FACTORS INFLUENCING SOIL CONSERVATION EFFORT AND ADOPTION ON COMMERCIAL FARMS IN KWAZULU-NATAL

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As an extension of the findings presented in a previous article, logistic and multiple regression are used to estimate models representing soil conservation adoption and soil conservation effort respectively. A single conservation adoption model is estimated based on results in the previous article.. The model shows sufficient financial resources, farm enterprise types, farmers' willingness to invest own capital in conservation activities, awareness of erosion's adverse implications for agricultural productivity and visible erosion impacts, significantly affect adoption. In addition, variables reflecting farmers' technical abilities to implement conservation measures are significantly correlated to those in the adoption model. Conservation effort is dependent on the following financial factors: farmers' willingness to invest own capital in conservation activities, debt repayment obligations, and on-farm financial benefits from implementing conservation activities. These findings illustrate the significance of financial characteristics necessary for extensive implementation of soil conservation measures once adoption has been initiated, and highlight the distinction between conservation adoption and conservation effort. The variable reflecting subsidy payments for implementing soil conservation practices is not significant in either model. This suggests the effectiveness of current subsidy payment provisions provided for in Act 43/1983, in initiating incentives for implementing soil conservation measures, need to be clarified.

FAKTORE WAT GRONDBEWARINGSPOGINGS EN AANVAARDING OP KOMMERSIËLE PLASE IN KWAZULU - NATAL BEÏNVLOED

As verlengstuk van die bevindings wat in 'n vorige artikel aangebied is, word logistiese en veelvoudige regressie gebruik om modelle daar te stel wat onderskeidelik grondbewaringsaanvaarding en grondbewaringspogings uitbeeld. 'n Enkele bewaringsaanvaardingmodel word gepas gebaseer op resultate in die vorige artikel. Die model toon dat voldoende finansiële hulpbronne, plaasbedryfsoorte, boere se bereidwilligheid om eie kapitaal in bewaringsbedrywighede te belê, bewustheid van erosie se nadelige implikasies vir landbouproduktiwiteit en sigbare erosie-impak, aanvaarding aansienlik raak. Veranderlikes wat boere se tegniese vermoëns om bewaringsmaatreëls toe te pas reflekteer, word boonop met dié in die aanvaardingsmodel gekorreleer. Bewaringspogings is afhanklik van die volgende finansiële faktore: boere se bereidwilligheid om eie kapitaal in bewaringsbedrywighede te belê, skuldterugbetalingsverpligtinge, en finansiële voordele op die plaas uit die toepas van bewaringsbedrywighede. Hierdie bevindings illustreer die betekenis van die benodigde finansiële kenmerke vir uitgebreide toepassing van grondbewaringsmaatreëls as aanvaarding geïnisieer is, en onderstreep die onderskeid tussen bewaringsaanvaarding en bewaringspogings. Die veranderlike wat subsidie betalings vir die toepas van grondbewaringspraktyke weerspieël, is nie in een van die twee modelle betekenisvol nie. Dit suggereer dat die doeltreffendheid van die huidige subsidiebetalingsbepalings waarvoor in Wet 43/1983 voorsiening gemaak word om aansporings vir die implementeer van grondbewaringsmaatreëls te inisieer, duideliker uitgespel moet word.

1. Introduction

Given the seriousness of the erosion problem in South Africa, soil conservation strategies should ultimately aim to achieve widespread tangible reductions in erosion. In this regard, Ervin and Ervin (1982: 291), argue that adoption of soil conservation practices and soil conservation effort are not conceptually substitutable, despite the obvious link between the two. They contend that conservation adoption is associated with the number of different conservation practices implemented and does not correspond to effectiveness or extensiveness of their use (Ervin and Ervin, 1982: 280), while conservation effort reflects the extensiveness and effectiveness of conservation practices applied on a farm (Ervin and Ervin, 1982: 281).

The following example illustrates this difference. A livestock farm utilising a rotating camp system, while only adopting one type of conservation practice may be effectively conserved, thus representing a low level of adoption and a high level of conservation effort. Alternatively, a mixed enterprise farm with several different types of conservation practices may only be partially conserved, indicating high levels of adoption and low levels of conservation effort. This distinction has important implications for policy formulation, since factors affecting adoption decisions will not necessarily provide information pertaining to soil conservation effort (Norris and Batie, 1987: 80).

In a previous article (Barlow, Nieuwoudt and Levin, 1995), factors influencing specific stages in the conservation adoption process are identified, and results provide information about the variety of constraints farmers face when implementing soil conservation measures. These indicate how South Africa's existing soil conservation policy can be improved to encourage adoption of soil conservation practices. Nevertheless, if the primary objective of soil conservation policy is to minimise erosion, it is imperative that factors affecting the extent to which soil conservation is applied, are also considered.

Therefore, the primary objective of this study is to test theoretical relationships, establish the relative importance of, and distinguish between factors motivating or constraining conservation adoption and conservation effort. As in the previous article, this research relies on studies completed in the United States. However, most of these do not specifically differentiate between conservation adoption and conservation effort. Ervin and Ervin (1982: 281) acknowledge that variables affecting adoption are also expected to motivate effort, although in different ways.

Logistic and multiple regression models are used to specify conservation adoption and conservation effort models respectively. It is envisaged that results will complement those in Barlow *et al.* (1995) providing more comprehensive information that may emphasise short-comings in the current soil conservation policy and be useful in recommending improvements.

2. Conceptual models

Models that have been used to define conservation adoption and conservation effort are outlined below.

2.1 Conservation adoption

Conservation adoption relates to the use of different types of soil conservation practices, and is hypothesised to incorporate various stages reflecting constraints within the adoption-decision process.

Based on the results presented in Barlow *et al.* (1995) and therefore incorporating the need to overcome the various constraints, the following variables are expected to have positive impacts on adoption: personal factors (agricultural education levels, knowledge of erosion's implications for the broader environment, technical conservation management skills), physical factors (effects of reductions in agricultural productivity due to erosion, visible erosion impacts, predominantly crop enterprises), and financial factors (farmers' that invest their own capital when implementing conservation practices, perceptions about financial and managerial benefits derived from soil conservation). In addition, institutional factors (relating to the discovery of violations specified in Act 43/1983 and subsequent prosecutions), are also expected to influence adoption decisions positively.

Larger off-farm incomes, the more farm area owned relative to that operated, and the importance of on-farm or individual benefits derived from reducing off-site erosion impacts are expected to have negative impacts on adoption.

2.2 Conservation effort

Possibly the most appropriate measure of conservation effort is the difference between the estimated farm erosion rate without conservation practices and that erosion rate where practices are used (Ervin and Ervin, 1982: 282). It was not possible to collect this information for this study.

Norris and Batie (1987:80), measure conservation effort using total capital expenditures and operation and maintenance expenses for soil conservation practices. They concede these expenditures do not consider the amount of soil conservation achieved, and rather reflect farmers' willingness and ability to actually use conservation practices. Prundeanu and Zwerman (1958) use a physical measure of conservation effort, represented by the extent to which conservation measures, as recommended by Soil Conservation Service technicians, had been implemented on individual's farms (*Ibid*, 1958:904).

Since implementing all the farm's necessary soil conservation practices is likely to involve large expenditures, financial factors are expected to be the most important explanatory variables in this model.

The hypothesised relationship between effort and debt is uncertain. Higher debt obligations could mean less capital available for conservation expenditure and therefore the relationship would be negative. However, when farmers use their land as collateral to obtain credit, financial institutions may stipulate a conservation plan to protect their collateral. Alternatively, debt finance may be a source of funds for conservation expenditures, and in both these cases the relationship between debt and effort would be positive (Featherstone and Goodwin, 1993: 70-71). Financial variables expected to influence effort positively represent the effect of existing conservation measures on farm profit, farmers investing their own capital when implementing the required conservation measures, less risk averse farmers, and those favouring subsidies for implementing conservation measures. Similarly, farmers deriving most of their family income from the farm business are expected to protect their source of income, and so conserve their land (Nielsen *et al*, 1989: 12).

Personal factors, such as conservation management skills, intention to pass a farm on to a family member, education, and perceptions about the costs and benefits of soil conservation are presumed to have a positive influence on effort. In addition, years of farming experience is expected to capture knowledge gained about the importance of soil conservation, and a time period long enough for all required conservation measures to be implemented.

Institutional factors relating to the discovery of violations specified in Act 43/1983 and subsequent prosecutions, physical factors concerning farm enterprise types and erosion impacts, and information variables (agents and media providing information on soil erosion and conservation decisions), are included in the analysis and are expected to have positive impacts on effort. Prominent erosion impacts are expected to be associated with less conservation effort, and as hypothesised for the adoption-decision models, the relationship between enterprise type and effort is uncertain.

3. Model estimation procedures

Logistic and linear regression techniques are used to estimate the conservation adoption and conservation effort models respectively.

3.1 Conservation adoption model

Conservation adoption is defined as the ratio of the number of different types of soil conservation practices used on a farm, to the maximum number applicable for a particular farm enterprise mix. Table 1 shows percentages reflecting farmers' use of the following conservation practices: contouring (run-off control), conservation structures in dongas[1)], minimum tillage, and rotating camps.

Table 1: Use of conservation practices on sample farms in KwaZulu - Natal (1993)

Conservation practice	Percentage of farmers using practices
Contouring (run-off control)	87.8
Conservation structures in dongas	52.6
Minimum tillage	35.6
Rotating camps	66.7
Windbreaks	8.3

Contouring (run-off control), conservation structures in dongas, minimum tillage, and rotating camps are deemed applicable soil conservation practices for farms with both crop and livestock enterprises. Adoption scores for mixed farms are therefore out of four. Rotating camps and minimum tillage are not applicable if farms have only crop or only livestock enterprises respectively, and adoption scores for single enterprise farms are out of three. Windbreaks are excluded as a possible conservation measure as only 13 farmers indicated using them and this is highly site-specific.

Consequently, the dependent variable has a range of possible values between zero and one, and logistic regression is utilised to assess variables influencing conservation adoption using Genstat (Payne *et al*, 1987). This adoption model predicts the probability that a farmer will adopt all applicable conservation practices according to the farm enterprise mix. The logistic regression technique is described in paper one.

The same three stage procedure outlined in Barlow *et al.* (1995) was used to derive principal component (PC) explanatory variables for this adoption model. However, the model estimated using these PCs was not statistically significant. Therefore, individual variables were standardised, to avoid interpretation problems that may arise due to different units of measurement, and these are used to estimate the model using a stepwise procedure. At each step, the contribution made by the additional variable to the model is assessed. If the change in residual deviance between models with and without this variable is significant (based on the chi-square statistic), then the variable significantly improves the model and is retained despite any correlation with other variables already in the model.

As with the models estimated in the previous article (Barlow *et al., 1995)*, dummy variables for farm region were regressed on the adoption model's dependent variable, to establish if there are regional differences that significantly influence adoption. Similarly, to ascertain whether definitions for the adoption dependent variable for specific farm types are significantly different from each other, two dummy variables distinguishing between crop, livestock, and mixed farms were regressed in the final model. The significance of these dummy variables has implications for interpreting the model correctly.

3.2 Conservation effort model

Farmers provided estimates of the percentages of arable land and veld on their farms currently protected with soil conservation practices, and these are used to approximate conservation effort on crop and livestock farms respectively. For farms with both crop and livestock enterprises, the sum of weighted averages of percentages for arable land and veld, (according to their respective areas), are assumed to represent conservation effort. This is similar to the measure used by Prundeanu and Zwerman (1958), and although incomplete in that it does not necessarily reflect conservation effectiveness, it is the most appropriate considering the available data.

This model is estimated using linear regression analysis. It is appropriate to use a natural logarithmic transformation for the dependent variable (Y_i), when this has a relatively wide range of values (Steel and Torrie, 1988: 235), as is the case in this study. In linear regression analysis, when Y_i is in log form, model parameters represent the constant relative change in Y_i given a unit change in the corresponding explanatory variable (X_i). Multiplying model coefficients by 100 will indicate the percentage change in Y_i for unit changes in X_i (Gujarati, 1988: 147-148). To avoid complications where respondents may have recorded zero conservation effort, one was added to each conservation effort value prior to the logarithmic transformation. SPSS is used to analyse the conservation effort model (SPSS Incorporated, 1990).

A principal component analysis, following the same procedure described in paper one, is also used to reduce the number of explanatory variables for this model. These principal components (PCs) are regressed on the transformed conservation effort variable using the enter method for entering explanatory variables into the model. Dummy variables for farm region were also regressed on this model's dependent variable.

4. Data source and respondents' characteristics

The methodology employed to collect data for this analysis is described in section four of Barlow *et al.* (1995).

Sixty-seven percent (98 farmers) believe implementing all the farm's necessary soil conservation measures would be financially beneficial to their farming operation, while 80 percent (114 farmers) perceive this would improve managerial activities. Sixty-two percent (95 farmers) report the effect of existing conservation measures on the farm's profitability as beneficial. Excluding any government financial assistance, 39 percent of those sampled (59 farmers) believe economic returns to soil conservation measures outweigh the costs of implementation in the short-term, and 72 percent (111 farmers) envisage this in the long-term. Seventeen percent (26 farmers) were 'undecided' in each case.

Only 19 percent of respondents (29 farmers) indicate they are not aware of legislation under which farmers may be prosecuted for having excessive levels of erosion on their farms. Ninety percent believe this legislation should be binding on the landowner, 60.5 percent believe it should be binding on the farm manager, and 58.1 percent believe it should apply to both these parties.

5. Results

5.1 Conservation adoption model

Two techniques are used in assessing how well the stepwise logistic regression model fits the data. Firstly, the significance of the change in residual deviance (based on the chi-square statistic) indicates both the number and specific variables needed to define the model adequately (see 3.1). Secondly, as with the models in paper one, cases correctly classified by the predicted model are an indication of the model's goodness of fit (Norušis, 1990: 50). Again, cases used for classification are also used to predict the model, therefore cases correctly classified may be slightly biased upwards. Table 2 defines variables that are retained in the conservation adoption model.

Results from the stepwise logistic regression are presented in Table 3, where variable labels and their coefficient estimates (B_i) are indicated in the first and second columns respectively. The third column shows t-values which test the null hypothesis that corresponding variable coefficients are zero. Exponential (B_i) or Exp (B_i) presented in the last column is the factor by which the odds, or probability in favour of having the attribute, changes when the independent variable increases by one unit (Norušis, 1990: 49). As variables are standardised, only the relative magnitude of (B_i) can be interpreted. The estimated model correctly classifies 70.3 percent of cases in the sample.

Table 2: Definitions for variables that are significant in the conservation adoption model

Units of measurement for variables are based on a Likert-type scale of one (low) to five high), unless percentages or dummy variables are specified. Label definitions are as follows:

Rivest	=	frequency with which farmers invest their own capital when implementing soil conservation measures.
Cropor	=	proportion of farm area currently cropped percentage).
Losprd	=	reflecting perceptions that erosion causes losses in agricultural productivity.
Erofm	=	percentage of farm area visibly eroded.
Fincap	=	sufficient financial resources to implement all soil conservation practices required for the farm (dummy variable: yes = 1, no = 0).

Table 3: Logit model; factors affecting adoption of all applicable soil conservation measures on farms sampled in KwaZulu - Natal (October) 1993)

Dependent variable = probability in favour of farmers adopting all applicable soil conservation practices according to the farm enterprise mix

Variable	Coefficient estimate (B_i)	T-values	Exp (B_i)
Constant	0.61**	6.75	
Rivest	0.20**	2.13	1.22
Cropor	-0.34**	-3.32	0.77
Losprd	0.19**	2.03	1.21
Erofm	0.26*	1.91	1.30
Fincap	-.21**	1.97	1.23

Change in Deviance - 2.80
Chi-square 10% significance level for 6 df = 2.20

** = significant at 5% based on t-value
* = significant at 10% based on t-value

Number of cases included in this analysis: 130
Overall classification: 70.3%

Neither those dummy variables distinguishing between crop, livestock, and mixed farms, or those to capture farm regional differences, are significant. This implies the definition for the adoption dependent variable for specific farm types is not statistically significantly different, and similarly that there are no farm regional differences. However, the dummy variables for the predominantly livestock regions, Dundee and Estcourt, are negatively correlated to Cropor at the one percent level of significance.

Larger proportions of cropped land (Cropor), reduce the probability that all applicable conservation measures will be adopted. This result is unexpected, particularly since this variable has a positive influence on financial ability. This irregularity may be explained by the fact that Cropor is highly correlated with the dummy variables for the predominantly livestock regions. This variable may be capturing regional differences that have a negative impact on the probability of adoption. Alternatively, although minimum tillage is considered an applicable soil conservation practice on farms with crop enterprises, it is not widely adopted in areas sampled. As shown in Table 1, only 35.6 percent of respondents use this conservation measure, and this may explain the negative influence of Cropor on the probability in favour of adopting all applicable conservation practices. Increased weed and pest control and associated higher management skills required under minimum tillage, may be reasons why it is not widely adopted (Klein and Wicks, 1987: 319).

Visible erosion on individual's farms (Erofm), perceptions that erosion causes losses in agricultural productivity (Losprd), farmers investing their own capital when implementing conservation measures (Rivest), and adequate financial resources to implement conservation activities (Fincap), all enhance the probability of adoption. It should be noted that, due to the stepwise procedure used to estimate this model, variables correlated with those retained in the model[2)] (in particular those representing conservation management skills and regular attendance at soil conservation courses) are also likely to have significant impacts on adoption.

This conservation adoption model contains variables representing, or at least correlated to (at the one percent level of significance), attributes of each stage presumed to influence adoption. Therefore it supports the hypothesis that farmers face a variety of constraints when deciding to implement conservation measures. It is interesting to note that although financial resources have significant positive implications for adoption, the variable reflecting subsidy payments for implementing conservation practices, as provided for in Act 43/1983, is not significant.

Mean predicted probabilities for the adoption model P(ADOPT), in every region and for the whole sample are presented in Table 4. These are calculated by substituting variable values for each case into the predicted model. An analysis of variance was conducted on logit scores, and the F-statistic used to test for significant differences between regions (Steel and Torrie, 1981: 96). Dummy variables for farm region are not significant, and differences between regions for conservation adoption, as indicated by the significant F-statistic, can be attributed to variations in the model's explanatory variables.

The mean P(ADOPT) score is 0.64, and differences between regions are attributed to the frequency with which farmers invest their own capital when implementing soil conservation measures (Rivest), the proportion of arable land on a farm (Cropor), and whether there are sufficient financial resources available to implement all the farm's required soil conservation measures (Fincap). As with the other two variables, the mean score for Fincap is high for respondents in the Dalton/Wartburg region compared to those from Estcourt. However, although Dalton/Wartburg boasts the highest probability scores for all the previous models, it has the lowest P(ADOPT) score. It is likely that this is due to the negative influence of Cropor on P(ADOPT), and possible explanations for this have already been discussed.

Table 4: Mean predicted probabilities for the adoption model for each area sampled in KwaZulu - Natal (October 1993)

Farming area	P (Adopt)
Entire sample	0.64
Daltwon/Wartburg	0.60
Camperdown/Eston	0.64
Dundee	0.65
Estcourt	0.67
Winterton	0.64
F-statistic	2.24
Significance level	0.07

5.2 Conservation Effort model

Four PCs are shown to be significantly related to the transformed conservation effort variable, using the enter method for entering explanatory variables into the model. These are presented in Table 5.

Principal component EFF1 represents the value of short-term farm financial and managerial benefits derived from implementing soil conservation practices. EFF3 measures the effects of farms' debt repayment obligations, and EFF4 reflects the frequency with which farmers invest their own capital in soil conservation activities, the availability of financial resources required to implement all soil conservation practices required for the farm, and farmers' intentions to pass their farm on to a family member or relation. Finally, observable erosion impacts, either visibly or through their effect on farm input use, yields, or income, are captured by EFF5.

Results for this linear regression model are presented in Table 6. If coefficients, (B_i)s, are multiplied by 100, they represent the percentage change in conservation effort given a unit change in the corresponding principal component. Only the relative magnitude of this change can be interpreted rather than its absolute value, because PCs are measured in standardised units. Despite the low value for adjusted R^2, the signs of the estimated coefficients agree with prior expectations and t-values show these to be statistically significantly different from zero. This is supported by the highly significant F-value (Gujarati, 1988: 123), and the model therefore adequately represents those PCs that have a significant influence on conservation effort.

Farmers realising there are short-term farm financial and managerial benefits to be derived from implementing soil conservation measures (EFF1), are likely to demonstrate more conservation effort. This PC has the largest positive impact on effort levels. The positive relationship between debt repayment obligations (EFF3) and conservation effort suggests debt finance is a source of funds for conservation expenditures, or that lending institutions are more likely to approve loan capital to farmers if an extensive conservation plan has been implemented.

Levels of conservation effort improve with increases in the frequency with which farmers invest their own capital when implementing conservation activities, and if there are sufficient financial resources to implement all soil conservation practices required for the farm (EFF4). Farmers with these characteristics also intend to pass their farm on to a family member or relation. The adverse effects of erosion (EFF5) are negatively related to conservation effort. Obviously, if farmers have visible erosion on their farms, and are experiencing excessive soil loss with corresponding impacts on inputs, yields, or income (Impct), they are likely to have much lower levels of conservation effort.

Table 5: Details of principal components significantly related to the natural logarithm of the conservation effort variable

Principal component label		Variables with component loadings greater than 0.3
EFF1	=	0.86* Savmon + 0.74* Pnthvt + 0.72* Conpft
EFF3	=	0.80* Dbtass + 0.79* Dbtrep
EFF4	=	0.84*Rivest + 0.68* Pasfm + 0.51* Fincap
EFF5	=	0.77* Erofm + 0.72* Impct

Units of measurement for variables are based on a Likert-type scale of one (low) to five (high), unless percentages or dummy variables are specified. Label definitions are as follows:

Savmon = adoption of conservation practices save farmers money due to lower input costs.
Pnthvt = adoption of conservation practices reduces time required to plant and harvest.
Conpft = adoption of conservation practices increases farm profits for those using them.
Dbtass = debt to asset ratio on the farm business (percentage).
Dbtrep = percentage of farm turnover spent annually on debt repayment.
Rivest = frequency with which farmers invest their own capital when implementing soil conservation activities.
Pasfm = intention to pass farm on to a family member or relation (dummy variable: yes = 1, no = 0).
Fincap = sufficient financial resources to implement all soil conservation practices required for the farm (dummy variable: yes = 1, no = 0).
Erofm = percentage of farm area visibly eroded.
Impct = experience of circumstances where significant soil loss has had impacts on inputs, yields, or income (dummy variable: yes = 1.. mp = 0).

Table 6: Linear regression model; factors affecting conservation effort on farms sampled in KwaZulu - Natal (October 1993)

Dependent variable = logarithmic transformation of percentage values reflecting arable land and veld on respondents' farms, currently protected with conservation practices		
Variable	Coefficient estimate (B_j)	T-values
Constant	4.22**	48.55
EFF1	0.28**	3.07
EFF3	0.19*	2.05
EFF4	0.19*	2.23
EFF4	-0.16*	-1.98

Adjusted R^2 13.2%
F-value 5.45**

** = significant at 1% based on t-value
* = significant at 5% based on t-value

Number of cases included in this analysis: 150

Dummy variables for farm region are not significant in this model, and therefore apparent differences in conservation effort between regions can be explained in terms of variations in explanatory variables in the model. This model emphasises erosion's effects must become conspicuous before the need for soil conservation is realised, and that financial characteristics, in terms of availability of money for conservation expenditures and benefits of cost savings and higher profits, are important to encourage higher levels of conservation effort.

Mean predicted levels of conservation effort in every region and for the whole sample are presented in Table 7. These are calculated by substituting PC values for each case into the predicted model. An analysis of variance was conducted to test for variations in conservation effort between regions. To ensure validity of the test, it is conducted on the logarithmic transformation of the variances (Steel and Torrie, 1981: 235). The F-statistic shows there are no statistically significant differences between regions for conservation effort.

Table 7: Mean predicted levels of conservation effort represented as percentages, for each area sampled in KwaZulu - Natal (October 1993)

Farming area	Level of conservation effort (%)
Entire sample	73.9
Daltwon/Wartburg	79.1
Camperdown/Eston	76.1
Dundee	76.2
Estcourt	67.6
Winterton	70.0
F-statistic	0.69
Significance level	0.60

Results in Table 7 indicate farms in the Dalton/Wartburg district have the highest level of conservation effort, and those in the Estcourt region, the lowest. However, P(ADOPT) scores for these two regions are 0.60 and 0.67 respectively. If the lower P(ADOPT) score for Dalton/Wartburg is explained by the fact that only 30.8 percent of respondents from this region use minimum tillage, then these results support the hypothesis that conservation adoption and conservation effort are not substitutable. Although farmers in the Estcourt region are more likely to adopt a greater variety of soil conservation practices compared to farmers from Dalton/Wartburg, their effectiveness and extensiveness could be substandard.

Table 8 summarises predicted levels of conservation effort for the farms in the sample. Almost a quarter, 24.4 percent, of the farms in the sample show levels of conservation effort greater than 80 percent, and approximately 32 percent have effort levels below 50 percent.

It is difficult to judge the extent of the erosion problem in these farming areas, from these figures. However, due to the uncertainties surrounding the erosion problem, these results suggest substantial improvements in soil conservation effort are required.

Again, although these models correctly classify a relatively high percentage of cases in the sample, it is unlikely they represent all explanatory variables influencing soil conservation decisions. The limitations in this type of analysis are given in Barlow *et al.* (1995) and the following further conclusions for soil conservation policy formulation can be derived.

6. Conclusions

Data from 159 commercial farms in KwaZulu-Natal are used to assess factors influencing soil conservation adoption and effort. Variables associated with adoption are identified using logistic regression, while factors influencing conservation effort are determined using linear regression analysis. Results from the adoption model enforce the hypothesis that farmers face a variety of constraints when adopting conservation practices, while conservation effort is shown to be specifically related to financial factors.

Visible erosion on individual's farms, perceptions that erosion causes losses in agricultural productivity, farmers investing their own capital when implementing conservation measures, and adequate financial resources to implement conservation activities, all have positive impacts on adoption. Furthermore, variables reflecting technical abilities to implement conservation measures, are positively correlated at least at the five percent level of significance, to those in the adoption model. The significance of these results enforce expectations that farmers face more than financial constraints when adopting soil conservation measures.

Table 8: Summary of predicted levels of conservation effort on farms sampled in KwaZulu - Natal (October 1993)

Level of conservation effort (%)	Frequency (number of farmers)	Percent	Cumulative percent
80 - 100%	29	24.4	24.4
60 - 79%	34	28.6	52.9
50 - 59%	18	15.1	68.1
41 - 49%	17	14.3	82.4
0 - 40%	21	17.6	100.0

The negative impact of the proportion of farm area under crops has on adoption suggests crop farmers require information promoting minimum tillage as an effective soil conservation practice. Farmers need to be convinced that benefits of using minimum tillage outweigh additional costs incurred.

The conclusion that farmers who invest their own capital in conservation activities are more likely to adopt, has several implications for future research and policy formulation. Firstly, factors motivating farmers to invest their own capital need to be identified. Indications are that these relate to farmers' knowledge about erosion's impacts and benefits of soil conservation, and their subsequent worth being reflected in farm land values in a well functioning land market. Secondly, despite financial characteristics being potentially major constraints, subsidy payments for implementing conservation practices, as provided for in Act 43/1983, are not significantly related to adoption. Since over 80 percent of respondents are aware of soil conservation legislation, this suggests transactions costs incurred when applying for soil conservation subsidies, as provided for in the Conservation of Agricultural Resources Act 43/1983, may exceed the benefits of doing so.

This conclusion is supported by results from the conservation effort model. These emphasise the significance of financial characteristics for extensive implementation of soil conservation measures once adoption has been initiated, yet the variable reflecting subsidy payments for implementing conservation practices is not significantly related to effort either.

Physical characteristics representing erosion's prominent impacts, and the following financial factors are primarily related to effort. Farmers investing their own capital in conservation activities, and those perceiving on-farm managerial and financial benefits from soil conservation, are likely to demonstrate greater levels of conservation effort. The positive relationship between farm debt and effort enforces proposals that debt is a source of funds for conservation expenditures, and a well functioning land market would explain incentives behind this. Results support the hypothesis that conservation adoption and effort are not substitutes, and emphasise the need to clarify the effectiveness of current subsidy payment provisions.

Notes

1) Gullies created by excessive erosion.

2) A correlation matrix is provided in Table 9 in the appendix.

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Appendix

Table 9: Correlation matrix for variables correlated with those retained in the Conservation Adoption model. (Variable labels are defined on the following pages)

	EROFM	LOSPRD	RIVEST	FINCAP	CROPOR
EROP	.38**	-.10	.12	-.11	-.10
SPROB	.25**	.03	.02	-.16	-.22**
EROB	.30**	-.04	.12	-.19*	-.25**
IMPCT	.17*	-.01	.04	.10	.10
RCORSE	.21*	.05	.16	.24**	.18*
TIMPOR	.18*	.09	.10	.14*	.13
EXPFT	-.18*	-.05	-.02	.01	-.15
ERPROS	.18*	.03	.04	-.05	-.01
ENVIR	.00	.33**	-.09	-.07	-.08
CONSKL	-.01	.26**	.22**	.01	.10
PRCPCON	.15	.23**	.04	.16	.22**
FINE	.02	.33**	.05	.02	.01
RESPCT	.03	.33**	-.01	.24**	.02
FMRGHT	.06	.35**	.02	-.09	.23**
LDVAL	-.01	.17*	.18*	.17*	.11
RHELP	.15	.20*	.07	.15	-.01
RINTRO	-.01	.07	.34**	.10	.37**
FINCAP	-.14	.15	.27	1.00	1.00
CROPOR	-.02	.04	.24**	.37	-.26**
OFFMIN	-.05	.07	-.18*	-.11	-.36**
ATTENT	.08	.13	-.17*	-.10	.24**
RIVEST	.12	.08	1.00	.27**	-.17*
COMPFM	.12	.00	.01	-.17*	.11
CONCOM	.11	.16	.08	.20*	-.17*
BYFM	.03	.07	-.11	-.07	.20*
FLDDYS	.19	.08	-.03	.07	
** = Significant at 1% level		* = Significant at 5% level		(2-tailed)	

Definitions for variable labels specified in Table 9

Units of measurement for variables are based on a Likert-type scale of one (low) to five (high), unless percentages or dummy variables are specified.

EROFM	=	percentage of farm area visibly eroded.
LOSPRD	=	bad conservation practices cause losses in productivity.
RIVEST	=	frequency with which farmers invest own capital when implementing soil conservation practices.
FINCAP	=	sufficient financial resources to implement soil conservation practices (dummy variable: yes = 1, no = 0).
CROPOR	=	proportion of farm area currently cropped (percentage).
EROP	=	extent of erosion problem on farm considering climate and soils types.
SPROB	=	seriousness of erosion problem in farming area.
EROB	=	extent of erosion on the farm when the farmer began managing it.
IMPCT	=	past and current experience of circumstances where significant soil loss has had impacts on inputs, yields, or income (dummy variable: yes = 1, no = 0).
RCORSE	=	frequency with which farmers attend soil conservation courses.
TIMPOR	=	proportion of farm area currently under timber (percentage).
EXPFT	=	positive effect of existing conservation measures on farm profit.
ERPROS	=	chances of prosecution having violated soil conservation legislation.
ENVIR	=	index reflecting perceived seriousness of erosion impacts on the environment.
CONSKL	=	own ratings of relative soil conservation management skills.
PRCPCON	=	index reflecting perceptions about on-farm financial and managerial benefits of soil conservation activities.
FINE	=	farmers not using soil conservation measures should be liable for heavy fines.
RESPCT	=	land owners have responsibilities to protect soil resources for future generations.
FMRGHT	=	farmers do not have the right to use their land in ways that cause damage to resources.
LDVAL	=	bad conservation practices reflected in lower land values (dummy variable: yes =1, no = 0).
RHELP	=	frequency with which farmers help others implement and/or maintain soil conservation practices.
RINTRO	=	frequency with which farmers implement soil conservation measures with no outside technical assistance.
OFFMIN	=	current proportion of family income from off-farm sources (percentage).
ATTENT	=	insufficient attention is paid to soil conservation programs.
COMPFM	=	the government should compensate farmers who adopt soil conservation measures.
CONCOM	=	soil conservation committees provide valuable information on soil erosion and conservation.
BYFM	=	bought farm (dummy variable: yes = 1, no = 0).
FLDDYS	=	field days/conferences provide valuable information on soil erosion and conservation.