ABARE CONFERENCE PAPER 93.5

Factors influencing landholders' investments in soil conservation activities

Elton N. Miller and Gregory Andrews
Australian Bureau of Agricultural and Resource Economics
GPO Box 1563, Canberra 2601

37th Annual Conference of the
Australian Agricultural Economics Society
University of Sydney, 9–11 February 1993

Data collected in 1990-91 by ABARE were analysed to determine the relative influence of different factors on landholder investment in soil conservation. Factors which were found to be important in all agricultural zones were the farmer's perception of the need for soil conservation, and whether the farmer was in the mixed farming industry. Variables which were significant in at least two zones and in Australian broadacre farming as a whole were land value, and the use of demonstrations as a source of technical advice. The latter result could have implications for the way in which program managers allocate soil conservation training funds.

ABARE project 32.005

Introduction

The severity and extent of land degradation of various types in Australia have increased in the 200 years of European settlement. During this time governments and individuals have sought to combat this increase in land degradation (Reeve 1988).

The Commonwealth government is presently promoting land conservation through its Decade of Landcare Plan, under the provisions of the National Soil Conservation Program (NSCP). For the decade of the 1990s, the Commonwealth has committed over $320 million to landcare and related tree planting and remnant vegetation conservation programs (Commonwealth of Australia 1991). Uses of these funds will also include research and development, monitoring, and review and evaluation of the plan.

One of the underlying objectives of the plan is to facilitate change in both the attitudes and actions of individuals and the community. To maximise the prospects of the objectives of the plan being realised, it is important that initiatives for change continue to develop at the farm level. In this context, it should be remembered that the term landcare is most commonly used (and is used in this paper) to refer to the local farm community 'landcare groups' which began to appear in the mid-1980s and now number over 1300. An important area of research, therefore, is what influences landholders' adoption of conservation farming practices.

To examine this question, and also to assist the monitoring of the adoption of various land management practices related to soil conservation, ABARE conducted a supplementary survey on land management practices in its 1990-91 survey of Australia's rural industries. Preliminary results were presented at the 1992 National Agricultural and Resources Outlook Conference (ABARE 1992). At that time a range of factors thought to influence farmers' management decisions relating to soil conservation were briefly canvassed, including personal, economic, institutional and technological factors.

The purpose in this study is to determine the importance of various factors which are thought to influence investment in soil conservation activities. For this purpose, a logistic regression model was used to analyse the data collected in the 1990–91 supplementary survey.

A description of the data set used is given below, followed by a description of the model and a discussion of the results. In the final section of the paper, suggestions are presented

as to how the data set could be improved, together with potential policy implications and identification of possible future research areas.

Data

The data used were collected in a supplementary survey on land management practices conducted in conjunction with the Australian Agricultural and Grazing Industries Survey (AAGIS) undertaken by ABARE in 1990-91. The AAGIS sample in 1990-91 totalled 1654 farms, representing approximately 82 000 broadacre farms throughout Australia. The final data set comprised 1588 farms, due mainly to the exclusion of corporate farms. Although it would have been desirable to use the full sample, education information was not collected in the AAGIS for farm managers who did not own the properties they managed. Since education was possibly a significant variable, these properties were excluded from the data set, leaving only family farms. It is possible that land management practices on corporate farms may be different from those on family farms. A small number of other farms were dropped due to data deficiencies. The data were weighted to give population estimates for Australian broadacre agriculture (see Bardsley and Chambers 1984).

The supplementary survey was designed to elicit information from landholders regarding certain land management practices. The questions were designed to collect information on the usage of alternative management practices for both grazing and cropping, changes in management practices in the previous five years and reasons for these changes, and the usage of alternative sources of technical advice pertaining to property planning and management decisions. Although the supplementary survey was included as an attachment to the survey for all the AAGIS sample farms in Australia, the questions in it were most applicable to the wheat–sheep zone.

ABARE has also conducted supplementary surveys relating to land management practices in the past (1983-84 and 1989-90). Unfortunately the data obtained were not directly comparable with the 1990-91 supplementary survey data, because different questions were asked. They therefore could not be incorporated into the present project for time-series type analysis. The data used here are thus cross-sectional only.

Table 1 provides an example of the data collected. It shows the extent of adoption by landholders of conservation activities, in broad categories. It can be seen that the dominant

Table 1: Use of land conservation measures in Australian broadacre industries, 1990-91

	%	Relative standard error [a]
Percentages of farmers who, for conservation purposes, have		
• changed pasture management practices in the past five years	7	14
• changed crop management practices in the past five years	12	9
• conducted earthworks (at any time)	42	4
• planted trees in 1990-91	11	10
Percentage currently requiring earthworks	41	4

a Percentage of estimate (not percentage points)

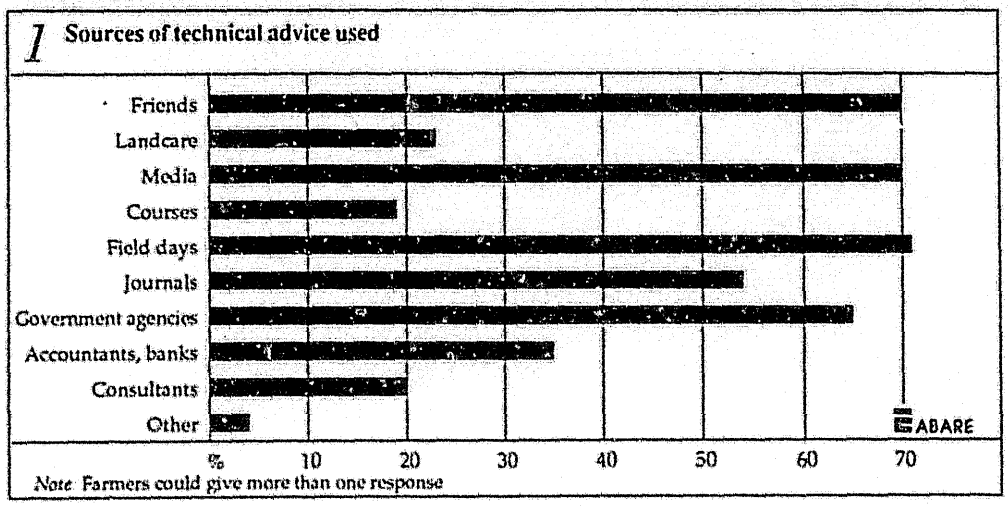
form of conservation activity undertaken by farmers has been conservation earthworks (42 per cent). Also, 41 per cent of landholders said they currently required earthworks; these were not necessarily the same landholders who had already conducted earthworks.

The model: factors influencing landholders' investments in soil conservation activities

As previously stated, the objective is to determine the relative importance of the factors which influence landholder investment in soil conservation activities. The data for many of the variables in the model (especially those concerned with the use of alternative sources of technical advice) were collected in the form of yes or no responses. Figure 1 shows the percentage of landholders who answered affirmatively concerning use of the various sources of technical advice.

From figure 1 it can be seen that the three principal sources of technical advice used by landholders are 'friends' (which includes neighbours and relatives), the media other than trade journals, and attendance at field days. 'Landcare' refers to the landcare groups mentioned in the introduction.

Because in this analysis the dependent variable is a yes or no response (which can be represented as 1 where the response was yes and 0 where the response was no) a logit model was chosen as the appropriate functional form, since this model allows a dummy



variable as its dependent variable. A number of researchers, including Ervin and Ervin (1982) and Sinden and King (1990), have also used logit models when analysing similar problems.

Ervin and Ervin (1982) developed a three-stage model of soil conservation behaviour, and tested it in Monroe county, Missouri. The first stage was perception of the problem, the second was the decision to adopt a conservation practice, and if so which, and the final stage was soil conservation effort. They found a limited range of factors to be significant, including erosion potential, education level and (affecting the later stages) perception of the problem.

Sinden and King (1990) adopted a similar model for Manilla shire in New South Wales. This model comprised three stages, namely: perception of land condition, recognition of a problem, and the decision to resolve the problem. The factors found to be significant included the condition of the land, the farmer's investment rating, wheat yield, and livestock carrying capacity.

Note that these two studies differed to some extent in the explanatory variables they used, and found different factors to be significant for the different stages and for the different regions. In conjunction with these two studies, the work of Yapp and Connell (1989) also proved helpful in designing the current model. Yapp and Connell identified many factors which they believed may affect investment in soil conservation tillage, ranging from the type and severity of degradation through to personal goals and attitudes such as stewardship of the land. Many of these could be expected to be applicable to soil conservation in general.

This study is not concerned with the factors which influence the landholder's decision to invest in soil conservation, but with those influencing the actual investment itself. (The decision to invest in soil conservation could be an additional topic for research.) Investment in soil conservation activities is here taken to include costs which were incurred in switching to soil conserving technologies and practices, in addition to investment in the usual sense. The term soil conservation here encompasses not only maintaining the soil stock but also conserving soil quality. The model used — a single stage model — included a broad range of factors which may influence investment, including economic, physical, personal and institutional factors. Their importance may vary across Australia's agricultural zones and agricultural industries.

From Studenmund and Cassidy (1987), a standard logit function may be defined as:

$$\log[P_i/(1-P_i)] = B_0 + B_1 X_{1i} + B_2 X_{2i} + ... + B_k X_{ki} + e_i$$

where P_i is the probability that the ith individual will have undertaken a certain activity, X_{ki} are the independent variables, B_k are the coefficients to be estimated and e_i is the stochastic error term. Logit functions are based on the cumulative logistic function, which is an S shaped function.

The dependent variable used in the model was a dummy variable (0 or 1) representing *investment in soil conservation*. This had a value of 1 if soil conservation earthworks had been carried out on the property at any time in the past; if the landholder used minimum tillage, direct drilling, contour cultivation or strip cropping; or if 100 trees or more had been planted in 1990–91 to combat salinity or acidity. This variable was designed to make the best use of the questions asked in the supplementary survey. As can be seen, it is most applicable to farms in the wheat–sheep zone. Only the tree planting question was specifically aimed at activities in 1990-91.

In specifying the model, the following variables were expected to have an influence on the dependent variable. A major expected factor was farmers' perceptions that soil conservation work, or additional work, needed to be done. It was thought that landholders who have already invested in soil conservation will often recognise that more investment needs to be undertaken.

It was also thought that the area and value of land might have an influence on investment in soil conservation activities, and that the amount of investment may increase with the operator's level of education.

Different sources of technical advice used by operators for property planning and management decisions were expected to have differing influences on, or associations with, investment. Finally, the industry and zone a property is in were thought to be important in influencing the amount of investment in soil conservation activities, especially because of the definition of the dependent variable.

In light of the previously mentioned studies, and working within the scope of the data available, the following independent variables were used in the model:

- a dummy variable (*needs soil conservation*) for the farmer's perception as to whether or not soil conservation work needs to be done on the property;
- *area* of property (hectares);
- perceived *value of land*, provided by operator ($);
- two dummy variables relating to level of education, the reference category being attendance at secondary school —
  - *nil or primary education*, for operator having no schooling or having attended only primary school;
  - *tertiary or other education*, for operator having completed a trade, technical apprenticeship, university or other tertiary course;
- three dummy variables relating to where the operator received technical advice, the reference category being friends, neighbours and relatives —
  - *demonstrations*, for farm management courses or field days;
  - *landcare*, for farm landcare groups;
  - *other* (government agencies, technical journals, media, consultants, banks or accountants, or the use of a computer for farm management);
- four dummy variables specifying the industry the property is in, the reference category being the beef–sheep industry —

  - *beef*;
  - *sheep and wool*;
  - *mixed farming*; and
  - *grains and other crops*;
- two dummy variables specifying the zone in which the property is located, the reference category being the wheat–sheep zone —
  - *pastoral zone*; and
  - *high rainfall zone*.

Results

The analysis was first conducted on the full Australian data set and then disaggregated to the pastoral, wheat–sheep and high rainfall zones. The data set comprised 206 observations in the pastoral zone, 933 in the wheat–sheep zone and 449 in the high rainfall zone. Note that the zone in which a farm is located, and the industry in which it is currently engaged, are separate variables: there is a variety of industries in each zone. The different agricultural industry dummies were therefore included in the zonal regressions, since the different conditions in, and characteristics of, each industry might aid the explanation of variance in the dependent variable.

Nationwide results

The results of the regression for Australia as a whole are presented in table 2. The likelihood ratio was found to be greater than the χ^2 critical value at 95 per cent confidence. The regression had a percentage of right predictions of 74.47 per cent.

The coefficient of *needs soil conservation* was positive, well determined and relatively large. The finding that landholders' perceptions of the need for soil conservation work were positively correlated with their investment in soil conservation conformed with a priori expectations.

Table 2: Regression results for Australia

Variable	Coefficient	*t* ratio
Needs soil conservation	1.660	12.45**
Value of land	0.34E–6	3.42**
Nil or primary education	–0.606	–3.32**
Tertiary or other education	–0.200	–1.21
Demonstrations	0.704	5.01**
Landcare	0.583	3.49**
Other technical advice	0.320	1.62
Beef	–0.081	–0.41
Sheep and wool	–0.044	–0.22
Mixed farming	1.127	5.08**
Grains and other crops	0.711	2.56**
Pastoral zone	0.840	2.82**
High rainfall zone	1.399	4.63**
Constant	–2.615	–6.92**

** = significant at 95% confidence ($t \geq 1.96$)
* = significant at 90% confidence ($t \geq 1.65$)

Tests	
Likelihood ratio test	504.18
Percentage right predictions	74.47

The positive coefficient for *value of land* implies that there may be an association between investment in soil conservation and perceived land value. The negative coefficient for the variable *nil or primary education* conformed with a priori expectations. However, it should be noted that the *tertiary or other education* coefficient was also negative, though statistically insignificant.

Two of the sources of technical advice were found significant and positive. These were *demonstrations* (field days and farm management courses) and *landcare*. Attendance at field days and farm management courses and use of landcare advice were assumed to be very practical in nature, whereas the other forms of technical advice, which included technical journals, government agencies, banks, accountants and the like, while also having some practical applications, were assumed to be less practically orientated in general. If this assumption holds true, then it appears that sources that are more 'hands on' in nature have a greater influence than other forms of advice.

Operators may use the various forms of technical advice in relation to investment in soil conservation activities for a number of reasons. First, they could recognise that they have

a land degradation problem and access technical advice to address the problem. Alternatively, they could for example attend field days for reasons other than soil conservation, and learn about it while in attendance.

Results of this kind may have policy implications for government. The Commonwealth is currently targeting expenditure at education and training relevant to soil conservation, in addition to attempting to increase awareness of ecologically sustainable development goals and activities more generally. It may be that in order to maximise efficiency in the use of these resources, government programs could be aimed at the 'hands on' forms of technical advice, which from the results reported appear to be the forms in which farmers are most practically receptive to advice, at least in relation to investment in soil conservation. It could also be that practical forms of advice are the most efficient way of introducing concepts of ecologically sustainable development at the farm level.

Of the industry dummies, *mixed farming* and *grains and other crops* were significant and positive. The fact that these two industries were found to be statistically significant, and the grazing industries were not, may indicate either that landholders in cropping areas are more willing to undertake investment in soil conservation than livestock farmers, or that there has been more land degradation in cropped areas. However, the *pastoral zone* dummy had a significantly positive coefficient, though that of the *high rainfall zone* was also significantly positive and was larger.

Zonal results

The results for the regressions by the three agricultural zones are shown in table 3. The likelihood ratios were all greater than the χ^2 critical values at 95 per cent confidence (table 3), implying that all three regressions were significant.

The regression for the pastoral zone yielded a percentage of right predictions of 81.30 per cent. In the results for the pastoral zone, as in those for Australia as a whole, the coefficient for the variable *needs soil conservation* was large and positive. The coefficient for *mixed farming* was also significant and positive — farmers engaged in mixed farming in the pastoral zone were more likely to invest in soil conservation than those with other types of enterprise. These would be the opportunity croppers on the margin of the wheat–sheep zone but still included in the pastoral zone. This may be because mixed farming properties in the marginal cropping lands are particularly susceptible to degradation, especially through wind and water erosion.

Table 3: Regression results by agricultural zone

	Pastoral zone		Wheat–sheep zone		High rainfall zone	
	Coefficient	*t* ratio	Coefficient	*t* ratio	Coefficient	*t* ratio
Needs soil conservation	3.157	7.212**	1.527	8.27**	1.806	7.66**
Area	–	–	–0.13E–3	–3.71**	–	–
Value of land	–	–	0.93E–6	4.33**	0.32E–6	2.03**
Nil or primary education	–	–	–0.744	–3.08**	–	–
Tertiary or other education	–	–	0.040	0.16	–	–
Demonstrations	–	–	0.492	2.70**	1.153	4.52**
Landcare	–	–	1.028	4.09**	–	–
Beef	0.786	1.26	0.264	0.76	–0.129	–0.42
Sheep and wool	0.437	0.74	–0.325	–1.02	0.296	0.94
Mixed farming	3.182	3.79**	1.041	3.46**	1.362	2.20**
Grains and other crops	29.661	0.1E–3	0.657	1.89 *	–0.149	–0.16
Constant	–3.079	–4.86**	–0.906	–2.89**	–1.968	–5.90**

** = significant at 95% confidence ($t \geq 1.96$)
* = significant at 90% confidence ($t \geq 1.65$)

Tests	Pastoral zone	Wheat–sheep zone	High rainfall zone
Likelihood ratio test	87.12	220.57	126.36
Percentage right predictions	81.30	77.74	71.60

The regression for the wheat–sheep zone had a percentage of right predictions of 77.74 per cent, slightly less than that for the pastoral zone. In the wheat–sheep zone the variable *needs soil conservation* was significant, and positive, as were the variables *value of land*, *demonstrations*, *landcare*, *mixed farming* and *grains and other crops*.

Again, farmers engaging in mixed farming were more likely to undertake conservation investment. In this zone the variable *grains and other crops* was significant and positive. *Nil or primary education* was significant and negative. These results are similar to those found for Australia as a whole. This may be attributable to the definition of the dependent variable, which was biased toward investment activities in this zone.

The *area* coefficient was statistically significant and negative. The a priori expectation was that larger farms would be more likely to have soil conservation carried out on them than smaller farms, due to economies of size. However, the result indicated that investment was more likely on smaller farms. This may be attributable to landholders on smaller properties being more aware of degradation problems on their properties than operators on more extensive holdings.

For the high rainfall zone, the percentage of right predictions (71.60 per cent) was the lowest among the three zones. Variables which had significant coefficients that were positive were *needs soil conservation*, *value of land*, *demonstrations* and *mixed farming*. In all zones investment was more likely to be undertaken on mixed farming properties than on other properties. The effects of *value of land* and *demonstrations* were both found positive and statistically significant in all cases except that of the pastoral zone.

Although the model was not directly comparable to the three stage models of Ervin and Ervin (1982) and Sinden and King (1990), some comparisons of the findings may be made. Different variables were found significant in the different models, which may imply that different factors are relevant in different places and situations. The differences between the results could also be partly due to differences in data sources, collection techniques and variable definitions.

The variables found mainly to influence landholders' investments in soil conservation in the current study, in all zones, were their perception of the need for such work and whether they were in the mixed farming industry. Other variables which were also important (in at least two zones) were the perceived value of the land and the acquisition of technical advice at field days or farm management courses.

This analysis was first undertaken for Australia as a whole and then disaggregated to a zonal level. However, the dependent variable was biased toward the wheat–sheep zone. This was partly due to the composition of the supplementary survey. While this analysis has been of use in determining factors which may influence investment in soil conservation in general, further research should be more focussed in nature. It may be best to determine the factors which influence investment in soil conservation activities at a regional level. Not only are different factors relevant for different zones (as this analysis has indirectly shown) but they may also be different for individual regions.

Because this analysis employed a non-time-specific dependent variable, it would not have been relevant to incorporate current financial factors such as farm cash income, debt levels, and off-farm income into the regressions. A time-specific indication of soil conservation investment in subsequent surveys could allow more rigorous analysis.

Conclusions

Reliable time-series data would enrich the data set and could allow trends in variables over time to be identified. ABARE is seeking to collect such a time-series database relating to soil conservation and land degradation over the Decade of Landcare.

In the present study, it was found that different factors were relevant to landholders' investments in soil conservation in different zones. For example, use of landcare groups as a source of advice was a statistically significant influence on investment only in the wheat–sheep zone, where it was found to have a greater influence than the other practical sources of technical advice. In the high rainfall zone, in contrast, its influence was undetectable; here the only statistically significant source of advice was management courses and field days. The value of the land was a positive influence on conservation investment in the wheat–sheep and high rainfall zones. The influence of land area was statistically significant only in the wheat–sheep zone, where it was negative. In the wheat–sheep zone alone it was found that the *grains and other crops* variables was a significant positive influence.

Farmers involved in mixed farming, in all zones, were more likely to undertake investment in soil conservation as defined in the dependent variable. This is intuitively reasonable, since the dependent variable was biased toward the wheat–sheep zone and the cropping industries.

The influence of technical advice of a generally less practical nature was not found to be statistically significant in any zone or for Australia as a whole In view of the greater influence of the more 'hands on' forms of technical advice, and the implication that landholders are more receptive to practical forms of advice, it could be that government resources relating to educating landholders about land degradation and soil conservation might best be aimed at these forms of advice.

With time-series data collected over the 1990s, it will be possible for ABARE to undertake more rigorous analyses of the underlying economics of soil conservation. These further analyses should assist in verifying or modifying the conclusions drawn in this paper. It is possible that these could be done at a regional level. In addition, ABARE may be able to identify trends in investment in soil conservation and determine the impediments and incentives which determine landholders' investments in soil conservation. Finally, further research is required to examine the relationship between the landholder's

perception of the need for soil conservation, the decision to invest, and the actual investment. This is one area to which questions in subsequent supplementary surveys could be targeted.

References

ABARE 1992, Land management and financial conditions on Australian farms. Paper presented at the National Agricultural and Resources Outlook Conference 1992, 4–6 February, Canberra.

Bardsley, P. and Chambers, R.L. 1984, 'Multipurpose estimation from unbalanced samples', *Applied Statistics*, vol. 33, no. 3, pp. 290–9.

Commonwealth of Australia 1991, *Decade of Landcare Plan: Commonwealth Component*, AGPS, Canberra.

Ervin, C.A. and Ervin, D.E. 1982, 'Factors affecting the use of soil conservation practices: hypotheses, evidence and policy implications', *Land Economics*, vol. 58, no. 3, pp. 277–92.

Reeve, I.J. 1988, *A Squandered Land: 200 Years of Land Degradation in Australia*, Rural Development Unit, University of New England, Armidale, New South Wales.

Sinden, J.A. and King, D.A. 1990, 'Adoption of soil conservation measures in Manilla shire, NSW', *Review of Marketing and Agricultural Economics*, vol. 58, no. 2, pp. 105–92.

Studenmund, A.H. and Cassidy, H.J. 1987, *Using Econometrics: A Practical Guide*, Little, Brown and Company, Boston.

Yapp, T.P. and Connell, L.J. 1989, A review of factors influencing the adoption of conservation tillage. Paper presented at the 33rd Annual Conference of the Australian Agricultural Economics Society, Lincoln College, Christchurch, New Zealand, 7–9 February.