but returns are produced more quickly. Clear-

[2] Stewart, J. D., and Thornton, D. S., "A Problem in Phased Development", University of Reading, Miscellaneous Studies, No. 24, June 1962.

ing costs are the same for both, but the "intensive" method requires 24 pounds of subterranean clover and one-half pound of phalaris while the "extensive" method requires only 6 pounds of clover and the same rate of phalaris. For the first three years of establishment the "intensive" method requires almost twice the annual application (300 lb.) of super-phosphate as the "extensive", while after that the rates are much the same. Clearing, seeding and fertilizer costs per acre for the two methods are £25.95 (intensive) and £17.80 (extensive).

Returns are measured indirectly as sheep carrying capacity of the pastures. Table 1 illustrates how the "intensive" method gives pastures which reach maximum stocking rates more rapidly than do those of the "extensive" method.

TABLE 1

Pasture Carrying Capacities
(Dry Sheep per Acre)

Year	Intensive	Extensive
1	—	—
2	—	—
3	2·5	0·5
4	3·0	1·5
5	4·0	2·0
6	4·0	2·5
7	4·0	3·0
8	4·0	4·0
9	4·0	4·0
10	4·0	4·0

It was assumed that the only source of income was from merino sheep. Cropping and pasture seed harvesting activities were excluded, because of the high risk element involved in this region. A description of activities and restraints is given in the Appendix.

Restricted and Unrestricted Models

Parallel programmes were computed for the 2,000 acre property with starting capital levels ranging from £12,000 to £40,000. In the first no prohibition was placed on land left uncleared during any year of the plan. In the second a prohibition was placed on less than 1,000 acres being cleared in the first five years.

This restriction does not rigidly conform to the regulations outlined earlier, but it has been followed for two reasons. Firstly, it is a "popular" interpretation of the regulations held by farmers, and secondly computer capacity was not large enough to include all the necessary constraints of the precise regulations. This approach does not invalidate the general argument or conclusions, though it will change specific optimal plans. This change would not be justified in a definitive or prescriptive study.

Undiscounted net incomes transferred to the eleventh year (work-ing capital available for the eleventh year) at selected levels of starting capital are summarized in Table 2. These figures do not include the disposal value of all working livestock at the end of the tenth year, though this sum is included in the function maximised. The shadow

prices for capital at the various levels of starting capital are also given in Table 2. These are the additional compounded net income to the eleventh year which would result from each additional pound of starting capital. Within the assumptions of these models the shadow prices have been interpreted as marginal productivities of capital. Table 2 also shows the opportunity cost to the eleventh year of the restriction at each level of starting capital.

TABLE 2

A Comparison between Models of Working Capital in Year 11, Marginal Productivities of Capital, and the Opportunity Cost of the Restrictions

Starting Capital	Unrestricted Model		Restricted Model		
	Working Capital Year 11	Marginal Productivity	Working Capital Year 11	Marginal Productivity	Opportunity Cost of Restrictions
£	£	£	£	£	£
12,000	7,779	3.35	—	—	—
14,000	13,948	2.99	3,242	13.60	10,706
15,000	15,730	2.73	9,414	6.85	6,316
17,000	19,260	2.73	14,178	3.82	5,082
20,000	24,491	2.60	23,339	2.80	1,152
25,000	32,809	2.48	32,798	2.52	11
40,000	57,658	2.48	57,658	2.48	0

As we would expect, income increases at a decreasing rate for both restricted and unrestricted models. The rate of increase, however, is more rapid in the restricted model up to a starting capital level of £25,500 at which point the optimal pasture development programme in the unrestricted model fulfils the conditional purchase regulations. At starting capital levels greater than £25,500 the optimal plans for both models are identical.

Table 2 illustrates the cost of the regulations in two ways. First, a greater starting capital is necessary in order to launch a farmer successfully if the regulations are enforced than is the case where the regulations are not enforced. Starting capital of £13,540 is necessary before the regulations can be met and any surplus revenue be transferred from the tenth year, whereas at this capital level an accumulated surplus income of £12,700 could be had if the regulations were not enforced. Second, at the smaller capital levels the regulations regarding clearing divert capital away from heavy livestock purchases in the early years, and the rate at which development can be financed from farm generated income is severely limited. Hence income in subsequent years grows at a slower rate. The opportunity cost of the regulations declines rapidly as starting capital levels increase, however.

Optimal pasture development plans for the same starting capital levels are given in Table 3. Only with starting capital in excess of £25,500 can farmers fulfil the conditional purchase regulations and develop in a manner which is in their best interest.

It is also interesting to note that in both models the amount of land cleared in the first year is very similar, and further land is cleared in the restricted model as late as possible. This would also be true were

the restrictions programmed according to the specific regulations for Esperance. By bringing clearing requirements forward in time, the opportunity costs of the regulations would undoubtedly be higher than those given in Table 2.

TABLE 3

Optimal Clearing Plans for Restricted and Unrestricted Models

Model	Starting Capital (£)	Year 1 Intensive acres	Year 1 Extensive acres	Year 4 Intensive acres	Year 5 Intensive acres	Year 5 Extensive acres
Restricted	14,000	375	—	—	—	625
	15,000	426	—	—	—	574
	17,000	466	63	—	126	345
	20,000	606	88	92	214	—
	25,000	801	124	75	—	—
	40,000	1,387	223	95	—	—
Un-restricted	12,000	286	—	26	—	87
	14,000	376	11	21	—	—
	15,000	411	30	27	—	—
	17,000	482	69	32	—	—
	20,000	602	95	40	—	—
	25,000	799	127	54	—	—
	40,000	1,387	223	95	—	—

Again it must be stressed that these plans do not represent optimal recommendations for action. The objective function selected specifically discourages clearing after the fifth year, and obviously farmers with the large accumulated surplus incomes shown in Table 2 would put them to work in later years on land which still remains to be cleared.

Conclusions

The models examined are simple and do not take into consideration other constraints such as taxation, nor some of the farming activities already being undertaken in Esperance such as cropping, pasture seed harvesting, and cattle raising. Cropping and pasture seed harvesting are not yet generally successful at Esperance, and the main interest in cattle appears to be in spreading risks at a slight cost. The simple models do lead to conclusions which appear to be quite general, however. To develop a normal 2,000 acre block of virgin land only farmers with large amounts of starting capital can fulfil the conditional purchase regulations and do what is most profitable for them. Also, the quickest way to regional development is by establishing pastures "intensively", i.e., by heavy seed and fertilizer rates. In effect, however, the government, by enforcing the clearing conditions, is making the farmer with limited capital establish his pastures in the "extensive" and less profitable way. The clearing conditions are hence not of maximum benefit to the farmers, the region, or the state.

The position of the farmer with plenty of capital is more relevant to the total acreage limitation. By restricting all farmers to the same acreage, the government is handicapping farmers who could profitably develop much larger areas. In the long term this could be to the disadvantage of the state in that output would not increase as rapidly as it otherwise could.

APPENDIX

The difficulties associated with estimating production relationships are numerous. There is almost complete lack of experimental data regarding stocking capacities of pastures. This has necessitated assumptions being made on a grand scale. These assumptions have been made, and in this study they are the independent and averaged estimates of two scientists of the Department of Agriculture who have both had experience in commercial farming at Esperance.

Activities and Costs

Activities appear in the programming matrix in the following order: "intensive" development, "extensive" development, ewe acquisition, ewe "activity", wether acquisition, wether "activity", ewe sales, wether sales, labour hiring. In addition, revenue transfer and ewe and wether lamb transfer activities are included. A separate activity for each of these types has been defined for each year, though considerable economy of space is achieved by deleting those which obviously will not apply in any particular year. In general the prices chosen were those current at the end of 1962.

Development activities. Clearing costs are the same for both "intensive" and "extensive" development activities. The difference in the two lies in the seeding and fertilizer applications. The operations and costs which lie behind these activities and give rise to the carrying capacities of Table 1 are summarized in Table 4.

TABLE 4
Clearing and Development Costs (£ per acre)

Year	Operation	Intensive	Extensive
1	Logging	0.6	0.6
	Burning	0.1	0.1
		0.7	0.7
2	First ploughing	1.0	1.0
	Second ploughing	0.8	0.8
	Seeding	3.35	1.10
	Fertilizer	3.07	1.89
	Dams and watering	1.0	1.0
	Fencing	1.25	1.25
		10.47	7.04
3	Drilling	0.5	0.4
	Fertilizer	2.16	1.08
		2.66	1.48
4	Drilling	0.5	0.4
	Fertilizer	2.08	1.04
		2.58	1.44
5-10	Spreading (by contract)	0.2	0.15
	Fertilizer	1.39	1.04
		1.59	1.19

Acquisition activities. The acquisition values for ewes and wethers have been taken as 60/- and 55/- per sheep respectively throughout the whole plan period. The farmer is presumed to buy average to good quality merino weaners or two-tooths.

Sales activities. Sale values for the lambs are taken as for weaner type sheep. Ewes are presumed to lamb in autumn, making the lamb 3 to 4 months old by the time the next marketing date (September 1st) arrives. Weaners are sold for 50/- each, adult ewes for 55/-, and adult wethers for 50/-.

The values for adult sheep would be too high if the farmer were selling age culls. However, all the culling is incorporated as part of the ewe and wether activities and the value of the culls is averaged out on a per animal basis and added to the per animal returns in those activities.

Ewe and wether activities. Fixed costs for both ewes and wethers are are taken as 8/- annually. This includes shearing, crutching, inoculation, drenching, and dipping expenses. An additional cost of 10/- per ewe is added for the supplementary feeding made necessary by lambing in autumn and other lambing expenses.

Assuming a wool cut of 10 lb. per ewe and 11 lb. per wether selling for an average price of 4/- per lb., wool returns are 40/- per ewe and 44/- per wether. Added to each of these is 7/6 which is an average return per sheep for the sale of 15 per cent culls annually at 40/- per head.

Mortality is taken at 5 per cent and this means that ewe and wether numbers are depleted by a total of 20 per cent each year excluding the build-up from lamb transfer and acquisition activities. A lambing percentage of 70 is shared equally by ewe and wether activities in the next year.

Resource Restrictions and Requirements

Capital. Starting capital is available only as a lump sum at the beginning of the plan. Capital can be produced by activities, however, and each £1.0 capital and income not used in any year is transferred to the next year as £1.03. Fixed costs are incurred in each year of the plan. These are given in Table 5. These costs must be met before any other capital-using activities can be included. It has been assumed that the fixed costs of year 1 (consumption) are met apart from the stated starting capital.

TABLE 5

Fixed Cost Schedule

Year	Item	£
2	Consumption	800
	House	800
	Tractor, plough, drill and truck	2,200
3	Consumption	800
	Multi-purpose shed	1,000
4–10	Consumption	800

Land. The overall land restriction is 2,000 acres of virgin Esperance Downs sandplain. The vegetation of this country is generally a low heath scrub. The development activities are the only ones which directly use land. The costs involved in each of these and the carrying capacity which they produce is worked out on a 1 acre unit basis.

Carrying capacity. This is an intermediate resource which is produced from land by the development activities. It becomes a resource for the ewe and wether activities which are the only ones directly using it.

Labour. It is assumed that one man can handle 1,600 sheep. Further labour can be acquired at a cost of £780 per man per year. Labour hiring has been treated as a perfectly divisible activity, in that it is assumed that a man can be hired for fractions of a year.

A battery of other restrictions for ewes, wethers, ewe lambs, and wether lambs is added to allow for the interdependence of the various livestock activities. These, again, are purely intermediate resources.

The Objective Function

All activities are suspended at the end of the tenth year, and all ewes and wethers on hand are sold off. This revenue is added to any revenue transferred from year 10 to year 11, and the sum of these amounts is maximized. Results given in the text of this article are net of the revenue from ewes and wethers sold off, however. The final plan as presented by the computer (I.B.M. 60K 1620) gives these components separately, together with the value of the objective function. This criterion maximises the working capital which can be generated in a 10 year planning period.