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A NOTE ON A MANDATORY LAND-USE PROGRAMME: SOIL CONSERVATION ON THE DARLING DOWNS*

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The declaration of Soil Erosion Hazard Areas on the Queensland Darling Downs represents a further public intervention in farming. This paper outlines the background to the Darling Downs soil conservation programme and the procedures involved in translating this programme into a linear programming, comparative statics, farm-planning model. This model is then used to examine the effect of the programme on land-use and net cash surplus of several types of farms. A number of conclusions are discussed concerning both the provision of government subsidies and the possibility of farm amalgamations resulting from the mandatory programme.

The aim of the study summarized in this note was to analyze certain economic aspects of the recently introduced compulsory soil conservation programme for the Darling Downs region of Queensland. This programme represents a major undertaking which has been guided primarily by technical recommendations. The major emphasis of our research was to translate the technical aspects of the mandatory soil conservation measures into an economic framework and trace through the consequences of these measures on farm viability; on the relationship between farm net cash surplus and capital availability; and the adequacy or otherwise of the dollar-for-dollar subsidy provided by the Queensland government to individual farmers.

This research began following the declaration of four Darling Downs shires as areas of Soil Erosion Hazard in March, 1973. The declarations were made under the Queensland Soil Conservation Act of 1965 and together with the subsequent declarations made in August, 1974, eleven shires have now been declared Areas of Soil Erosion Hazard (1). The 1965 Soil Conservation legislation gives the state government powers to enforce the implementation of approved soil conservation plans within declared areas and thus has involved the Queensland government in a massive, long-term mandatory land-use programme. The Soil Conservation Branch of the Queensland Department of Primary Industries is empowered not only to prepare run-off and drainage plans on a catchment and sub-catchment basis but it also has the responsibility of preparing detailed plans for individual farms. After a period during which objections can be filed, these plans become mandatory. Plans use guidelines based on the universal soil loss equation (2). Specific sets of mechanical and agronomic practices are detailed for each farm to maintain estimated soil losses within specified limits.

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This note discusses specific problems of our study within the overall context of soil conservation economics; the procedures involved in translating the physical specifications of the Soil Conservation Branch into a farm planning matrix; some specific features of the model; some preliminary results; and some extensions of the model which are currently being developed. Also, we hypothesize that the level of government subsidy is generally inadequate, that shifts in farming activities caused by the Declaration will require more funds than soil conservation, and that only specific forms of farm amalgamation will be beneficial.

The Nature of the Problem

Typically, economic studies of soil conservation, at either the individual farm level or at the regional programme level[1], have estimated costs and benefits over time. These cost-benefit oriented studies are typically applied either to a specific programme where the measures to be taken to meet the objective are given, or to a range of programmes in an effort to select one programme which maximizes some economic objective. The planning procedures which have arisen after the mandatory sections of the 1965 Act were invoked placed the Darling Downs programme in the first category. Rather than exploring a range of possible levels of annual soil loss and the probable time stream of costs and benefits which might result, the objective was defined as holding annual average soil loss to 12·6 tonnes per hectare on the deeper soils and to 7·6 tonnes per hectare on the shallower soils. The study by Cummins *et al* (2) traced through the possible consequences of this soil loss objective using net present value analysis of a 'typical' dairy and grain farm in an effort to determine if the associated soil conservation activities were profitable for the individual farmer. A straight-line decline in productivity was assumed without soil conservation and this was converted into value terms over ten and twenty year planning horizons. The Cummins study showed that, in common with others using a similar methodology (3, 4, 5) and using the low soil loss tolerances specified for the Darling Downs, soil conservation was not profitable for the individual farmer operating under planning horizons of ten to twenty years. A variety of subsidy measures were then advanced to increase the rates of return on private capital invested in soil conservation.

The research approach we adopted was conditioned by the fact that the technical conditions under which the Darling Downs soil conservation programme were to operate represented a *fait accompli*. Information was not available on the technical or economic consequences of various levels of annual soil loss and the permissible forms of land use following from these levels. Thus opportunity costs of each additional tonne of soil lost could not be calculated although these costs obviously could have been of benefit in planning the Darling Downs programme. However, upon examination of the options which were available to maintain the specified soil loss levels, some flexibility in enterprise choice was

[1] A soil conservation programme, as used here, refers to an integrated set of physical structures and agronomic practices implemented on a catchment or sub-catchment level. Such a programme is almost always designed around an objective defined in annual soil loss per unit of area.

obvious. Therefore our approach became one of systematically examining all possible farming activities given the range of soil conserving methods available to maintain the specified soil loss levels. Also, rather than focus on government subsidies we chose to focus on levels of cash reserves as a means of maintaining or even increasing post-conservation levels of farm net cash surplus. A linear programming approach was judged as the most appropriate for this problem. The results of this type of study could be extended in a cost-benefit manner to an ex-post evaluation of the Darling Downs programme. However, given the lack of systematic information in Australia on the relationships between rainfall intensity and soil loss, soil depth and soil productivity, rates of technological change, or future input and output prices for the rural sector such an analysis would be fraught with difficulties. Such an evaluation would, however, seem warranted given the magnitude of the Darling Downs programme. A coordinated research effort to obtain the above data would be required.

Another topic not investigated in detail was the relationship between soil erosion levels and land values. The land value question is crucial in analyzing the adequacy of the subsidy. A time series on land values for the study area was not available but it was obvious that land values in heavily eroded dairying areas were falling while land values for cash grain farms were firm. In the former case, the farmers were generally unable to invest in soil conservation measures to halt the erosion in land values due to a cost-price squeeze. In the latter situation, buoyant grain prices led to some investments in soil conservation although the grain farms were generally less eroded than dairying areas.

Farm Planning Framework

The linear programming model has been used to compare farm organization and farm net cash surplus before and after soil conservation (6, 7, 8). Net cash surplus was calculated within the matrix by subtracting fixed cash costs specific to each farm type, contour bank maintenance charges per hectare banked, a family living allowance and income tax payments through an averaging procedure (7).

Land zoning procedures adopted by the Soil Conservation Branch have led to specific sets of allowable practices for each soil-type/slope combination which should allow soil loss to be maintained within specified limits. Four zones were specified for the Eastern Downs. Soil types were sorted into deep, heavy soils and light, shallow, or previously eroded soils and slope limits for each zone were determined for these soil categories.

Within a zone some flexibility in land-use is possible since limited trade-offs can occur between the cropping practice factor and the erosion control practice factor in applying the universal soil loss equation. For example, moving to a more intensive form of land-use such as three crops in four years rather than a crop-pasture ley system must be combined with more intensive erosion control structures (e.g. from double-spaced to single-spaced contour banks). This flexibility in land-use implies that levels of available capital, will, to a large degree, influence the ability of an individual farmer to compensate for the short-run loss in income brought about by the mandatory soil conservation programme (9). Some compensation for lost income may also be possible through investment in more capital intensive enterprises such as fat lambs or intensive beef production.

Within the linear programming matrix, the same sets of input-output coefficients and activity vectors were used for both the pre-conservation and post-conservation farm plans. This required adjusting the land coefficients in the latter case to reflect land use for ungrazed grass strips or strips of grass used for pasture. For example, Zone II land can be used for unrestricted cash cropping with single spaced banks or with double spaced banks which require only half the investment but require 10 per cent of the land in ungrazed grass strips. The more erosion-prone forage cropping rotations on Zone II land require 33 per cent of the arable land as pasture strips.

Also of interest is the subsidy transfer activity which maintains the dollar-for-dollar subsidy for soil conservation structures up to the $1,000 limit. The demand for conservation capital is met by the capital pool plus the government contribution represented by the maximum subsidy constraint row. The subsidy qualifying row has —1 and +1 coefficients to guarantee that funds are supplied into the conservation capital row on a dollar-for-dollar basis up to the subsidy limit represented by the right hand side coefficient for that row. After this limit is reached, all further conservation funds come from the pool.

Highlights of the Preliminary Results

The model was applied to six farms which were surveyed in detail by Soil Conservation Branch officers in 1972-1973. This group was selected on the basis of major enterprise, farm size and extent of erosion control measures required. Dairying and cash grain production represented the two major farm types to be considered. Farms were classified as small (dairy <135 ha, grain <150 ha) or large. The degree of erosion control measures required was based chiefly on slope with either intermediate or steeper slopes prevailing on the majority of land. There are very few small or large grain farms on steeper slopes. Therefore, there were a total of six possible combinations of major enterprise, farm size and degree of control likely to be influenced by the Erosion Hazard Declaration. Each of the study farms was chosen to represent one of these possible cases. The upper section of Table 1 gives some general characteristics of these farms. The area of each soil-type/zone combination was entered as a constraint and the effect of varying cash reserves was studied using reserves of $4,000, $8,000, $12,000 and $16,000.

The normative results produced by the model, as a rule, generated a more optimistic picture than that actually faced by the operator. In this sense they represented upper limits of net cash surplus that might be reached. The declines in net cash surplus from pre-conservation to post-conservation farm plans represented the extreme case of a one year conversion from unrestricted land-use to a fully implemented soil conservation programme. In reality, the plan of action prescribed is implemented in stages over a 10 year period which smoothes out the annual expenditures on soil conservation structures. The results would be less biased for severely eroded farms where a high proportion of expenditures must be undertaken in a few years. The relative impact

on the farms should be considered more accurate than the absolute magnitude of the income figures reported below.

TABLE 1

Summary of Selected Farms and the Impact on Farm Net Cash Surplus of the Erosion Hazard Declaration.

Farm number		1	2	3	4	5	6
Farm area (ha)		97	132	139	147	140	181
Major enterprise		Dairy	Dairy	Dairy	Dairy	Grain	Grain
Per cent land in Zone III & IV		100	23	100	18	61	25
Levels of available capital ($)	Item	Levels of net cash surplus ($)[a]					
		Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6
4,000	Before conservation	4,190	3,755	6,518	3,892	6,374	9,756
	After conservation	1,865	2,350	1,596	881	5,612	8,778
	Decline	2,325	1,405	4,922	3,011	762	978
		(55)	(37)	(76)	(77)	(7)	(10)
8,000	Before conservation	4,819	4,762	7,561	5,781	6,374	9,756
	After conservation	3,119	3,811	4,640	4,533	5,935	9,418
	Decline	1,700	951	2,921	1,248	439	338
		(35)	(20)	(37)	(22)	(7)	(3)
12,000	Before conservation	5,368	5,598	8,269	6,777	6,374	9,756
	After conservation	3,119	4,533	4,851	5,701	5,935	9,418
	Decline	2,249	1,065	3,418	1,076	439	338
		(42)	(19)	(41)	(16)	(7)	(3)
16,000	Before conservation	5,837	6,126	8,467	7,659	6,374	9,756
	After conservation	3,119	5,027	4,851	6,759	5,935	9,418
	Decline	2,718	1,099	3,616	900	439	338
		(47)	(18)	(43)	(12)	(7)	(3)

[a] The bracketed numbers in the body of the table are the percentage decline in net cash surplus for each farm/available capital combination.

With these caveats in mind, Table 1 summarizes the results of eight runs for each of the six farms. Lower levels of capital resulted in double-spaced contour banks and less intensive forms of land-use. Increasing levels of capital on dairy farms leads to more cows, more forage cropping, and higher levels of net cash surplus.

On grain farms the response of net cash surplus to increased capital availability was less evident. Firstly, the working capital requirements per activity for cash grain farms are low relative to livestock activities. Secondly, because the cash payments for most grain crops are received as advances throughout the year these supplement the quarterly cash balances in the model. Thirdly, the grain farms require less conservation capital per hectare than the dairy farms because grain farms have less steep land and forage cropping on dairy farms requires intensive conservation measures. At the highest level of available capital ($16,000), soil conservation for dairy farms required an average of $28·53 per hectare while cash-grain farms averaged only $21·45 per hectare.

The cash-grain farm plans were more stable than dairy farm plans when comparing pre-conservation and post-conservation solutions. The differences are created by some income response at lower cash reserves as more single spaced banks are provided and a downward shift in the response curve reflecting a small reduction in the effective area cropped.

Four other important results not demonstrated in Table 1 were as follows:—

(a) If the dairying activities are excluded then cash-grain activities enter the plan rather than other livestock activities.

(b) The financial impact of the Erosion Hazard Declaration on dairy farms is caused not so much by expenditures on soil conservation or reductions in effective area cropped but by the restrictions on forage cropping created because the programme requires up to 66 per cent of the area to be put into pasture. This increases summer feed supplies (pasture) relative to winter feed supplies (forage crops). Farms in this area normally already have surplus summer feed. The problem is compounded if the farm has a significant area of Zone IV land which must go into permanent pasture. Therefore dairy farm amalgamation would only be a feasible strategy for maintaining farm net cash surplus if the area acquired has a high proportion of Zone I and Zone II land.

(c) The allocation of capital between conservation, cropping, and livestock indicated that to reach pre-conservation levels of net cash surplus the increased quantity of capital required for cropping and/or livestock activities was much larger than that allocated to conservation works. This held true even with the $1,000 government contribution accounted for.

(d) The subsidy was fully utilized on all six farms. In several cases the farmer's required soil conservation expenditures, over and above his dollar-for-dollar subsidy contribution, were over $1,000. Two avenues are open to make the subsidy scheme more equitable. The first is for the government to subsidize all soil conservation expenditures on a dollar-for-dollar basis while the second is a general subsidy on farm credit for affected farmers without specifying the allocation of loan funds to soil conservation or farm operating expenditures.

In summary we find that the hypotheses advanced earlier were basically correct. The level of government subsidy was found to be inadequate on the range of farms examined. More funds were demanded for activity changes resulting from land use restrictions than for the physical soil conservation structures. Finally, farm amalgamation would appear to offer high returns only when the additional land supplied dairy enterprise feed resources which were sharply curtailed on the existing farm through land use restrictions.

In an overall policy context, we believe the model has adequately highlighted these problems and has led us to the conclusion that, if government assistance is warranted to compensate landowners for restrictive land use regulations, a general subsidy on farm credit would be more desirable than the present system. A general subsidy would permit a better allocation of funds between operating and conservation expenditures and avoid the hardship suffered by larger fa ners who

are forced into large soil conservation expenditures over and above the amount covered by the existing government subsidy program.

Further Work

The basic model described above is now being extended to encompass the dynamic features of the ten year planning horizon permitted in the conservation program. A research team at Griffith University is using the model developed by the authors to select key variables which may indicate which farms will experience low income problems once the land-use restrictions are fully enforced (10). In addition the Division of Dairying, Queensland Department of Primary Industries is modifying the dairy farm portion of the model to examine dairy farm readjustment possibilities.

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