To the Graduate Council:

I am submitting herewith a dissertation written by Jufu Chen entitled "Analysis of Socioeconomic Factors Affecting the Use of Soil Conservation Practices in West Tennessee". I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

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ANALYSIS OF SOCIOECONOMIC FACTORS AFFECTING THE USE OF SOIL CONSERVATION PRACTICES IN WEST TENNESSEE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Jufu Chen

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DEDICATION

This dissertation is dedicated to my wife

Suzhen Pu

Whose deeply love and support has made this possible

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ABSTRACT

Soil erosion is an old and new enemy to agriculture and environment in the United States. Costs of soil erosion include the loss of agricultural productivity and the environmental damage. The application of soil conservation measures on cropland to reduce soil erosion in order to maintain agricultural production and to protect environment have been main tasks for both farm operators and public agencies. Increased public awareness about environmental protection and concerns of sustainable agricultural growth have pushed policy-makers to solve soil erosion problems by creating major national conservation programs to assistant farmers in adopting conservation practices.

The key point in soil erosion control is the adoption of soil conservation practices by thousands of individual farm operators. It is essential for policy-makers to have a comprehensive understanding of farm-level conservation behavior so that the most cost-effective conservation programs can be implemented. Conservation programs in the U.S. in the 1980's were concentrated on "subsidies to buy conservation" (Young and Osbom, 1992). The success of the Conservation Reserve Program (CRP), that removed millions of acres of cropland from production is the most dramatic example. The recent 1995 Farm Bill allowed farmers to extend this program for another seven years. In addition, program participants are also allowed to modify their conservation practices if they can demonstrate the modification can provide greater erosion control. How to guide farmers to use soil conservation measures on cropland planted to row crops is a big task for the policy-makers and concerns environmentalists. However, the understanding of farm-level

conservation behavior is weak (Lockeretz, 1990). More research needs to be done on farm-level conservation behavior.

The objective of this study was to identify and investigate the factors that affect the use of conservation practices in West Tennessee that is a region of major row crop production and major soil erosion. The household production theory was introduced to describes the use of soil conservation practices by farmers. The conceptual model of decision process of soil conservation was constructed and investigated by regression analysis. Hypotheses in the study were tested through regression analysis. Ordinary least square regressions and logit regressions were used to analyze the factors and affects on both the perception of soil erosion problem and the use of conservation practices. These analyses focused on 1) factors affecting perception of soil erosion rate, and 2) factors affecting the numbers of 13 selected conservation practices used by farmers. Logit regressions were also used to analyze the use of 13 individual conservation practices.

The results of the study showed that both economic and non-economic factors played important roles in the use of conservation practices. Economic factors played a major role towards profit maximization. Personal and sociological factors tended to play important roles towards utility maximization. Among the non-economic factors, attitude variables, personal values, beliefs, neighborhood pressure and social obligation variables played essential roles in both perception of soil erosion and the use of soil conservation practices. Institutional and communication factors, such as information sources, educational program and participating conservation programs, provided financial and technical supports for improving the perception of soil erosion problems and the use of soil conservation practices. Resource factors were physical conditions for farmers to use different types of conservation practices.

The results of the study indicated that farmers' economic feasibility and other circumstances permit them to use different types of conservation measures. The various federal conservation programs are important in providing economic incentives and options in soil erosion control. The major conclusion was that economic incentives and feasibility were important factors for farmers to adopt conservation practice. Personal factors and sociological factors determined attitudes, beliefs towards soil conservation. Information sources, educational programs and other technical supports were also important in increasing knowledge and changing farmers' attitudes toward conservation and the use of conservation practices.

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CHAPTER I

INTRODUCTION

The Erosion Problem and Conservation Measures

Conservation tillage was introduced in recent decades to reduce conventional tillage in order to reduce soil erosion level and maintain water quality. Some researchers have estimated that various conservation tillage practices can reduce the level of soil erosion on many types of soil from 50 to 90 percent compared with the high loss by use of conventional tillage practices (Myer, 1988). Because of the advantages and effectiveness of conservation tillage, many U.S. research workers and various government agencies have urged greater adoption of conservation tillage and other conservation measures. For instance, there were about 30 million acres of cropland under conservation tillage use in 1972 in the United States and over 100 million acres in 1982. In 1988, the national average of conservation tillage used on cropland was 32.2 percent. Researchers have estimated that ,by the year 2010, ninty-five percent of U.S. cropland will be farmed with conservation tillage (Myer, 1988).

Soil erosion is a serious problem in the United States. More than 1.6 billion tons of soil are lost each year (USDA, Soil Conservation Service, 1990). Overall, an estimated one-third of U.S. topsoil on cropland has been lost in the last 200 years (Walker, 1982). Such a loss creates socioeconomic and environmental problems for both landowners and society. Costs of soil erosion include both on-site and off-site costs. On-site costs of soil erosion include soil loss that lowers productivity of erodible land and, thus, limits the ability of the U.S. to produce sufficient and low-cost food. With the loss soil productivity, more inputs such as fertilizer and other technologies are needed to maintain productivity.

However, higher on-site costs for individual farmers go beyond the loss of long-term fertility and productivity. The consequences of soil erosion may result in major losses of chemical nutrients and adversely affect the aesthetic qualities of farmstead. In addition, high soil erosion may forces the retirement of highly erodible acreage, and potentially reduce the land's resale value. Each of these costs adversely affects the economic viability of a farm and farmer.

Off-site costs received much increased attention in the early 1980's when societal environmental quality was considered. The Conservation Foundation estimated that off-site costs may total $6 billion a year (Crosson, 1984 and Sampson,1985). Deposition of mass amount of soil in reservoirs, rivers, and road ditches affects many people beyond the farmland owners. Off-site consequences of soil loss include the added cost of the dredging of commercial waterways, cleaning of highway ditches, and added costs of purification of drinking water by both public and private sectors. Other consequences are the loss of water for recreational use, loss of fish, loss of wildlife habitat and a reduction in the aesthetic quality of the environment.

In the last decade, environmental considerations of soil erosion received considerably more attention not only from the agricultural sector, but also from many non-agricultural public and governmental agencies. However, while it is possible to demonstrate that off-site soil erosion is a serious socio-environmental issue for the society, it is difficult for the government to solve the problem because farmland is privately owned by many thousands of individuals who may 1) either fail to recognize the larger environmental problem or 2) can not afford the expenses of soil erosion reduction measures unless their own improved benefits pay the costs. Some landowners ignore their larger social responsibility to protect the land resource because they do not understand the importance of tillage practices on soil loss or off-site water quality. The government program justification for soil erosion control in the 1980's considered high off-site cost, loss of soil productivity for society and a need for greater environment protection besides the impact upon the farm owners and operators.

Early Soil Conservation Policies in the United States

Soil conservation has been an important topic in the United States in recent decades. With the development of modern technology in agriculture and further increased demand for agricultural products both for a growing U.S. domestic and international markets, soil conservation has been an important issue in protecting soil and maintaining environmental quality. In the last several decades, greater public awareness of soil erosion problems has pushed the federal government and policy-makers to pay greater attention to soil conservation issues to obtain sustainable and profitable agricultural growth in the U.S. to feed the domestic population and to produce agricultural commodities for trade in the international market. During the last two decades, a lot of efforts through the federal and state governments and many research institutions have been made to try to reduce erosion on our farmland. However, soil conservation requires the cooperative efforts of farmers, commercial dealers and government agencies. Major attention should be paid to why and how farmers make conservation efforts. Improved environmental protection, resource conservation and sustainable agricultural development continue to be main issues in the 1990's and are likely to continue to be important in the future.

Several major U.S. conservation programs were started in the 1930's. The first major one was the Conservation Operator's Program which was authorized by the 1935 Soil Conservation Act. This program provided technical assistance to farms for soil conservation. The Soil Conservation Service, established in the same year, began to help farmers become more actively involved in soil conservation activities by providing both technical and financial support to farmers. The Agricultural Conservation Program (ACP) was authorized as part of the Soil Conservation and Domestic Allotment Act of 1936 and served as the mechanism by which the federal government shared in the costs of various conservation practices. The Agricultural Conservation Program mainly provided incentives and benefits for farmers to reduce soil erosion, but also had some provisions to control excess agricultural production. In 1956, the Soil Bank Program was establish. The Soil Bank Program consisted of the acreage provision reserve and the conservation reserve provision. The acreage reserve provision was to control and reduce the acreage of some row crops by providing farmers payments for diverting acreage of some row crop use to conservation cover crops. The conservation reserve provision was to encourage farmers to remove cropland and place it in conservation use. These conservation programs continued through the 1940's, 1950's and 1960's. By the 1970's, studies of soil loss indicated that greater efforts were needed to preserve soil on row crop land, especially those lands subject to extreme levels of soil loss. Also water quality decline from soil erosion became a major topic of resource conservation.

In 1977, Congress enacted the Soil and Water Resource Conservation Act which required the USDA to continually appraise soil, water and related resources on nonfederal land and develop a program for furthering the conservation and protection of these resources (Rasmussen, 1982), (Batie et. al., 1985). Along with changes in the soil conservation program, the Federal Water Pollution Control Act of 1972 emphasized non-point source pollution control. Non-point pollution control regulations required states to develop plans to improve water quality. The Soil Conservation Service of the

U.S.D.Awas mandated to carry out these regulations along with other government agencies. [1]

Conservation Program in the 1980's and 1990's

Beginning in the 1980s, environmental consideration for land, water and air had a major impact on governmental laws, regulations and level of federal appropriations. The public had a growing environmental awareness that farmers should become better stewards. Environmental protection and resource conservation became widely accepted objectives and were supported by the public. Environmental consideration from the public greatly affected U.S. conservation policy in the 1980s and the 1990s.

The 1980 and 1985 U.S. Farm Bills gave the USDA increased discretionary power to make adjustments in government support program within a highly flexible set of policy guidelines. Both of these farm bills provided greater incentives for farmers to conserve soil, especially in the application of conservation practices on highly erodible farmland. In addition, the soil conservation programs had mandatory requirements for farm operators to meet soil erosion control goals. Since 1985, government programs supported and assisted in the application of soil conservation practices financially, technically and administrationally. These programs have made significant achievements in controlling the level of soil erosion. But these programs have also cost the U.S. government huge sums of money to implement them. The major conservation provisions are the Agricultural Resources Conservation Program, which includes the Conservation Reserve Program, Wetlands Reserve Program, and the Agricultural Water Quality

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[1] The Soil Conservation Service was recently named as the Natural Resource Conservation Service.

Program, Sodbuster, Conservation Compliance, Swampbuster, and the Environmental Easement Program (USDA, 1990).

The conservation compliance provisions of the 1985 Farm Bill (the Food Security Act) was further amended by the 1990 Farm Bill (the Food, Agriculture, Conservation, and Trade Act). These provisions strongly discouraged the production of row crops on highly erodible cropland unless the land is protected from erosion under an approved conservation plan. Under these provisions, if a farmer produces crops on highly erodible land without an approved conservation plan, the farmer would lose eligibility for most USDA program benefits. These provisions include the ineligibility for price supports, crop insurance, Farmers Home Administration loans and the loss of farm storage facility loans. Furthermore, the loss includes the benefits of Agricultural Conservation Program, CPR cost-share payments, and disaster assistance. (USDA, 1990). Under the 1990 Farm Bill, farmers with highly erodible land were required to have an approved conservation plan that would be fully implemented by December 31, 1994. In addition, the 1990 law established graduated payment reduction for unintentional violations after November 28, 1990 (USDA,1990).

Both the 1985 and 1990 farm bills took a broad approach to conservation issues. Before 1985, soil conservation provisions were defined largely around resource protection measures that would maintain and enhance agricultural productivity. The 1985 and 1990 Farm Bills strengthened the environmental components and broadened the rationale for conservation by tying use of conservation measures to other agricultural provisions. The 1990 Farm Bill broadened the mandate of additional programs, such as the Conservation Reserve Program (CRP) and made protection of nonagricultural resources for nonagricultural purposes an explicit goal. Second, the 1990 Bill enhanced the conservation program portfolio in many ways, such as the water quality provisions, which are primarily for the broader community environmental protection and only secondarily protect against the lost of agricultural productivity (Zinn, 1991).

The Conservation Reserve Program (CRP) was mandated under the 1985 Farm Bill and was amended by the 1990 Farm Bill. The CRP, which mainly targeted highly erodible cropland and sets conservation compliance standards, was enacted to keep farm land from returning to row crop production. Owners and operators of cropland defined for CRP purposes as "highly erodible" were allowed to submit bids for enrollment of their crop acreage to be taken out of row crop production. Enrollment into the CRP establishes a ten-year contract prohibiting hay production, grazing or commercial harvest of any crop. Further it required adequate grass or tree cover (Reichelderfer and Boggess, 1988). The CRP provided producers 10 years of rental payment in return for forgoing cropping rights in the contract period. Since 1986, 36.5 million acres of "highly erodible" cropland, or about 8.7 percent of the nation's 420 million acres of cropland, have been enrolled in the CRP in the United States (Heimlich and Osborn, 1993). On the other hand, the implementation of the CRP costs the government approximately $1.8 billion annually or an average of 50 dollars per acre in the program. Because of budgetary consideration, the extension of all CRP land in the 1995 Farm Bill was in question untill the recent passage of the 1995 Farm Bill.. With the ten-year contract, about 24 million acres enrolled in the CRP would expire in 1997 and nearly all of the contracts would be expired by 2001. (Heimlich and Osborn, 1993). A detailed study (Nowak, Schnept and Barnes, 1991) indicated that the CRP landowners planned to return over one half of current CRP land to crop production after the program contract ended. This means that many of the 36.5 million acres of previous "highly erodible" cropland could return to crop production by the year 2001 if there had been no further program extension.

Under the conservation circumstances facing in U.S., the 1995 Federal Agricultural Improvement and Reform (FAIR) Act (1995 Farm Bill) has allow the CRP to extend for another seven years. According to the 1995 Farm Bill, the enrollment of the CRP will be maintained at up to 36.4 million acres which is the almost the same as current level (38 million acres). In addition, the 1995 Farm Bill also updated the conservation compliance provision. Participants of conservation programs must continue to maintain conservation plans including compliance with highly erodible land provision and wetland conservation provision to receive contract payment. The 1995 Farm Bill also authorized a new conservation program called Enviromental Quality Incentive Program (EQIP) over next 7 years. The purpose of the EQIP is to provide technical, educational, and cost-share assistance and incentive payments to crop and livestock farmers At the same time, the 1995 Farm Bill also gives some flexibilities to farmers for soil erosion control. Farmers are allowed to modify conservation practices in their conservation plan if they can demonstrate that the modification can provide greater soil erosion control. How to direct and assist farmers to use conservation practices and modify conservation practices will be important issues to the government and research institutions in the next few years.

Motivations and Factors for Farmers to Adopt Soil Conservation Practices

No matter how the public and the government care about soil conservation, the final users of most conservation measures are the thousands of individual farmers. There are three aspects in implementing government conservation programs and reaching the conservation goals. First, farmers must desire to use conservation practices. Second, farmers' farm physical conditions, economic feasibility and other farm circumstances must permit them to use different conservation practices. Third, government and other agencies must provide technical and financial supports to help farmers adopt conservation practices.

Previous research found that the majority of farmers believed that soil erosion and water quality degradation are problems (Christensen and Norris, 1983) (Swanson and Thigpen, 1985) (Duff et. al., 1991). However, most farmers also tended to underestimate the erosion rate in their own land and, thus, underestimated the extent of the problem (Ervin and Alexander, 1981), (Korsching and Nowak, 1980) and (Leuthold and Hart, 1988). These study indicate that farmers were frequently aware of the need for soil erosion control measures, but often underestimated the extent of erosion on their own lands. One reason for this may be the different views of the measurement techniques by farmers and the SCS (Chistensen and Norris, 1983). Another reason may be that farmers do not have enough knowledge of the measurement of soil erosion. Farmers are more likely to evaluate erosion in terms of its effect on crop yields, costs of production and farm profit whereas scientists can measure soil erosion. Additionally, the findings suggest that the gap between the actual erosion and estimated erosion by farmers should be recognized by farm operators and policy makers. Underestimation of erosion problem by farmers has a negative impact on the intent of use of conservation practices. If a farmer does not realize the soil erosion problem or underestimates the erosion rate in his own land, he may not see the needs to fully implement soil erosion control measures.

While farmers often tend to underestimate soil erosion problems and often don't perceive the serious consequences of the soil erosion problems, researchers have suggested that more educational programs may be needed to provide information and increase knowledge of soil erosion problems. In addition, information and assistances are also needed to aid farmers in adopting conservation practices. The process of the adoption of conservation practices through educational program is called the diffusion model or educational model (Napier and Forester, 1981), (Rogers and Shoemaker, 1968) and (Nowak 1983 and 1987). A previous study found that high awareness of the soil erosion problem, especially for landowners, encourages the adoption of conservation practices (Taylor and Miller, 1978). Cressel (1995) suggested that conservation education to the public and farmers is an essential aspect for the soil conservation movement. Research results and scientific information must be translated so that final users can benefit. It is possible that more information made available via government programs may have added to the original disparity in knowledge among farmers. On the other hand, some researchers argued that additional information could increase the information gap among farmers because those with knowledge of soil erosion programs tend to gain more information when it is available, while those with less knowledge become more disadvantaged (Korsching and Nowak, 1980). However, most researchers agree that information and educational programs should increase knowledge about conservation and provide information about the use of conservation measures.

Once farmers perceive the need for soil erosion control, there should be incentives and motivation for them to adopt conservation practices. Economic incentives and profit maximizing attitudes of farmers are important factors which affect soil conservation use. Previous research indicated that many farmers were interested in short-term profit from land resources (English and Heady, 1980), (Uchtman and Seitz, 1979) (Featherstone and Goodwin, 1993). Intensive use of the land resources while ignoring soil erosion control measures is a means of gaining short-term economic successes. Short-run profit maximizing attitudes of farmers, however, are not the only factors influencing soil erosion. Many conventional agricultural tillage practices produce short-run economic return, but produce long term soil erosion problems. For instance, a continuous row-cropping system may be a highly profitable farming system for a number of years. The system performs well for growing corn, soybeans, cotton and other row crops, but it can also be harmful to the soil if used year after year without the use of conservation tillage practices. Continual row-cropping greatly increases the probability that the land will be eroded. The use of fertilizers and pesticides with continuous row-cropping is feasible, but these also increase cost and fail to reduce the soil erosion problem. Many high-scale agricultural practices can produce immediate economic return, but few soil conservation practices produce high short term economic return. An economic return on the investment of soil erosion control often takes several years. Ervin (1981) found that the adoption of soil conservation practices by farmers was motivated by "perception of profitability" of the practices. Some researchers also discovered that the majority of farmers believed that most conservation practices were profitable (Ervin and Alexander, 1981), (Swanson and Thigpen, 1985). Researchers also found that some soil erosion control measures could be profitable in the short-run if used on "appropriate soil" with some conservation tillage practices (Napier and Forster, 1981). But in general, most soil control measures require farmers to make costly short-term investment for a long period benefit. This often makes it difficult for farmers to use conservation measures when farmers place major consideration on short-term profit. Farmers are more likely to adopt innovations to increase profits rather than to adopt those aimed at improving environment quality (Pampel and Van Es, 1977).

Many researchers, however, indicated that even though economic incentives were not the only factors affecting adoption of conservation practices, they stressed the importance of economic incentives. Previous studies indicated that farmers perceived the need of economic incentives to motivate farmers to adopt soil conservation practices. On the other hand, besides economic incentives, farmers' attitudes and behaviors toward conservation also influence the adoption of conservation practices (Nowak and Korsching, 1979), (Nowak, 1983, 1987) and (Lynne et. al., 1988).

Government plays an important role in the resolution of soil erosion. Both regulations and incentives are used to accomplish these government functions although environmental regulations are also imposed to implement government programs. The primary government programs for reduction of soil erosion are to provide farmers incentives to adopt conservation measures while setting conservation objectives and goals. The government also provides financial incentives and technical support to farmers in the use of conservation practices. On the other hand, previous research indicated that farmers often wanted the advantages of government aid programs, but did not want to assume additional costs. Farmers favored government intervention in the area of soil erosion when the intervention programs were voluntary in nature. Farmers favored government involvement when it is to their advantage, but opposed intervention when they were subject to major restrictions or to any program that would not benefit them. The previous study also found that over 50 percent of farmers thought that the federal government should have an important technical and financial role in soil erosion control and agricultural non-point source water pollution. Therefore, government programs and regulations should combine both benefits and environmental standards to affect land use. Past government program implementation showed that economic incentives play an essential role for farmers to use conservation measures. There is a general agreement to implement conservation programs in which local farmers maintain control of soil erosion by abatement programs, and that funding for the programs should be provided by state and federal government to assist farmers in education about the benefits of use of conservation practices.. In the last decade, a growing body of local, state and federal environmental regulations have been imposed on farmers. The Conservation Reserve

Program is a voluntary program that involved the resolution of soil erosion control in the 1980's. The CRP combined economic incentives and environment standards, and is connected to other government programs. However, due to the federal government budget consideration, the extension of CRP may not be realistic in future decades as mentioned before.

Conservation practice use is highly related to the farmers' voluntary decisions. Hence, while government programs of communication, information and other educational activities play important roles in encouraging farmers to adopt conservation practices, it is farmers who decide to use and invest funds in conservation measures. Conservation goals and objectives can only be reached through the actual use of conservation measures by farmers. Characteristics of farmers and their farms influence farmers' conservation attitudes, behavior and, actual use of conservation practices. Previous research results have identified factors affecting farmers' conservation attitudes and behaviors. These major factors are personal, economic, institutional, sociological and resource factors. Personal factors include age, farm experience, educational level, conservation attitudes and farm orientation. Economic factors include farm income, farm planning horizon, debt level, off-farm work and type of farm. Institutional factors include size of farm, information sources for farm decision and land tenure. Sociological factors include opinion leadership, social activities and social status of farmers. Physical factors include soil type, slope of farm land and erosion potential. How all these factors affect the adoption of conservation measures will be discussed in the following chapter.

Problem Justification

The present study examines factors affecting conservation practice use and conservation effort of a representative sample of West Tennessee farmers. Agriculture is one of the Tennessee's largest industries with on-farm cash farm receipts of over two billion dollars annually and West Tennessee is the major agricultural production area of row crop production in Tennessee. Agriculture is the neart of the economy throughout the West Tennessee counties. The 21 West Tennessee counties between the Tennessee River and Mississippi River form the major production region of row crops in the state. According to 1992 statistical data, these 21 counties produce 81 percent of the soybeans, 68 percent of wheat, 62 percent of corn and 98 percent of cotton produced in Tennessee (Tennessee Agriculture, 1993).

High rates of soil erosion is a serious problem in much of West Tennessee. Of the estimated 116 million tons of soil lost annually in Tennessee, an estimated 58% occurred in the 21 West Tennessee counties. In the late 1970's an extensive evaluation of soil erosion and water quality problem on 6.8 million acres of farmland in West Tennessee revealed an average annual erosion rate of about 40 tons per acre on the 2.3 million acres of sloping cropland. Overall, cropland in the West Tennessee region had an average erosion rate of 17.4 ton per acre in 1982. This level of soil loss from the region was among the highest of any region in the nation ("Conservation and Management Update" by Tennessee State Rural Development Committee, 1983). For example, 21 West Tennessee county region is one of the four U.S. regions targeted by the Federal government that experienced excessively high soil erosion (USDA 1985). Reducing annual soil loss erosion to five tons per acre or less is widely considered as a target in the U.S. for preserving the long term capability of cropland to produce crops efficiently

(Shelton and Bradly, 1987). The study by Jent et al. shows that soil loss tolerance (T) values in most Tennessee soil series is five tons. However, this level of soil loss is exceeded in much of the West Tennessee region cropped by conventional tillage methods (Jent, et. al., 1988).[2]

Use of conservation tillage is an especially effective way to reduce soil erosion for coastal plains soils found in the counties in the West Tennessee region. Starting in 1979, the Tennessee Rural Development Committee assumed leadership in developing a multi-agency plan to reduce soil loss. The plan touched all phases of agricultural field production and involved agricultural agencies at the local, regional, State and Federal level. The plan was called the West Tennessee Management and Conservation Educational Program ("Conservation and Management Update" by Tennessee State Rural Development Committee, 1983). With help from several agencies, many West Tennessee farmers began to apply conservation practices on their farm operations. The program has produced significant results. The program included the development of the Resource Management Conservation (RMC) demonstration farms, Small Resource Conservation Management (SRCM) demonstration areas and Large Resource Conservation Management (LRCM) demonstration areas. For instance, in 1983, 144 farmers were enrolled in the RMC program, 335 farmers (29,362 acres) were enrolled in the SRCM program, and 800 farmers (132,510 acres) were enrolled in the LRCM program. These programs in the early 1980s' influenced conservation practice use in West Tennessee.

Under both the Food Security Act of 1985 (1985 Farm Bill) and the Food, Agriculture, Conservation and Trade Act of 1990 (1990 Farm Bill), the conservation provisions were greatly expanded. The provisions of both the 1985 and 1990 acts make

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2 Soil loss tolerance is defined as the maximum rate of annual soil erosion that may occur and still permit a high level of crop productivity to be obtained economically and indefinitely. T values were derived by soil scientists, agronomists, geologists, soil conservationists, and federal and state research leaders.

the goals of USDA commodity programs and conservation programs more consistent and interrelated. More specifically, the conservation provisions began to be enforced under the 1990 Farm Bill. Conservation practice use was dramatically increased after 1985. With the help of different government agencies and conservation compliance through government programs, the cropland of 21 West Tennessee counties applied conservation tillage on 56.1 percent of soybeans acreage, 60.1 percent of corn acreage, 45.6 percent of sorghum acreage and 27.8 of cotton acreage in 1992 (Tennessee Agriculture, 1993). Because various conservation practices were widely used by West Tennessee farmers since 1980, the soil erosion rate has significantly decreased in the West tennessee region. According to the 1992 National Resource Inventory report, estimated soil erosion rate from Universal Soil Loss Equation (USLE) in West Tennessee counties had an overall average annual erosion rate of 7.1 ton per acre on cropland. This estimate was much lower than the 1982 National Resource Inventory estimate (1982 National Resource Inventory, USDA Soil Conservation Service). A research study done by the Natural Resource Conservation Service in Nashville estimated that in the ten-year period between the 1982 and 1992 NRI's, there was a reduction in the erosion from cropland in West Tennessee in excess of 12.3 million tons per year (USDA, National Resource Conservation Service, 1996).

West Tennessee farmers have been involved in the CRP on highly erodible cropland since 1986. By 1990, 270,004 acres of cropland in 21 west Tennessee counties were in CRP. Most of the land (251,793 acres or 93 percent) was contracted between 1986 and 1990 (USDA, Agricultural Stabilization and Conservation Service, 1993). After the ten year contract expiration, most farmers may extend their contract under the 1995 Farm Bill. Participants may also modify their conservation practices to meet the conservation compliance provision. The modification will also affect the use of different conservation practices in the next 7 years. Further research needs to be done in order to provide guidelines for policy-makers to encourage the use of conservation practices and to implement the government program for soil erosion control.

Even though many conservation goals were mandated through the 1990 Farm Bill, the use of most conservation practices is still a voluntary decision of farm operators. The voluntary adoption of conservation practices is often a long term process for individual farmers. Thus, a cooperative effort to implement conservation tillage and other conservation measures is needed from both the government and individual farmers. In addition to the mandated plan through the government program, farm operators need information, technical assistance and financial aid to help them implement soil conservation measures. Numerous economic, physical, institutional and sociological factors and personal characteristics of farm operators are associated with the use of conservation practices. In order to assist farmers and to provide guidelines for policy makers and government agencies in soil conservation program implementation, it is important to investigate how various factors affect soil conservation decisions and use by West Tennessee farmers.

A number of studies have been done in the past decade to identify factors associated with use of soil conservation practices in the U.S. However, due to the relatively small geographical areas of most studies, the specific variables employed and the different statistical approaches, it is somewhat difficult to determine how representative these studies would be for the West Tennessee region. Further, studies are needed to provide guidance and implementations of effective programs for government agencies and policy makers in the region.

Lockeretz (1990), by reviewing some of the past research of factors influencing soil conservation adoption, concluded that despite considerable effort from various agents and researchers, people still know little about who conserves soil and what kinds of farmers care the most about conserving soil. Lockeretz listed several reasons for this: "First, statistical presentations often overemphasize the positive findings and understate how much has not been learned. Second, many studies have been hemmed in by too narrow a set of preconceptions so other variables that might be relevant have not been explored. Third, we do not know enough about how soil conservation behavior varies geographically and over time for the results to be of much use in guiding policy" (pp. 523). Lockeretz also suggested that the further studies be done with different approaches, such as use of other kinds of variables and more attention to linking studies undertaken at different places and different times.

Objective of the Study

The general purpose of this research is to identify and examine personal, economic, institutional, sociological, communication and resource endowment factors in the West Tennessee region that influence the use of conservation practices and how economic and non economic factors affect farmer's conservation behaviors. Specific objectives are:

1. To employ a theory model for farmers' conservation behaviors and to construct a conceptual model of the conservation decision process and empirically test the model for the adoption process.

2. To identify the personal, economic, institutional, sociological communication and resource factors which affect the perception of erosion problems and the use of different types of conservation practices and to examine how likely these factors affect the level of conservation use.

3. To analyze how non-market factors affect soil conservation use by application of the "household production theory".

4. To draw policy implications and to provide guidelines for the government policy and programs on soil conservation practices.

CHAPTER II

LITERATURE REVIEW

Background

Recognition of soil erosion in the U.S. can be traced back to more than two centuries ago (Rasmussen, 1982). However, little public attention on the soil erosion problem was paid until the early 1930's when the Soil Erosion Service was established. Despite the government programs on soil erosion control since the early 1930's, studies still indicated that soil erosion was a big problem in the 1970's. In the last two decades, significant efforts have been made by researchers and government agencies on the soil erosion problem. A number of studies have been completed on factors related to adoption of soil conservation, farmers' behavior and use of soil conservation measures.

There are many factors that contribute to the decision and adoption of soil erosion control practices. Generally, the factors can be categorized into two groups: they are economic factors and non-economic factors. Some previous studies used mathematical programming models to optimize one or more objectives with given resource constraints in soil conservation issues (Taylor and Frohberg, 1978), (Wade and Heady, 1978), (English and Heady, 1982), and (Alexander, 1991). Those studies have provided dramatic results for optimal soil erosion control and policy guides. Mathematical models assume that a farmer's primary motivation is profit maximization. Such studies mainly concentrated on translating the factors relevant to the soil and water control decision into economic terms. However, there are other non-economic factors beyond economic factors involved in a farmer's decision and adoption of conservation practices. It is important to realize that the decision to adopt and use conservation measures is not made solely on the basis of economics. Personal values and beliefs, existing attitudes, social status and traditions may have a great effect on farmers' decision to use conservation practices. In addition, economic characteristics, personal characteristics, education and experience, institutional characteristics and physical conditions of farmers also influence farmers' decisions on conservation. All of factors are based on a previous condition: A farmer should perceive a need for soil erosion control.

Conservation Adoption Models and Significant Variables Found in the Past

An important study about the factors affecting adoption and use of soil conservation practices was done by Ervin and Ervin (1982). Ervin and Ervin (1982) constructed a conceptual model of the decision-making process for soil conservation measures. There were three major stages in the decision-making process according to the Ervin and Ervin's model. The first step was the recognition of an erosion problem by a farmer. Once the erosion problem was perceived, the second step was the decision to adopt a conservation practice. The third step was the determination of soil conservation effort. In the entire decision-making process, personal, physical, economic, and institutional factors would play important roles. However, the different factor categories were modeled to play separate roles and different ways to use one or more practices in the decision-process. For instance, personal factors, such as higher education and management ability, can influence a farmer's disposition to use conservation practices and affect the proper application and maintenance of the practices. Economic factors may either enhance or constrain dispositions of farmers toward erosion control.

Three dependent variables in the study were defined corresponding to the three major decision components. There components were 1) perception of the degree of erosion problem on farm land, 2) decision to use conservation practices on the farm; and 3) conservation efforts or the total capital expenditures and maintenance expenses for conservation practices. Four categories of factors were defined for the explanatory variables. They were physical, personal, economic and institutional factors. Multiple regression analysis was introduced in the study. Three regression models were used to test the hypothesized relationships. The three dependent variables were 1) perception of erosion problem; 2) number of conservation practices used, and 3) soil conservation effort. The three models had different key explanatory variables. There were seven variables in the perception model. Five of them had the hypothesized signs and two of them were significant at the 0.10 level. The models of the numbers of practices and conservation effort had the same 15 explanatory variables. Most explanatory variables had the hypothesized signs. Four variables in the numbers of practices model, and five of them in the conservation effort model were statistically significant at the .10 level. The two models had almost the same significant variables, which indicated a high degree of substitution between the number of conservation practices used by farmers and the conservation effort. The results of the study showed a strong relationship between adoption of conservation practices and the cash grain farm. Some previous research also indicated that operators of larger farms have more flexibility in their decision making, greater access to discretionary resources and greater ability to deal with the risks associated with the adoption of new agricultural practices. Erosion potential, education level, perception of erosion problems, and the percentage of owned cropland that received cost sharing were found to be positively related to soil conservation efforts.

In addition to investigating the relationships between explanatory variables and the numbers of conservation practices and the conservation effort, the study also examined relationships between individual conservation practices and explanatory variables. The results showed that use of structural conservation practices appeared to be more associated with the variables than were non structural conservation practices. For instance, the results from the study showed that cash grain farms were less likely to use contouring or hay rotation because those farmers who use contouring or hay rotation emphasized maximizing short-run returns from row crops. These results indicated that different conservation practices had their own characteristics and that personal and economic factors may have different influences on individual set of conservation practices.

Another important study about conservation behavior of farmers was done by Lynne et. al. (1988). The researchers constructed a model of conservation behavior and decision of farmers by incorporating economic and non-economic variables. The non-economic variables were considered as a broad concept which consists of values, beliefs and attitudes toward conservation. The model stated that a conservation decision of a farmer encompassed a broad set of motivations. All the factors such as economic, psychological and physical factors would influence farmers' conservation behaviors. The factors affecting the conservation decision of farmers in the study included 1) social situation factors which were reflected by income, price paid for the conservation effort and the features of the farm, 2) attitudes of the farmers toward conservation practices and 3) social norms which were reflected by the perceptions of what others wanted. By constructing a conservation behavior model with an indirect utility function, the authors deemed that the decision model was not greatly different from the subjective expected utility (SEU) model in economics where Um was the indirect utility function for farming with conservation effort "m".

$$Um = Um(Ym, Pm, Am, Fm), \tag{2.1}$$

Where Ym includes income from both farm and off-farm sources. Pm is price paid for the conservation effort. Am is a farmer's attitude toward conservation practices which also includes social norm. Fm represent the features of the farm. In the equation (2.1), Am is an important variable because it represents farmers' attitudes toward conservation. For instance, if an individual farmer has a strongly positive attitude toward soil conservation activity, the farmer will gain a higher positive utility through the conservation action. Lynne et al.(1988) stated that "the attitude concept is a near kin of the SEU model wherein the probability of event occurring (belief) is multiplied by the utility (evaluation) of the event"(p. 14).

A Tobit estimation method was used to analyze the relationships between the conservation effort (dependent variable) which mainly was represented by the numbers of conservation practices used and the explanatory variables which covered attitudes and beliefs of farmers toward conservation. Nine of the fourteen tests between explanatory variables and conservation use were significant at the 5% level. The results of the study showed that owners of farm land put more effort in conservation than renters. Farmers with highly erodible land generally expended more effort. Farmer income was found to be positively related to conservation effort. Farmers who were willing to bear risk were likely to expend more effort on conservation.

An important finding was that the attitude variables were important variables in explaining use of conservation practices. All the attitude variables in the study were significant. This result indicated that a substantial specification error would occur if only economic and physical variables were used. Belief and attitude variables in the study improved the overall performance of the model. Strong attitudes favoring conservation increased the level of conservation effort. Economic incentive would increase conservation effort, but responsiveness would differ with the strength of conservation-related attitudes. For instance, farmers with strong views about the use of nonrenewable resources, preserving the integrity of renewable resources and taking responsibility toward others expended strong efforts on conservation measures. This study suggested that behavioral models would improve economic models of conservation behavior.

Gould et al. (1989) used both Probit and Tobit models to examine the effect of various factors on the use of conservation tillage by application of the Ervin and Ervin model (1982). The study used both perception of soil erosion and level of soil conservation use as dependent variables. Probit equations were used to estimate the relationship between perception of soil erosion and explanatory variables and Tobit equations were used to estimate relationship between soil conservation use and explanatory variables. The independent variables in the study were categorized into farm, financial, and operator characteristics. Six of eight estimated coefficients of independent variables in the perception model were significant at the 10% or 5% level. Crop acres, cropland slope, education, farm experience and SCS contact were positively related to soil erosion perception. The estimated coefficients of independent variables in the conservation use model had the expected signs except for cropland acres. Farm size was found to be negatively related to the perception of soil erosion problems, but positively related to conservation use.

In addition to the estimated coefficients, the "elasticity of changes" in the independent variables were presented in the study. The study had some new findings about conservation tillage use compared to the previous studies. For instance, younger farmers were more likely to adopt alternative tillage practices than older farmers. But older farmers with more experience on the farm were more likely to perceive soil erosion as a problem. The study also indicated that the farm operators with smaller farms were more likely to recognize the existence of soil erosion problems. However, once given the recognition of soil erosion problems, larger farm operators were more likely to adopt soil conservation technologies. Thus, the results of the study suggest that efforts to increase knowledge of soil erosion problems should be targeted to the younger and less experienced farm operators. The results about farm size suggest that information likely should be targeted to these larger operators with the objective of increasing their perception of soil erosion problems. The perception of the need for soil conservation was found to be an important factor in conservation adoption. Off-farm employment was found to be negatively associated with soil conservation adoption.

Carlson et. al. (1977) found that educational level, farm size and gross income were associated with the number of conservation practices used. Carlson also found that older farmers were more likely to rely on traditional SCS programs than were younger farmers. Higher income was found to be associated with higher degrees of soil conservation uses.

Hoover and Wiitala (1980) found that younger and more educated farmers were more likely to perceive erosion as a problem and, therefore, perceive benefits from using conservation practices. However, some studies suggest that older farmers are more inclined to look to future generations, thus, use conservation practices. Education has often been found to be associated with the use of conservation since higher educated farmers have better access to information sources and have better management skills.

Napier et. al. (1984) used data gathered from 918 farmers in nine Ohio counties to test the relationships between the frequency of use of conservation tillage practices and various farm characteristics. The study found that both personal and farm characteristics were significant variables. The study found that farmers with higher levels of agricultural education used no-till more frequently, left more crop residue on the land, employed chisel plowing more often, retired erodible land to grasses, and adopted grass waterway more frequently than farmers with lower educational levels. Also greater exposure to information sources and environmental concerns were related to the use of conservation tillage practices. However, age and years of farming experience were of little utility in explaining frequency of use of tillage practices. The study, surprisingly, found that size of the farm operation was of little consequence in understanding the frequency of use tillage practices.

Swanson and Thigpen (1985) used survey data from Kentucky to study how farmers felt about and used soil conservation practices. Several factors were found to be associated with the use of eight conservation practices. Educational level and total family income were related to the of use all conservation practices evaluated. Farmers with more education and higher income used conservation practices more often. Younger farmers used five of eight practices more often than older farmers. More than 90 percent of the farmers in the study stated that they believed that farmers were responsible for control of soil erosion .

Park and Ferguson (1986) tested farmer behavior toward conservation practices on the NFFD Watershed in West Tennessee. The study found that the number of years farmed, the existence of a livestock enterprise and ownership of a no-till planter were positively related to conservation efforts while the percentage of net household income from farming was not. The reason for this latter finding was explained as operators with off-farm income sources have a higher "opportunity" cost of time and, thus, may find reduced tillage or no-till practices as highly advantageous when time is reduced by conservation tillage methods. In the same study, Park and Ferguson used a "logit model" to test the factors which were related to the operator's expression of need for conservation practices. The study found that the rate of erosion had a positive influence on the perceived need for conservation practices. In the study, the percentage of the farm in cropland was used as a proxy for physical characteristics of land based on the results of the study.

Featherstone and Goodwin (1993) investigated factors affecting the investment in long-term conservation measures on 541 Kansas farms. The study found that differences of farm sizes, incomes, types of farms and use of other farming practices greatly influence conservation investment decisions. Older farmers made lower levels of investment in conservation technologies. Larger farm households were more likely to make conservation investments. Farms that were principally livestock operations had lower levels of conservation investment than farms that were primarily crop operations. Farms that received direct government program payments were more likely to invest in conservation than those not in the programs.

Use of conservation practices in farm operation is one type of the agricultural technology innovation. Many studies have shown that early adopters differ in their characteristics from persons who adopt new technology later or who never use new technology practices. Bultena and Hoiberg (1983) identified 10 factors as explanatory variables related to the speed with which farm operators adopt conservation tillage. The study also found great differences in the perceptions of early adopters, later adopters and non-adopters toward conservation practices in Iowa.

Nowak (1987) examined the adoption of conservation technologies through analysis of diffusion, economic and ecological factors in the East-central section of Iowa. The study found that diffusion or information variables played an important role in adoption of conservation technologies. The study observed that the decision process of the adoption of conservation technologies has a strong economic dimension. On the other hand, the study also observed that what farmers should do according to economic theory is not the same as what farmers actually do in adopting a new conservation technology. Therefore, the findings of the study indicated that both economic and diffusion factors were important in predicting the adoption of conservation practices. Conservation practices are agricultural technologies. Both economic and diffusion factors play important roles. The study argued that the economic and diffusion perspectives were complementary. As the study stated, for instance, "financial incentives may be used to reduce risk of using a new technology when that practice is fairly simple and involves a significant initial investment. With more complex new practices, however, the most effective way of reducing risk is through the generation and distribution of knowledge" (p. 216).

Leuthold and Hart (1988), in a study of conservation practices in West Tennessee, found that the positive and negative attributes of no-till planting were viewed differently by continued users and non-users of no-till. Continued users viewed the positive attributes more favorably and the negative attributes as less of a problem than farmers who never used no-till or those who discontinued use of no-till. Combining the views of advantages and disadvantages of no-till greatly aided in predicting use of no-till. Continued users consistently viewed advantages of no-till much greater than the disadvantages. Non users of no-till often viewed there were several advantages to no-till, but not sufficiently greater than the disadvantages. Those who never used no-till rated the positive attributes of no-till only slightly higher than the negative attributes. For example, of the 10 positive and 10 negative attributes of no-till studied, those who never used no-till listed a mean of 3.8 positive attributes as of major importance and 3.1 of the negative attributes as of major importance. On the other hand, those continuing use of no-till listed

5.6 positive attributes of major importance and only 1.4 of the negative attributes of major importance. The net difference for continued users was a plus 4.2 attributes compared to only a plus 0.7 attributes for non users. Those who discontinued use of no-till were intermediate in views between those who continued no-till and those who never used no-till. They listed a mean of 3.9 positive attributes of major importance and 2.4 of negative attributes of major importance. These findings imply that positive attributes of a conservation technology must not only be greater, but must be substantially greater than negative attributes for continued use to occur. The failure of a farmer to find this afteron farm trial use may result in discontinuance of the conservation practice. The Leuthold and Hart (1988) study also found that continued no-till users were younger, had higher educational levels, larger sized farms, and greater gross farm income than those who never used no-till. Another key finding was that farmers who "expected a child to farm" were twice as likely to use no-till as those who did not expect a child to farm. The reason given for this latter finding was the importance of preserving soil productivity for the next generation because children often operate the home farm. A long-term view and longer planning horizon may occur for both young farm operators and older farmers who expects a child to farm. Conservation of soil may be a strong motivating factor for those with long planning horizons.

CHAPTER III
THE THEORETICAL MODEL AND APPLICATION

Theory of Conservation Uses and Behaviors

In this study, the primary theoretical basis for analyzing the use of conservation measures is the "household production theory". This model has been used elsewhere, although not specifically in the study of use of soil conservation measures. A farmer is both a household consumer and producer of agricultural goods and services in the market economy. As a consumer, a farmer will try to maximize his "utility" with respect to budget constraints. As a producer, he will attempt to maximize his profit with respect to input factor constraint. As a member of a household, a farmer, no matter what kinds of production or consumption behavior is followed, may view utility maximization as an important goal. Thus, utility maximization needs to be recognized as goal of a farmer and as a consumer. One important reason for a farmer to choose conservation practices is that higher utility can be gained if he gives a high rank to a particular value associated with conservation of resources. The decision of soil conservation use and the actual effort may depend on many factors, including economic and non-economic factors. By introducing "indirect utility function", which was used by Lynne et. al.(1988) in the behavior model , a farmer's utility function with conservation use "c" can be expressed as the following:

$$Uc = Uc\ (Ic, Pc, Ac, Fc, Nc) \qquad (3.1)$$

Where

Uc = individual farmers' utility.

Ic = individual farmers' income from both farm and off farm sources.

Pc = prices farmer paid to have conservation effort.

Ac = farmer's attitudes and beliefs toward conservation.

Fc = the features and characteristics of the farm .

Nc = social status and social norm.

In the equation (3.1), Ic and Pc are economic factors and Ac, Fc and Nc are non-economic factors. The equation states that both economic and non economic factors play roles for a farmer's utility function.

If Pc is the same for all farmers, it can be dropped from the equation for purposes of explaining differences in farmers' actions (Lynne et. at. 1988). Therefore, Ic is crucial for the utility function. If a farmer can obtain a higher income especially in the future through the conservation effort, the utility with soil conservation use (Uc) would be larger than the utility without soil conservation use (Un) when other factors are held constant. Ac represents the attitudes of farmers toward conservation practices. If an individual farmer has a positive attitude toward conservation practices, he will gain utility from conservation and will likely make an effort to use conservation practices. For instance, in a study done by Sampson and Thigpen (1985), they found that a majority of the farmers surveyed believed that use of conservation practices are profitable. This finding challenged the common explanation that farmers often do not adopt conservation practices because they believe conservation practices are unprofitable. The study also showed that most farmers believe that they are responsible for soil erosion control. If the farmer has a favorable attitude toward conservation tillage, he will gain higher utility through actual conservation efforts to reduce soil loss. That is, when the farmer makes investments for conservation tillage, he must believe that conservation efforts have either increased current net economic benefits and/or long-term net benefits for preserving soil productivity. Fc is the feature of the farm. For instance, farmers with "highly erodible" land may be more likely to use conservation practices because of lower expected productivity of soil in the future. Ns is the farmer's social norm and status. For instance, if the farmer believes that he is responsible for soil erosion control, this will probably influence his conservation intention and conservation effort. A farmer's utility for conservation is also combined with other factors affecting adoption behavior such as psychological attitudes, peer group pressures, personal experiences and other non-market sociological factors. Lynne et. al. (1988) argued, through the study of behavior and attitude toward conservation, that substantial error of prediction occurs if only economic and physical variables are used.

An individual farmer is also a producer of agricultural commodities. Farmers choose both private market input goods combining with other non-market goods to produce agricultural commodities. An individual farmer obtains utility from both composite goods and services he receives and farm production activities. Sociological and psychological factors greatly influence value and attitudes of an individual in the use of non-market goods in production activities. Because an individual also derives utility from production activities and non-marketed goods, non-market goods and social factors play important roles in both production activity and utility maximization.

The "household production theory" was introduced in economic analysis in the early 1960's (Becker,1965), (Muth,1966), and (Lancaster,1966). For instance, Becker (1965) presented a theory of the allocation of time among different activities. Becker stated that households are producers as well as consumers. Households produce commodities by combining inputs of goods and time according to cost-minimization. Commodities are produced in quantities determined by maximizing a utility function of a set of the commodities subject to prices and constraints on resources. In the 1970's and the 1980's, more researchers attempted to improve the theoretical framework of household production theory including Hori(1975), Barnett(1977), Bockstael and McConnell (1983), and Neill (1988). Smith (1990), for instance, provided greater details on a theoretical overview and application of the development of household production framework methods. Several studies have been done to test empirical data of "household production theory" on people's attitudes toward acceptance of environmental and other non-market goods. In general, the household production theory provides a basis for individuals to make the choices between private goods and non-market goods. The household production theory states that households frequently purchase market goods that do not yield utility directly, but are combined to produce commodity service flow for which the household places a value. Thus, observed behavior is determined by household production technology as well as individual tastes and preferences. By describing how goods and services are used, the theory framework makes people better understand how non-market goods and services affect the attitudes of individuals' demand behaviors. The household production framework argues that market and non-market goods and services are demanded as intermediaries in a household consumption process. These goods are considered as inputs to be used to produce good and service flows. A household obtains utility from both the output of production activity and other composite goods.

Empirical studies of household production theory, as previously stated, have not been employed in research on the use of soil conservation practices by farmers. The household production theory can be used to investigate attitudes of individual farmers and behaviors toward acceptance of soil conservation use because a farm household is both a producer and a consumer. Therefore, non-market factors may have a great influence on the farmers' decision making including choice of conservation use. Thus, soil conservation use could be affected by both economic and non-economic factors. Because a farm household is both a consumer and a producer, a farmer gains utility from both composite consumer goods and output of the agricultural production activities. As a producer, the farmer produces agricultural commodities by combining inputs of goods according to cost minimization. As a consumer, however, agricultural commodities are produced in quantities determined by maximizing a utility function of the commodities subject to prices and constraint on resources. Soil conservation measures such as the purchase of conservation equipment, conservation investment on land, and paid and unpaid labor serve as inputs in the production process. Farmers would try to minimize the cost of soil conservation as an input to agricultural production if soil conservation was viewed only as a production related factor. However, individual farmers' utility is a function of both composite goods and production activities according to household production theory. If soil conservation use involves more production activities of utility maximization, non-economic factors would influence farmer attitudes, decision to use and actual use of soil conservation.

While many researchers have indicated non economic factors in analyses of use of conservation efforts, none have specifically studied these variables as part of the household production theory. This study is an application of the above theoretical model to the use of soil conservation measures. Many researchers analyzing soil conservation measures have found that economic maximization factors are poor predictors of use of soil conservation practices. Including household consumption factors may improve the predictors of conservation effort.

By introducing a direct utility function from the household production theory, a farmer's utility is a function of a composite good and his production activity:

$$U = U(G, Z) \tag{3.2}$$

$$Z = Z(X, Q) \tag{3.3}$$

$$X = X(r) \tag{3.4}$$

$$Q = Q\,(s,c) \tag{3.5}$$

Where:

U = utility of an individual farmer

G = composition of goods

Z = final goods and service from a farmer through the farm operation

X = combination of market input goods

r = price of market input goods

Q = conservation choices and effort

s = conservation price

c = conservation attitudes and belief

By combining Equation (3.2) and Equation (3.3),

$$U = U\,(G, Z(X, Q)) \tag{3.6}$$

Equation (3.6) states that the utility derived by a farm operator comes from the composition of goods and services which the farmer receives and the production activities of final goods and service from the farm operation. In the equation (3.3), non-market goods are essential because they determine the individual farmer's behavior toward conservation practices and conservation effort. Non-market goods here include the farmer's attitudes toward conservation, social factors, and features of the farm which are also covered in the factors of Ac, Fc, and Nc in the equation (3.1).

An individual farmer obtains income from both farm production and off farm work. His budget expenditure consists of 1) composite goods for his household consumption, 2) private market input goods for farm production, and 3) conservation efforts. Thus, the farmer's budget can be written:

$$Y = Y_1(T_1) + Y_2(X, Q, T_2) = G + rX + sQ + w_1T1 + w_2T_2 \tag{3.7}$$

where:

Y = farmer's total income

Y_1 = income from off-farm sources

Y_2 = income from on-farm activities

T_1 = work time in off-farm

T_2 = work time in on-farm

w_1 = off-farm wage rate

w_2 = on-farm wage rate

and X, Q, and G are as defined above.

Assuming that G has a unit price, and also assuming that a farmer's total labor is fixed in a certain time, thus,

$$T = T_1 + T_2 \tag{3.8}$$

The individual farmer's decision for utility maximization then can be expressed as

$$\text{Max } L = U[G, Z(X, Q)] + \lambda\, [\, (X, Q, T_1, T_2) - G - rX - sQ - w_1T_1 - w_2T_2] \tag{3.9}$$

In the equation (3.9), selected variables are X, Q, G, and T_1 and T_2, and r, s, w_1 and w_2 are parameters. By taking the first order condition, we yield:

$$\frac{\partial L}{\partial G} = U_G - \lambda = 0 \tag{3.10}$$

$$\frac{\partial L}{\partial Q} = \frac{\partial U}{\partial Z}\frac{\partial Z}{\partial Q} + \lambda\frac{\partial Y}{\partial Q} - \lambda s = 0 \tag{3.11}$$

$$\frac{\partial L}{\partial X} = \frac{\partial U}{\partial Z}\frac{\partial Z}{\partial X} + \lambda\frac{\partial Y}{\partial X} - \lambda r = 0 \tag{3.12}$$

$$\frac{\partial L}{\partial T_1} = \lambda \frac{\partial Y}{\partial T_1} - \lambda w_1 = o \tag{3.13}$$

$$\frac{\partial L}{\partial T_2} = \lambda \frac{\partial Y}{\partial T_2} - \lambda w_2 = 0 \tag{3.14}$$

Note in the equation (3.11), if the utility gained from the conservation effort in a farm operation was not considered, it would yield: $\frac{\partial Y}{\partial Q} = s$. In other words, this means that the marginal revenue obtained for conservation input is equal to the price of conservation input. In fact, marginal revenue from the use of conservation measures may be less than the marginal cost for the conservation measures ($\frac{\partial Y}{\partial Q} < s$) on many farm operations because conservation investments often yield a long-term benefit. Because conservation effort from a farm household will also yield utility ($\frac{\partial U}{\partial Z}\frac{\partial Z}{\partial Q} > 0$), the conservation effort in a household farm could compensate for the short run loss for conservation investment in the farm operation. For instance, a farmer may consider the conserving of the soil resource in his farm for the future generation an important good or resource. Also, a farmer may take a broader societal view about the consequences of soil erosion and, thus, will consider use of conservation as a social obligation. Under the utility maximization, utility gained from conservation plays an important role in conservation use ($\frac{\partial U}{\partial L}\frac{\partial L}{\partial Q} + \lambda \frac{\partial Y}{\partial Q} = \lambda s$). The above arguments would explain why some farmers make substantial conservation effort in their farm operation, even though conservation practices are not profitable in the short run or even in the person's own production horizon for the farm operation. Investments made to benefit a child or grandchild or for the entire society may produce non market good incentives to apply conservation measures.

Equation (3.12) also states that a farmer can obtain utility by enjoying farming activities. In the consideration of profit maximization, marginal revenue must be equal to marginal cost. In equation (3.2), marginal value of product must be equal to the price of input ($\frac{\partial Y}{\partial X} = r$). However, in some cases, marginal value of product could be less than the price of input ($\frac{\partial Y}{\partial X} < r$). In this event, the farmer must get some compensation through farm activities. Under utility maximization, the farmer gains utility from farm activities. For instance, a farmer may enjoy staying in farming for fresh air and a better life style. Therefore, marginal utility through farm activities is greater than zero ($\frac{\partial U}{\partial L}\frac{\partial L}{\partial X} > 0$). Equation (3.12) combines with utility maximization in the farm operation ($\frac{\partial U}{\partial L}\frac{\partial L}{\partial X} + \lambda\frac{\partial Y}{\partial X} = \lambda s$). It also explains that even though a farmer receives less income from farming than other business activities, he prefers to farm because he gains enjoyment or utility from farming.

The application of household production theory in this study takes into consideration both 1) consumption behavior or utility maximization and 2) production activities or profit maximization for farm households. The theory model in the study gives a clearer picture of an individual's attitudes and behaviors in term of economic and non-economic factors. By introducing farmers' attitudes and belief toward soil conservation use, the household production theory may help to explain farmers' conservation use behavior more clearly than the conservation behavior model developed by Lynne et al (1988). Both models stress the roles of non-economic factors in soil conservation use. The two models show that both economic and non-economic factors would affect the use of conservation practices. Among the non-economic factors, attidutes would play important roles.

Modeling the Process of Farmers' Conservation Behaviors and Efforts

Rogers, a sociologist, in his book "Diffusion of Innovation" (1995) developed a model of the innovation-decision process of agricultural technology. The model is the leading sociological approach in agricultural technological change. The model states that adoption by a farmer of a new technology passes through five stages. These stages are knowledge, persuasion, decision, implementation and confirmation (Rogers, 1995). The adoption process for conservation practices will also pass the five stages described by Rogers. However, Rogers model only describes a general model for a technology adoption process. The model developed by Rogers is unable to describe a specific technology adoption process or the specific factors affecting such technology adoption. Analysis of the soil conservation adoption process needs a more specific model to describe its own characteristics and to investigate factors affecting the process.

Ervin and Ervin (1982) developed a three-stage model for the soil conservation decision process. The model stated that the process of soil conservation will pass three stages. The first stage is the recognition of an erosion problem. The second stage is the decision stage. After an erosion problem is realized, the farm operator would decide whether to adopt a conservation practice(s), and if so, what type. The third stage is the determination of soil conservation effort. Considering the general decision process for soil conservation adoption, Ervin and Ervin's model is in a large degree merged with the model of innovation decision process developed by Rogers. The first stage that Ervin and Ervin developed is mainly covered by knowledge and persuasion stages of the innovation decision model outlined by Rogers. The second stage of Ervin and Ervin model is the same as in the innovation decision model, and the third stage from Ervin and Ervin is covered by the implementation and confirmation stages of the innovation decision model by Rogers.

Conservation practice use and adoption is a complicated process with components of personal, economic, institutional, sociological and resource factors. According to the technology innovation theory discussed by Rogers, farm operators must first observe the soil erosion problem on their own land and determine its negative impact. After farmers observe a soil erosion problem and obtain information and advice from off-farm sources , a decision for a conservation practice use will be made. If a farm operator decides to use conservation measures on his farm land, the next step for the farm operator is to determine what kinds of conservation practices will be selected to use in his farm operations and the extent of use of the item of technology. This process is covered by the implementation stage where Rogers states that first use is often a "limited trial use" to provide for a test or probation period. The final stage is the confirmation stage where full application of practice and acceptance occur. Conservation effort, however, is a dynamic process for farm operators. Thus, a long-term period to review effort of conservation use must occur because many practices and much time is often combined. Some practices may be discontinued after a trial use period due to various reasons. There may be two types of termination of use of a conservation practice. The first type is where one conservation practice is replaced by another conservation practice and the second is a termination of a conservation practice without another effective conservation replacement. The first type of termination assumes that a farmer improves the effort on conservation use. The second type of termination may represent a decrease of conservation effort. If conservation effort in the farm operation is diminished, soil erosion could become a greater problem, and the farmers may go back perception stage again. The stages of conservation practice decision process is shown in Figure 1.[3]

The soil conservation use process starts from the perception of a soil erosion problem by farm operators. The physical conditions and previous farm operation history take shape the actual soil erosion situation. The perception of an erosion problem is affected by personal, institutional and sociological factors and resource endowment. However, the factors may not play equal roles in the perception stage. Personal and institutional factors and resource endowment play a more direct role in this stage. Sociological factors should play a lesser function for the perception of the erosion problem. In other words, personal and institutional factors and resource endowment are more important in this stage.

On the other hand, the perception of a soil erosion problem by a farmer will not directly lead to conservation use. The perception of a soil erosion problem is a necessary condition, but not a sufficient condition for the decision to use conservation practices. If a farmer does not perceive that there is a soil erosion problem, then belief of the capability of soil conservation practices to reduce soil erosion effectively would have little impact. The study done by Leuthold and Hart (1988) showed that farmers aggregate estimate of soil erosion loss was much less than the official levels reported by soil scientists. According to the study (Leuthold and Hart, 1988), if a farmer believes there is a serious erosion problem, he would then have to address the situation with greater effort. This belief leads to the decision stage. Farmers will decide whether to adopt or reject conservation practices in an effort to reduce soil erosion.

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[3] The conceptual figure of decision process was originally developed by Ervin and Ervin (1982). However, the figure constructed in this study is not limited to Ervin and Ervin model.

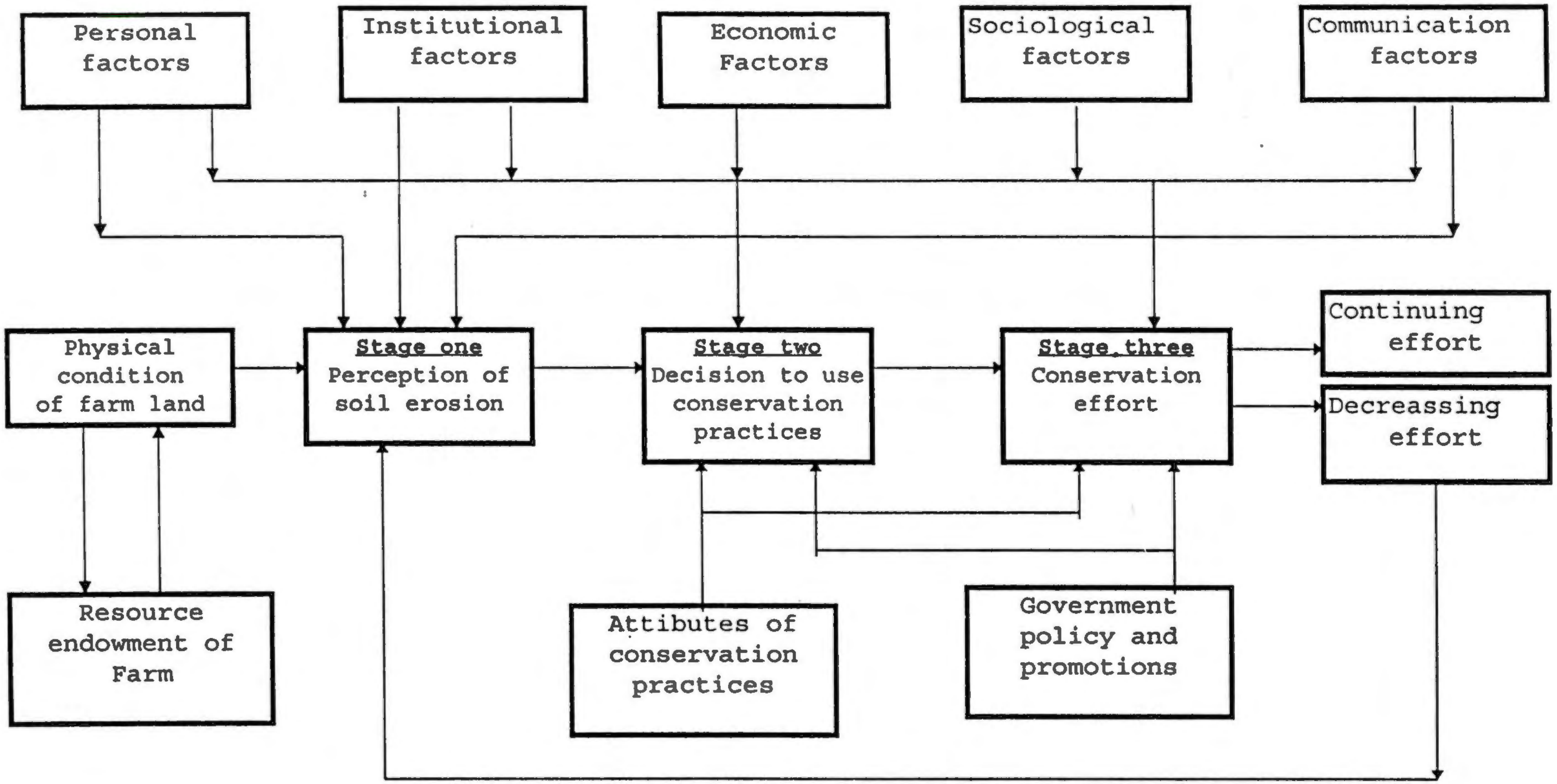

Figure 1. Process of Conservation Decision and Effort

The decision to use conservation practices is not only affected by personal, economic, institutional, sociological, and communication factors. other characteristics of conservation practices besides reducing soil erosion probably also greatly influence the decision to use conservation practices.[4] For instance, no-till can save time and fuel and help in timeliness in planting for double cropping. In some cropping systems, higher profit can be obtained by using no-till than by using conventional tillage. Phillip et al. (1980) found that the no-till system reduced the energy input into corn and soybean production by 7 and 18 percent, respectively, when compared to the conventional tillage system. In addition, crop yields were as high as or higher than those obtained with conventional tillage practices on large areas of agricultural land. Hudson (1981) also found that no-till had the potential to reduce soil erosion and increase income at the same time. Farm income potential was increased due to 1) lower production costs, 2) equal or higher yield, 3) less labor required at planting time which permits expansion of crops or livestock and 4) a more intensive use of the existing land resource. Thus, the farmer may use a conservation practice primarily for reasons other than reducing soil erosion which could be viewed as a partial or added benefit. Therefore, the above five types of factors as well as the attributes of conservation practices are necessary conditions for the decision of soil conservation use.

An important step in the analysis of the process of soil conservation adoption should be concentrated on how much conservation effort farmers will put into the implementation of conservation use after the decision for greater conservation use is made. Even though these factors and attributes of conservation practices influence conservation effort, they may play different roles in the process. Personal and

[4] According to technology innovation theory, characteristics of technology (conservation methods) will also affect the adoption of a new technology (conservation practice). However, this study will not try to directly deal with measurement of the characteristics of conservation practices.

sociological factors may have a greater influence on attitudes of a farmer toward conservation of soil. Economic factors and institutional factors may stimulate more incentives for farmers to use conservation practices beyond the reduction of soil loss. Communication factors help farmers secure information and messages about conservation use from off-farm sources, while physical factors and resource endowment help farmers determine types and degree of use of conservation practices. However, each group of factors is hypothesized to influence one or more of the process components. Attributes of conservation practices and macroeconomics policies also have a great influence on soil conservation use. Due to the data limitations, the present study will not directly investigate macroeconomic policy variables and attributes of conservation practices.

CHAPTER IV

DATA USED AND HYPOTHESIS IN STUDY

Data Sources

The data used in this study come from both primary and secondary sources. The primary data were obtained from a survey conducted by Leuthold and Hart, in which they surveyed household farmers in seven representative counties in West Tennessee counties. The seven counties were selected to represent the main soil types, cropping patterns, farm operations and institutional efforts at soil erosion control measures in the 21 West Tennessee county region (Leuthold and Hart, 1988). These counties include Carroll, Dyer, Gibson, Haywood, McNairy, Tipton and Weakley counties (Figure 2). Fifty farm operators, selected by random area procedure, were personally interviewed in each of the seven counties. The surveyed data were primarily analyzed for no-till use by Leuthold and Hart.[5] Although data on use of several conservation practices were gathered in the survey, these data were not analyzed in relationship to independent variables.

Variable Definitions and Hypothesis of the Study

To test the hypothesized relationships between the level of soil conservation effort and the main factors in the study, two dependent variables are defined. The first dependent variable is farmer perception of an erosion problem on the farm. The second dependent variable, which is defined as conservation effort, is the numbers of soil

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[5] See Leuthold and Hart "West Tennessee Farmers' Use of No-Till Planting" The University of Tennessee , Agricultural Experiment Station 1988 Bulletin 660.

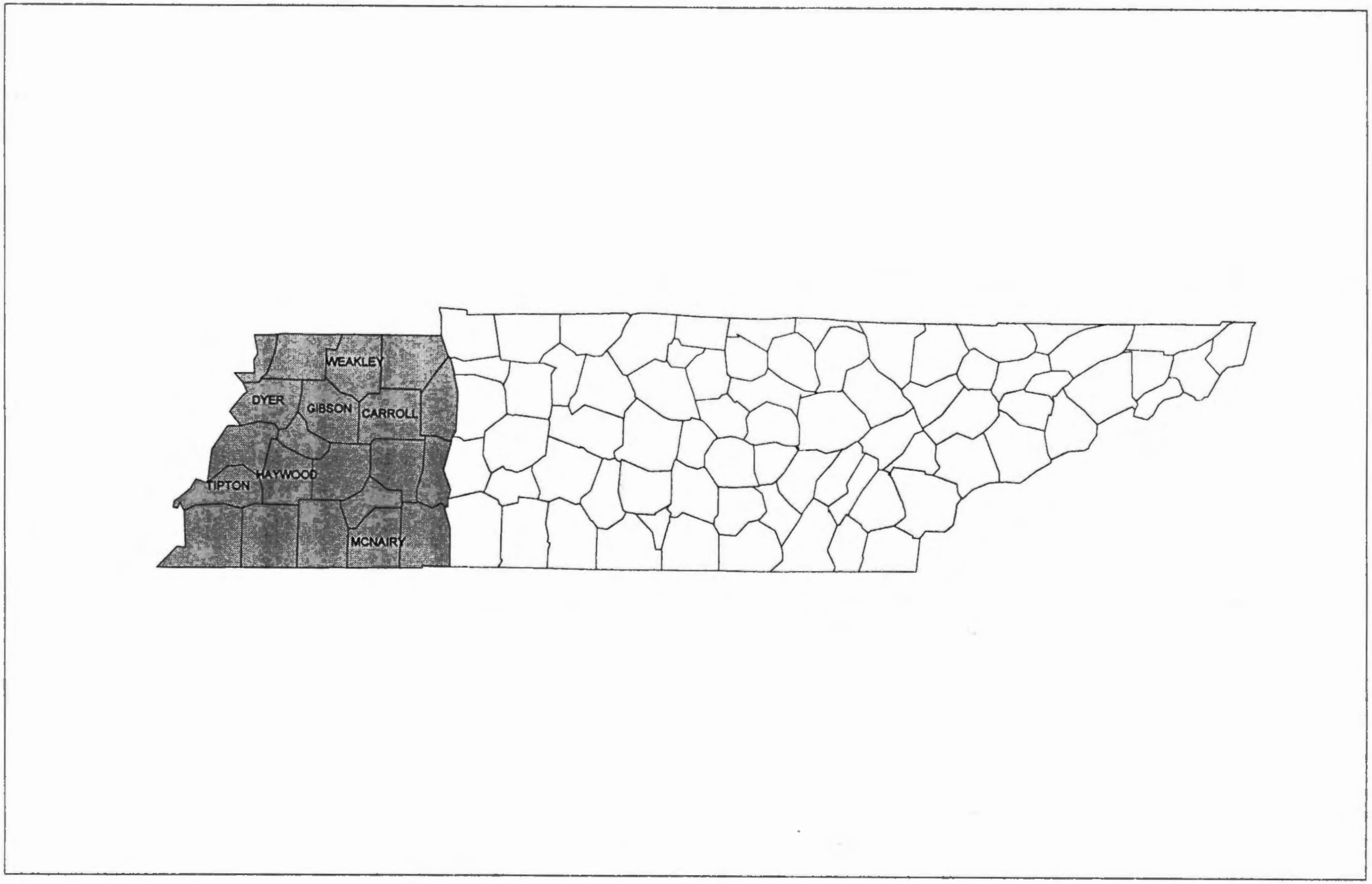

Figure 2. Map of Tennessee, Showing study area and the survey counties

conservation practices used. The survey provides data on use of 13 conservation practices which covered the major conservation practices in West Tennessee.[6]

Ervin and Ervin (1982) in their study developed two variables for conservation practices as dependent variables. One variable was the number of conservation practices used and another was termed as conservation effort. The two variables were similar. The reason is that, in most cases, a higher number of conservation practices used meant more effort toward conservation use. For instance, Lynne et. al.(1988) believed that the number of conservation practices used could represent the amount of conservation efforts for expenditure. Ervin and Ervin argued, however, that from an economic theory perspective, conservation efforts included total capital expenditures plus annual operation and maintenance expenses for soil conservation practices. However, it is very difficult to collect such detailed data on these expenses for the large number of sample farms, especially maintenance costs for conservation practices over time. Thus, it is hypothesized that the number of conservation practices reflects conservation efforts.

Park and Ferguson (1986) used the logit model to examine factors related to the expression of need for conservation practices. Since the logit model is based on the cumulative logistic probability function, the dependent variable will be in the 0 to 1 interval. The logit model presents limitations in analyzing the expression of need for farm operators to use conservation practices because there is a variety of conservation methods for farmers to choose. It is not known what kind of conservation methods are needed according to farm characteristics and other factors. Farmers may select different types of

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[6] The survey form provided data on 13 conservation practices to see whether the farmer was currently using them in the farm operation (cropland). The conservation practices were (1) permanent vegetative cover, (2) grassed-based crop rotation, (3) winter cover crop, (4) spring rather than fall tillage, (5) leaving crop residue on field surface, (6) no-till, (7) minimum tillage, (8) contour tillage, (9) strip cropping, (10) terrace, (11) diversions, (12) grassed waterways and (13) debris basin.

conservation practices to meet their farm circumstances. This study uses the logit model to examine the factors associated with the adoption for specific conservation practices .[7]

Explanatory or independent variables are placed in six categories. They are personal factors, economic factors, institutional factors, sociological factors, communication factors and resource factors. Ervin and Ervin (1982) selected four categories of factors for their independent variables. Sociological and communication factors were not directly covered in their models. However, other studies have found that social status and communication factors have a major influence in new technology adoption (Rogers 1983). Lynne at. al. (1988) indicated that social factors and social norms greatly affect conservation behavior. Thus, it was felt that sociological and communication factors should be included in this study .

Personal factors used in this study include education levels, age, and years of farming experiences. Education level is hypothesized to be positively associated with level of conservation use. Younger age of farm operators has been generally hypothesized to be positively related to conservation effort because most younger farmers have higher education levels and may have higher motivation to use conservation practices. Another reason for younger farmers to use conservation practices is that younger farmers have longer planning horizons, and thus, use of conservation practices has a higher probability to return long term profits. On the other hand, most younger farmers may have less farm experience than older farmers. Furthermore older farmers may more likely use some traditional conservation practices in their farm operation. For instance, Garlson (1976) found that older farmers were more likely to rely on traditional SCS programs than younger farmers. Thus, the use of conservation practices and age may not show a clear relationship. Expecting a child to farm may be positively related to effort

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[7] Jent et. al. (1988) in their research on Predicting Soil Losses in Tennessee also suggested that the most important conservation practices are contour tillage, contour stripcropping, and terracing.

of conservation use because farmers may be concerned about the next generation for soil preservation and, hence, have a long planning horizon (Leuthold and Hart,1988). The years of farming experiences generally should be positively related to effort of conservation use, especially some traditional conservation practices according to previous studies.

Economic factors in the study cover variables which are directly related to the economic situation of a farm. Gross farm income is hypothesized to be positively related to the level of conservation use. The basic argument is that operators with larger farms may have more flexibility in their decision making, greater access to discretionary resources, and greater ability to deal with the risks associated with the use of new agricultural practices. On the other hand, farmers with a small operation size may choose conservation practices with relatively low costs. That is, smaller size farms may use less expensive conservation practices than larger farms do. For instance, due to financial constraints, small size farms may choose minimum tillage or contour tillage rather than purchase expensive no-tillage equipment. Off-farm employment of farmers is hypothesized to be positively associated with the level of conservation use because farmers with off-farm work may have a higher opportunity cost for labor (Park and Ferguson). However, the positive influence could be offset by other factors related to off-farm employment.

The renting or leasing of farmland may be associated with conservation use because of 1) restrictions imposed by landowners, 2) the short term length of farmland leases whereas most conservation practices require long-term productivity benefits to be profitable, and 3) because farmers may feel less responsibility for preserving soil of land owned by others. However, if the rented land is from family members or relatives, there may be little difference between owned land and rented land on the level of conservation use. Farm operators leasing land from relatives may have a long-term commitment to the land and may , in fact, may become the owner of the property later. Owners of land who rent to others may desire the operators to use conservation practices to preserve their investment, so the relationship may not be clear.

Debt level is expected to be negatively related to conservation use. For instance, Ervin and Ervin (1982) argued that operators with high debt service loads may be forced to plant high return and more erosive row crops and, thus, may not be able to afford to invest in costly conservation practices. The planning horizon for a farm property has a big influence on farmers' discount rate for investment. A longer planning horizon also means lower discount rate for a farm operator. Lower discount rates and longer planning periods should make conservation investments more attractive for conservation methods. The discount rate from farmers in the study is reflected by two factors. The first is a farmer's plans for continuing farming and the second is expecting a child to take over the farm. If a farmer is not going to continue farming very long and has no child to farm, the farmer may care little about conservation use. Also the discount rate may be much higher than for a farmer who is going to continue to farm for many more years. The same principle may also hold true when a farmer considers whether a child may continue to farm.

Institutional factors are generally hypothesized to be positively associated with conservation use. For instance, use of technical assistance conservation programs, such as the S.C.S Farm plan and the Agricultural Conservation Program, should affect perception of erosion problems and the decision to use conservation practices.

Some studies have directly measured and examined sociological factors associated with soil conservation use, while others studies have combined economic and sociological factors together or categorized personal and sociological factors into a group. There are many variables which can be considered as sociological factors. Sociological factors in this study cover 1) attitudes toward new technology change, 2) social activity participation and 3) organizational and community involvement. Many studies have found that higher social status are positively associated with new technology adoption (Rogers, 1995). Sociological factors are hypothesized to be positively related to conservation use.

There are many public information agencies that assist farmers in farm decision making. However, not every farmer obtains information from public sources in their farm decision making process. Information sources which assist farmers in their decision making not only affect conservation use, but also indirectly measure the efforts of various public change agencies which are related to agriculture. There are two aspects in analyzing communication factors. One is where farmers obtain information in their decision making. Another is how public and private change agencies provide information that help farmers in their decision making.

All the variables in the study are categorized in the different groups. However, some variables can be placed in different categories. For instance, attitudes toward new technology use could be either categorized as a personal factor or a sociological factor. Farm size could be categorized as a resource endowment or an economic factor.

A summary of the variables used in the model and the hypothesized signs of explanatory variables is shown Table 4.1:

Farm and Farm Operator Characteristics Based on the Survey

The overall data of the farmers surveyed, such as personal, economic, institutional, sociological, communication factors and conservation use, are analyzed. The purpose of this analysis are 1) to look at the basic characteristics of farmers and

Table 4.1. Hypothesis of the Explanatory Variables

Variable Categories and Variables	Hypothesis and Expected Sign	Variable Descriptions
Personal Factors		
Farm orientation	+	1=reared on farm, 0=not reared on farm
Education level	+	Years of formal education
Farm experience	+	Years of farming
Age of farmers	-	Years
Attitude toward new technology	+	1=inactive, 2=normal, 3=active
Economic Factors		
Gross farm income	+	Index of annual gross income
Off farm work	-	1=off farm work, 0=no off farm work
Farm debt	-	Percentage of farm debt to farm asset
Types of farm	+	1=row crops only, 0=otherwise
Plan to continue farming five years or longer	+	1=continuing farming, 0=not continue
Expecting a child to farm	+	1= expecting a child to farm, 0=not expecting a child to farm
Tenure of farm	+	1=both own and rent land, 0=only own only
Institutional Factors		
SCS Farm Plan	+	1=participant, 0=not participant
Enrollment in Conservation Program	+	1=participant, 0=not participant
Communication Factors		
Information sources for farm decisions	+	Number of information sources
Opinion leadership for technology	+	Index score of advising other farmers
Sociological Factors		
Organization participation	+	Index of active participation
Other government programs	+	Index of active participation
Level of social activity	+	Index of active participation
Resource Factors		
Percentage of row crops	+	Percentage of row crops in total farm land
Slope of crop land	+	1=less than 2%; 2=2%-4.9% 3=5%-14.9%; 4=greater than 15%
Size of farm	+	Acres of farmland operated

conservation use in West Tennessee, and 2) to see if the data surveyed match the official census.

The survey had 64 questions covering personal, economic, institutional, sociological and communicating aspects for each individual farm operator. The farm operators surveyed include a large number (72%) who both owned and rented farmland. When all farm acreage was counted, about one half of farm land acreage operated was rented and the other one-half acreage was owned by farm operators. The farm operators surveyed included some who only planted row crops and some who planted both row crops and raised livestock. Some 58% of farmers surveyed had livestock.

The average farm size from the survey was 814 acres of which 83.1% of acres were planted in crops. Over 62% of farms from the survey were between 100 to 1,000 acres. According to the 1987 Census of Agriculture for Tennessee, the average farm size in the seven counties surveyed was only 273 acres. One of the reasons to explain this difference is that the Agricultural Census counts the part-time farm operations. In the present survey, farming was the primary occupation of the farmers in order to be surveyed. For instance, Park (1986) indicated in his survey of Tennessee that if farms operated under the part-owner tenure were included, the average total acreage operated by the farmers in the survey would be comparable to the census figure.

The average age of farm operators in the survey is 49 years old. Farmer under 30 years old represented only 7% of the total farmers surveyed. Farmers over 60 years old, however, represented 22% of the total farmers surveyed. About 50% of farmers from the survey were over 50 years old. Farmers age tends to be older than other labor groups not only in Tennessee, but also in the United States as well. The oldest farmer surveyed was 81 years old and the youngest farmer was 23 years old. The age structure is comparable to the 1987 Census of Agriculture with the average age of farmers in the seven West

Tennessee counties being about 52 years old. The average farming time was 24 years for the farmers surveyed.

About 3/4 of farmers from the survey had 7 to 12 years of formal education. About 20% of farmers surveyed had some college education and about 5% of farmers had under seven years of school education.

The farmer characteristics of farm size, age and education from the survey are shown in the table 4.2 to 4.4.

The survey also provided land use combination of row crops, hay/pasture and wood/forest. The most important row crops in West Tennessee was soybeans. More than one half (52.7%) of farm land was used for soybeans including single-crop and double cropped acreage. The soybean planting in the survey were nearly consistent with the study done by Morris et al. (1983) and by Park and Ferguson (1986). Table 4.5 shows the uses of farm land from the survey.

Farm operators were asked to characterize information sources that help them make decisions about farming. Fourteen information sources were listed in the survey. Table 4.6 shows the information sources farmers used for their farming decisions. A mean of 7.1 sources of these 14 sources were listed.

The farmer's own personal observation was the most important source for the farm operation decision. Ninety-five percent of farmers used their own personal observation and 78% of farmers relied on information from other farmers in making their farm decisions. This is also consistent with previous findings that farmers rely heavily on other farmers to secure information (Rogers, 1995 and Leuthold and Hart, 1988). About half of farmers got information from county Extension agents and Soil Conservation

Table 4.2. Farm Size Characteristics of Survey of 350 Farmers in Seven West Tennessee Counties (1985)

Farm Size (acres)	Number of Farmers	Percentage
0-99	33	9.4
100-999	218	62.3
1000-1999	75	21.4
Over 2000	24	6.9
Total	350	100.0

Table 4.3. Farmer Age Characteristics of Survey of 350 Farmers in Seven West Tennessee Counties (1985)

Age of Farmers	Number of Farmers	Percentage
20-29	26	7.4
30-39	58	16.6
40-49	92	26.3
50-59	96	27.4
Over 60	78	22.3
Total	350	100.0

Table 4.4. Farmer Educational Characteristics of Survey of 350 Farmers in Seven West Tennessee Counties (1985)

Education (years)	Number of Farmers	Percentage
1-6	18	5.2
7-12	264	75.4
Over 12 (some College)	68	19.4
Total	350	100.0

Table 4.5. Farmland Use Distributions of Survey of 350 Farmers in Seven West Tennessee Counties (1985)

Land Use	Total Acres of Land	Mean acreage per farm	Percentage
Single cropped soybeans	96,101	274.6	33.7
Double cropped soybeans and wheat	57,089	163.1	20.0
Cotton	25,972	74.2	9.1
Corn	25,117	71.8	8.9
Grain sorghum	23,893	68.3	8.4
Single wheat	5,985	17.1	2.1
Other crops	2,646	7.6	0.9
Hay/pasture	21,859	62.4	7.7
Wood/forest/homestead	26,325	75.2	9.2
Total	284,987	814.3	100.0
Cropland	236,803	676.7	83.1
Hay/pasture	21,859	62.4	7.7
Wood/forest/homestead	26,325	75.2	9.2
Total	284,987	814.3	100.0

Table 4-6. Important Sources Used to Obtain Information for Farm Decision by 350 Farmers from Survey in Seven West Tennessee Counties, (1985)

Information Sources	Number of Farmers	Percentage of Farmers
1) Own personal observation	333	95.2
2) Agricultural books and magazines	279	79.7
3) Other farmers	274	78.3
4) Farm chemical dealers	211	60.3
5) Farm supply dealers	187	53.4
6) County extension agent	182	52.0
7) Soil conservation agent	166	47.3
8) Agricultural field day	154	44.0
9) Extension research publication	148	42.3
10) Family members	146	41.7
11) Agricultural demonstration farms	116	33.2
12) University Extension specialist	115	32.9
13) Farm equipment dealers	107	30.6
14) Bankers or financial adviser	71	20.3
Total/mean	2,489*	50.8

* The mean number of sources by farmer was 7.1.

Service agents. Only 33% of farmers obtained information from university extension specialists. Agricultural books and magazines also played an important role for farm information. Eighty percent of farmers got information from agricultural books and magazines for their farm decisions.

The survey data also showed other related information about farm operators. Ninety-two percent of farmers surveyed were raised on a farm. Farm operators had an average of 24 years farm experience. Forty-eight percent of farmers had a child who was a farmer. Fifty-three percent of farmers wanted a child to be a farmer. Eighty-two percent of farmers planned to continue farming for five years or longer. Seventy-four percent of farmers felt better off today than before. Twenty-one percent of farmers had an off-farm job.

The survey also provided information on conservation measures and use in seven West Tennessee counties. Farm operators were asked about their current conservation use in their farm operation. Thirteen conservation practices were included in the survey. The minimum aggregate number of conservation practices used by the 350 farmers surveyed was 1 and maximum number was 12. The average number of conservation practices farmers used from the survey was 6.3 practices. The survey also asked farmers to list obstacles in their use conservation practices. About 80% of farmers in the survey answered that lack of money was a major obstacle to use some of conservation practices. Conservation practices used by farmers are shown in Table 4.7.

Among 13 conservation practices, leaving crop residue on field surface and spring rather than fall tillage were highly used by farmers. Eighty-two percent and 83% of farmers were using the two conservation practices respectively. These two conservation practices were relatively simple and cost less for farmer operators compared to other conservation practices. About half of farmers used other conservation practices studied

Table 4.7. Conservation Practices Used by 350 Farmers From Survey in Seven West Tennessee Counties (1985)*

Conservation Practice	Number of farmers using practice	Percentage
Land coverage practices		
Leaving crop residue on field	288	82.3
Winter cover crop	170	48.6
Grass-based crop rotation	159	45.3
Permanent vegetative cover	144	41.3
Tillage Practice		
Spring rather than fall tillage	291	83.2
Minimum tillage	192	54.9
Contour tillage	149	42.6
No-till planting	119	34.0
Strip cropping	14	4.0
Water control practices		
Terraces	197	56.3
Diversions	171	48.9
Grassed waterways	168	48.0
Debris basin	149	42.6
Total/mean	2,211	48.6

* The farmers used the practices to some extent. The mean number of these 13 conservation practices used, at least to some extent, was 6.3. All conservation practices operate to increase ground cover to some extent by timing of tillage, a planted cover crop or leaving plant coverage.

except strip cropping. Only 4% of farmers used strip cropping conservation practice. One reason to explain this is that strip cropping may require more effort and cost more to do because strip cropping requires different types of tillage in alternate strips along the land contour, also slope of land was not great.

Farmers were asked to estimate the average annual soil erosion rate per acre on their cropland. The estimated soil erosion rate by the farmers was much lower than the National Resource Inventory (NRI) estimated rate. Table 4.8 shows the average estimated soil erosion rate by the farmers and by the NRI in the seven counties. The unweighted estimated soil erosion rate by the farmers survyed was only 31% of the NRI estimated rate in 1982 and 60% of the NRI estimated rate in 1992. From 1982 to 1992, the NRI estimated soil erosion rate decreased from 17.7 tons to 8.8 tons, about a 50% decrease in ten years. The change of the soil erosion rate in the seven West Tennessee counties indicated that the government and farmers have put a lot of effort in the last ten years to decrease soil erosion rate in West Tennessee.

Table 4.8 Estimated Average Annual Soil Erosion Rate on Cropland of Farmers and the NRI in Seven West Tennessee Counties

	Farmer's estimates tons per acre	NRI estimates tons per acre	
County	(1985)	(1982)	(1992)
Carroll	8.5	15.4	6.2
Dyer	5.6	19.8	6.0
Gibson	5.1	13.6	8.5
Haywood	3.7	18.7	9.9
McNairy	4.9	17.2	6.4
Tipton	3.2	22.4	17.8
Weakley	6.2	16.7	7.0
All Counties (unwieghted mean)	5.3	17.7	8.8

Sources: USDA, "National Resource Inventory." (1982) and (1992).

CHAPTER V

MODEL ESTIMATION AND RESULTS

Analytic Methodology and Process of the Study

The perception of erosion problems by farmers is hypothesized as a pre-stage for farmers to make a decision to use conservation practices. The OLS multiple regression analysis will be used to identify how explanatory variables affect the perception of erosion problem. Dummy variables will be used in the regression model to test for differences between some variables such as farm types (row crop and both row crop and livestock farm), farm operations (only own land and both own and rented land), employment (off-farm job or full time farm) and etc..

The total number of conservation practices used by farm operators is assumed to represent the conservation effort from farm operators as discussed before. In other words, the higher number of conservation practices a farmer used means the more effort the farmer puts. On the other hand, conservation practice is a broad concept; each conservation practice has its own characteristics. Independent variables in the study may have various influences on the probability of adoption of different conservation practices. The study will further analyze the effects of independent variables on different types of conservation practices. Therefore, it is expected that several factors affecting soil conservation use will be identified in the different conservation practices. However, each conservation practice used by the farm operators from the survey is a discrete variable, the number of conservation practices used by the farm operators can not be used in OLS as a dependent variable. Thus, a multinomial logit model was used to estimate the relationship between the number of conservation practices used by farmers and the independent variables. The data from the survey provided a binary response variable for each conservation practice used by farm operators. However, the total number of conservation practices used by farm operators is not a binary variable. The response variable of the total number of conservation practices is numeric. The logistic procedure can allow binary response data to be input in the form of count data from binomial observations. The logistic procedure fits a regression model that is based on the cumulative distribution probabilities of the response of total conservation as a group, rather than on their individual probabilities.

A logit regression analysis was used to test the hypothesized relationships between the dependent variables and the independent variables. The numbers of conservation practices used by farmers represent the conservation effort in the study. The explanatory variables show how these variables affect the level of soil conservation effort.

Logit models were also used to identify and examine factors that affect use of each conservation practice from the survey. These conservation practices are considered as major conservation practices for soil erosion control in the West Tennessee region.

Logistic regression analysis is often used to investigate the relationship between the response probability and the explanatory variables. A thorough discussion of binary response model is given in Cox and Snell (1989). The logit model is based on the cumulative logistic probability, which allows for the transformation of the linear probability model and allows prediction in the (0,1) interval. The transformation of the logit model allows the dependent variable to become the natural logarithm of the odds that a choice will be made. Because the logit is very similar to the cumulative normal function, but easier to calculate, the logit model is often used as a substitute for Probit model (Pindyck and Rubinfeld, 1981). The form of the logit model is explained in the following equation:

$$\ln \frac{P_i}{(1 - P_i)} = a + B_i X_i$$

Where: Pi = the probability that an event will occur
a = intercept parameter
Bi = vector of slope parameters
Xi = explanatory variables

Because the above equation is a nonlinear function, maximum likelihood procedures will be used to estimate the parameters. The maximum likelihood estimation involves a search over alternative parameter estimates to find those which would most likely generate the slope (Pindyck and Rubinfeld, 1981). The maximum likelihood coefficients are consistent and asymptotically normally distributed, allowing application of conventional tests of significance (Judge).

Through studies on the factors affecting conservation use, it expected to provide guidance for decision makers regarding soil conservation policies. Furthermore, the survey data in this study was conducted in the middle of the 1980's, the study can also help to test what the government has done and what government needs to do in conservation programs and policy making.

Results and Their Interpretations

The models in the study were estimated using both the general linear regression and the logit regression procedures in the SAS package (SAS Institute IN., 1990). A general linear regression analysis was used to test the hypothesized relationships between perception of erosion and independent variables. Logit regressions were used to analyze the use of conservation practices by farmers.

Table 5.1 presents the results of multiple regression of perception of erosion by farmers. The R^2 had a lower level, but still fair according to the previous studies (Hoover and Wiitala, 1980), (Ervin and Ervin, 1982). Of seventeen variables in the model, thirteen of them had the hypothesized signs and nine of them were significant at 10% or higher level.

One important finding in the perception model is that farm size is negatively related to perception of erosion rate which indicates that farmers with higher acreage may perceived less erosion rates on their farmland. This result was opposite from the hypothesis. However, there are several factors to be considered for the larger size farms. For instance, farmers with higher acreage could have different land resources which had lower erodibility or farmers with larger size may plant low percentage of row crops which had lower erosion rate. Farmers who leased land from other landowners are negatively related to perceptions of erosion, which means that farm operators who rented land tended to observe less soil erosion than landowners. Physical condition of farm land is an important factor for soil erosion. The positive and significant sign of slope of cropland means that farmers who had a higher slope rate were more likely to perceive soil erosion. This is not surprising because high slope of land is related to a higher soil erosion. Percentage of row crops is also positively associated with perception of erosion rate because the row crop system is another major reason for soil erosion.

The results of the perception model also showed that information for farm decision is positively related to perception of soil erosion rate. The positive and significant sign of information sources for farm decision indicated that information

Table 5.1 Results of Multiple Regression of Perception of Erosion Rate by 350 West Tennessee Farmers (1985)

Variable Categories and Variables	Hypothesis and Expected Sign	Coefficient	T statistical
Intercept		**-0.924**	**0.52**
Personal Factors			
Farm orientation	+	1.682	2.79**
Education level	+	0.019	0.04
Farm experience	+	0.006	0.22
Age of farmers	-	0.015	0.48
Attitude toward new technology	+	1.473	4.43**
Economic Factors			
Gross farm income	+	-0.050	0.38
Types of farm	+	0.574	1.37
Tenure of farm	-	-1.163	2.65**
Institutional Factors			
Enrollment in Conservation Program	+	-0.387	0.89
Communication Factors			
Information sources for farm decisions	+	0.210	2.79**
Opinion leadership for technology	+	0.015	0.06
Sociological Factors			
Organization participation	+	0.211	1.77*
Other government programs	+	-0.060	0.24
Level of social activity	+	0.359	3.35**
Resource Factors			
Slope of crop land	+	0.901	2.85**
Size of farm	+	-0.00065	2.19*
...percentage of row crops	+	1.064	1.91*
R^2 (and overall level of significant)		0.293	(0.0001)

* Significant at 10% level. ** Significant at 5% level.

channel and related technical assistance from different agencies play important roles in perceiving soil erosion. Sociological factors were found to be positively related to perception of soil erosion. The organization participation and social activity participation are positively related to perception of erosion. The significance of organization participation and social activity can be interpreted in two ways. One is that social status of farmers was positively related to the perception of soil erosion problems. The second is that a farmer may obtain more information and knowledge about soil erosion through the organization activities, that lead positively to the perception of soil erosion. The attitude of accepting new technology was positively associated with the perception of the soil erosion rate, meaning that attitude plays an important role for farmers in perceiving soil erosion problems.

Overall in the perception model, non-economic factors showed more important roles. Economic factors did not directly show a significant role for the perception model because perception of erosion may not be directly link to economic benefit to farmers.

The perception of soil erosion as a problem is a necessary condition for the use of soil conservation practices, but not a sufficient condition. The use of conservation practices is related to personal, economic, communication, institutional and resource factors. The study uses logit regression to analyze the factors affecting the use of soil conservation practices. The model estimation includes two parts. The first part is to use multinomial logit regression to analyze the total 13 conservation practices from the survey. This analysis is based on the assumption that the numbers of conservation practices farmers used represent the conservation effort of farmers.

Table 5.2 presents the results of a logit regression for 13 conservation practices used by farm operators. Of the 23 independent variables, 18 of them had expected signs and 14 of them were significant at the 10% statistical level or higher. However, five of

Table 5.2 Results of Multinomial Logit Regression of Numbers of Conservation Practices used by 350 West Tennessee Farmers (1985)

Variable Categories and Variables	Hypothesis and Expected Sign	Coefficients	Standard error
Intercept		-1.3351	0.3942
Personal Factors			
Farm orientation	+	0.0670	0.1197
Education level	+	0.0263	0.0152*
Farm experience	+	0.0138	0.0047**
Age of farmers	-	-0.0209	0.0054**
Attitude toward new technology	+	0.1389	0.0537**
Estimated erosion rate	+	0.0219	0.0086**
Economic Factors			
Gross farm income	+	0.1007	0.0206**
Off farm work	+	0.1305	0.0860
Farm debt	-	-0.00004	0.0220
Types of farm	+	0.1119	0.0659*
Plan to continue farming five years or longer	+	-0.1082	0.0922
Expecting a child to farm	+	-0.0010	0.0694
Tenure of farm	-	-0.1542	0.0708**
Institutional Factors			
SCS Farm Plan	+	0.0550	0.0951
Enrollment in Conservation Program	+	0.3826	0.0696**
Communication Factors			
Information sources for farm decisions	+	0.1110	0.0121**
Opinion leadership for technology	+	-0.0558	0.0447
Sociological Factors			
Organization participation	+	0.0340	0.0128**
Other government programs	+	-0.0212	0.0157
Level of social activity	+	0.0230	0.0157
Resource Factors			
Percentage of row crops	+	-0.1949	0.0903**
Slope of crop land	+	0.2341	0.0502**
Size of farm	+	-0.00008	0.00005*
Prediction success: Concordant			68.5%
Discordant			31.0%

* Significant at 10% level. ** Significant at 5% level.

them had opposite signs from the hypothesis. Among the variable with opposite sign, percentage of row crops and acreage of farms were significant.

Results of the logit regression showed that all the categories of factors play some significant roles. In the group of personal factors, age of farmers and farm experience have expected signs and are significant, which are consistent with the findings from previous studies that farmers with younger age and longer farm experience were more likely to use conservation practices. The estimated erosion rate is positively related to conservation use meaning that farmers who perceived a higher erosion rate in their farmland were more likely to use conservation practices. The perception of higher erosion rates by farmers means that farmers had observed erosion as a problem in their farmland. This will lead farmers to use conservation practices to preserve their soil. This result also supports the theoretical model that the decision of conservation practice adoption will pass the perception stage. The perception of soil erosion is a pre-stage for farmers to make decisions to use conservation practices. Attitude toward new technology as a personal factor is positive and significant, which implies that attitude toward soil conservation technology also plays an important role in the use of soil conservation. The significance of technology attitude is also consistent with previous findings that the behavior model would improve the economic model in the use of conservation practices (Lynne et.al., 1988).

Among economic factors, gross farm income, types of farm and tenure of farm operation have expected signs and are significant. The positive and significant sign of gross farm income supports the hypothesis that farmers with higher incomes may have more flexibility to use resources in their decision making and greater ability to deal with risk, and thus, are more likely to use conservation practices. The coefficient of farm type is positive and significant, which indicates that farm operators who only planted row crops were more likely to use conservation practices. Higher row crop use is one of major reasons for soil erosion. Farmers who only had row crops may find conservation measures beneficial in their farm operation. The negative sign of tenure of farm indicated farm operators who had rented land from other landowners were less likely to use conservation practices in their farm operation. This result supports the hypothesis that farm operators who rented farmland from other landowners may expert less conservation effort than owners. Off-farm work and debt level have expected signs but are not significant as economic factors. It is difficult to tell why these two variables are not significant here.

The results showed that participation in a SCS farm plan and conservation programs have positive signs, but only participation of conservation programs is significant. Participation in conservation programs is positively related to the use of conservation practices because most conservation programs required farmers to use conservation practices in the farm operation. Information sources for farm decisions are significant, indicating that information and education programs about soil conservation are very important, not only for perception of erosion, but also for the decision to use conservation measures. Organization participation and community activity participation are positively related to use of conservation practices. However, only organization participation is significant. Higher organization and social activity participation usually means that a farmer had a higher social status. The results indicated that farmers with higher social status were more likely to use conservation practices. This can be explained as farmers with higher social status may have more channels to get information, obtain knowledge and have a broader view of social obligation about the conservation use through organization activities and participation. Thus, organization participation directly and indirectly influences the use of conservation practices.

In the group of resource factors, slope of cropland and percentage of row crops are both significant, but percentage of row crops shows a negative sign. The positive sign of slope of cropland means that farmers whose cropland had higher erosion potential are more likely to use conservation practices. On the other hand, those farmers with a higher percentage of row crops were less likely to use conservation practices. It is not surprising to see that farmers who had higher portion of row crops would use less conservation practices because farmers with higher portion of row crops may have consideration in short run profits a high priority. It is interesting to see that the sole row crop farmers were more likely to use conservation practices than those who had diversified farm operations. However, the negative sign of row crop percentage implies that farmers with a higher percentage of row crops may have more incentives for short-run profit maximization because most conservation practices might result in lose short-run profits.

Conservation is a broad concept. Use of different types of conservation measures may have different effects on soil erosion control. At the same time, all the factors may have different influences on different conservation practices. The second part of the study further analyzes how the different factors affect each individual conservation practice. The thirteen conservation practices were categorized into three types of conservation measures. They are 1) land coverage practices, 2) tillage practices, and 3) water control practices. The purpose of the analysis is to investigate how the different factors affect each individual conservation practice.

Logit regressions were used to analyze each conservation practice. The results of logit regressions in the study provided estimated coefficients, standard errors, McFadden R-Squares and prediction success. McFadden R-Squares provides "fits" of the estimated model. According to Hensher and Johnson (1981), the 0.2 to 0.4 range of a Mcfadden R-Square would be considered as "extremely good fits". Concordant value provides the percentage of the correct prediction of the respondents.

The estimated coefficients of logit regressions should be carefully interpreted because the estimated coefficients are the weights of that parameter. When the parameter is multiplied the left side of the equation, it will affect that much change in the logarithm of the "odds" of choice, not of the probability itself. The actual probability to choose a conservation practice will be:

$$Logit(Pi) = a + Bi\ Xi$$

$$Pi = e^{logit(Pi)} / (1 + e^{logit(Pi)})$$

Where: Pi = estimated probability of the choice to use of a conservation practice
a = intercept
Bi = estimated coefficients for parameters

Pindyck and Rubinfeld (1981) suggested that the change in probability be used to more precisely interpret the estimated model. The change in probability is calculated as:

$$\Delta Pi = Bi\,[\,Pi(1 - Pi)\,]$$

The change in probability is a function of the probability itself and it also shows the percent change in the probability of event occurring given a change in the parameter in the model while holding everything else constant.

Hensher and Johnson (1981) suggested the use of the weighted aggregate elasticity. The elasticity for each parameter is estimated at the mean and then aggregated, weighting each individual elasticity by the individual's estimated probability of choice. The weighted aggregate elasticity can be used to interpret the change of independent variable. For instance, if the weighted aggregate elasticity of a independent variable is 0.05, it means that a 1 percent increase in the independent variable will result in a 5 percent increase in the probability of farmers choosing the conservation practice. However, the weighted aggregate elasticity is difficult to be interpreted if the independent variable is a dummy variable.

Table 5.3 presents the results of logit regressions for land coverage conservation practices. Most independent variables have expected signs, but not many variables are significant. It should be noted that three of the land cover conservation practices (except permanent vegetative cover) were commonly used by farm operators. Farmers may use them for other production purposes rather than soil conservation. Overall, of the three types of conservation practices, land coverage conservation practices are relatively simple and cost less to use compared to other conservation practices.

The results of Table 5.3 show that most independent variables have expected signs but not many variables are significant. The coefficient of information are positive and significant in the four conservation practices, which implies that information sources for farm decision are important factors for the land cover conservation practices. Among the four land coverage conservation practices, age and farm experience have expected signs and are significant for permanent vegetative cover, grass-based crop rotation and winter cover crops which indicates that personal factors such as age of farmers and farm experience play important roles in the use of those conservation practices.

Coefficients of estimated erosion rate are positive and significant for permanent vegetative cover and winter cover crops, meaning that farmers who perceived a higher erosion rate were more likely to use those two conservation practices. Gross income is significant only for winter cover crops. The coefficients of row crop farms and percentage of row crops are negative and significant for permanent vegetative cover, which indicates that farmers who only had row crops or had a higher percentage of row crops were less likely to use permanent vegetative cover. In fact, the income of row crop farmers was more dependent on row crop production. Short-run profit orientation for those row crop farmers may be more important because their income solely depends on row crop production; thus, those farmers with row crops were less likely to conserve farmland in

Table 5.3: Results of Logit Regression of Land Cover Conservation Practices Used By 350 West Tennessee Farmers (1985)

Variable Categories and Variables	Permanent vegetative cover		Grass-based crop rotation		Winter cover crop		Leaving crop residue	
	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. Error	Coefficient	Stand. error
Intercept	-0.5483	1.5326	0.5065	1.5238	-1.2550	1.5737	0.6027	1.5553
<u>Personal Factors</u>								
Farm orientation	0.3036	0.4901	0.5363	0.4647	0.3162	0.4750	-0.6954	0.6785
Education level	-0.0433	0.0595	-0.0264	0.0596	-0.0826	0.0609	0.1716	0.4419
Farm experience	0.0376	0.0186**	0.0450	0.0194**	0.0385	0.0195**	0.0264	0.0213
Age of farmers	-0.0407	0.0210*	-0.0599	0.0221**	-0.0579	0.0223**	-0.0218	0.0240
Attitude toward new technology	0.3359	0.2096*	0.2647	0.2039	0.3231	0.2110	0.2106	0.2702
Estimated erosion rate	0.1249	0.0348**	0.0253	0.0326	0.0819	0.0359**	-0.0493	0.0402
<u>Economic Factors</u>								
Gross farm income	0.0703	0.0821	0.1200	0.0804	0.2166	0.0820**	-0.1100	0.1044
Off farm work	-0.0011	0.3393	-0.0271	0.3299	0.2403	0.3463	0.0895	0.4139
Farm debt	0.1249	0.0890	0.0602	0.0877	0.0308	0.0898	0.0764	0.1145
Types of farm	-0.7906	0.2676**	0.1241	0.2553	0.0813	0.2654	0.3488	0.3329
Plan to continue farming five years or longer	-0.2152	0.3594	-0.5634	0.3566	-0.2136	0.3704	0.3507	0.4317
Expecting a child to farm	0.2211	0.2677	-0.2616	0.2634	-0.0745	0.2712	0.2164	0.3313
Tenure of farm	-0.1645	0.2741	-0.5761	0.2782**	-0.2804	0.2833	0.0962	0.3388
<u>Institutional Factors</u>								
SCS Farm Plan	0.5843	0.3633*	-0.4215	0.3627	0.2877	0.3768	-1.5165	0.4561**
Enrollment in Conservation Program	0.5614	0.2835*	0.0177	0.2736	0.0206	0.2811	1.6756	0.3987**
<u>Communication Factors</u>								
Information sources for farm decisions	0.1181	0.0482**	0.1938	0.0481**	0.1834	0.0489**	0.1508	0.0670**
Opinion leadership for technology	0.0884	0.1741	-0.2448	0.1741	0.0596	0.1810	0.2090	0.2147
<u>Sociological Factors</u>								
Organization participation	-0.0544	0.0489	0.0285	0.0481	0.0474	0.0510	-0.0108	0.0706
Other government programs	0.0542	0.0772	0.0195	0.0757	0.0314	0.0780	-0.1084	0.1054
Level of social activity	0.0785	0.0648	0.0585	0.0658	0.0958	0.0708	-0.0864	0.0929

Table 5.3 (Continued)

Variable Categories and Variables	Permanent vegetative cover		Grass-based crop rotation		Winter cover crop		Leaving crop residue	
	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. Error	Coefficient	Stand. error
<u>Resource Factors</u>								
Percentage of row crops	-2.2738	0.5551**	0.2495	0.3364	-0.2834	0.3780	0.1638	0.5959
Slope of crop land	0.4493	0.1976**	0.1209	0.1913	0.4106	0.1961**	0.0408	0.2503
Size of farm	0.0001	0.0002	0.0001	0.0002	-0.00028	0.00021	0.0004	0.0003
Prediction success: Concordant		76.7%		76.0%		79.5%		76.4%
Discordant		23.3%		24.0%		20.5%		23.6%
Mcfadden R^2	0.260		0.259		0.296		0.154	

* Significant at 10% level. ** Significant at 5% level.

permanent vegetative cover. The coefficient of the slope of cropland is positive and significant, which implies that farmers with higher sloped cropland were more likely to use permanent vegetative cover.

By looking at individual land coverage conservation practices, the results showed that the use of permanent vegetative cover has more significant independent variables than the use of three other conservation practices. Ten independent variables are significant in the use of permanent vegetative cover. Use of three out of four land coverage conservation practices is more related to personal factors (except the use of leaving crop residue on farmland). Use of leaving crop residue on the surface of farmland only has three significant variables. An important reason to explain this is that leaving crop residues on the surface of farm land is a common farm practice in a farm operation. Farmers may save time and keep land in a higher fertilized condition and nutrition by leaving crop residues on the surface of land. Leaving crop residue on farmland is also a conservation practice because soil loss can be greatly reduced by leaving crop residues on farmland. It is understandable that such conservation practices may not be directly related to the majority of independent variables in the study. However, three significant variables in the use of leaving crop residue also show that some factors can influence the use of leaving crop residues on farmland. For instance, the coefficient of enrollment of conservation programs is significant in the use of leaving crop residue on cropland which indicates that farmers who enrolled in conservation programs were more encouraged to leave crop residue on the farmland. Information is also important to the use of leaving residue on farmland. The negative sign of the SCS farm plan in the use of leaving residue on farmland may be interpreted as farmers who had the SCS farm plan could use other

Table 5.4 presents results of logit regression for tillage conservation practices. The data surveyed provided five tillage conservation practices. However, one of those

Table 5.4: Results of Logit Regression of Four Tillage Related Conservation Practices Used By 350 West Tennessee Farmers (1985)

Variable Categories and Variables	Spring rather than fall tillage		No-tillage		Minimum tillage		Contour tillage	
	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. Error	Coefficient	Stand. error
Intercept	-0.1241	1.5932	6.4488	1.8775	2.0174	1.4237	-1.0427	1.5868
Personal Factors								
Farm orientation	0.2603	0.6106	0.9081	0.5160*	-0.1601	0.4374	0.7331	0.5071
Education level	0.8931	0.5109*	0.1384	0.0748*	0.1212	0.0553**	-0.0619	0.0614
Farm experience	0.0361	0.0222*	0.0037	0.0222	0.0374	0.0171**	0.0575	0.0204**
Age of farmers	-0.0307	0.0246	-0.0289	0.0246	-0.0414	0.0196**	-0.0522	0.0229**
Attitude toward new technology	0.4673	0.2924	0.8859	0.2512**	-0.0176	0.1928	0.0676	0.2108
Estimated erosion rate	0.0735	0.0412*	0.0408	0.0357	0.0343	0.0315	-0.0053	0.0334
Economic Factors								
Gross farm income	-0.2405	0.1104**	0.4353	0.0970**	0.1209	0.0748*	0.0774	0.0828
Off farm work	-0.5631	0.4174	-0.0723	0.3866	0.1249	0.3094	0.4320	0.3340
Farm debt	-0.1817	0.1213	-0.0886	0.1032	-0.0575	0.0816	0.0873	0.0900
Types of farm	0.0242	0.3441	-0.0964	0.2969	0.0993	0.2384	0.6349	0.2705**
Plan to continue farming five years or longer	0.5310	0.4380	0.8852	0.4523*	-0.2371	0.3290	-0.1784	0.3718
Expecting a child to farm	-0.2117	0.3550	1.0007	0.3210**	-0.0938	0.2443	-0.2994	0.2740
Tenure of farm	0.0423	0.3594	-0.0797	0.3478	-0.1592	0.2572	-0.5369	0.2942*
Institutional Factors								
SCS Farm Plan	-1.0737	0.5275*	0.7695	0.4040*	0.3926	0.3519	0.3118	0.3655
Enrollment in Conservation Program	1.4166	0.4043**	0.1040	0.3273	0.1360	0.2511	1.2848	0.2841**
Communication Factors								
Information sources for farm decisions	0.2909	0.0792**	0.0260	0.0534	0.0391	0.0443	0.2176	0.0498**
Opinion leadership for technology	-0.0530	0.2370	0.3911	0.2159*	0.0692	0.1617	-0.2475	0.1785
Sociological Factors								
Organization participation	0.1026	0.0741	-0.0831	0.0531	0.0510	0.0469	0.1229	0.0503**
Other government programs	-0.1274	0.1106	-0.0011	0.0849	0.0981	0.0716	-0.0764	0.0790
Level of social activity	0.0482	0.1232	-0.0832	0.0753	0.0165	0.0631	-0.0364	0.0664

Table 5.4 (Continued)

	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. Error	Coefficient	Stand. error
Resource Factors								
Percentage of row crops	0.2798	0.6544	0.5304	0.4390	-0.5415	0.3574	-0.7816	0.4476*
Slope of crop land	0.3461	0.2759	0.7191	0.2285**	0.0276	0.1793	0.1327	0.1964
Size of farm	0.0007	0.0003*	0.0002	0.0002	0.0002	0.0002	-0.0003	0.0002
Prediction Success: Concordant		80.7%		85.4%		66.9%		78.7%
Discordant		19.3%		14.6%		33.1%		21.3%
Mcfadden R^2	0.173		0.318		0.168		0.281	

* Significant at 10% level. ** Significant at 5% level.

tillage practices (strip cropping) was used by a very low portion (4%) of farmers. The logit regression showed that no independent variable was significant. Thus, strip cropping was eliminated from the analysis.

Most tillage conservation practices need some capital investment and require more labor input than land cover conservation practices. The tillage conservation practices also need higher skills than land cover conservation practices to manage them. The positive and significant signs of education level, gross farm income and farm experience in three of the four tillage conservation practices generally support the above hypothesis. The results show that both economic and non-economic factors affect the use of tillage conservation practices. Negative and significant signs in age for the four tillage conservation practices implies that farmers of younger age tend to use tillage conservation practices. Technology attitude was positively related to use of spring rather than fall tillage and no-tillage, meaning the attitude variable plays a role in the use of tillage conservation practices.

Gross farm income is positively related to the use of no-tillage and minimum tillage, but negatively related to the use of spring rather than fall tillage. Farmers with lower farm income may find use of spring rather than fall tillage more beneficial since such practices generally cost less. It is interesting that use of spring rather than fall tillage is positively related to enrollment in the conservation program and negatively related to the SCS farm plan. One reason is perhaps that farmers who participated in the SCS farm plan may have used other conservation practices for soil erosion control. Farm size is positively associated with the use of spring rather than fall tillage. Use of spring rather than fall tillage may be also an effective way for a larger farm to save time, but add to farm operation costs. On the other hand, land percentage of row crop is negative and significant, indicating that higher percentages of row crops were less likely to involve conservation tillage practices. It is not surprising to see that farmers who had high portion of row crops would use less conservation practices because farmers with higher percentages of row crops may place more emphasis on short run profit. Use of contour tillage was positively related to younger age of farmers, technology attitude, row crop farm, land ownership, conservation program participation, information sources for farm decision, organization participation and opinion leadership.

Overall, concerning the use of tillage conservation practices, the results showed that use of no-tillage had more significant variables than any other practices studied. No-tillage use was positively related to farm orientation, younger age of farmers and new technology attitude which indicate that personal factors are important in no-till use. No-till is a very effective way to reduce soil erosion for cropland with higher slopes. The positive and significant sign means farmers with steeper sloped cropland were more likely to use no-till. Use of no-tillage was also positively associated with participation in a SCS farm plan and opinion leadership. Economic factors also play a role in no-till use. Gross farm income, planning to continue to farm and expecting a child to farm were positively associated with use of no-till. The significant coefficients of continuing farm in the future and expecting a child to farm indicate that farmers with longer planning horizons and the future generation consideration were more likely to use no-tillage. These findings of no-tillage use are consistent with the findings by Leuthold and Hart (1988).

Use of minimum tillage had less significant variables in the four tillage conservation measures. However, use of minimum tillage is positively related to educational level, farm experience, and cross farm income, meaning some personal and economic factors were still important to the use of minimum tillage.

Table 5.5 presents the results of logit regression for water control conservation practices. Water control conservation practices generally require more capital investment

Table 5.5: Results of Logit Regression of Water Control Conservation Practices Used By 350 West Tennessee Farmers (1985)

Variable Categories and Variables	Terrace		Diversions		Grassed waterways		Debris basins	
	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. Error	Coefficient	Stand. error
Intercept	-3.2252	1.3492	-2.8811	1.5441	-4.7560	1.3416	-5.9633	1.7381
Personal Factors								
Farm orientation	0.7682	0.4855	-0.8314	0.4789*	0.2592	0.4856	0.4560	0.5034
Education level	-0.2823	0.3710	-0.0517	0.0588	-0.2020	0.3422	0.0109	0.0669
Farm experience	0.0165	0.0191	0.0032	0.0178	0.0089	0.0186	-0.0286	0.0199
Age of farmers	-0.0311	0.0218	0.0198	0.0209	0.0070	0.0206	0.0144	0.0225
Attitude toward new technology	0.2834	0.2190	0.0704	0.2115	0.3768	0.2093*	0.0022	0.2329
Estimated erosion rate	0.1114	0.0398**	0.0035	0.0334	0.0223	0.0335	-0.0156	0.0350
Economic Factors								
Gross farm income	0.1115	0.0858	0.2238	0.0803**	0.2113	0.0810**	0.2359	0.0904**
Off farm work	0.0181	0.3542	0.7412	0.3425**	0.3381	0.3403	0.1113	0.3673
Farm debt	0.1046	0.0935	-0.118	0.0886	0.0212	0.0872	-0.0360	0.0981
Types of farm	0.3657	0.2736	0.4418	0.2603*	0.3600	0.2583	0.6249	0.2937**
Plan to continue farming five years or longer	-0.1849	0.3830	-0.0095	0.3584	0.3552	0.3643	-0.4807	0.4183
Expecting a child to farm	-0.3200	0.2808	-0.0095	0.3584	0.0828	0.2626	0.2777	0.2959
Tenure of farm	-0.4030	0.2997	-0.3295	0.2779	-0.3480	0.2756	0.3221	0.3139
Institutional Factors								
SCS Farm Plan	0.5937	0.4079	-0.3242	0.3715	0.1408	0.3638	-0.3138	0.4033
Enrollment in Conservation Program	1.1095	0.2910**	1.0049	0.2745**	0.5096	0.2726**	0.2305	0.3089
Communication Factors								
Information sources for farm decisions	0.1400	0.0512**	0.2083	0.0496**	0.1021	0.0479**	0.2237	0.0540**
Opinion leadership for technology	-0.2854	0.1887	-0.0955	0.1745	-0.1617	0.1741	-0.2496	0.1954
Sociological Factors								
Organization participation	0.0332	0.0584	0.1312	0.0518**	0.1615	0.0527**	0.0921	0.0541*
Other government programs	0.0227	0.0800	0.0002	0.0759	0.0319	0.0761	0.1350	0.0819
Level of social activity	0.1595	0.0803**	-0.0958	0.0692	0.1872	0.0768**	-0.0185	0.0737

Table 5.5 (Continued)

Variable Categories and Variables	Terrace		Diversions		Grassed waterways		Debris basins	
	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. Error	Coefficient	Stand. error
<u>Resource Factors</u>								
Percentage of row crops	-0.2969	0.3472	-0.2357	0.3326	0.2376	0.3257	-0.1563	0.5047
Slope of crop land	0.6864	0.2101**	0.1187	0.1908	0.1743	0.1933	0.8167	0.2170**
Size of farm	-0.00033	0.00022	0.0003	0.0002	0.0005	0.0002**	0.0001	0.0002
Prediction success: Concordant		81.8%		76.9%		77.5%		84.7%
Discordant		18.2%		23.1%		22.5%		15.3%
Mcfadden R^2	0.315		0.270		0.280		0.341	

* Significant at 10% level. ** Significant at 5% level.

and high labor costs. Water control conservation practices cost farmers more than the other two types of conservation practices. In addition, farmers also need more management and technical skills to use water control practices.

The results of Table 5.5 show that the majority of variables have expected signs. Information sources for farm decisions are positive and significant for the four conservation practices. The enrollment in the conservation program is positively related to the use of three of the four water control conservation practices except the use of debris basins. These results indicate that the use of water control conservation practices needs more information sources and conservation programs such as educational programs and technical support for farmers to use those conservation practices. Gross farm income is positively related to the use of three of the four conservation practices, meaning that financial and direct economic factors play important roles for the use of water control conservation practices because water control conservation practices always need a large initial investment for a long term benefit. The economic feasibility is always a major factor for farmers to use conservation measures that have higher investment rate. This is also indicates that government financial supports such as subsidies and cost share are important to assistant farmers to use high cost conservation practices.

Organization participation is significant in the use of diversion, grassed waterways and debris basin. Level of social activity is significant in the use of terrace and grassed waterways. The significance of sociological variables indicates that overall sociological factors play important roles in the use of water control conservation practices. These findings also support technology diffusion theory that use of new agricultural technology is positively related to higher social status, especially some complicated technologies. Erosion potential (slope of crop land) is positively associated with the use of terraces and debris basin because use of terraces and debris basins in water control conservation measures is the most effective way to control soil loss on higher slope cropland.

Personal factors were found to have lower significant levels in the use of water control conservation practices. However, use of tillage and land cover conservation practices had more significant personal variables, which implies that personal factors were more related to the use of those conservation practices. Use of tillage and water control conservation practices were more associated with economic factors and sociological factors, Since tillage and water control conservation practices normally require higher skills to manage them and higher investment, the results indicated that farmers with higher economic feasibility and higher social status play positive roles to use these types of conservation practices.

CHAPTER VI

SUMMARY AND CONCLUSIONS

With the development of agricultural technology and increased demand for agricultural products, soil conservation has been an important issue in the U.S. in protecting soil and maintaining enviromental quality. Costs of soil erosion go far beyond the on-site loss of agricultural productivity. Off-site loss affects environmental quality for the whole society. In the last two decades, increased public concern has put more pressure on policymakers to solve larger or off-site enviromental problems. Recent government programs have placed greater emphesis on enviroment protection than on loss of soil productivity due to soil erosion. The conservation goals and mandatary requirements for soil erosion control are implemented through various government agricultural conservation programs. On the other hand, the final users of most conservation measures are the thousands of individual farmers. Thus, the use of most conservation practices is largely a voluntary decision of farm operators. Further understanding of farmers' conservation behavior and factors affecting the use of conservation practices could provide guidelines for the policymakers and conservation program implementation in the coming decades.

The overall objective of this study was to identify and examine personal, economic, institutional, sociological communication and resource endowment factors affecting the use of soil conservation practices. The conservation behavior model developed by Lynnee at. al (1988) and the household production theory were economic models employed in the study to describe farmers' conservation behavior and the use of conservation practices. A conceptual model was developed to empirically describe the conservation decision process following the model by Ervin and Ervin (1982).

The data were collected by Leuthold and Hart in survey of 350 farmers in seven West Tennessee counties through personal interview with fifty farmers in each county. With regard to the perception of soil erosion by farmers, a multiple regression analysis was used to measure the ralationships between the farmer's perception of soil erosion level and personal, institutional, sociological and resource factors. With regard to the use of conservation practices, logit regressions were used to analyze the use of conservation practices. A multinomial logit regression model was used to test the relationships between the number of conservation practices used and the independent variables. Logit regressions were also used to analyze the relationships between the use of each of the 13 conservation practices and the independent variables.

About Theory of Conservation Behavior and Decision Process

The theoretical model of the household production framework states that farmers' utility is a function of composition of goods and production activity. The use of conservation practices is a part of the agricultural production activity. The essential point of this theory applied to soil conservation use is that the use of soil conservation practices is determined by both economic and non-economic factors. The non-economic variables are farmers' attitudes, beliefs and values towards soil conservation practices that would affect the actual use of conservation practices. Farmers would gain utility through the production activity by using conservation practices as the theoretical model stated. The study used regression models to test the theory in the use of conservation practices.

The results of the study indicated that both utility and profit maximization are important for the households of farmers and played essential roles in the decision to use conservation practices. Both economic and non-economic factors are important in the use of soil conservation practices. The significant variables of non-economic factors in the study generally support the household production theory in that farmers could obtain utility from production activities such as the use of conservation practices.

The conceptual model of the conservation decision process illustrated that the use of conservation practices by farmers passed through the stages of 1) the perception of soil erosion, 2) the decision to use conservation practices and 3) the conservation effort. Various factors have influences in the different stages. The findings also support the conceptual decision model for soil conservation use in that perception of soil erosion and the use of conservation practices were affected by both economic and non-economic factors.

By summarizing factors affecting the use of conservation practices in the study, economic and non-economic factors played important roles in the use of conservation practices by West Tennessee farmers.. Economic factors play roles toward profit maximization in the use of conservation practices, while personal and sociological factors tended to play more important roles in utility maximization. Among the personal and sociological factors studied, it was noted that attitude variables and social status played essential roles in the use of conservation measures. Institutional and communication factors provided financial and technical supports for the use of conservation practices. Resource factors were physical conditions for farmers to use various types of conservation practices. Economic factors helped determine farmers' economic feasibility of the use of conservation practices. Non-economic factors helped determined farmers' attutudes toward conservation practices. Non-economic variables include personal values, beliefs, neighborhood pressure and social obligation towards conservation practices.

Information sources for farm decisions are very important for both the perception of the soil erosion rate and extend of the use of conservation practices. The findings suggest that information sources, educational programs and technical support about conservation are important factors for farmers in realizing erosion as a problem and to use conservation measures. Farmers who participated the conservation programs were more likely to use conservation practices, suggesting that government financial and technical support are essential in the implementation conservation programs and the reaching of the conservation goals..

The results of this study indicate that farmers with higher education levels, younger age, more years of farm experience and higher gross farm income were more likely to use conservation practices than those with lower educational level, older age, less years of farm experience and lower gross farm imcome. The results also showed that farmers who rented land or partially rented land were less likely to use conservation practices than land owners. The results also revealed that attitudes towards new technology and social status were positively associated with both the perception of soil erosion and the use of conservation practices.

Use of conservation practices not only depends on economic and non-economic factors of farm operators, but the attributes of different conservation practices also affected the use of different conservation practices. Farmers selected conservation practice combinations based on their economic, non-economic factors and attributes of different conservation practices. Farmers will increasingly use sophisticated management conservation strategy in their application of different contributions of conservation measures. The results of this study showed that varying factors affected farmers' decision to use conservation measures. Different sets of personal, economic, institutional, communication, sociological and resource factors were significant for various conservation practices. In addition, farmers choose different types of conservation measures according to their farm circumstances.

Conclusions

Based on the analyses of the data in Chapter IV, the regression results and interpretations in Chapter V, and the discussions in the above section, the following major conclusions are made:

1. Soil erodibility mainly depends on physical conditions of farmland and soil erosion is related to different crop systems. However, perception of soil erosion by farmers not only depends on physical conditions of land and crop systems, but also depends on personal personal and sociological factors and knowledge of farmers. Even though there was a big gap betwen the perception of soil erosion rate and NRI estimation of erosion rate, personal factors and farmers attitudes toward conservation are positively related to the perception of erosion problems. In addition, educational programs and information are essential to help farmers understand erosion problems, and their impacts and the value of conservation.

2. The results of the study support the hypothesis that perception of soil erosion level is a "nescessary condition", but not a "sufficient condition" for farmers to actually use the consevation practices. The use of conservation practices is affected by personal, economic, institutional, communication, sociological and resources factors.

3. Both economic and non-economic factors both play key roles in the use of conservation practices. Economc factors play roles toward profit maximization, while

non-economic factors tend to play more important roles toward utility maximization in the use of soil conservation practices.

4. The variables of attitudes, belief and values, as well as social status of farmers toward conservation, were found to be influential in the choice of the use of conservation practices. The results of the study support the theory that farmers' attitudes, belief and values toward conservation play positive roles in the use of conservation practices.

5. The final users of many conservation practices are farmers. Conservation techniques and technical supports must be available to farmers. Educational programs and information are also important for farmers to use conservation practices. Government agencies and private organizations should be responsible in providing information, education and other related support to help farmers to use conservation practices.

6. Government financial incentives of conservation program play important roles in encouraging farmers to adopt conservation measures and to provide a subsidy to decrease the costs of conservation measures.

7. The attributes of conservation practices are important factors for farmers to use different types of conservation measures. Farmers' circumstances and economic feasibility must permit them to use different types of conservation practices. Conservation programs need to give farmers various options in selecting soil erosion control measures. Further, it is difficult to reach national conservation goals and objectives without technical and financial support and assistance from public agencies to individual farmers.

Limitations

This study identified and investigated socioeconomic factors in the use of conservation practices. The findings from the study generally support the theoretical model tested. Several variables were identified in the use of conservation measures. However, there were still many variables studied which did not explain the variation of the dependent variables at statistically significant levels or in some instances were in the opposite direction from that hypothesized.

Survey data were provided on current use of thirteen conservation practices by farmers. There may be other conservation measures which were not be covered in the study. The decision model in the study only looked at whether a farmer was currently using a certain conservation measure and excluded past use. In other words, the data surveyed only had information about conservation use at the time of the survey. Further, the data in the study did not provide data of the portion of farmland for each conservation measure used by the farmers. Neither did the data provide the situation of future plans for each conservation measure. There was insufficient evidence on total effort that farmers put into conservation use on the farms in term of dollar investment, although it is difficult to collect valid information about conservation effort on investment of capital and labor for each conservation practice over time. The use of conservation measures is a continuing process, and a single observation does not fully reveal the dynamic process of conservation behavior over time.

The data used in the study were collected in 1985 before the 1985 and 1990 Farm Bills and new conservation compliance requirements had been implemented. Over ten years of new conservation compliance requirements, farmers got financial and technical supports from various agencies and government programs. Further, research needs to be done on conservation behaviors of farmers after new conservation compliance provisions are implemented.

Conservation decision and behaviors are a complicated and dynamic process. There are many factors affecting the decision to use conservation measures. Independent variables in this study should be more adequately specified and measured, especially, attitude and belief variables. The study did not test for multicollinearity of independent variables. A serious multicollinearity situation could affect the power of explanatory variables in the study.

The use of soil conservation to conserve soil resources and to protect the environment is a long-term process. A study of soil conservation behavior and factors influencing the use of conservation practices need need more detailed information of farmers' economic and non-economic circumstances as well as farmers' personal, sociological and institutional factors. Many of the limitations of the study were lack of complete information of farmers' conservation behavior. Further research should be conducted on the farmer's conservation behavior at different time and in the different geographic areas (Lockeretz, 1990).

The limitations of this study also suggest that different approaches and theoretical models should be conducted to investigate and understand farmers' conservation behavior. Such approaches and models may better explain and predict farmers' conservation behavior. The results of futher studies could provide more accurate information and conclusions to guide conservation policy.

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