To the Graduate Council:

I am submitting herewith a thesis written by Susan F. Jamnick entitled "A Logit Analysis of No-Till Users in Henry County, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Thomas Klindt

Thomas H. Klindt, Major Professor

We have read this thesis and recommend its acceptance:

William M. Park

Glen D. Whipple

Accepted for the Council:

CW Minkel

The Graduate School

A LOGIT ANALYSIS OF NO-TILL USERS IN HENRY COUNTY, TENNESSEE

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ABSTRACT

The objective of this thesis was to determine the social and economic characteristics of farmers and the physical characteristics of the farm associated with the use of no-till. Data for this research were obtained from a 1981 random survey of row crop farmers in Henry county, Tennessee.

A logit model was used to analyze the data. The dependent variable in the model was a (0,1) binary variable indicating whether or not the farmer used no-till. Twelve explanatory variables were included in the logit model, five of which were statistically significant.

The results of this analysis indicated that the probability of adoption of no-till by farmers in Henry county, Tennessee increases with: (1) increasing age of the farmer, (2) greater number of acres operated by the farmer, (3) farmers whose primary occupation is not farming, (4) greater proportion of land experiencing erosion problems and, (5) increasing use of other conservation practices.

This study concluded that the use of no-till is influenced by both economic and environmental factors. The ability to finance farm operations increases with the age of the farmer (since older farmers generally carry less debt) and generally increases with the size

of farm operation. Part-time farmers who have an outside source of income may be willing to take on more risk than farmers whose primary occupation is farming. If these are the reasons that these variables behaved as they did, then policies which subsidize the use of no-till among farmers who do not have the above characteristics may promote the use of no-till among farmers in Henry county.

The environmental factors which influence the use of no-till are the greater proportion of land experiencing erosion problems and increasing use of other conservation practices. These factors suggest that farmers who have a peroeption of the erosion problem and who show an inclination, through the use of other conservation practices, to minimize erosion are most likely to use no-till than farmers without these characteristics. Thus policies such as information and education which increase the perception of the erosion problem and give technical assistence in conservation practices may help promote the use of no-till in Henry county.

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CHAPTER I

INTRODUCTION

Problem and Objectives

West Tennessee, which consists of 6.8 million acres between the Tennessee River on the east and the Mississippi River on the west, is considered the most agriculturally productive portion of the state (Resources in Review, 1980). The soils that characterize the area are silt-loam in nature, and easy to farm, but the combination of gently sloping hills and these soil types produces serious erosion problems.

Soil erosion in West Tennessee has been a recognized problem for several decades. During the 1950's one million acres of farmland were terraced in West Tennessee and other conservation practices such as contour farming, reforestation of land, and planting of cover crops were used. During this period much of the highly erodable land was taken out of row crop production (Resources in Review, 1980). These efforts of the 1950's were not enough however, to curtail soil erosion. During the 1960's and the 1970's the problem of soil erosion in West Tennessee increased due to increased demand for soybeans. At times erosion rates have been ten times the national average (Resources in Review, 1980).

Farmers have increasingly become more concerned about soil erosion. They are generally aware that excessive soil loss can result in higher costs of production and lower crop yields and thus a reduction in net farm income (Hudson, 1981). To try to alleviate excessive erosion, many farmers have adopted soil conservation techniques. One soil conservation practice presently increasing in use is no-tillage agriculture. No-tillage agriculture (no-till), a form of conservation tillage, has been defined as:

> placing the crop seed or seed transplant into the soil by a device that opens a trench or slot through the sod or previous crop residue only sufficiently wide or deep to receive the seed or transplant roots and to provide satisfactory seed or root coverage. No other soil manipulation is required. Weeds are controlled by herbicides, crop rotation, and plant competition (Young, 1973).

Crosson (1981) has outlined the advantages and disadvantages of conservation tillage systems such as no-till. The two major disadvantages are: (1) that conservation tillage, and no-till especially, requires more herbicides per acre and usually requires more insecticides and/or fungicides per acre than conventional tillage, and (2) more management skills are needed for conservation tillage than for conventional tillage methods. The four advantages of conservation tillage systems are: (1) that it requires less labor per acre, (2) that machinery and equipment costs are less per acre for a farmer who converts completely to conservation tillage, (3) that conservation tillage requires less preharvest fuel (no-till saves three to four gallons of diesel fuel equivalent per acre relative to conventional tillage), and (4) that conservation tillage has been found to reduce soil erosion by fifty to ninety percent relative to conventional tillage. The fourth advantage is perhaps the most important advantage of no-till, especially where soil erosion is a problem.

There are some farmers who will adopt no-till simply because of the economic advantages (reduced costs due to the need for less labor, fuel, etc.) of no-till over conventional tillage systems but, this level of adoption will probably not represent a social optimum. Stoll and Griffin (1981) state that market mechanisms inadequately deal with problems of intergenerational interdependence (soil loss over time and the associated loss of production potential) and water pollution caused by soil erosion. The latter is an obvious technological externality. The presence of these market failures indicates a potential need for policy which addresses the soil erosion problem.

Given the above, policy makers face two issues. The first is to establish viable policy options. The second and equally important is to efficiently direct the policies. If encouraging no-till farming is the policy objective, it seems reasonable to direct policy toward farmers who presently do not use no-till and more specifically, a subgroup of non-users who have a greater probability of adopting no-till than other non-users. Assuming it is desirable to promote the use of no-till in areas where erosion is a problem, how can those farmers who are most likely to adopt no-till be identified? To do so requires an understanding of the factors associated with the adoption of no-till. Therefore, the problem was to identify characteristics (social, economic, and/or physical characteristics of the farm) associated with the users of no-till and to construct a model which can be used to identify potential users of no-till.

The objective of this thesis was to determine the social, economic, and/or physical characteristics of the users of no-till so that farmers with the greatest probability of adopting no-till could be identified.

Study Area

Data for the model presented in this thesis were obtained from a 1981 random survey of crop farmers in Henry county in West Tennessee. Henry county is largely agricultural and has a serious erosion problem which is indicative of West Tennessee. Henry county is also one of the leading no-till counties in Tennessee. It was estimated that in 1980 approximately 25,000 acres of no-till corn and soybeans were planted in Henry county (Resources in Review, 1980). Given the objectives of this study, these characteristics indicate that Henry county is an acceptable study area because the serious erosion problem represents the potential for the use of no-till and a random sample with adequate variation in the variable of interest could be obtained since many farmers use no-till.

Henry county borders Kentucky on the north and the Tennessee River on the east. It consists of 362,880 total acres with 217,724 acres in farms (Census of Agriculture, 1978). There were an estimated 1069 farmers in Henry county and the average size of a farm was 204 acres. Of the 1069 farms, 922 had harvested cropland which consisted of 91,199 acres, and 455 operators were farmers by principle occupation. The average age of an operator was 50.2 years (Census of Agriculture, 1978).

Procedures

A random survey of row crop farmers was conducted during the summer of 1981 in Henry county, Tennessee. Data were collected through personal interviews. It was determined that the crop farmers who would be chosen to participate in the survey would fulfill the criteria of: (1) residing in Henry county, (2) being the household head actively engaged in crop farming, (3) being primarily responsible for making those decisions required in the management of the farm, and (4) owning cropland.

It was determined, given the statistics in the 1978 Census of Agriculture, that a sample size of approximately 150 farmers was desired. To choose the random sample of farmers, the county was divided into 50 blocks with approximately equal numbers of occupied rural residences. Next, these blocks were randomly ordered and all of the crop farmers in a block who met the criteria previously stated were personally interviewed and included in the study.

The survey consisted of various descriptive and attitudinal questions such as size of operation, types of crops grown, whether or not the farmer used no-till, perceived advantages and disadvantages of no-till, ownership characteristics and arrangements, amount of perceived erosion, other conservation practices used, conventional and no-till equipment owned, personal characteristics such as age, education, primary occupation, and years farming, as well as communication and information sources. A copy of the survey used in this study is included in Appendix A. A summary of relevant descriptive statistics obtained from the survey is presented in Chapter IV of this thesis.

Since the objective of this thesis was to determine the characteristics of the users of no-till so that farmers with the most potential for adopting no-till could be identified, it seemed reasonable to use whether or not the farmer used no-till as the dependent variable and the farmer's characteristics as explanatory variables in a regression model. This type of model specification is a binary choice model where the dependent variable is a (0,1) dummy variable. The decision was made, for reasons given in Chapter III, to use a logit model to analyze the data. Specifically, the Logist Procedure (written by Frank Harrell) included in the Statistical Analysis System (SAS) was used for this analysis. The results of the logit analysis are presented in Chapter IV.

Organization of the Study

Chapter II of this thesis, entitled "Review of Literature," consists of a brief literature review of the factors affecting the adoption of soil conservation practices. Chapter III, "Research Methodology," discusses the logit model used in this thesis. The first section of this chapter discusses the reasons for selecting the logit model over other possible models which could have been used to analyze the data. In the second section the method of logit analysis is briefly described. In the final section of the third chapter the model specification is given along with the hypothesized relationships. Chapter IV, the "Results" chapter, first gives relevant descriptive statistics followed by the results of the logit analysis and an example of how the logit model can be used. Finally, Chapter V discusses conclusions and research recommendations.

CHAPTER II

REVIEW OF LITERATURE

Previous Research

Why a farmer chooses to use a particular conservation method may be a very complex decision. Lee (1980) and Lee and Stewart (1983) outline the theory of soil management decisions in the context of maximizing expected net income over a planning horizon. According to these authors, the rational individual would calculate the expected net income effects of the proposed conservation method over time and compare these net income effects to his expected net income over time without the additional conservation method. The farmer would use the method if the expected net income with the conservation method outweighed expected income without the conservation method.

> Within this framework, individuals whose land exhibits similar physical characteristics may reach different conservation decisions depending on their planning horizon and individual time preference or discount rates (Lee and Stewart, 1983).

Longer planning horizons and lower discount rates would tend to encourage the use of conservation measures by increasing expected net revenues and by allowing sufficient time to recoup conservation investments (Lee and Stewart, 1983).

There are many additional factors, economic and personal, which have been found to influence the above decision process. Some of these additional factors are land ownership arrangements, educational level, size of operation, perception of an erosion problem, years farming (farming as a way of life), and attitudes toward profit-making in farming. An extensive literature review concerning the factors affecting the adoption of soil erosion control practices has recently been written by Napier and Forster (1981). A similar, shorter literature review has been written more recently by Ervin and Ervin (1982).

Seitz and Swanson (1980) used the results of four recent studies of farmer's opinions in an effort to understand farmer's beliefs on soil erosion questions. They concluded that farmers perceive the existence of a soil erosion problem and that many farmers believe that they should improve soil conservation on their farms. They also concluded that young farmers, new owners, and farmers already practicing some conservation were most likely to recognize the need for additional conservation practices.

Lee (1980) examined land ownership factors and soil conservation and found that nationally, there were no significant differences in mean soil losses between different types of ownership groups, although there were differences within the Southeast. In the Southeast family ownership units averaged 6.3 more tons/acre of soil loss annually than nonfamily corporations. Lee explained that the distribution of physical factors and management practices differed between these two groups. Lee found that 57% of the land owned by nonfamily corporations was operated using minimum tillage while only 36.4% of the land operated by families had these practices in effect. In addition, cultivated cropland owned by families in the Southeast is apparently more susceptible to erosion than land owned by nonfamily corporations (54% erosion hazard compared to 45% erosion hazard) (Lee, 1980). Lee gave the following reasons for these differences: (1) crops grown may differ between these groups, (2) it is possible that attitudes toward conservation differ between families and corporations, and (3) family landowners in the Southeast are smaller, less affluent, and may have more problems obtaining capital for conservation investments than corporations. Lee also found that mean levels of erosion on cultivated cropland did not significantly differ among net farm income categories nationally or within most regions of the U.S. The relationship between net farm income and mean level of erosion appeared to depend on tenure category of the landowner. Nationally, full owner-operators with relatively high income levels were associated with lower rates of erosion. Lee found this relationship between higher incomes and lower rates of erosion for owner-operators to result from a combination of operating on less erosive land and utilizing more conservation practices. In the Southeast, mean rates of erosion for full owner-operators did not differ among income groups.

In a study of soil erosion rates on rented versus owned land Ervin (1982) found that higher rates of erosion on rented land were produced on farmland that was less erosion prone, indicating lower levels of soil conservation effort on these lands. Ervin also examined the degree of difference in use of conservation practices between rented and owner-operated land. He found that the percentage of owner-operated land in each conservation practice exceeded the corresponding percentage for rented land. Ervin believed that the difference in the percentages might be partially attributable to higher average erosion potential on owner-operated cropland but, the significantly higher erosion rates on rented land imply that tenure and/or associated factors were also important. Ervin found that there was a lack of significant difference for conservation tillage between owner-operated and rented land and concluded that this may indicate that the adoption of this practice rests more on cost considerations than on erosion control benefits.

Thus, Ervin found less erosion control on rented cropland than on owner-operated cropland but could not conclude from his data whether the difference was due to rental arrangements or to varying personal characteristics.

Lee and Stewart (1983) conducted a study concerned with land ownership and the adoption of minimum tillage. They hypothesized that, unlike traditional conservation investments, separation of ownership from farm operation would not pose significant obstacles to minimum tillage adoption. They stated that two characteristics of minimum tillage supported their hypothesis. These two characteristics were first, that minimum tillage can be effective as a cost reduction measure and second, that the operator is independent of the landowner in the adoption process since minimum tillage does not permanently alter the land. The authors found that there were differences in the adoption of minimum tillage among landowner groups across all regions, sizes of farms, and erosion hazards. The adoption of minimum tillage was found to be lowest among full owner-operators (those who operated only the land that they owned). Lee and Stewart reported that one possible explanation is that differences in the adoption by tenure reflect the total acres worked and that small operating size may be an inhibiting factor in minimum tillage adoption by full owners. In addition, Lee and Stewart suggest that part-owners may have longer planning horizons, be more likely to adopt conservation measures, and be younger than full owner-operators. The authors state that the study results indicate that it is necessary to further investigate personal characteristics and economic factors which might be associated with farm operator's adoption of minimumtillage. In summary, this study concluded that full owner-operators and landowners with small holdings have lower minimum tillage adoption rates on cultivated cropland than do other groups and that small operating size poses more of an obstacle to minimum tillage adoption than separation of ownership from farm operation.

In recent literature, theories of adoption and decision-making concerning soil conservation practices have included roles for personal, physical, economic, and/or institutional factors, but usually not all simultaneously (Ervin and Ervin, 1982). In their 1982 study, Ervin and Ervin conceptualized adoption and use of soil conservation practices as a decision-making process. This process was composed of three major steps or components each with several social, economic, physical, and/or institutional factors influencing them. The initial step of the decision-making process was the recognition of an erosion problem. This was viewed as a product of the landowner's personal characteristics that would cause awareness of the erosion problem and the actual physical characteristics of the land being operated. Once a problem is perceived, the landowner decides whether to adopt a conservation practice. Adoption of a conservation practice is the second step in the decision process described by Ervin and Ervin. According to them, this component is influenced by personal factors, the degree of the physical erosion potential of the land, economic factors, and institutional factors such as educational programs, technical assistance, and cost sharing. The final step in the decision-making process is the determination of the soil conservation effort which is "a function of the effectiveness and extensiveness of individual practices over the farm's land" (Ervin and Ervin, 1982). According to Ervin and Ervin (1982) "all factor categories influence effort, but in different ways than they influence the decision to use one or more practices."

To measure the effects of the different factors (personal, physical, economic, and institutional) on the three decision-making components, Ervin and Ervin used the three components as separate dependent variables in regression models. A random sample of farmers from a Missouri county was used to test the model (only those farmers owning and operating cropland were used). The first regression model used the farmer's perception of the degree of erosion as the dependent variable. In the second regression model the number of soil conservation practices used on the farm was the dependent variable while in the third model soil conservation effort was the dependent variable.

The results for the perception model showed that only education and erosion potential were significant and both variables were positively related to perception of erosion. The number of conservation practices model had four significant explanatory variables. Education and perception were positively related to the number of practices while risk aversion and cash grain farming were negatively related to the number of soil conservation practices.

There were five variables that significantly explained soil conservation effort. Ervin and Ervin (1982) found more severe erosion potential was associated with higher conservation effort. In addition, they found that cost sharing was significant, indicating that operators with higher percentages of subsidized acres achieved greater erosion reduction. Ervin and Ervin (1982) state that these findings indicate that economic factors play more important roles in explaining conservation effort than for the number of soil conservation practices used. Other significant factors found in the third model were perception of the degree of erosion problem and education, which were both found to positively influence effort.

Also, cash grain farming showed a significant, negative relationship to soil conservation effort.

In conclusion, Ervin and Ervin (1982) state that "the decision to use a large number of practices and soil conservation effort are not conceptually substitutable." They further state that there is a link between the two but that economic factors play a more important role in determining conservation effort than for the number of soil conservation practices used. Ervin and Ervin (1982) also point out that a number of factors were conspicuously absent from the set of significant variables in the number of practices and in the effort models. Participation in SCS programs, farm orientation, an index measuring public conservation attitudes, transfer of farm to child, off-farm income, and debt concern were all found to be nonsignificant.

In this same 1982 study, Ervin and Ervin were also interested in the factors affecting the use of specific conservation practices. Of interest to this thesis are the results concerning minimum tillage. For minimum tillage, the significant variables were found to be perception of the degree of erosion problem and erosion potential. It was found that more educated operators who had a greater perception of the erosion problem were more likely to use minimum tillage. Farmers with higher erosion potential lands were found to be less likely to use minimum tillage.

Summary

A recent paper by Napier and Forster (1981) summarized the recent literature on factors affecting the adoption of soil conservation practices. They concluded that many factors are linked to adoption and that no single factor is capable of stimulating the adoption of soil conservation practices by itself. A recent review of the literature done for this thesis also indicated that many factors influence the decision to adopt conservation practices. Thus it was apparent from the literature that a large number of factors should be included in the model of no-till users in Henry county, Tennessee. Not only did the literature review reveal that many factors should be included in this model, but the literature also indicated what types of explanatory variables should be used to model decisions regarding no-till use.

In the next chapter the particular model chosen on the basis of the objectives of this thesis is discussed. Also included in the next chapter is the model specification. The particular explanatory variables and hypothesized relationships which were chosen on the basis of the literature review and other reasons are also discussed.

CHAPTER III

RESEARCH METHODOLOGY

Model Choice

Since the objective of this thesis was to identify the users of no-till, a model was chosen that would describe the relationship between farmer characteristics and the use of no-till. Data available for model construction included the farmer's characteristics, personal and economic as well as physical characteristics of the farm, and the farmer's choice concerning whether or not he used no-till. It seemed reasonable, given the objectives, to use whether or not the farmer used no-till as the dependent variable and the farmer characteristics as the explanatory variables. Such a model specification, called a binary choice model, would have a binary (0,1) dependent variable. "Binary choice models assume that individuals are faced with a choice between two alternatives and that the choice they make depends on the characteristics of the individuals" (Pindyck and Rubinfeld, 1981). It was further desired that the model be capable of predicting the choices regarding the use of no-till by farmers whose characteristics were known but who were not included in the original sample. More specifically, it was desired to find a relationship between a set of attributes describing an individual and the probability that the individual will make a given choice.

Three types of binary choice models were examined for possible use for this analysis. The first model examined, and subsequently rejected, was ordinary least squares regression. When such a regression model is used and a (0,1) dependent variable is specified, it is referred to as a linear probability model. The linear probability model was rejected because there are several problems associated with its use which have been outlined by Nerlove and Press (1973), Judge et.al., (1980), and Pindyck and Rubinfeld (1981). First, the error term is heteroscedastic; the error term is not normally distributed with a constant variance. The use of ordinary least squares regression will therefore give inefficient parameter estimates. Secondly, since the error is not normally distributed, the usual statistical tests cannot be applied, R^2 is no longer meaningful, and the standard errors are not consistent. The third problem with the linear probability model arises when using the model to predict. Since the model involves interpretation of the dependent variable as probabilities, while the explanatory variables may take on many values, the predicted values produced from the model may lie outside the (0,1) interval. Although it is possible to apply remedies to these problems, it is generally at the cost of biased estimates (Pindyck and Rubinfeld, 1981).

Two other binary choice models, probit and logit (which are alternatives to the linear probability model), were also examined for possible use in this thesis. These models transform the linear probability model in such a way that the predictions will lie in the (0,1) interval. The probit and logit models are very similar, with their differences arising from the fact that the probit model is based on the cumulative normal probability function while the logit model is based on the cumulative logistic probability function. The logit model is considered easier to use from a computational point of view, and unless there are theoretical reasons for preferring the cumulative normal distribution to the cumulative logistic distribution, the logit model is preferred to the probit model when repeated observations are available (Pindyck and Rubinfeld, 1981; Judge et.al., 1980; Nerlove and Press, 1973). For this reason the logit model was chosen over the probit model for use in this thesis.

Logit Analysis

As previously stated, the logit model is based on the cumulative logistic probability function. This function is the basis for the transformation of the dependent variable and provides a method that solves the problem of predicting probabilities that lie in the (0,1) interval.

> One important appeal of the logit model is that is transforms the problem of predicting probabilities within a (0,1) interval to the problem of predicting the odds of an event's occuring within the range of the entire real line (Pindyck and Rubinfeld, 1981).

The dependent variable becomes the natural logarithm of the odds that a choice will be made. The form of the logit model is as follows:

$$\ln \frac{P_i}{1-P_i} = a + BX_i \qquad (1)$$

where:

P_i = the probability that an event will occur

a = intercept

B = slope

X_i = explanatory variable

Maximum likelihood estimation was used to estimate the logit model presented in this thesis. Maximum likelihood estimates of the logit model parameters are consistent, asymptotically efficient, and normally distributed (Pindyck and Rubinfeld, 1981; Judge et.al., 1980).

Once the model parameters have been estimated, use of the model for prediction is straightforward. To obtain a probability for each farmer, first the farmer's values for the explanatory variables are multiplied by the parameter estimates and summed. The number obtained is the natural logarithm of the odds that the farmer will use no-till. Next, the inverse logarithm (odds) is converted to a probability according to the following formula:

$$P_i = \frac{\text{odds}}{1 + \text{odds}} \tag{2}$$

Thus, the P_i obtained from the above process is the probability that the farmer will use no-till.

It is possible to use the logit model to see how a farmer's probability will change with a change in an explanatory variable. The previous process can be repeated with a change in an explanatory variable to obtain a new probability. A comparison of the two probabilities will indicate the effect that a change in one of the farmer's characteristics has on the probability that the farmer will use no-till.

The shape of the cumulative logistic probability distribution is such that its slope is greatest at $P_i = .5$ and decreases to the endpoints. In terms of the logit model, changes in independent variables have their largest impact on the probability that an event will occur at the midpoint of the distribution. The smaller slopes farther away from the center of the distribution imply that large changes in independent variables are necessary to bring about small changes in probability (Pindyck and Rubinfeld, 1981).

One final comment about the logit model concerns a possible limitation in its use. This limitation concerns the assumption that choices are independent. Judge et.al., (1980) state "that conditional logit analysis may not be appropriate in situations where several alternatives in the choice set are close substitutes." In the model used for this thesis there were no close substitutes in the set of choices, therefore, this limitation did not affect its use.

Model Specification

It was necessary to estimate a number of different logit models in this research effort because in early models some independent variables were correlated, had missing observations, or were combined to create new variables (eg., acres owned plus acres rented equals total acres). The model presented below overcame these problems and was superior to other models as measured by the D statistic, the Chi-square statistic, and the percentage of the farmers that were correctly predicted.

The specification of the logit model presented in this thesis is:

$$\ln \frac{P_i}{1-P_i} = a + B_1\text{TOTACRES} - B_2\text{PEROWNAC} + B_3\text{OCCFARM} - B_4\text{CVEQUIP} + B_5\text{NOINFO} + B_6\text{EDUC} + B_7\text{CSPRACT} - B_8\text{AGE} - B_9\text{RELIGION} - B_{10}\text{TRANSFER} + B_{11}\text{INVEST} + B_{12}\text{EROSION}$$

where:

P_i = the probability that a farmer will use no-till

a = intercept

B_i = slope (parameter estimate)

TOTACRES = total acres operated

PEROWNAC = owned acres operated as a percentage of total acres operated

OCCFARM = 1 if primary occupation is farming; 0 otherwise

CVEQUIP = number of pieces of conventional tillage equipment owned

NOINFO = number of technical information sources utilized

EDUC = level of formal education

CSPRACT = other conservation practices used

AGE = age of the farmer

RELIGION = 1 if Amish or Mennonite; 0 otherwise

TRANSFER = 1 if expect to transfer, sell or rent out owned land in next five years; 0 otherwise

INVEST = investment in farm operation

EROSION = percentage of cropland experiencing erosion problems

A more complete listing of variables and their definitions which are of interest to this thesis is presented in Appendix B.

The variable STILLUSE was specified as the binary dependent variable. This variable was taken directly from the survey question: Are you still using no-tillage farming? The variable equals one if the farmer was using no-till at the time of the survey and zero if he was not using no-till.

The independent variable TOTACRES represents the total acres that the farmer operates. This variable was created by adding the number of acres owned and operated (ACRESO) with the number of acres rented and operated (ACRESR). Several preliminary models included the variables ACRESO and ACRESR instead of TOTACRES. The variable TOTACRES was chosen as a better variable since it represented the total number of acres that the farmer was operating or had management control over. A positive relationship was expected between TOTACRES and the adoption of no-till since it has been found that small farm size may inhibit adoption of minimum tillage on cultivated cropland (Lee and Stewart, 1983). Thus it is hypothesized that the larger the farm operation the more likely the farmer would be to adopt no-till.

The variable PEROWNAC (percent owned acres) was created to represent the ratio between rented and owned acreage. The variable PEROWNAC was calculated as ACRESO/TOTACRES where 1.0 would indicate that the farmer operated only owned land. It was hypothesized that there would be a negative relationship between PEROWNAC and the adoption of no-till since Lee and Stewart (1983) found that full owner-operators have lower adoption rates for minimum tillage on cultivated cropland.

The third independent variable used in this model was OCCFARM. This variable was a (0,1) dummy variable where one indicated that the farmer's primary occupation was farming, and a zero indicated a primary occupation other than farming. It was hypothesized that this variable would have a positive relationship with the use of no-till. This was expected since a person whose primary occupation is farming may be more attached to farming as a way of life and be more inclined to use conservation measures (Pampel and van Es, 1977).

The independent variable CVEQUIP represents the number of pieces of conventional tillage equipment owned by the farmer. The farmer was asked to indicate out of a list of five pieces of conventional tillage equipment how many pieces he owned. In preliminary models the explanatory variable NTEQUIP, which indicated the number of pieces of no-till equipment owned by the farmer, was also used. This variable was later dropped since it was believed that its relationship with the adoption of no-till would be tautological. It was hypothesized that CVEQUIP would have a negative relationship with the use of no-till since a farmer who owns many pieces of conventional tillage equipment would have a large investment and may be unwilling to change.

The independent variable NOINFO was the number of technical information sources used by the farmer in the past two years. This variable was created by adding together the number of times in the past two years the farmer had: talked with a county extension agent, plus talked with a SCS Specialist, plus attended field day demonstrations. Orginally, the number of organizations that the farmer belonged to was included but was later dropped since these may not have given technical assistance exclusively. It was hypothesized that the more a farmer took advantage of technical assistance opportunities the more likely he would be to use no-till.

The independent variable EDUC represented the level of formal education that the farmer had received. For example, 12 represented a high school education, 16 represented a college degree, etc. Education was expected to have a positive relationship with the use of no-till since higher educational levels are associated with more information and a better ability to understand no-till and its advantages and disadvantages (Ervin and Ervin, 1982).

The variable CSPRACT was created to represent the number of other conservation practices used by the farmer. The farmer was asked to indicate how many of the following conservation practices he used: parallel terracing, debris basins, tree planting, pasture planting, diversion, winter cover crop, grassed waterway, conservation cropping, crop residue management, and other. These conservation practices were added together to obtain a number that represented the number of conservation practices other than no-till that were used. In preliminary models the conservation practice minimum tillage was added into the CSPRACT variable. It was later excluded since it was believed that the farmers may have been confused as to its definition. A positive relationship was expected between CSPRACT and the use of no-till because farmers who already use many conservation practices show a concern for erosion control and they would more readily accept no-till.

The variable AGE was simply the numerical age of the farmer. A negative relationship was expected between age and the use of no-till since older farmers may be more unwilling to change from traditional, established practices and also may have shorter planning horizons.

The variable RELIGION was a (0,1) dummy variable where one indicated Amish or Mennonite and zero indicated other. It was hypothesized that a negative relationship would occur between RELIGION and the use of no-till since the Amish and Mennonites would not be expected to purchase no-till planters or other equipment needed to practice no-till such as herbicide sprayers.

TRANSFER was a (0,1) dummy variable used to represent the length of the farmer's planning horizon. The question used to obtain this data was: Do you expect to transfer, sell or rent out land (owned by you) in the next five years? For this question, a one indicated yes and a zero indicated no. It was hypothesized that persons who replied yes to this question would have shorter planning horizons than persons who answered no. Therefore a negative relationship was expected between TRANSFER and the use of no-till.

A variable called INVEST was used to represent the size of the total investment that the farmer had in his farm operation. It was expected that INVEST would be positively related to the use of no-till since capital may be more readily available to farmers who have larger investments in their farms. This would make it easier for them to adopt no-till practices.

The variable EROSION represented the farmer's perception of the degree of the erosion problem on his land. The farmer was asked what portion of the cropland that he operated was experiencing erosion problems. This question, subjective in nature, was aimed at determining the farmer's perception of the seriousness of erosion on his farm. In a similar manner, the farmer was asked what portion of the cropland that he operated had a slope greater than five percent. The response to this question represents the farmer's perception of the erosion hazard on his farm. The answers to both questions were correlated so only one answer was included in the model. The variable EROSION was chosen over SLOPE since EROSION was thought to be a better indication of the actual erosion problem that the farmer perceived on his farm. A positive relationship was expected between EROSION and the use of no-till since farmers who perceived greater erosion problems on their lands would be more likely to use conservation methods such as no-till (Ervin and Ervin, 1982).

There were four other independent variables that were considered for inclusion in the logit model. These four variables were years farming (YRSFARM), decision making authority (DECAUTH), innovativeness (INNOVATR), and erosion problem in Henry county (ERPROB). For various reasons noted below, none of these variables were included in the final model. The variable YRSFARM represented the number of years that the farmer had been farming. This variable was believed to be important since Pampel and van Es (1977) found that years farmed predicted adoption of environmental practices. This variable was not included in the final model however, since it was correlated with AGE and AGE was also believed to be an important variable.

The variable DECAUTH was an index of decision making authority and it was believed that this would be important in predicting the use of no-till. Unfortunately, this variable had 62 missing observations and missing observations were excluded from the logit model. Therefore, this variable was dropped from the model.

Another variable, INNOVATR, was also excluded from the model because of its correlation with ACRESO, NTEQUIP, AGE, NOINFO, and EDUC. This variable was an answer to the question: Are you an innovator? This variable was believed to be important in the decision to adopt no-till.

The final variable that had to be eliminated from the model was ERPROB. This variable was the response to the question: Do you feel that there is a serious erosion problem in Henry county? This variable could have been used as an attitudinal variable except that all farmers but one felt that there was a serious erosion problem. Thus this was not considered to be a useful variable.

CHAPTER IV

RESULTS

This chapter presents an analysis of the data obtained from a random survey of crop farmers conducted in Henry county, Tennessee in 1981. This section begins with a brief discussion of several descriptive statistics (means, ranges, and percentages) of variables used in the logit analysis. Then, the results of the logit analysis are given followed by an empirical example of how the model is used.

Descriptive Statistics

Information gathered about cropland included both owned and rented land. The average total acres operated by the 120 farmers surveyed was 388.4 acres. The distribution of the total cropland operated is shown in Table 1. Of the 120 farmers in this study, 63 farmers (52.5%) operated both owned and rented land and 57 farmers (47.5%) operated owned acreage only. The number of acres that were owned and operated ranged from 10 to 800 acres and the mean number of acres that were owned and operated was 200.8 acres. The distribution of the owned and operated cropland is shown in Table 2. The number of acres that were rented and operated ranged from 30 to 1720 acres and the average number of acres that were rented and operated was 187.7 acres. The

TABLE 1. Distribution of Total Acres Operated by 120 Crop Farmers in Henry County, Tennessee in 1981

Number of Acres Operated	Number of Farms
10 - 99	29
100 - 199	18
200 - 299	13
300 - 399	15
400 - 499	8
500 - 599	12
600 - 699	3
700 - 799	3
800 - 899	7
900 - 999	3
1000 - 1099	3
1100 - 1199	0
1200 - 1299	1
1300 - 1399	1
1400 - 1499	1
1500 - 1599	0
1600 - 1699	2
1700 and greater	1

TABLE 2. Distribution of Owned and Operated Acreage of 120 Crop Farmers in Henry County, Tennessee in 1981

Number of Acres Owned and Operated	Number of Farms
10 - 99	42
100 - 199	30
200 - 299	17
300 - 399	15
400 - 499	4
500 - 599	4
600 - 699	3
700 - 799	3
800 and greater	2

distribution of the rented and operated cropland is shown in Table 3.

In addition to acres operated, several personal characteristics of the farmers were surveyed. The average number of years that these farmers had been farming was 28.3 years. The average number of years that those surveyed had owned and operated farmland was 17.8 years while the average number of years that they had rented and operated farmland was 4.7 years. Those who owned land were asked if they expected to transfer, sell or rent out the land in the next five years. Of those owners who responded, 27 farmers (24%) replied yes.

Age, education and occupation were also surveyed. The average age of the farmers was 48.7 years and the average education was 11 years of formal schooling. When asked if their primary occupation was farming, 100 farmers (84%) replied yes. Approximately 32 farmers (27.1%) said that they also had a secondary occupation.

The farmers were also asked about their perceptions of the erosion problem. Basically, every farmer felt that there was a soil erosion problem in Henry county. When asked about the portion of their own farmlands experiencing soil erosion, 27 farmers (22.9%) replied that none of their land experienced any soil erosion problem, while 25 farmers (21.2%) replied that all of their land experienced a problem.

TABLE 3. Distribution of Rented and Operated Acreage of 120 Crop Farmers in Henry County, Tennessee in 1981

Number of Acres Rented and Operated	Number of Farms
NONE	57
1 - 99	9
100 - 199	13
200 - 299	11
300 - 399	10
400 - 499	3
500 - 599	6
600 - 699	6
700 and greater	5

Since this research was specifically concerned with the farmer's use of no-till, several questions were asked regarding no-till. Every farmer interviewed said that he had heard of no-till. Of the 120 farmers interviewed, 83 farmers (69.2%) said that they had tried no-till. At the time of the survey, 74 farmers (61.7%) were still using no-till methods.

In addition to the use of no-till, the farmers were asked what other conservation practices, if any, were used. A summary of responses is given in Table 4. Only four farmers (3.4%) responded that they used none of these conservation practices.

Another area of interest to this research was the number of technical information sources used by the farmers. The specific information sources surveyed were visits with county extension agents, SCS Specialist, and field day demonstrations attended. The farmers were asked how many times in the past two years they had done each of the following: talked with a county extension agent, talked with an SCS Specialist, and participated in a field day demonstration. The responses according to information source are summarized in Tables 5-7. It is of interest to note that 46 farmers (39.7%) did not talk with a county extension agent, 62 farmers (53.9%) did not talk with a SCS Specialist, and 71 farmers (60.7%) did not attend a field day

TABLE 4. Use of Other Conservation Practices by 118 Crop Farmers in Henry County, Tennessee in 1981

Conservation Practice	Number of Farmers Using Practice
Parallel Terracing	68
Debris Basins	41
Tree Planting	2
Pasture Planting	59
Diversion	19
Winter Cover Crop	74
Grassed Waterway	67
Conservation Cropping System	61
Crop Residue Management	51
Other	5

TABLE 5. Contacts With County Extension Agents by 116 Crop Farmers in Henry County, Tennessee in 1980 and 1981

Number of Times Talked With a County Extension Agent in Past Two Years	Number of Farmers
0	46
1	14
2	30
3	1
4	10
5	1
6	8
7	1
8	1
9	4

TABLE 6. Contacts With SCS Specialists by 115 Crop Farmers in Henry County, Tennessee in 1980 and 1981

Number of Times Talked With a SCS Specialist in Past Two Years	Number of Farmers
0	62
1	7
2	29
3	1
4	8
5	1
6	4
7	0
8	0
9	3

TABLE 7. Attendance at Field Day Demonstrations by 117 Crop Farmers in Henry County, Tennessee in 1980 and 1981

Number of Times Attended a Field Day Demonstration in Past Two Years	Number of Farmers
0	71
1	12
2	24
3	3
4	4
5	2
6	1

demonstration. A statistic was computed that represented the total number of technical information sources used by each farmer. This was done by adding together the number of times that the farmer had talked with the county extension agent, plus the number of times the farmer talked with the SCS Specialist, plus the number of field day demonstrations that were attended. The total number of information sources are summarized in Table 8. Again, it is interesting that 32 farmers (28.1%) did not use any of the three information sources in the past two years.

Results of the Logit Analysis

The logit model used in this research, specified according to the criteria outlined in Chapter III, is presented in Table 9.

In order

> to test the significance of all or a subset of the coefficients in the logit or probit model when maximum likelihood is used, a test using the chi-square distribution replaces the usual F test (Pindyck and Rubinfeld, 1981).

The likelihood ratio, which is the ratio of the likelihood function when all parameters except the constant are set equal to zero to the likelihood function at its maximum, follows a chi-square distribution (Pindyck and Rubinfeld, 1981) and indicates whether the amount of variation explained by the model is significantly

TABLE 8. Total Number of Technical Information Sources Used by 114 Crop Farmers in Henry County, Tennessee in 1980 and 1981

Number of Technical Information Sources Used in Past Two Years	Number of Farmers
0	32
1	9
2	16
3	6
4	12
5	9
6	8
7	2
8	3
9	3
10	3
11	2
12	2
13	1
14	0
15	1
16	2
17	0
18	1
19	1
20 and greater	1

TABLE 9. Empirical Results of the Logit Analysis

Variable Name	Mean	Estimate	Standard Error	Chi-square	P
INTERCEPT	-	-4.21137	2.99970	1.97	0.1603
TOTACRES	407.267	0.00328	0.00171	3.71**	0.0541
PEROWNAC	0.698	-0.74015	1.23271	0.36	0.5484
OCCFARM	0.842	-1.58865	0.94848	2.81**	0.0939
CVEQUIP	3.089	-0.38977	0.30460	1.64	0.2007
NOINFO	4.208	-0.04419	0.06676	0.44	0.5080
EDUC	10.921	-0.07419	0.11821	0.39	0.5303
CSPRACT	3.762	0.78749	0.20059	15.41*	0.0001
AGE	48.297	0.06531	0.03293	3.93*	0.0474
RELIGION	0.109	-0.92911	1.06221	0.77	0.3817
TRANSFER	0.238	0.37112	0.68879	0.29	0.5900
INVEST	3.951	0.23373	0.21136	1.22	0.2688
EROSION	45.911	0.02181	0.00853	6.54*	0.0105

* significant at the 0.05 level

** significant at the 0.10 level

different from zero. The overall model chi-square statistic for the model presented here was 56.24 which is significant at the 0.001 level which indicates that the amount of variation explained by the model is significantly different from zero.

The D statistic, which measures the overall fit of the model (and is comparable to R^2 in a regression analysis), is 0.390. This indicates that 39% of the total variation in the dependent variable is explained by the model independent variables. Capps and Kramer (1981) note that "dichotomous dependent variable models are not likely to yield R^2's close to 1 . . .its upper limit is likely to be substantially less than 1." Furthermore, Judge et.al., (1980) state that "the pesudo-R^2 is a convenient measure, but it does not have an intuitive interpretation between its limits." This is due to the fact that the predicted probabilities produced from the logit model are generally not either zero or one but some estimated probability in between. Thus the probabilities produced by the model are not usually at the extremes so that perfect prediction (R^2=1) is unlikely.

A final measure of the goodness of fit of the logit model involves the correct classification of the farmers in the sample as either using no-till or not using no-till. This procedure uses the explanatory variables of each farmer in the estimated model to predict the farmer's choice. If the probability obtained is greater than 0.5, the farmer is predicted as a user of no-till and if the probability obtained is less than 0.5, the farmer is predicted as a non-user of no-till. If the predicted choice matches the actual choice of the farmer then he is correctly classified. If the predicted choice does not match the actual choice of the farmer then he is incorrectly classified. The model presented in this thesis correctly classified 83.2% of the farmers. The classification table produced from testing the logit model is presented in Table 10. This particular logit model using these data was more efficient at classifying the users of no-till (88.9% were correctly classified) than the non-users (only 73.4% were correctly classified). The reasons for these differences can not be determined unless the model is further validated through the use of an independent sample.

Of the 12 independent variables in the logit model, three were significant at the 0.05 level and two were significant at the 0.10 level. The variables with significant chi-square statistics at the 0.05 level were other conservation practices used (CSPRACT), portion of the cropland experiencing erosion problems (EROSION), and the age of the farmer (AGE). The variables with significant chi-square statistics at the 0.10 level were

TABLE 10. Classification Table for the Logit Model

		Choice of Farmers Predicted by the Model		
		Do Not Use No-Till	Use No-Till	Total
Actual Choices of Farmers in Henry County	Do Not Use No-Till	23	10	38
	Use No-Till	7	56	63
	Total	35	66	101

total acres operated (TOTACRES) and primary occupation (OCCFARM). Of these five statistically significant explanatory variables two, primary occupation (OCCFARM) and age of the farmer (AGE) had signs that were opposite from hypothesized.

In model development, it was hypothesized that a person whose primary occupation was farming would be more likely to use no-till than a person whose primary occupation was not farming. The actual relationship was found to be negative, indicating that those persons whose primary occupation was not farming were more likely to use no-till. There are at least two plausible explanations for this result. First, persons who are not farmers by occupation may view the land as an investment and thus may be more inclined to use conservation methods to protect their investment. A second explanation may be that part-time farmers, who have a source of outside income, may be willing to take on risk and try new practices moreso than full-time farmers who may be less willing to try new practices which may introduce risk into their operation.

The other significant explanatory variable which had a sign opposite from that hypothesized was the age of the farmer. It was hypothesized that younger farmers would be more likely to use no-till than older farmers. The results indicate however, that older farmers are more likely to use no-till. A possible explanation for this result may be that younger farmers are probably more heavily in debt and have higher discount rates than older farmers (Ervin and Ervin, 1982) and thus may not be able to purchase no-till equipment. In addition, since older farmers may be ready to replace tillage equipment whereas younger farmers have not reached the point where replacements are necessary, it is easier for the older farmer to switch to no-till.

Three of the remaining seven explanatory variables which were not statistically significant had signs other than expected. These variables included the number of technical information sources utilized (NOINFO), the level of formal education (EDUC), and expected transfer of owned land (TRANSFER). However, since these variables have no statistically significant impact on the probability of a farmer using no-till these variables will not be discussed.

Example

Some examples of how the logit model can be used to determine the probability that a farmer in Henry county will use no-till are given in Table 11. The procedure for obtaining the probability from the logarithm of the odds was explained in Chapter III in the section entitled "Logit Analysis."

TABLE 11. Example Using Logit Model Estimated in this Research

Variable Name (Mean)	Mean Increased and (Decreased) by 25%	New Log Odds for the Model	Probability Obtained from New Log Odds	Change in Probability from Average Farmer
TOTACRES (407.267)	509.08	1.19504	76.8	+6.5
	(305.45)	0.54714	62.9	-7.4
PEROWNAC (0.698)	.8719	0.73206	67.5	-2.8
	(.5231)	0.99022	72.9	+2.6
CVEQUIP (3.089)	3.8613	0.56012	63.6	-6.7
	(2.3168)	1.16212	76.2	+5.9
NOINFO (4.208)	5.2599	0.81461	69.3	-1.0
	(3.1559)	0.90759	71.2	+0.9
EDUC (10.921)	13.66	0.65788	65.9	-4.4
	(8.19)	1.06365	74.3	+4.0

TABLE 11. (continued)

Variable Name (Mean)	Mean Increased and (Decreased) by 25%	New Log Odds for the Model	Probability Obtained from New Log Odds	Change in Probability from Average Farmer
CSPRACT (3.762)	4.703	1.60175	83.2	+12.9
	(2.822)	0.12033	53.0	-17.3
AGE (48.297)	60.371	1.64967	83.9	+13.6
	(36.223)	0.07253	51.8	-18.5
INVEST (3.951)	4.938	1.09193	74.9	+4.6
	(2.963)	0.63026	65.2	-5.1
EROSION (45.911)	57.389	1.11143	75.2	+4.9
	(34.433)	0.61077	64.8	-5.5
OCCFARM	Value changed from 1 to 0	2.44975	92.0	+21.7
RELIGION	Value changed from 0 to 1	-0.06801	48.3	-22.0

TABLE 11. (continued)

Variable Name (Mean)	Mean Increased and (Decreased) by 25%	New Log Odds for the Model	Probability Obtained from New Log Odds	Change in Probability from Average Farmer
TRANSFER	Value changed from 0 to 1	1.23222	77.4	+7.1

A change in any independent variable in the logit model produces a direct and proportional change in the log odds that a farmer will use no-till. To evaluate the effect of a change in an independent variable on the probability that any particular farmer will use no-till, however, requires that all of the characteristics that contribute to the adoption of no-till (as specified in the model) are known for that farmer. Therefore, the examples given in Table 11 have all been evaluated for a hypothetical "average" farmer in Henry county. In other words, the probability that an "average" farmer in Henry county will be a user of no-till was calculated using the means of the continuous independent variables in combination with the most common values for the independent dummy variables which were: the dummy variable for occupation equalling one (primary occupation farming), the dummy variable for religion equalling zero (religion other than Amish or Mennonite), and the dummy variable for transferance of land equalling zero (transfer not expected in next five years).

This average Henry county farmer operates 407.3 acres of cropland 69.8% of which he owns. He owns slightly more than three pieces of conventional tillage equipment. His primary occupation is farming and in the past two years he has used approximately four different technical information sources. This farmer has 10.9

years of formal education and he uses an average of 3.7 other conservation practices. His age is 48.3 years and his religion is something other than Amish or Mennonite. He does not expect to transfer, sell, or rent out owned land in the next five years. The total investment in his farm operation is $200,000 and the average farmer feels that 45.9% of his land is experiencing an erosion problem. According to the logit model, this average farmer has a 70.3% probability of using no-till and would be classified as a user of no-till according to this model.

To illustrate the effects of changes in each independent variable upon the probability that an average farmer in Henry county will use no-till, each independent variable was replaced with a changed value while all other variables in the model were held at their means (means of continuous variables and OCCFARM = 1, RELIGION = 0, and TRANSFER = 0). For the continuous independent variables, the new values used were an increase in the mean value by 25% and a decrease in the mean value by 25%. For the dummy independent variables, the value was simply changed to the opposite value that was used for the average farmer (primary occupation was considered to be other than farming, religion was changed to Amish or Mennonite, and transferance of land in the next five years was expected).

As previously stated the average farmer has a 70.3% probability of using no-till. The log odds used to obtain this figure is 0.8611. As an example of how a change in an independent variable affects the probability of a farmer using no-till the mean of the variable AGE was increased by 25% from 48.3 years (the average age of the farmers in the sample) to 60.4 years. Using this value (60.4) and holding all other variables at their means (means of continuous variables and OCCFARM = 1, RELIGION = 0, and TRANSFER =0) produced a new log odds equal to 1.6497. The probability of adopting no-till obtained from these new log odds is 83.9%. Thus, a 25% increase in AGE (of the average farmer) produced a 13.6% increase in the probability that this particular hypothetical farmer would be a user of no-till. Similarly, a 25% decrease in the age of the average farmer produced a probability of 51.8% of using no-till which is an 18.5% decrease. Even though changes in age produced rather large changes in the probability of using no-till a 25% change in the mean age was not large enough to change the classification of this average farmer who would still be classified as a user of no-till at both ages 60.4 and 36.2.

To illustrate a change in the probability of using no-till produced by a change in a dummy variable the variable RELIGION is examined. A change in the dummy variable for religion from zero for the average farmer (religion other than Amish or Mennonite) to one (Amish or Mennonite) in Table 11 produced a change in the log odds equal to the value for the coefficient for RELIGION. The probability that this hypothetical Amish or Mennonite farmer would use no-till decreased by 22% from the average farmer from 70.3% to 48.3% thus the hypothetical average farmer with a religion of Amish or Mennonite would be predicted to be a non-user of no-till.

The variables which have the most impact upon the probability of a farmer in Henry county using no-till are the religion of the farmer, the primary occupation of the farmer and the age of the farmer. The variables which have the least impact upon the probability of a farmer in Henry county using no-till are the number of technical information sources utilized, the percent of total acres operated that is owned by the farmer, and the education of the farmer.

These examples help to illustrate the point that a change in log odds does not indicate a proportional change in the probability that a farmer will use no-till. The effect of a change in an explanatory variable is propotional to the change in the log odds but its effect on probability is dependent upon the probability which is produced by all of the variables included in the logit model.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The objective of this thesis research was to determine the social, economic, and/or physical characteristics of the users of no-till so that farmers with the most potential of adopting no-till could be identified. This objective was accomplished and some of the characteristics of the users of no-till were identified. The logit model constructed for this analysis was statistically significant, indicating that the model could be useful for identifying potential users of no-till.

This analysis indicates that the probability of adopting no-till by farmers in Henry county, Tennessee increases with: (1) increasing age of the farmer, (2) greater number of acres operated by the farmer, (3) farmers whose primary occupation is not farming, (4) greater proportion of land experiencing erosion problems and, (5) increasing use of other conservation practices. There are several possible reasons why these variables may make adoption of no-till more likely. These reasons appear to be both economic and environmental.

The ability to borrow funds or finance farm operations would generally be expected to increase as the age of the farmer increases and the number of acres operated by the farmer increases. Older farmers generally carry less debt than younger farmers who may have made more recent tillage equipment purchases. Thus older farmers may be in a better position to borrow funds to purchase no-till planters etc. In addition, farmers who operate larger farms may find capital more accessible which would make it easier to switch to no-till farming methods. Part-time farmers, those whose primary occupation is not farming, have a second source of income and thus may be more willing to take on risk and try new practices such as no-till. This may be due to the fact that part-time farmers feel that they can withstand greater losses since they have a primary income source outside of farming and are therefore more willing to try practices which may be perceived as having high risks.

If these are the reasons that these variables behaved as they did, then policies which subsidize the use of no-till (equipment purchases, chemicals, etc.) among farmers who do not have the above characteristics may promote the adoption of no-till among farmers in Henry county. Ervin (1982) and Lee and Stewart (1983) have suggested that cost considerations may be important in the adoption of minimum tillage. Therefore, economic incentives such as cost-sharing to younger farmers, to farmers who have small holdings, and to farmers whose primary occupation is farming may ease the economic burdens and lessen the perceived risk of adopting no-till and induce these farmers to use no-till.

The other two statistically significant variables, greater proportion of land experiencing erosion problems and increasing use of other conservation practices, suggest that farmers who have a perception of the erosion problem and who show an inclination, through the use of other conservation practices, to minimize erosion are more likely to use no-till than farmers without these characteristics. These findings suggest that policies concerned with information and education may promote the use of no-till in Henry county since information and education may improve the farmer's perception of his erosion problem and supply technical assistance for conservation practices. However, since the number of technical information sources used by the farmer was not found to significantly influence the adoption of no-till, traditional information and education efforts may not be effective. Ervin and Ervin (1982) also found that traditional education and information services did not significantly influence the adoption of conservation practices. Thus, there may be a need to investigate alternative information and education methods. Perhaps alternative methods such as one-to-one demonstrations of no-till and its benefits (particularly decreases in soil loss) may be more effective in persuading farmers to use conservation practices.

Research Recommendations

There is a need to investigate why the adoption of no-till by farmers in Henry county increases with the age of the farmer and part-time farming since these variables did not have the expected signs. Possible reasons why these variables behaved contrary to expectations have been suggested, but further research is needed to consider alternative explanations for these results. This is necessary so that policies can be correctly designed to influence the adoption of no-till.

It would also be desirable to further validate the model presented in this thesis through the use of an independent sample. A second random survey of farmers in West Tennessee could be used for this purpose.

In addition, other factors which may influence the use of no-till need to be investigated. Perhaps some measure of management ability might help explain the use of no-till since the difficulty of managing no-till operations has been suggested as a disadvantage of using conservation tillage (Crosson, 1981). Another factor that could be investigated is risk-aversion. A method that would effectively measure a farmer's risk aversion might help explain why some farmers are unwilling to use no-till.

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APPENDIXES

APPENDIX A

SURVEY

University of Tennessee
Department of Agricultural Economics & Rural Sociology
Soil Conservation Survey

Questionnaire

I. Farm Characteristics

1. What is the total acres of cropland which is:
   a) owned and operated by you
   b) owned but rented to others to operate
   c) rented and operated by you

2. Have you ever heard of no-tillage farming? If yes, when did you first hear of it?

3. Have you ever tried no-tillage farming? If yes, when did you first try it?

4. Are you still using no-tillage farming? If no, when did you quit using it?

5. IF NO-TILL WAS TRIED:

   In the blanks below, please indicate the number of acres of corn, soybeans, and wheat planted the year before you first tried no-till.

	Owned and Operated	Rented and Operated
Corn	____acres	_____acres
Soybeans	____acres	_____acres
Wheat	____acres	_____acres
Soybeans and Wheat Double-Cropped	____acres	_____acres

In the blanks below, please indicate the number of acres of corn, soybeans, and wheat you planted when you first tried no-till under each of the tillage systems listed.

	Owned & Operated	
	No-Till	Conventional Till
Corn	______ac.	________ac.
Soybeans	______ac.	________ac.
Wheat	______ac.	________ac.
Soybeans and Wheat Double-Cropped	______ac.	________ac.

	Rented & Operated	
	No-Till	Conventional Till
Corn	______ac.	_________ac.
Soybeans	______ac.	_________ac.
Wheat	______ac.	_________ac.
Soybeans and Wheat Double-Cropped	______ac.	_________ac.

6. IF NO-TILL WAS TRIED, NOT TRIED, OR TRIED AND DISCONTINUED

In the blanks below please indicate the number of acres of corn, soybeans, and wheat which were or will be planted in 1981 under each of the tillage systems listed.

	Owned & Operated	
	No-Till	Conventional Till
Corn	______ac.	__________ac.
Soybeans	______ac.	__________ac.
Wheat	______ac.	__________ac.
Soybeans and Wheat Double-Cropped	______ac.	__________ac.

	Rented & Operated	
	No-Till	Conventional Till
Corn	______ac.	__________ac.
Soybeans	______ac.	__________ac.
Wheat	______ac.	__________ac.
Soybeans and Wheat Double-Cropped	______ac.	__________ac.

7. We are interested in getting your perceptions of no-tillage farming at different points in time.

CODE (Circle): 1) Tried and still using no-till
2) Never tried no-till
3) Tried and discontinued using no-till

Please review the list of possible advantages and disadvantages of no-till and check the ones which were important in forming an opinion about no-till at each point in time.

	Prior to Trying	Presently
ADVANTAGES: Reduced Labor Requirements		
Reduced Fuel Costs**		
Reduced Long Term Equipment Costs		
Increased Yields**		
Increased Moisture Retention		
Reduced Soil Erosion		
Conserve Future Soil Productivity		
Reduced Time for Planting & Harvesting		
Other (Specify):		
DISADVANTAGES: Weed Control Problems		
Inappropriate Soil Type		

	Prior to Trying	Presently
DISADVANTAGES:		
Yield Variability		
Pest Control and Disease Problems		
More Difficult to Manage		
Poor Drainage		
Increased Chemical Costs**		
Other (specify):		

*After respondent checks the most important factors, circle the one advantage and disadvantage which is most important.

**Determine only changes (actual and percentage) in yields, fuel costs and chemical costs. (Use per acre change for soybeans and corn.)

8. If cropland is owned and operated by you, what proportion is

    a) a sole proprietorship

    b) a partnership (outside the family)

    c) a corporation (outside the family)

9. If cropland is owned and operated by you, how long have you owned the land? ______________ Do you expect to transfer, sell, or rent out the land in the next 5 years? ______________

10. If cropland is rented or partially owned by you, do you have primary authority to make the following decisions.

    a) amount of crop to plant

    b) types of crops to plant

c) capital investments

d) techniques for growing crops

11. If cropland is rented, how long have you been renting the land? __________
Do you expect to rent the land in the next 5 years? ____________

12. What proportion of the cropland you operate has a slope greater than 5 percent?

13. What proportion of the cropland you operate is experiencing soil erosion problems?

14. Have you ever looked at a soil map of Henry County to determine your soil types? ___________ If yes, what are they? _________________

15. Please check any of the following conservation practices currently being used:

Conservation Practice	Unit
Minimum tillage	ac.
Parallel Terracing	ft.
Debris Basins	no.
Tree planting	ac.
Pasture Planting	ac.
Diversion	ft.
Winter Cover Crop	ac.
Grassed Waterway	ac.
Cons. Cropping System	ac.
Crop Residue Mgmt.	ac.
Other (specify) ____________	

16. Do you own any of the following equipment:

a) chisel plow

b) moldboard plow

c) field cultivator

d) disk

e) no-tillage planter

f) do-all

g) cultimulcher

h) ridge planter

i) other tillage equipment (specify): __________

17. How much of a financial incentive ($/acre) would be required to induce you to adopt or increase your use of no-tillage farming? Note: financial incentive can take the form of a subsidy, cost-sharing, low interest loan, or any other monetary benefit.

II. Farmer Characteristics

1. Is farming your primary occupation?
   Yes _______ No _____

2. Do you have a second job or occupation?
   Yes _______ No _____ If yes, what is it? ______

3. How many years have you been farming? __________

4. What was your father's main occupation while you were growing up? _________________

5. What was the highest grade in school you completed? _______________

6. If you attended college, please specify in which field. _______________

7. What is your present age? _________________

III. Communication Sources

1. Please indicate which of the following sources of information were most useful to you in forming an opinion about no-till farming. Consider which sources you used to: a) gain a general knowledge of no-till and b) to decide whether no-till was valuable for your farming operation.

	To Obtain Basic Knowledge of No-till	To Decide Whether To Adopt Or Not Adopt No-Till
agricultural magazines		
agricultural books		
extension or research pub.		
experiment station field day demonstration		
radio		
television		
county extension agent		
SCS Specialist		
other farmers		
own experience		
dealers and suppliers		
others (specify)		

2. During the past two years how many times have you:

   a) talked with a county extension agent? ______

   b) talked with a SCS Specialist? ______

   c) participated in a field day demonstration at an experiment station or sponsored farm? ____

3. Approximately how many organizations do you belong to as a member? ______

4. Please answer yes or no to the following 4 questions.

   a) During the past year have you told anyone about no-tillage farming techniques? ______

   b) Have you tried to persuade people to adopt no-tillage farming? ______

c) Compared to other farmers you know, are you more likely to be first in adopting new agricultural ideas and techniques? ___________

d) Who would you ask to get advice on farming matters? _________________

IV. There are a couple of attitudinal questions on which we wish to have your opinions.

1. Do you think soil erosion is a serious problem in Henry county? Yes _______ No _______
If yes, should farmers cooperate in reducing soil erosion even if it means incurring short-run expenses? Yes _______ No _______

2. Which method do you think would be most effective in increasing soil conservation practices in Henry county?

a) more extension and experiment station programs.

b) more financial incentives provided by the government.

V. Finally, we have some background questions which will help us interpret the results of the survey.

1. Please review and check the following items if they are owned by you.

_____ home
_____ no-frost refrigerator
_____ automatic dishwasher
_____ color television
_____ central heat or air conditioning
_____ automatic washing machine
_____ motor boat
_____ electric freezer
_____ microwave oven

2. Approximately what were the total sales of crops produced by your farm business (gross farm income from crops) in 1980?

______ 0-10,000	______ 40,001-60,000
______ 10,001-20,000	______ 60,001-80,000
______ 20,001-30,000	______ 80,001-100,000
______ 30,001-40,000	______ over 100,000

3. What is the approximate value of your investment in:

   a) land and farm building structures (including barns and other out-buildings).

   b) machinery and equipment.

APPENDIX B

VARIABLE NAMES AND DEFINITIONS

TABLE 12. Variable Names and Definitions Used in Computer Analyses

Variable Name	Variable Definition
ACRESO	Number of acres owned and operated
ACRESR	Number of acres rented and operated
AGE	Age of the farmer
CSCROP	Conservation cropping system
CSPRACT	Number of other conservation practices besides no-till being used (summation of: CSCROP + CROPRES + DEBRIS + DIVER + GRASSWAT + OTHERCS + PARTER + PASTURE + TREE + WINTCROP)
CROPRES	Crop residue management
CVEQUIP	Number of pieces of conventional tillage equipment owned
DEBRIS	Debris basins
DECAUTH	Index of decision making authority
DIVER	Diversion
EDUC	Years of formal education
EROSION	Portion of land experiencing erosion problems
ERPROB	1 if farmer feels erosion is a serious problem in Henry county; 0 otherwise
GRASSWAT	Grassed waterway
INNOVATR	1 if farmer feels that he is an innovator; 0 otherwise
INVEST	Total investment in farm operation coded into seven categories
MINTILL	Minimum tillage
NOCOAGT	Number of visits with county extension agents in past two years
NOFDAY	Number of times farmer attended a field day demonstration in past two years

TABLE 12. (continued)

Variable Name	Variable Definition
NOINFO	Summation of: NOCOAGT + NOFDAY + NOSCS
NOORGAN	Number of organizations that the farmer belongs to
NOSCS	Number of visits with SCS Specialist in past two years
NTEQUIP	Number of pieces of no-till equipment owned
OCCFARM	1 if primary occupation is farming; 0 otherwise
OTHERCS	Other conservation practices (named by the farmer)
PARTER	Parallel terracing
PASTURE	Pasture planting
PEROWNAC	Percent owned and operated acreage of the total acres operated and calculated as: ACRESO/TOTACRES
RELIGION	1 if Amish or Mennonite; 0 otherwise
SLOPE	Portion of land with slope 5% or greater
STILLUSE	1 if presently using no-till; 0 otherwise
TOTACRES	Summation of: ACRESO + ACRESR
TRANSFER	1 if farmer expected to transfer, sell, or rent out owned acreage in next five years; 0 otherwise
TREE	Tree planting
WINTCROP	Winter cover crop
YRSFARM	Number of years farming

VITA

Susan F. Jamnick was born in DuBois, Pennsylvania on December 11, 1957. She attended public elementary and secondary schools in Parsippany, New Jersey and was graduated from Parsippany Hills High School in June 1976.

Susan began attending West Virginia University in August 1976. She received a Bachelor of Science in Agriculture, Magna cum laude, in December 1980. While attending West Virginia University Susan was president of the Resource Management Club and was a member of the Agriculture and Forestry Council and Alpha Zeta.

After graduation from West Virginia University Susan and her husband, Mark, moved to Knoxville, Tennessee where Susan worked as a Statistical Clerk from March 1981 to September 1981.

In September 1981 Susan began attending graduate school at The University of Tennessee, Knoxville. She received a research assistantship from the Department of Agricultural Economics and received a Master of Science in Agricultural Economics in August 1983.

Susan is a member of the American Agricultural Economics Association and the Southern Agricultural Economics Association.