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**CONSERVATION TILLAGE ADOPTION BEHAVIOUR AND IMPLICATIONS
FOR PROGRAM APPROACHES TO REDUCE SOIL EROSION**

By

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A THESIS

Submitted to

Michigan State University

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1986

ABSTRACT

CONSERVATION TILLAGE ADOPTION BEHAVIOUR AND IMPLICATIONS FOR PROGRAM APPROACHES TO REDUCE SOIL EROSION

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This study examines conservation tillage adoption decisions and their implications for program approaches to reduce soil erosion in the State of Michigan. It was undertaken to aid decision makers in Southwestern Ontario to learn from the Michigan experience.

A conceptual model of farmers' tillage investment decisions is developed based on earlier empirical and theoretical work. Subsequently, a survey was used to develop tentative observations regarding the correspondence of this model to farmer behaviour in Huron, Tuscola, Saginaw and Berrien Counties of Michigan. These regions were selected because of: the presence of soil erosion and water quality problems; their similarities to Southwestern Ontario in terms of crops, soils, topography, and proximity to the Great Lakes; and their institutional make-up. The survey probed reasons why or why not conservation tillage was adopted and included key government personnel who were knowledgeable about adoption behaviour and farmers who have and have not adopted conservation tillage.

The study showed that while farmers have many motives affecting their decisions, farmers generally try to maximize profits in response to the flow of costs, yields, and prices from alternative investments. Short-term incentives seem to play a primary role: farmers convert to conservation tillage from conventional tillage when there are short-term

cost-savings with no short-term losses in yield.

The implications of this behaviour for program approaches ranging from informational to regulatory were discussed. Cross-compliance strategies may have the most merit as an approach to encourage greater adoption.

ACKNOWLEDGEMENTS

I wish to thank members of my thesis committee. Dr. L. Libby served as chairman and Drs. J. R. Black and E. Dersch completed the committee.

Appreciation is extended to the Regional Development Branch, Agriculture Canada for suggesting the topic and providing financial assistance. Special thanks goes to the Soil Conservation Service of the U.S.D.A. who helped with the selection of a sample of farmers and contributed their knowledge to this project.

I am also grateful to Bill Wellington for his help with the methodology for this study and Bill Rockwell who helped with editorial work. Lastly, I would like to express my gratitude to my parents who provided me with continued support throughout my program at M.S.U.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 The Soil Erosion Problem

An appraisal of United States' soil and water resources was completed by the United States Department of Agriculture in 1981 in response to a requirement of the Soil and Water Resources Conservation Act of 1977 (RCA).¹ It provided the best evidence to date on the physical state of soil erosion in the United States, estimating that cropland erosion was occurring at a rate of 2 billion tons a year.

The effects of erosion on yields differ by soil type, by crop, and by management practices. Studies have shown that soil erosion reduces yields on many soils and that in the past, fertilizers, improved plant varieties, and various farming techniques compensated for some of these effects (Crosson, 1982). However, differences in these factors from region to region and over time have caused problems in measuring damage to soil productivity from erosion. Walker and Young (1981) have asserted that crop yields in many richly endowed farming regions appear to be nearing the point where further soil loss will not be offset by technological progress and yield declines could be experienced on many land classes.

There are costs of soil erosion that are not taken into account by

¹ The Soil And Water Resource Conservation Act (P.L. 95-192), commonly known as the RCA, requires that the U.S. Department of Agriculture (1) appraise on a continuing basis the soil, water, and related resources on non-federal land; (2) develop programs for furthering the conservation, protection, and enhancement of these resources; and (3) annually evaluate program performance in achieving conservation objectives.

the farmer. The International Joint Commission² notes that the Great Lakes are being polluted from land drainage sources, especially those land areas of intensive agricultural and urban use (IJC, 1980). The IJC felt that "Priorities should be established for major remedial measures, with highest priority given to areas in the drainage basins of the lakes and lake segments having the worst water quality (Lakes Erie and Ontario, Saginaw Bay, and southern Lake Huron)".

Phosphorous, the principal component of water quality degradation through eutrophication, is a significant pollutant from agricultural sources. The Commission felt that cropland was the major source of non-point loads, especially in areas characterized by high density row crops and fine-grained soils. Agricultural sources also contribute sediment to the Great Lakes, resulting in siltation and negative effects on drinking water, aesthetics, fish spawning grounds, and navigation. Sediments also function as pollutant carriers (IJC, 1980).

1.1.2 The Policy Situation

Soil conservation programs have existed for more than 50 years in the United States. With the exception of various educational assistance provided through the Cooperative Extension Service (CES) in each state, and research through Agricultural Experiment Stations at the Land Grant Universities, most soil conservation programs are administered through

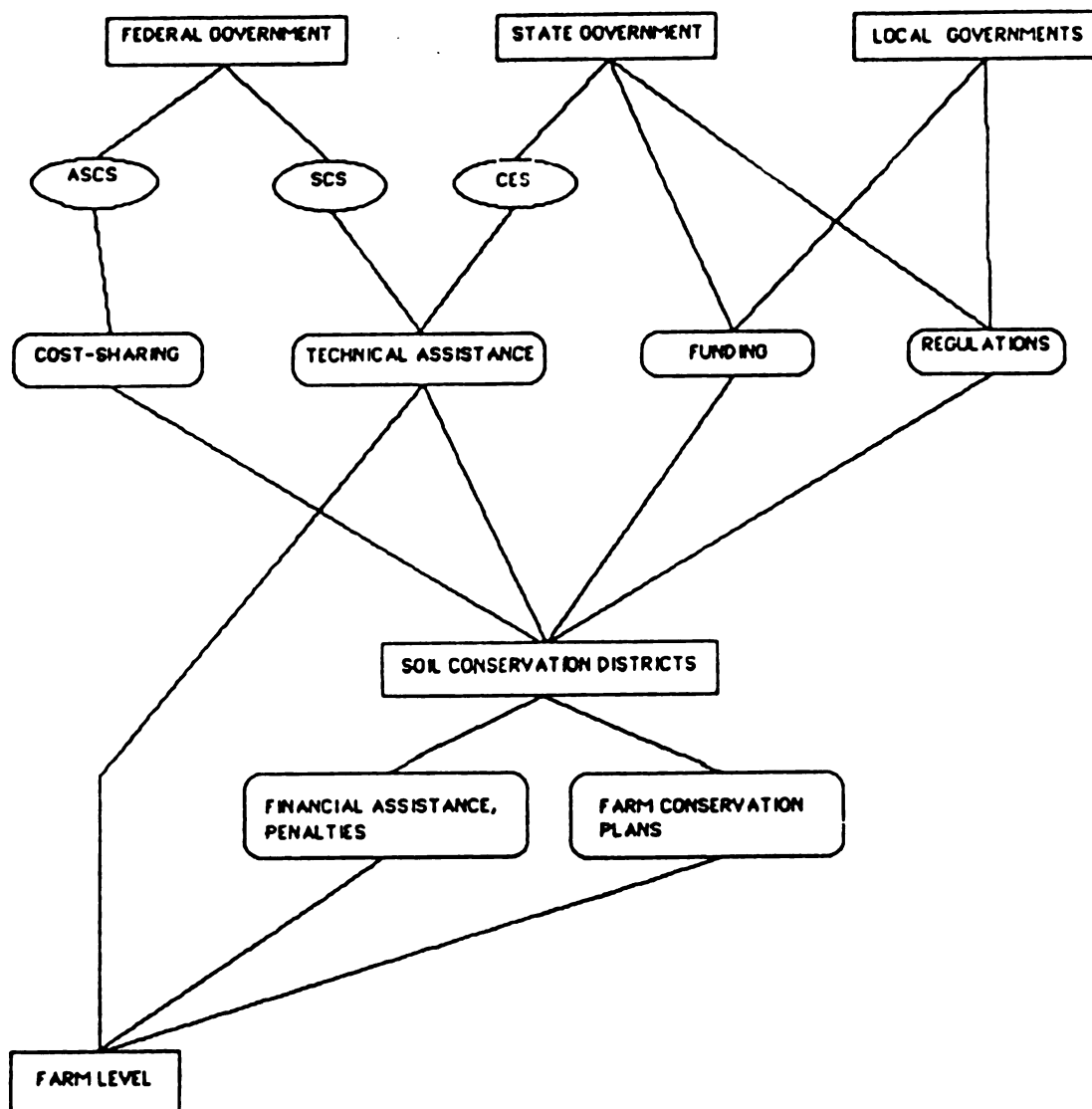
² The International Joint Commission was the principal product of a treaty, signed in 1910, between the United States and Great Britain and was created to deal with issues relating to boundary waters, and questions arising between the United States and Canada regarding their common border.

Soil Conservation Districts (see Figure 1). Almost all SCD's rely on a voluntary program with federal cost-sharing through the Agricultural Stabilization and Conservation Service (ASCS), county committees, and technical assistance from the Soil Conservation Service (SCS). Some Districts, given considerable regulatory powers by some states, can require particular methods of cultivation such as contouring or the retirement of highly erosive areas. However, such land-use regulations are rarely used. The high rates of soil erosion estimated in the 1981 USDA appraisal and the results of the study by the International Joint Commission on "Pollution In The Great Lakes Basin From Land Use Activities" (IJC, 1980) suggest that these programs may be no longer adequate, and that new incentives may be needed.

1.1.3 Approaches to Solving the Problem

Erosion is the result of the usage of land according to opportunities, obligations, and penalties that exist in farming enterprises. Observing how farmers respond to these incentives and disincentives will yield insights about why erosion occurs and what might be changed to discourage erosive land use. Disincentives exist that block the adoption of technical solutions for controlling erosion on most croplands. To encourage the use of soil conservation practices, these disincentives to adoption must be identified and removed while at the same time offering new and better incentives (Libby, 1985).

Figure 1: THE SOIL CONSERVATION PROGRAM



1.2 CONSERVATION TILLAGE AS A POTENTIAL SOLUTION

1.2.1 What is Conservation Tillage?

A technical solution for controlling erosion that has received much attention is conservation tillage. Conservation tillage is usually a form of non-inversion tillage that retains protective amounts of residue mulch on the surface (Mannering and Fenster, 1983). It reduces loss of soil and water relative to conventional tillage.

Conservation tillage reduces soil and water losses by leaving appreciable crop residue on the soil surface and/or leaving the surface rough, porous, cloddy, or ridged (Mannering and Fenster, 1983). On the other hand, conventional tillage generally removes most plant residue from the surface of the field soon after harvest (fall plowing), leaving soil exposed to storms and wind throughout the winter months. Such fields have a high erosion potential until plants have grown high enough to provide a "canopy" to protect the soil from erosion.

1.2.2 Conservation Tillage Practices

The most common forms of conservation tillage used in Michigan are:

- 1) No-till eliminates seedbed preparation so that the residue cover is retained and cut through only to plant seeds. Chemicals are substituted for conventional plowing to control weeds.
- 2) Ridge-planting develops ridges leaving residue in the furrows which collects runoff so that eroded sediment remains next to its source. Seeds are planted in the ridges.
- 3) Plow-plant eliminates secondary tillage as seeds are planted immediately after plowing which therefore reduces the time that soil

is exposed before plants begin developing.

- 4) Till-plant involves opening a seed furrow, dropping in the seed, and closing the soil over the seed all in one process.
- 5) Chisel plowing loosens the soil for air and water flow without inverting it and leaving some plant residue on the surface. It is especially useful where the soil has become very compact as it provides for enhanced root growth but still minimizes the exposure of subsurface soils.

1.2.3 Why Conservation Tillage?

In 1983, Peter C. Meyers, then Chief of the Soil Conservation Service of USDA, asserted that conservation tillage can reduce erosion on many soils 50% to 90% while at the same time: lowering equipment, labor, and fuel costs; increasing soil moisture retention; maintaining soil productivity; allowing for greater flexibility in land use; and reducing the potential for water pollution.

He also noted that this practice is being adopted faster than any other in the history of farming. In 1984, conservation tillage was being practiced on almost 97 million acres out of 327.3 million acres planted in crops whereas in 1972, it was practiced on only 30 million acres. As well, there have been important advances in weed and insect control which act to complement the adoption of this practice.

1.3 PURPOSE OF THE RESEARCH

There has been much exchange of information between the governments of the United States and Canada as they try to tackle similar problems,

including soil erosion and water quality. Southern Ontario and Michigan have much in common in terms of their geography, climate, agriculture and the presence of soil erosion and water quality problems. However, there have been some differences in their approaches in seeking to resolve such problems. Much can be learned from the institutional environment in Michigan that is of value to those designing institutions to reduce soil erosion problems in Southern Ontario.

1.4 OBJECTIVES

To develop information to aid decision makers in designing programs to more effectively achieve soil conservation and water quality goals, this study pursues three objectives:

- 1) To develop a conceptual model of farmers' tillage investment decisions based on earlier empirical and theoretical work.
- 2) To draw conclusions about adoption behaviour in Huron, Tuscola, Saginaw, and Berrien counties of Michigan based on observations regarding the correspondence of this model to farmer behaviour in these regions.
- 3) To identify the implications of these findings on adoption behaviour in conjunction with results from previous research about relationships between soils, crops, and management practices for various alternative program approaches to encourage more soil conservation in these regions.

1.5 ORGANIZATION OF THE STUDY

This chapter has discussed the nature of soil erosion as a problem, conservation tillage as a technical solution and the purpose and basic objectives of the research.

Chapter 2 provides historical background on soil conservation institutions and incentives in the U.S. It is important to understand the evolution of current institutions and their effectiveness in the past to make recommendations about institutional innovations to promote greater soil conservation in the future.

The role of economics in examining the nature of the soil erosion problem is discussed in Chapter 3. A conceptual framework is developed, including environment, behaviour, institutional structure, rationale for government intervention, soil conservation, and policy alternatives.

Chapter 4 develops a conceptual model for the adoption decision regarding conservation tillage incorporating the factors suggested in current literature.

Chapter 5 discusses the use of a survey to confirm or negate the applicability of the findings from the literature to the various counties in Michigan. The design of the survey, the selection of the sample, the statistical analysis to be used on the results, and a description of the sample areas are also covered in this chapter.

Chapter 6 presents the results of the survey and interviews with the SCS district conservationists. These results are also discussed.

Principal findings regarding adoption behaviour in Michigan are presented and their implications for various soil conservation program approaches are discussed. Suggestions for further research are mentioned

as well.

CHAPTER 2

EVOLUTION OF PUBLIC INSTITUTIONS FOR SOIL CONSERVATION

2.1 THE ORIGINS OF SOIL CONSERVATION POLICY

Decision makers in the early 1920's thought that making farmers aware of the seriousness of the problem of soil erosion to their long term interest was enough to encourage them to conserve their soil: public assistance was not needed. This belief had lost support by the mid-1930's. The depression, the drought and the persuasiveness of Hugh Bennett brought about the passage of the Soil Conservation and Domestic Allotment Act of 1936. Today, the Soil Conservation Service, the Agricultural Stabilization Service and the Conservation Districts administer the major soil conservation programs. These comprise financial assistance and technical and educational assistance (see Figure 1).

2.2 THE SOIL CONSERVATION SERVICE

2.2.1 History of the Soil Conservation Service

The 1936 Domestic Allotment Act created the Soil Conservation Service (SCS) as a permanent agency within the United States Department of Agriculture to develop and execute a continuing program of soil and water conservation. There was much opposition to the SCS as its activities had traditionally been the responsibility of extension personnel at land-grant universities.

A "framework plan" for the SCS was devised to help cope with the rapidly changing circumstances of the 1960's which set out three long-range mission objectives: to help the American people enhance the quality of the natural resource base; the environment; and their standard

of living. There were two major changes in the SCS programs following the development of this plan. Firstly, there was a significant expansion of effort in inventorying and monitoring natural resource data. There was also a broadening of SCS planning assistance beyond farms and ranches to try to meet the workload developing with urban and suburban landowners and local governments with soil- and water- related programs.

In 1977, the comptroller general of the United States criticized all of the programs in a report to Congress. In the report, all of the federal soil conservation programs were criticized and the existence of a continuing soil erosion problem, despite the 40-year history of USDA efforts, was viewed with alarm. The SCS was censured for its failure to direct assistance toward areas with critical erosion problems and for spending too much time on farm plans for individuals. Many of the conservation plans in SCS files were outdated, forgotten by the farmer, or just not carried out or used as a basis for making farm decisions.

SCS has asserted that the lack of data on the nature and extent of soil erosion limit its ability to target efforts. SCS had assumed that its mandate did not include such institutional or social factors as capital gains taxes, leasing arrangements, or loan policies which might be encouraging soil depleting practices, thus off-setting positive results of the traditional programs.

2.2.2 Conservation Operations Program

The Conservation Operations Program provides funding for the SCS to provide technical assistance to farmers and ranchers for soil conservation measures. The SCS administers the program in cooperation

with local soil and water conservation districts. Since 1936, the SCS has expended \$3.6 billion through COP, mainly to provide technical assistance to farmers and to meet personnel requirements for developing farm plans to aid farmers in implementing soil conservation practices.

At present, a farmer desiring technical assistance will make application to the soil conservation district for assistance, signing a non-binding agreement to apply a complete conservation plan to his land in return for the free technical assistance. After approval of this application by the district, a professional conservationist (usually an SCS employee working with the district under the memorandum of understanding) visits him on his land to view the situation; make the necessary inventories, surveys, and investigations; and propose alternative solutions for the land user to consider. The farmer is free to do anything he wants, including nothing, but the conservationist tries to help him select an approach that will solve the soil and water problem with what the farmer wishes to grow on the land. Once a plan has been chosen by the farmer, there may be more surveys and investigations, engineering designs, or other technical work needed to assure that he can install the conservation practices properly.

2.3 THE AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

2.3.1 History of the ASCS

The mid-1930's were a time when many farmers were being forced off the land and others needed major help to adjust to the new circumstances brought on by the drought, the Depression, and the mechanization of farming. The Agricultural Adjustment Act of 1933 made such payments to

farmers, from a fund created through a tax on processors. That tax, and consequently the act, was ruled unconstitutional by the Supreme Court.

The Soil Conservation and Domestic Allotment Act of 1936 constituted a new way to support farm income legally by making federal payments to farmers who shifted cropland from soil-depleting crops to soil conserving crops. In addition, the department was given the authority to share in the cost of soil building practices such as the application of fertilizer and lime or the construction of soil conservation practices such as terraces or tile drains.

This constituted the birth of the Agricultural Conservation Program (ACP) which is administered by the ASCS through a system of offices and committees at the national, state, and local levels. It is a program that involves transfer payments to enhance the income of the farm population and promote soil conservation. A major aspect of this program is that it represents a dual federal approach to soil conservation incentives and program administration.

The goals of conserving soil and maintaining farm income continued their peaceful coexistence until World War II. Then increased farm production was needed and Federal funds were allocated to production improving practices to bring about an increase in farm output. Despite the return to surplus production conditions following WWII, cost sharing for production-oriented practices continued until 1980. In the 1970's, with the increase in farm exports, the goals of soil conservation and improved farm income seemed to be in conflict.

The ASCS, like the SCS, was criticized in the comptroller general's report to Congress in 1977. The comptroller general criticized the use

of cost-sharing for practices aimed more at enhancing agricultural productivity than at soil conservation. Drainage systems, land levelling and liming of fields, had been supported for example, for which the return on investment was large enough for the farmers to finance the activities themselves. It was felt that the county committees were given too much latitude in deciding which practices should or should not receive ACP cost-sharing.

This public criticism led to policy changes. The Soil and Water Resources Conservation Act of 1977 (RCA) was adopted, in part, to provide a more scientific basis for budget and program decisions and thereby reduce the conflict between the legislative and executive branches. In addition to an appraisal of non-federal soil and water resources, USDA must develop programs for furthering conservation, protection, and enhancement of these resources.

A number of other rule changes required by the Agriculture, Rural Development and Related Agencies Act of 1979, were made as a result of these criticisms. Cost-sharing for practices identified as adding to production but having little or no conservation or pollution abatement benefits was eliminated. Also, recommendations by county committees for cost-sharing expenditures must now be approved by a state committee and the U.S. secretary of agriculture. The state committee is to give particular attention to projects that conserve or improve water quality. Funds for cost-sharing shall be directed to the accomplishment of the most enduring benefits attainable.

The dual and often conflicting programs of SCS and ASCS have been the source of a great deal of friction over the years. The SCS has

criticized the administration of the ACP, feeling that it has been used as much for farm income support and maintenance of a strong political lobby for ASCS as it has been to address soil erosion. SCS feels that all cost-sharing should be based on a complete farm conservation plan, arguing that in many instances the construction of one specific practice might waste federal funds if not supported by all the elements needed in a complete conservation system. The ASCS has suggested that the way SCS technical criteria was provided was beyond what was needed. They felt that SCS did not have the manpower to do all the individual conservation planning that would be needed to allow all farmers to participate in the ACP and suggested that the plans were in any event, not needed. As a result, a small percentage of the total funds from the ACP program were made available for transfer to SCS for hiring technicians to service the ACP workload. In return, SCS agreed to work with ACP participants whether or not they were cooperators with the local conservation district.

The new method of operating forced the USDA agencies, and the conservation districts to work much more closely at the local level, but it did not solve all the problems. There were still major disagreements over the best use of the limited program funds, over how the cost-shared conservation practices should relate to a total conservation plan on a farm, and the quality that should be required when the farmer installed a practice, not to mention which practices to approve.

2.3.2 Agricultural Conservation Program

The Agricultural Conservation Program (ACP) is administered by the ASCS and provides both long-term (3 to 10 years) and short-term (1 year) agreements for financing soil conservation practices. Under ACP, the federal government will pay for 50 to 75 percent of the cost of approved practices, up to a maximum of \$3500 per farmer per year. A local agricultural stabilization and conservation committee, elected by farmers, recommends which problems and solutions appear to be appropriate for cost-sharing. The SCS provides the technical advice for establishing and implementing the approved practices.

Farmers who wish to participate in the ACP cost-sharing program must go to the local ASCS office and apply for that program, stating what they want to do and certifying that they would not be able to carry it out if cost-sharing assistance from USDA were not available. If the practice involves engineering, the application is forwarded to the local office of the SCS for the necessary technical assistance.

In this case also, the SCS technician visits the site with the farmer, determines that the proposed practice is needed and feasible, and does whatever surveys and designs are needed. The farmer is given a copy of the standards and specifications that will need to be met in order for the completed practice to qualify for the government payment. Following construction, the finished job is checked to see that the standards have been met, and if they have, the ASCS pays the appropriate amount under the rules of the county program.

The differences created when a farmer utilizes the ACP are subtle, but significant. Once the farmer has applied for government cost-sharing

funds, the technical determination of the SCS technician becomes an important factor in whether or not he will receive his payment. His relationship is no longer the voluntary one he enjoyed with the conservation district. If he does not construct the job according to specifications, he may be rejected and denied the cost-sharing money. Sometimes this is the result of negligence or willful attempts at fraud on the part of the farmer, but most of the time it stems from disagreement between the farmer and the SCS technician over what is needed to do the job correctly.

Where the farmer feels the SCS specifications are overly strict or will result in a job that is unnecessarily expensive, he may try to cut corners, or substitute his own judgement for that of the technician. If the SCS technician rejects the final product, the farmer can appeal to the ASC County Committee. If the issue is not resolved there, it can be appealed to the ASC State Committee or perhaps even find its way into USDA headquarters in Washington. The conservation district is not part of this battle, which is strictly between the farmer and the USDA. By seeking the federal cost-sharing support, the farmer gives up a measure of the independence he enjoys in his relationship with the local conservation district.

2.4 SOIL CONSERVATION DISTRICTS

To help solve the problem of who within the USDA would control federal conservation efforts, the Standard State and Soil Conservation District (SCD) legislation was passed in 1937 which established soil conservation districts as independent special purpose units of government

to guide and fit the national goal of soil and water conservation at the local level. These districts had the sole mission of soil and water conservation much like a school district operates only schools.

At the local level, the districts entered into a memorandum of understanding with the Secretary of Agriculture, and the SCS agreed to provide technical assistance to the district and its cooperating land users. This assistance was in the form of federal technicians who would live in the district and help farmers solve soil and water problems. This enabled the national goal of soil and water conservation to be translated into local action programs designed to fit local conditions and guided by locally elected leaders. Through conservation districts, the SCS brought a national research and testing effort and the knowledge of skilled technicians to the farmers of America. The federal agent did not have any authority over the landowner and it was the district that provided a local agency to establish a cooperative, voluntary arrangement: the sensitive issue of federal intervention in private land use was successfully averted. If any harsh measures such as sanctions or regulations were ever needed, it would be state law and local enforcement that would carry out the task, not the federal government.

These districts represented a new concept in the relationships between federal, state, and local government for which there was no precedent. The state law gave them the authority to conduct local surveys, investigations, and research relating to soil erosion and control, carry out preventative and control measures, develop comprehensive plans for soil conservation and prevention of erosion, cooperate with and enter into agreements with landowners, as well as with

any governmental agency, and in most states, adopt land-use regulations.

Regional and state associations were organized for district leaders to discuss mutual problems and share ideas. 52 state associations were formed that represented all states, Puerto Rico, and the Virgin Islands, as well as a national association that provides opportunities for information-sharing and service to all districts.

In the early 1960's, rapid shifts in land use from agriculture to urban-type uses, excessive soil erosion and sedimentation from construction of housing and other developments, and growing public concern for environmental quality presented new challenges that conservation districts were ill equipped to meet. As a result, the scope of state soil and water conservation district laws to include issues such as flood prevention, drainage, irrigation, water pollution and storm water runoff, including urban areas within district boundaries; providing for urban or non-farm representation on district governing bodies; authorizing the levying of taxes or assessments; and the exercise of eminent domain; allowing districts to receive funds from counties.

The SCS did not have enough manpower or authority to handle all of the new responsibilities of the districts. As a result, districts sought state and local funds to hire district technicians to supplement the personnel available from the SCS. Today, over 6000 district employees provide engineering, conservation planning, and conservation education services as part of the local programs. These employees receive technical training from SCS technicians, which allows the benefits of national research and technology development to flow to each district. Policy and program guidance, however, is provided by the elected district

leaders, which keeps the program local in nature.

2.5 OTHER FEDERAL LEGISLATION

In 1956, Congress established a new conservation program, the Soil Bank which was essentially a program to control the supply of farm products. Farmers received federal payments if previously harvested croplands were placed in soil conserving uses such as pasture. Criticisms and complaints resulted in the termination of this program after 1960. In the mid-1930's whole farms were put into reserve, leading to complaints from agricultural suppliers and community leaders when farmers no longer purchased farm supplies. As well, there was much opposition to paying farmers for not producing. Another criticism was that it was an exceptionally expensive program that had little effect on production since farmers would farm those fields not dedicated to the Soil Bank program more intensively.

In the 1950's, instead of an overall program to solve all problems everywhere, an approach was developed that targeted resources toward specific needs in specific areas: the small watershed program; the Great Plains Conservation program and several others. The small watershed program required leadership and strong participation on the part of local groups and soil conservation districts took on much of the responsibility associated with watershed projects. Along with a broadened institutional framework came a broadened constituency and thus many new groups became involved: County and municipal governments and state natural resource agencies were among these. This program tried to tackle the problem of flood control, by giving conservation treatment and appropriate flood

control dams or structures to every farm in a watershed.

In enacting the Great Plains Conservation Program, Congress addressed the climatic problems of the Plains but it also created another new program approach in doing so. Cost-sharing was provided under a multi-year contract, based on a complete conservation plan, including the cost-sharing aspects, administered by SCS. The long-term contracting features of the program have been widely praised but the voluntary nature of the program limited its success in reaching seriously eroding lands. As well, when contracts expired, there simply were no economic incentives to keep those lands in grass, particularly when wheat prices went high enough.

During the 1960's, Congress adopted several other programs that included soil conservation goals. Among these programs was the 1965 Appalachian Regional Development Act, which provided assistance to landowners in the Appalachian Mountain region to control erosion and to stabilize and retain land. Another program was the Food and Agriculture Act of 1962, which provided assistance to rural communities to meet economic development goals, including soil conservation.

In the 1970's, the National Environmental Policy Act (NEPA) brought many new players to the game, a new and broader focus, a new need for cross-coordination among programs in many departments, and a strong new voice for and by the public. NEPA and its environmental statement process changed institutional arrangements throughout government and still are doing so. There was also a new focus on water quality in this period. This brought about a whole new set of players, rules and regulations, and concern about roles.

The 1970's overall were a time when the institutional framework for soil conservation greatly expanded. Perhaps no other development characterizes that happening so well as the passage of, and the intensive activities generated by, the Forest and Rangeland Renewable Resources Planning Act (RPA) and the Soil and Water Resources Conservation Act (RCA). These two programs represent the most fundamental look ever taken at soil and water resource conditions and trends and needs for appropriate action.

CHAPTER 3

CONCEPTUAL FRAMEWORK

3.1 ECONOMICS AND SOIL CONSERVATION

3.1.1 Economic Welfare and Social Well-being

Agricultural activities including soil management are ultimately concerned with social well-being (Van Kooten, 1985). Neo-classical economics concerns itself with maximum economic welfare in which society is as well-off as it can possibly be given its resource base, its production technology, the tastes and preferences of its members, and its distribution of property rights. This paradigm can provide a framework for examining the costs and benefits of various actions concerning soil erosion. However, when concerning ourselves with social well-being we must also give attention to the distribution of these costs and benefits that result from economic activity and this is not dealt with using the concepts of economic efficiency taken from neo-classical economics.

3.1.2 Environment

The market conditions in which farmers operate may more closely approximate those of the model of perfect competition than is true for most other sectors. The large numbers of buyers and sellers for agricultural commodities means that all participants are price takers. The commodities produced across different firms are indistinguishable in the eyes of the buyers. Farmers can enter into or exit from the various forms of crop production and marketing freely. As well, both buyers and sellers of agricultural commodities possess a substantial degree of information about current prices and costs. However, there is greater uncertainty about future prices and costs.

3.1.3 Behaviour

Libby (1984) notes that while farmers have many motives influencing their behaviour, farmers generally do respond in a predictable way to the economic incentives of price and cost. To stay in business, farmers must make normal economic profits and they will make decisions regarding their enterprise that will increase or at least maintain profit levels.

Profit is generally considered to be the difference between total revenue and total cost which includes the opportunity cost of employing a resource in its best alternative use. Van Kooten notes that in farming, some inputs such as family labour, the management component and soil depletion, are not included by the farmer as a part of total cost, although they should be.

In using this traditional analysis, to assure the highest profits possible given the size of the farmer's operating budget, the farmer will allocate his or her various inputs including soil, fertilizer, etc., until the return to the marginal input is equal among alternative enterprises. The fixed asset, land, is allocated among alternative production enterprises based on monetary incentives. As individual proprietorships, farms have a relatively short planning horizon with asset transfer a key part of management (Batie, 1985).

The concept of income over time plays an important role in the farmer's decision regarding alternative investments in tillage practices. Each tillage investment will result in a stream of costs and benefits over time which need to be compared and evaluated. Present value theory provides one method to bring a stream of expected future net returns back to a present measure for evaluation and analysis (Kugler,

1984). This approach is used to derive a market value of land in terms of the present worth of all future incomes (Barlowe, 1972). A farmer faced with a number of mutually exclusive productive opportunities is hypothesized to invest in that opportunity which maximizes the present value of wealth (Randall, 1981). The basic formula for computing present value of future net returns (revenues minus costs) is:

$$PV = \sum_{t=1}^n \frac{NR_t}{(1+r)^t}$$

PV = present value of the stream of net returns from time period 1 to time period n

NR = net returns in time period t associated with a particular technology

r = discount rate used to weight the contribution of future net benefits to the present

t = time period 1.....n

3.1.4 Prediction

Libby (1984) feels that by concentrating on the economic incentives that affect the relative attractiveness of conservation and how they interact with other factors that guide farmers' decisions relative to conservation investment, predictions regarding conservation investment can be made based on the choices available and on the returns involved. Thus, this economic paradigm offers a model that is an approximation of the farmers' investment behaviour which can be used as a basis for predictions regarding the effects of institutional change.

3.1.5 Role of Institutions on Distribution

Neo-classical economics helps to analyze problems in the allocation of soil resources, to identify the causes of these problems, and to identify and examine the benefits and costs of alternative programs, policies, and projects. However, if we are concerned with social well-being, it is also important to examine the incidence of those benefits and costs.

It is important to recognize that the behavioural model discussed previously operates within a broader system of institutions. Institutions are the "going concerns" (John R. Commons) which give structure to the individual relations that exist within a society. They include laws, constitutions, traditions, moral, and ethical strictures, and customary and accepted ways of doing things. Institutions alter the incidence of costs and benefits arising from economic activity. In so doing, they alter the costs and benefits which enter into the farmer's accounting and thus affect his decision making.

Batie (1985) suggests that by focussing on the impact of current institutions on farmers' practices and the impact of the practices on environmental quality, a different set of issues emerges. Instead of the optimal level of erosion, Batie suggests that attention should then be given to the evolution and distribution of property rights, the role of government in reflecting emerging societal values, and the design of institutions.

Property rights are one facet of a total institutional structure. In order to ensure maximum economic welfare, property rights must be non-attenuated which means that they are exclusive, transferable, and

enforced (Randall, 1981). However, there are many different specifications of non-attenuated property rights which will yield a Pareto-efficient solution and each different specification gives rise to a different Pareto-efficient solution. It is important to analyze the geographic, sectoral, socioeconomic, and intertemporal incidence of the benefits and costs associated with economic activity under the alternative institutional arrangements (especially with different specifications of property rights).

3.2 RATIONALE FOR PUBLIC INTERVENTION

3.2.1 Market Failure

The concept of market failure where the privately optimal intertemporal allocation of resources diverges from the socially optimal allocation of resources has been the traditional logic behind the rationale for public intervention in neo-classical micro-economic theory.

Crosson et. al. discuss the reasons for two types of market failures which he suggests can occur in soil conservation decisions:

- 1) First, the marginal present value of land in agricultural production is underestimated as the result of masked or blocked market signals to invest which occur in a number of ways:
 - a) In the short term, the long-term effect of soil erosion on yields may not be detected by farmers. In that case, the value of land in agricultural production is underestimated and the future supply of land for production is overestimated.
 - b) If future demands for production are underestimated by the market, future commodity prices will also be underestimated and

since these reflect the value of the land in production, it too will be underestimated.

- c) This also occurs if the market overestimates the long-term discount rate used to calculate the present value of returns to land.
- 2) Lastly, Crosson et. al. note that if the rate of development and implementation of land substituting technologies is overestimated by the market, the future supply of land for agricultural production would be overestimated. Overestimating the future supply of land would underestimate the value of land in production.

Those that intervene need to be better able to project or foresee long-term market effects on agricultural land values than are farmers. This is unlikely and for this reason Crosson et. al. do not feel that market failure is a compelling argument for intervention.

3.2.2 Off-site Impacts and Intergenerational Equity

Another argument for intervention deals with the costs of non-point water pollution resulting from agricultural runoff. Batie (1983) notes that while farmers have reason to be concerned with the effect of erosion on their farms, there is no financial incentive for them to be sensitive to off-farm impacts. Effects on water quality are extremely difficult to quantify but Pimental (1971) estimates that the damages of off-farm erosion to lakes, reservoirs and harbors probably are not less than \$1 billion per year in 1980 dollars.

The compelling argument for public intervention in soil conservation according to Crosson et. al. rests with the concept of intergenerational

equity based on equitable distribution of income between present and future generations. Implied in this concept is a moral obligation to maintain soil productivity at its current level for future generations.

There is a good deal of risk associated with investments in soil conservation because uncertainty exists about present and future prices, the effects of soil conservation on productivity, as well as about the methods of measurement and accounting of benefits and costs for evaluating off-site benefits (especially related to water quality). Crosson et. al. argue that the potential problems due to overinvestment are somewhat less than those due to underinvestment. Allowing soils to erode and deplete at erosion rates greater than the soil tolerance or "T" level can have devastating irreversible effects on agricultural productive capacity. As well, conservation will provide offsite benefits. However, since there is a need to establish methods to measure and value off-site benefits, there is a good deal of uncertainty about the social consequences of soil conservation policy. On the other hand, overallocation of exhaustible resources for erosion control simply means that some other concern in the social accounts is being underallocated and that some form of social disequilibrium would result.

3.3 SOIL CONSERVATION AND DEPLETION

If public intervention is justified because farmers are using their soil as an input into production in an undesirable way for the reasons just discussed, then it is important to determine what constitutes desirable use. First, the aspects of land that are important to agricultural production will be discussed followed by a definition of

soil conservation. As well, ways of measuring soil conservation and depletion will be examined.

3.3.1 Concepts of Land

While there are many different views of land, in examining the nature of soil erosion problems, it is important to conceive of land as an input into agricultural production. According to Gaffney (1965), land has a Ricardian and a capital component. He views the Ricardian component of the land (soil) matrix which includes such factors as location, climate, drainage, relief and abundant supplies of particular nutrients, as being that which is permanent and indestructible. The "conservable flow", the "revolving fund" and the "expendable surplus" are terms used by Gaffney to describe the capital component of the soil matrix. The conservable flow element is that which requires some expense or investment to maintain in its original state and this is justified since the present value of the future income derived from this particular element of the soil matrix is greater than that investment. The component of the soil matrix which is not economical to conserve but is economical to replace with materials brought in from offsite is termed the revolving fund. Finally, there is the expendable surplus which is that component of the land which a farmer would view as a free good (eg. over abundance of nitrogen that exists after sod has been broken for the first time). However, because it is a finite stock and thus a capital component, once depleted or nearly depleted, it can be treated the same as either the conservable flow or the revolving fund component of the soil matrix.

3.3.2 Defining Conservation

Using Gaffney's (1965) concept of land, desirable soil use or conservation can now be examined. There are many definitions of conservation and these depend on the nature of the perceived soil use problem.

Randall (1981) defines conservation as being synonymous with the socially optimal allocation of natural resources over time. Thus the privately optimal allocation corresponds to the socially optimal allocation. The optimal private investment strategy in the "conservable flow" and the "revolving fund" components of the soil matrix is that which maximizes the net present value of future revenues. This definition is most appropriate when market failure is the cause for inappropriate soil use.

Gaffney (1965) defines conservation as the "effort effectively devoted to reduce the loss of virgin flow resources that may be, but need not be, deteriorated by use". This viewpoint is most consistent with reducing soil erosion to control non-point water pollution resulting from agricultural runoff.

Sampson (1981) feels that "the objective in using soils should be that those soils will maintain their productive potential despite that use. Any goal short of that is simply transferring the cost of today's excesses on to our children or grandchildren." This implies that there is no "expendable surplus" if the land is to remain as productive in the future as it is at present. Such a definition of conservation applies when intervention is defended as a moral obligation to manage soil resources so that productivity remains intact from generation to

generation.

3.3.3 Measuring Conservation and Depletion

Soil losses can be estimated using the universal soil loss equation (USLE) or the wind erosion equation (WEE), both of which estimate the average annual tons of soil lost from each soil type as a function of climate, topography, cropping systems and management practices. These estimates are used with caution due to a number of limitations with them but these instruments are the best available for determining erosion rates (Batie, 1983).

The estimated losses are usually compared to soil-loss tolerances, called T-values which are defined as the maximum annual soil losses that can be sustained without adversely affecting the productivity of the land. Soil erosion at rates exceeding specified T-values is often termed as "excess" soil erosion (Batie, 1983). They are meant to represent the maximum soil losses that allow the maintenance of existing soil levels but many question its actual ability to do so.

Despite this Batie feels that the important issue is protection of long-run productivity. To represent maintenance of long-run productivity, T-values need to reflect the impact of technology on crop yields. They have to reflect the costs and benefits of soil maintenance as well if they are also to represent economic conditions. The uncertainty of these future technological and economic influences makes it difficult to incorporate these into T-values (Batie, 1983). With these considerations in mind, many experts argue for retaining the concept of T-values as a physical measure of the maximum erosion

allowable without reducing present soil depths (Batie, 1983).

While T-values are of some value as a guidepost to soil use when looking at the productivity question, they do not deal with the off-site impacts and the relationship between soil erosion and water quality. There is a great need for work to be done in this area.

3.4 POLICY ALTERNATIVES

Traditionally, market failure has been used by economists as a conceptual construct as the justification for government intervention. Farmers have had implicit user rights to the property they own and they were normally considered to conserve soil only if it was in their own economic interest. Thus prescriptions called for raising the benefits of conservation, lowering the costs, and providing more information with programs such as cost-sharing, technical assistance, and educational assistance (Batie, 1985).

An alternative approach attempts to exploit other, non-economic goals of farmers such as independence, maintenance of a style and a quality of life, maintenance of social standing in their community, and meeting challenges in encouraging more favorable stewardship of the land. Programs embracing this approach might include the possibility of selecting certain farmers for out-reach programs, placing demonstration practices on the farms of recognized community leaders putting greater emphasis on the diffusion of knowledge, offering technical assistance that allows a farmer to learn the appropriate technical skills, and providing follow-up assistance in conservation programs.

These two sets of options which constitute a more traditional

approach operating within existing property rights present a contrast to a third alternative which fundamentally questions this existing structure of property rights. This perspective examines the impact of current policies and institutions on farmer's practices and the impact of those practices on natural resource quality and quantity. It addresses issues such as social values and the equitable distribution of resources among generations and calls for modifications in the existing rules of ownership to bring about a more desirable land use. This modified perspective focusses on the distribution of benefits and costs of soil erosion and conservation as well as the role of institutional incentives.

CHAPTER 4

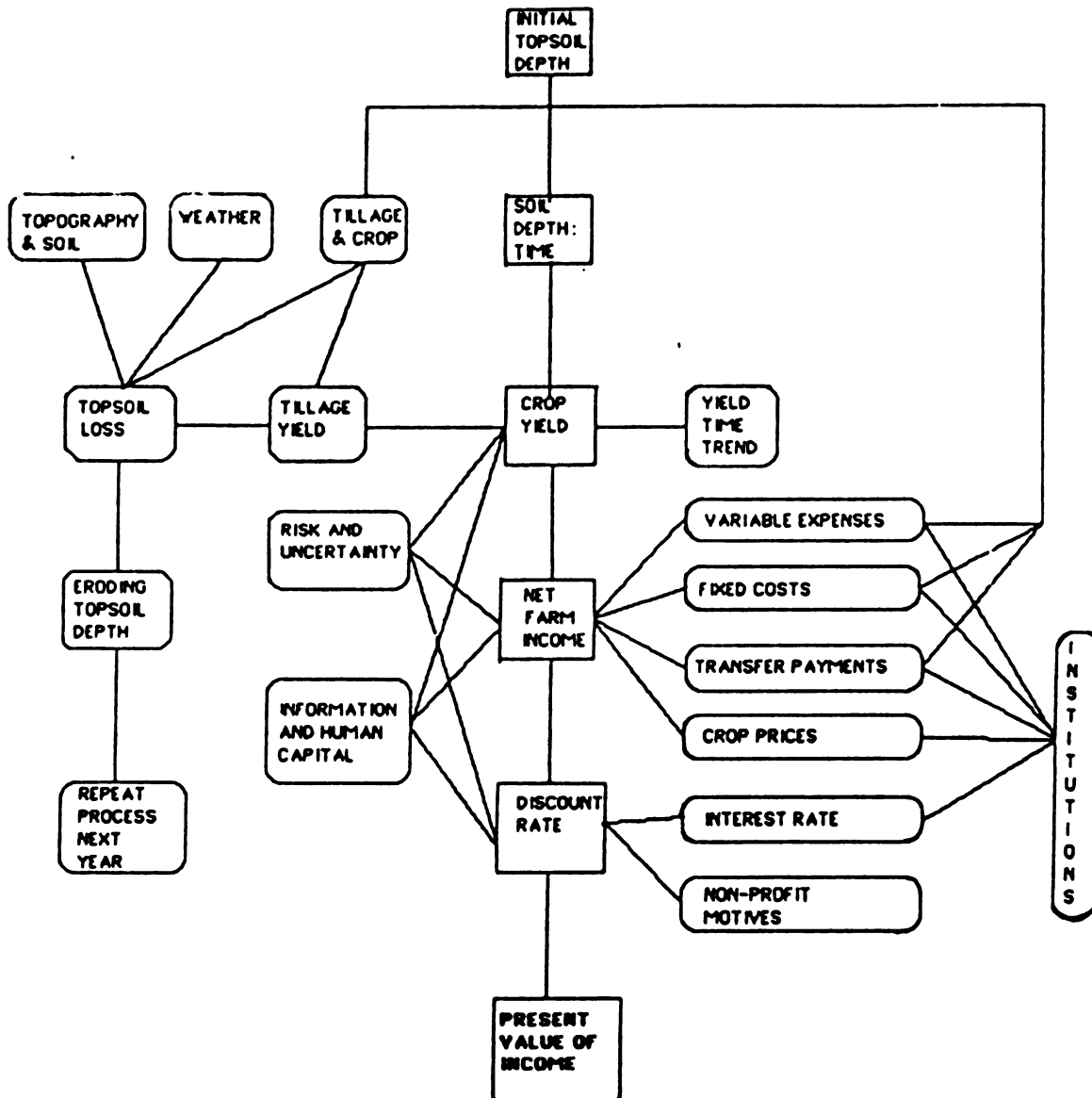
FACTORS AFFECTING THE ADOPTION OF CONSERVATION TILLAGE

4.1 TILLAGE INVESTMENT DECISION

There are several categories of factors hypothesized to affect the conservation tillage adoption decision. The adoption decision itself will be based on the flow of annual net returns associated with the practice of conservation tillage as compared to conventional tillage. The discount rate and planning period used by the farmer determine the length of time into the future for which these net returns will be considered.

These categories of factors will in turn be affected by three other categories of factors. The amount of risk and uncertainty associated with the practice themselves, the economy in general, his/her own plans for the future, and the institutional environment in which he/she operates will affect the reliability and the stability of the projected benefits, costs, discount rate and planning horizon. Likewise the institutional structure will affect what benefits and costs will accrue to the farmer, the discount rate and his planning horizon. Lastly, information and human capital variables will affect the farmer's perceptions of costs, benefits, discount rate and risk. Physical factors also influence the costs, benefits, and risk associated with each technology but these cannot be manipulated like the other variables and are thus considered as fixed (see Figure 2).

Figure 2 : TILLAGE INVESTMENT DECISION (based on model by Walker and Young, 1981)



4.2 DECISION COMPONENTS

4.2.1 Net Returns

Many different factors influence cost, yield, and profit per hectare for alternative tillage/planting systems. Soil temperature following planting, soil moisture availability throughout the growing season, weed and insect populations and control measures, fertility and liming programs; soil management group and drainage, cropping system, and machinery and labor requirements are key determinants of the relative returns of alternative tillage systems (Black et. al., 1984).

A study comparing yields from conventional, chisel plow, and no-till systems which was conducted in Indiana, showed that conservation tillage systems achieved yields .3 ton/ha higher than those under conventional tillage. However, no-till yields were 1.0 ton/ha less than under conventional tillage on poorly drained soil (Griffith and Mannering, 1984).

Taylor, et. al. (1981) showed that during years of moderate and normal rainfall, higher corn yields were produced under conservation tillage than under conventional tillage in Quebec. Conservation tilled yields were lower than the alternate technology in years with much higher rainfall.

Ameniya (1977) discovered that droughty conditions favored conservation tillage in Iowa, especially on the more coarse textured soils. The study showed that corn planted under a conservation tillage system yielded 2.8 ton/acre more than conventionally planted corn during years of severe water deficiency whereas there was little difference in yields under typical conditions.

The yield decreases that have occurred on poorly drained soils due to reduced tillage were shown by Van Doren, et. al., (1976) to be lessened by practicing crop rotation instead of continuous corn. In Ohio, on relatively well drained soils, no-till yields under continuous corn were twelve percent higher than those under conventional tillage whereas on naturally poorly drained soils they were fifteen percent less. For the corn-soybean rotation, no-till yields were 8.6 percent higher on the relatively well drained soil but 4.5 percent less on the naturally poorly drained soil. For the corn-meadow rotation, no-till yields were 7.7 percent higher than conventional yields on the moderately well drained soil, and 3 percent lower on the naturally poorly drained soil.

Both field experience and research have supported the increased herbicide requirements of no-till as compared to conventional till. There is little difference however, for other forms of conservation tillage except that perennial grasses and other specialized weeds tend to appear under conservation tillage after three or four years(Black et. al., 1984).

Insect and plant diseases also tend to pose more problems after three years of conservation tillage than for conventional tillage due to the favorable habitat for some insects and diseases provided for by the crop residue left on the surface. With this economically significant buildup, conservation tillage may require heavier application of insecticides and fungicides to achieve proper control (Black et. al., 1984).

Black et. al., (1984) noted the differing views about whether

conservation tillage and conventional tillage require different fertilizer application rates. While the nutrients required for plant growth are the same, the material available for uptake and the efficiency of nutrient uptake may be different. They interpreted Vitosh et. al. (1984) as indicating that when nitrogen is knifed down as anhydrous ammonia, there is no difference in application.

Several investigations have published results on the impact of tillage systems on labour, fuel and machinery (Crosson, 1981). Less labour is needed with conservation tillage; pre-harvest labour may be as little as 50 percent of conventional tillage requirements for some systems. Similarly, less fuel is required. Data on annual machinery use cost differences are scattered and application specific, but all show a reduction due to conservation tillage relative to conventional tillage.

Walker and Young (1981) showed that there was a severe "double penalty" impact of erosive farming systems on future crop yields resulting from the complementary relationships between technical progress and soil conservation. Their yield projection model showed that unchecked soil erosion can severely reduce the yield gains from future investments in agricultural research and technology development.

Soil conservation practices may or may not be profitable for the adopter depending on the factors just mentioned. Hoover and Crosswhite (1984) in summarizing the current literature found that if the farmer is convinced that the benefits of practice adoption exceed the costs in his or her own planning horizons, then the practice is more likely to be adopted.

4.2.2 Planning Period and Discount Rate

The Walker and Young study (1981) stressed the important implications that the choice of discount rate has for conservation decisions. Kugler (1984) notes that the decision about the use of the soil resource with respect to time is likely to be different amongst individuals and different from individual and societal perspectives. Individual discount rates reflect the influence of factors such as imperfect competition and knowledge, institutional settings, individual goals, etc. As the discount rate (individual rate of time preference) varies, so does the producer's planning period and thus his willingness to engage in conservation practices. Lower discount rates weigh the present value of future benefits more heavily and, in a relative sense, can serve to encourage investment in conservation. Higher discount rates may discourage investment in conservation because the present value of a stream of benefits will be lower. The individual producer decides based on his/her individual rate of time preference and planning horizon whether disinvestment, maintenance or investment in soil conservation is warranted (Kugler, 1984).

One might expect that age might be a factor in determining the planning period and discount rate in that younger farmers would have more incentive for adoption because of a longer pay-off period. However, in Hoover and Crosswhite's review of the literature on this subject, most studies indicated that it was the effect of other variables interacting with age which had an effect in the adoption process and that age was not related directly to adoption or participation.

The possibility of transferring the farm to a child or relative

might also lengthen the farmer's planning horizon. Little investigation has been done on the role of this action on the adoption decision despite its possible significance.

Studies have shown that tenancy status is significant in the conservation tillage decision. Hinman, Mohasci, and Young (1983) found that the absolute dollar incentive to adopt conservation tillage practices was considerably greater for operators with a higher percentage of leased land than for operators who owned most of their land. Operators capture the full value of the machinery cost savings, regardless of whether they are 100-percent owner-operators or 100-percent tenant-operators. On the other hand, owner-operators suffer the full amount of any yield penalties from the land, while tenant-operators suffer only a percentage of the yield penalties that might be associated with minimum tillage based on their crop share rent.

The real market rate of interest should exert a large effect on the discount rate used by the decision maker. This reflects his/her opportunity cost. Thus, the higher the real market rate of interest, the more future benefits will be discounted and the shorter the planning period will be (Randall, 1981).

Debt service requirements, in the Ervin and Ervin study, are perceived as obstacles to adoption. Operators under high debt service loads (eg. land mortgages) are forced to plant mostly high return, erosive rowcrops and cannot afford to invest in conservation practices which may yield longer-term benefits and thus they will discount long-term benefits heavily. The market rate of interest will be of greater concern to these farmers as they must meet debt repayment

schedules.

Hoover and Crosswhite have concluded that there was strong consensus that there was strong positive association between farm income and the adoption of soil conservation practices. Those with higher returns will be more likely to have lower marginal rates of time preference than those with lower net returns. Higher percentages of off-farm income reflect greater need for that income and thus a higher discount rate (Ervin and Ervin, 1982).

Hoover and Crosswhite found that the majority of researchers agreed that agrarianism and stewardship motives were a factor in the adoption decision. Farmers' attitudes toward environmental quality and conservation issues reflect their public concerns about resource use and consequently may reflect their perceptions of discount rate and planning period. Those expressing more concern for future generations will subsequently have lower discount rates and longer planning periods.

4.2.3 Information and Human Capital

Farmer's perceptions regarding the level of soil erosion on their land, the effect of that erosion on their yields and the effects of tillage practices on erosion and on yields plays a very important role in adoption decisions. Likewise perceptions regarding costs associated with alternate tillage practices and current and future macro-economic variables (interest rates, land values, commodity and input prices) also deserve attention in this context. Misconceptions regarding any of these variables will result in a non-optimal investment decision.

There have been few studies investigating the effect of human

capital investments on adoption behaviour. Rahm and Huffman (1984) examine the role of a number of human capital variables: these include years of formal schooling completed by farmer and other aspects pertaining to education such as vocational training in high school, completion of an agricultural major in college, attendance at short courses, conferences, and meetings at Land Grant Colleges, attendance at meetings, field days or demonstrations sponsored by the extension service, and utilization of media sources of information published or marketed by private information and management firms. Experience will also play a major role.

Because adopting the new technology is not always economically feasible, greater education and information are not always expected to increase the adoption of conservation tillage. Human capital variables, however, are expected to increase the probability of farmers making the economically "correct" decision. Only when the adoption of conservation tillage is the economically correct decision, will the human capital variables increase the adoption of conservation tillage.

Human capital variables will also affect the farmer's ability to achieve the desired results from a new technology. If during the trial period with the new technology the farmer does not achieve the desired results, he/she may decide to abandon any further attempts at using conservation tillage.

4.2.4 Risk and Uncertainty

Assuming that farmers operate under conditions of imperfect information, risk and uncertainty must be accounted for in the decision

making process. The investment decision will involve some tradeoff between risk and income based on the relative weights of the decision maker's preferences for each.

Two types of risk can be associated with these different tillage technologies. Due to the interaction between biological factors such as climate, weeds, and insects, and tillage practices a certain amount of technological risk can be associated with each different tillage system. Economic and institutional risk will affect the values of the various inputs and outputs and the distribution of costs and benefits associated with a particular economic activity. The amount of risk and uncertainty associated with each technology and the farmers predilections towards risk will greatly influence the decision to practice a particular technology. Nowak and Korsching's study (1981) revealed that risk avoiders are less likely to adopt conservation practices.

4.2.4.1 Technological Risk

Nowak and Korsching's study (1981) also revealed that farmers harbor overly pessimistic views of yield variability with reduced tillage. No-till was definitely perceived to be most risky. Most researchers would agree that no-till requires a higher level of management. Also, no farmers in the survey were using no-till planting and thus may have lacked good information on this alternative (ie. more negative risk perceptions).

4.2.4.2 Economic and Institutional Risk

Uncertainty in the rest of the economy enters into this decision framework through future prices for the various inputs and final products, and interest rates. Risk averse farmers will be reluctant to invest in conservation practices because they will be less willing to forego short-run returns for long-term and uncertain benefits (Ervin and Ervin, 1982). If a farmer is averse to risk taking, he may reject a more profitable reduced tillage activity in favor of a less profitable and less risky conventional tillage alternative.

Market changes for American agriculture in the past decade and a half related to exports have added even more uncertainty to the marketplace. Agriculture has traditionally been subject to uncertainty over the years due to the effects of weather, pests and production cycles. World demand must now be added as changes in foreign demand, production and government policies as well as weather must be accommodated. This adds more uncertainty to the future of U.S. agriculture (Ferris, 1985).

4.2.5 Institutional Framework

The institutional structure defines the structure of incentives facing individuals. Institutions determine the incidence of benefits and costs associated with economic activity. Property rights are one facet of a total institutional framework.

Current and past conservation programs implicitly give farmers user rights to the property they owned which entitle them to let their land erode if they so chose (Batie, 1985). Policies have been voluntary and

involve cost-sharing which in effect is the setting of an acceptable price to change certain farming practices.

Educational and technical assistance programs offer the necessary information required to practice the new technology at no direct cost to the farmer. This acts as a subsidy into the information costs of learning how to use a new technology. The majority of research reviewed by Hoover and Crosswhite (1984) was in agreement that technical assistance was a contributing factor to adoption.

Receipt of governmental cost-sharing effectively lowers the price of a conservation practice and should induce higher use levels than without cost-sharing. Hoover and Crosswhite noted that there is strong agreement that cost-sharing increases adoption rates. Farmers question the profitability of many practices. Cost-sharing lowers the cost of practices and is expected to reduce the risk of practice use.

Water quality regulations treat farmers differently than other polluters in that compliance should be in the economic interest of farmers and thus are voluntary whereas the rest have mandatory regulation (Swanson, 1985). Farmers do not face some of the costs which result from their activities.

Subsidized crop insurance, disaster payments and subsidized credit have reduced the risk of producing certain crops and commodity programs increase the attractiveness of program commodities which are less protective of soil resources than other crops (Miranowski, 1985). These would not affect the choice of tillage practice once the decision to grow a particular crop has been made.

4.3 SUMMARY

The net return that one tillage practice will provide relative to another as subject to an individual's discount rate and/or planning period will be a primary factor in that person's adoption decision. This is determined by a number of variables which are summarized in Table 1.

Table 1: Summary of Factors Affecting and Their Role in the Adoption of Conservation Tillage From Previous Research (Cont.)

<u>FACTOR</u>	<u>IMPORTANCE</u>	<u>SOURCE</u>
2. Planning Period/Discount Rate		
<u>Factors Affecting</u>		
a.) Perception	Perception of problem important to adoption	Ervin and Ervin, 1982
b.) Interest rate	Higher interest rates shorten planning period	Randall, 1981
c.) Debt level	Increased indebtedness discourages adoption	Ervin and Ervin, 1982
d.) Tenancy	Most rent share agreements favor conservation tillage systems	Hinman, Mohasci, and Young, 1983
e.) Gross income	Higher income levels associated with increased practice adoption	Hoover and Crosswhite, 1984
f.) Off-farm income	Higher percentages of total income reflect higher discount rates	Ervin and Ervin, 1982
g.) Agrarianism and stewardship	Favourably affects adoption	Hoover and Crosswhite, 1984
h.) Age	Other variables interacting with age affect adoption	Hoover and Crosswhite, 1984
<u>Role of</u>	Longer planning period and lower discount rate associated with greater adoption	Ervin and Ervin, 1982
3. Information and Human Capital		
<u>Factors Affecting</u>		
a.) Education	Higher levels of education associated with increased adoption when net return present	Rahm and Huffman, 1984
b.) Other information sources	Greater use of information sources encourages adoption when net return present	Rahm and Huffman, 1984
<u>Role of</u>	Increased information and human capital associated with increased adoption when net return present	Rahm and Huffman, 1984

Table 1: Summary of Factors Affecting and Their Role in the Adoption of Conservation Tillage From Previous Research

<u>FACTOR</u>	<u>IMPORTANCE</u>	<u>SOURCE</u>
1. Annual Benefits and Costs		
<u>Factors Affecting</u>		
a.) Cost reductions - labour requirement - fuel requirement - machinery requirements	Conservation tillage requires less Conservation tillage requires less Conservation tillage requires less	Crosson, 1981 Crosson, 1981 Crosson, 1981
b.) Cost increases - herbicide requirements - pesticides and fungicides requirements	No-till requires more, other tillage about the same Conservation tillage requires more	Black, et.al., 1984 Black, et.al., 1984
c.) Annual yields under each tillage system - drainage - rainfall - droughtiness and soils - rotations	Poor drainage favors conventional tillage yields High rainfall favors conventional tillage yeilds Droughtiness and coarse textured favor conservation tillage yields. Yield decreases on poorly drained soils lessened by practicing crop rotation instead of continuous corn	Griffeth and Mannering, 1984 Taylor, et.al., 1981 Ameniya, 1977 Van Doren, 1976.
d.) Long-term yields under each tillage system	Combined effects of technological advance and soil erosion hurt relative yields for conventional tillage	Walker and Young, 1981
<u>Role of</u>	Net return important prerequisite to adoption	Ervin and Ervin, 1982

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<u>Role of</u>		

CHAPTER 5

METHODOLOGY

5.1 RESEARCH DESIGN

5.1.1 Exploratory and Descriptive Components

There are two components of this research, which use both an exploratory research design and a descriptive research design. While exploratory research designs are useful in the development of hypotheses and descriptive research designs can test these hypotheses, these designs are not as satisfactory as experiments for establishing causality or inferences that a relationship exists (Churchill, 1983).

It was felt that the designs used would best satisfy the first two objectives of this study.

The first component utilizes exploratory research to exploit previous empirical and conceptual studies by economists and sociologists on the adoption of conservation tillage to construct a model of farmers' tillage investment decisions (objective one). This component allows the development of more precise sub-problem statements to form specific hypotheses which carry clear implications for testing stated relationships (Churchill, 1983). Chapters three and four represent this portion of the research.

Since this study is concerned with specific regions in Michigan and much of the empirical work used in the exploratory component was conducted in other regions of the U.S., there is a need for some additional empirical evaluation to confirm these previous results in the Michigan setting (objective two). The use of some conceptual work in the exploratory component also suggests the need for further confirmation.

Descriptive research needs the prior knowledge gathered in the

exploratory component to allow the " framing of some specific hypotheses for investigation, which then guide research" (Churchill, 1983). The second component of this study uses a descriptive research design to tentatively confirm or negate these hypotheses regarding trends in the adoption of conservation tillage in the regions of concern to this study. This component also is exploratory in nature in that it is also concerned with the generation of new insights and ideas which may or may not be particular to the specified regions.

5.1.2 Cross-Sectional Analysis

5.1.2.1 Field Study

A field study was performed as part of a cross-sectional analysis used in the second component of this research. Such an approach takes an in-depth look at a small number of situations (small sample approach): this emphasizes the interrelationships of a number of factors that bear on the adoption decision.

5.1.2.2 Experience Survey

To gain further insights and help confirm specific hypotheses, an "experience" survey or "key informant" survey was used to exploit the knowledge and experience of those familiar with the general subject of the adoption of conservation tillage (Churchill, 1983). Technicians from the United States Department of Agriculture, Soil Conservation Service were chosen as the "key informants": their work in the regions being studied to promote the use of soil conservation practices including tillage methods made it likely that they would provide useful insights.

To help confirm hypotheses from previous literature, the survey was somewhat structured.

5.2 DATA COLLECTION

5.2.1 Survey Instrument

The communication method was used to collect primary data because it offered the advantages of versatility, speed, and cost. Communication involves questioning respondents to obtain the desired information, using a data collection instrument (questionnaire). The questionnaire was self-administered (the respondents complete the questionnaire themselves) in the presence of the interviewer which provided an opportunity for the respondents to seek clarification on points of confusion and for further discussion. This questionnaire was also used as a basis for discussion for the "key informant" survey to gain their insights regarding hypotheses affecting the adoption of conservation tillage from previous literature.³

5.2.2 Questionnaire Content

The hypotheses generated from the review of literature on this subject guided the questionnaire. They determined what information was sought because they specified the relationships to be investigated (Churchill, 1983). They determined the type of question and form of response used to collect it. Four types of information were collected through the questionnaires and interviews (Dillman, 1978) including

³ See Appendix C.

attitudes, beliefs, behaviour and attributes were gathered. There are six general areas of questions pertaining to net returns, planning period and discount rate, risk and uncertainty, information, institutional structure and a general summary.

5.2.3 Organization Of Questionnaire

As much as possible, the questions were ordered in such a way so that attitudinal questions were asked first, belief next, behavioral questions third and questions regarding attributes last. Consideration was given to sequential flow in organizing the different sections of the questionnaire. Demographic questions were put near the end because these are not the primary reason why the survey is being undertaken. As well, these questions may aggravate respondents.

The section on the net returns for the alternative techniques was first due to its general applicability and importance. This section was thought to have included "satisfying" questions that most would be able to answer. Sections were clearly delineated and their relevance explained during the interview process.

5.2.4 Question Format

The question format involved a combination of close-ended with ordered choices and close-ended with an open-ended follow up. For the first type, the respondent selects one response option that is placed on a gradation of responses and this is used to help confirm specific hypotheses. The second type gives the respondent the option of explaining/clarifying/describing the response on a close-ended question

and thus is exploratory in nature.

A number of guiding principles from Dillman (1978) were used in phrasing the questions. Words were used that were thought to be understandable by respondents. Words which were unlikely to be interpreted differently by different people were used. Questions were asked which were answerable by respondents. To prevent bias, attempts were made to avoid promoting the interviewer's own positions and to avoid encouraging a socially desirable response.

5.2.5 Response Format

There were also a number of guidelines that were followed for the response format. Repetition in the response format was built into the questionnaire. A combination of circling numbers and checking in blanks was used. All response options were organized in the same direction with four or five point response options. At the end of the questionnaire, respondents were asked for any final comments to give them a chance to express their views and concerns away from the "controlled" responses of the rest of the questionnaire.

5.2.6 Attitude, Belief, Behaviour, and Attribute Measurement

Measurement consists of "rules for assigning numbers to objects in such a way as to represent quantities of attributes" (Nunnally, 1978). Scales are used for measurement and in this study scales, were self-reported. Interval, cardinal and nominal scaling was used.

5.2.6.1 Scaling Procedures

Several different scaling procedures were used. Likert scaling and rating scales were the major ones. The Likert method of summated ratings allows an expression of intensity of feeling. The basic format of the scale for the summated ratings method is the same in both construction and use. Respondents are asked to indicate their degree of agreement or disagreement with individual statements in a series. Statements reflect qualities associated with conservation tillage relative to conventional tillage that possibly influence a person's attitude toward it. This scale was used as a method for comparing the strength of attitudes and beliefs amongst groups.

eg. The following have been suggested as annual cost-reductions that result from practicing conservation tillage. To what extent do you agree or disagree with each.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

- a) Prevention of deposition on cropland. _____
- b) Prevention of gullies and streambank erosion. _____
- c) Decreased fuel requirements for tillage operations. _____
- d) Decreased labor requirements for tillage operations. _____
- e) Decreased equipment costs. _____
- f) Other. _____

The Likert scaling method may not be enough to measure attributes that determine the individual's perceptions of conservation tillage relative to conventional tillage. Even though the individual believes that there are differences between the two tillage practices, the person may not value this attribute and therefore it may not affect their attitude towards conservation tillage (Churchill, 1983).⁴

Rating scales were used to rate the importance of various factors in the adoption decision in one of an ordered series of categories for which a numerical value is attached. In this case, an itemized rating scale which allowed individuals to make judgments regarding the importance of factors without direct comparison to other factors was used. The rater selects from a limited number of categories under the itemized rating scale and this questionnaire used a four-point scale with the description labels attached to the categories.

eg. If you now practice conservation tillage, how important were the following factors in your decision to practice conservation tillage? Discuss.

- 1 -- not important
- 2 -- slightly important
- 3 -- moderately important
- 4 -- very important

⁴ There is a good deal of controversy regarding how the importance of various attributes should be incorporated in determining a person's attitudes toward an object or in this case a practice.

- a) Profitability of practice (savings in equip., time fuel, etc.).____
- b) Availability of cost-sharing funds.____
- c) Availability of technical assistance.____
- d) Recognition of erosion as a future problem on farm.____
- e) Recognition of erosion as current problem on farm.____
- f) Recognition of erosion from farm causing water quality problems.____

5.3 SAMPLING

5.3.1 Population and Sampling Frame

The population of interest to this study is those farmers growing row crops in Berrien, Saginaw, Tuscola, and Midland Counties of Michigan. These counties were chosen because of the presence of serious soil erosion problems, their physical and demographic similarities to Southwestern Ontario, and their institutional makeup. Two sub-groups are compared and these are those farmers who are effective users of conservation tillage systems and those farmers who still use conventional tillage systems. The farmers within the conservation district ⁵ that are known by the SCS technician employed there constitutes the sampling frame. The officials from the Soil Conservation Service in these counties were also surveyed for the "key informant" portion of the survey.

⁵ Each county represents one conservation district.

5.3.2 Sampling Method

The sample drawn was a judgement or purposive sample which is a non-probability sample and therefore an assessment of the sampling error could not be made. Without some knowledge of the error that can be attributed to sampling procedures, bounds could not be placed on the precision of the estimates. The sample was established with the help from the United States Department of Agriculture, Soil Conservation Service. The District Conservationists in these counties selected what they thought was to be a sample of farmers which was representative of the total population of farmers growing rowcrops in their respective counties. They also specified those farmers whom they felt were effective users of conservation tillage and those who were still practicing conventional tillage: these are the two subgroups of farmers of interest in this study.

For the descriptive component of this research, it is important that sample elements are selected that are representative of the population of interest because of the small sample size. The research data based on this survey cannot be projected to the total population of interest with a known and high degree of statistical accuracy such as would be the case with large random samples. The results thus must be considered tentative and will be suggestive in nature and not statistical or conclusive. The representativeness of the sample does not matter for the exploratory component which is only trying to gain further perspective on the research question.

5.3.3 Sample Size

The sample size does not matter very much for the exploratory component but it does depend on the statistical analysis to be used for the descriptive component. The cross-sectional analysis involved a field-study which implies a small sample approach. In all, twenty-one farmers were surveyed with eight in Berrien county and thirteen in Huron, Tuscola, and Midland counties.

5.4 STATISTICAL ANALYSIS OF FARMER SURVEY DATA

5.4.1 Editing, Coding, and Tabulation

Data collection forms were reviewed to ensure that they were complete, consistent, and that instructions were followed. Responses to closed-ended questions with scaling devices were easily coded because the coding was basically established when the data collection instrument was designed. Respondents thus coded themselves with their responses.

The results were tabulated (classification and cross-classification that result from counting the values of the observations) and general summary statistics including means and standard deviations were calculated for each of the two sub-groups: adopters and non-adopters.

5.4.2 Statistical Analysis

The null hypothesis tested was that there was no difference in group response while the alternate hypothesis was that there was a significant difference in the mean responses of the two groups. Specifically, the mean responses of the two groups to questions regarding beliefs, attitudes, behaviour, and attributes which current literature suggests

play an important role in the adoption decision were compared. Two-tailed tests were used to determine group differences despite the fact that it was possible to develop hypotheses from the literature that would facilitate the use of one-tailed tests so that differences counter to the hypotheses would be evident. Directionality was inferred from the relative mean responses of the two groups.

The Student's *t* statistic was the technique used to test for differences in responses between the two groups. The small sample size implies that the assumption of normality required by many statistical techniques is important unlike the case when samples are large due to the application of the central limit theorem. If the assumption of normality could not be made, a technique would be required such as a non-parametric technique that does not depend on the underlying assumption of population normality for small samples. However, it was felt that the sample was somewhat representative of the larger population and thus the assumption of normality was made. The *t*-test which, because it is robust, does not depend too critically on this assumption (Malik and Mullen, 1973). As well, the testing for statistical significance of the difference in mean scores for the two groups is facilitated by the interval scale used by the Likert method (Churchill, 1983).⁶

⁶ There is a good deal of controversy over whether the mean or median should be used to calculate the average score. This depends on the assumption about the level of scaling being either ordinal or interval. The questions concern whether or not the differences in scores convey meaning other than relative ranking of individuals. Some argue that the procedure does not produce an interval scale, but only an ordinal one, and that the median is therefore the more appropriate average (Churchill, 1983). Psychologists argue that deviations from assumptions regarding interval scales have little effect on the analyses which are performed. Also, a good argument can be made that there are no "real" or "correct" intervals for any measurement scale, but rather intervals are established as a measure of convention. Thus they argue that there is nothing wrong with performing statistical analysis which assume interval scales (Nunnally, 1970).

The estimates of the variances were assumed to be equal since the two sub-groups came from the same population. Thus, the test statistic used a pooled estimate of the population variance (Gill, 1978).⁷

5.5 DESCRIPTION OF THE SAMPLE AREA

5.5.1 Huron, Tuscola, and Saginaw Counties

5.5.1.1 General Description

Huron and Tuscola Counties are located in the thumb area of Michigan whereas Saginaw County is in the east-central part of the Lower Peninsula (see Appendix B). The combined land area of the counties is 1,568,095 acres or 2450 square miles.

Those counties experience long cold winters, with mild pleasant summers. Precipitation is moderate and well distributed. They average between 140 and 150 frost free days. Crops directly along Saginaw Bay are not so susceptible to frost as elsewhere, because of the tempering effect of the large body of water.

Saginaw and large portions of Huron and Tuscola counties along Saginaw Bay are characterized by flat lake plain of loamy soils with some sandy areas. Due to its flat topography, there is poor natural drainage and water erosion is not a problem. This land is intensively cultivated

$$^7 \quad t = \frac{x_1 - x_2 - u_1 - u_2}{S_p \sqrt{1/N + 1/M}}$$

where:

x₁=observation group 1,

u₁=group 1 mean,

S_p=pooled standard deviation,

N=group 1 sample size,

x₂=observation group 2,

u₂=group 2 mean,

M=group 2 sample size

including the sandy areas which leads to wind erosion problems (U.S.D.A.).

Soils developed under these poor natural drainage conditions from loam, clay loam, or silty clay loam parent material. The predominant soils are Tappan and Londo Loams, Tappan and Londo complexes, and scattered Avoca loamy sand lenses. The upper end of the coastal drainage basin is predominantly Guelph and Guelph Londo complexes. The soils are relatively high in organic matter, nitrogen, and lime. They are moisture retentive, have good natural fertility, and are durable under cultivation (Black et. al., 1984).

The principle hazards to crop production are naturally poor drainage and poor tilth (soil structure). When tile drainage with adequate outlets is provided, the soils are very productive because the surface is deep, fine textured, and well supplied with humus. The soils tend to be cold in the spring. Cash cropping is the predominant form of agriculture in this area. Crops grown include corn, soybeans, drybeans, wheat, and sugar beets.

A moraine runs in a northeasterly direction from south-central Tuscola county up into Huron county which is characterized by loamy soils. This topography creates more problems due to water erosion but there are still some sandy areas which are susceptible to blowing. Immediately to the southeast of the moraine, there are sandier soils being part of the outwash during glaciation. Most of this land is not cropped and it has poor natural drainage. However, where the land is drained and cropped, wind erosion problems result (see Appendix B).

5.5.1.2 Profitability and Use of Tillage Practices

A study by Black et. al., (1984) comparing the net returns for conventional and conservation tillage systems in the southeast Saginaw Bay Coastal Drainage Basin included a 1980 survey of the commonly used tillage methods of farmers in Tuscola County.

This study revealed that 55% of soybean fields and between 70% and 80% of the land devoted to the other major crops was tilled by moldboard plow. For corn and sugar beets, most of this plowing was done in the fall however, in the case of navy beans which are planted much later than these crops, over half is spring plowed. Chisel plowing constituted the primary tillage method on between 10% and 30% of the land devoted to corn, sugar beets and dry bean fields and 41% of soybean fields. Most of the chisel plowing was done in the fall. The reason a significant portion of fields were chisel plowed when this sample was taken, was that many farmers chisel plow dry bean fields following harvest and between 25% and 40% of the cropland in this area is devoted to dry beans. This is a reflection more of the status of fields after harvest where residue is almost negligible and the soil surface has been disturbed by the bean puller. Small percentages of corn, dry bean, and soybean fields were disked as primary tillage. Over half of the corn and dry beans were disked in the spring whereas all soybeans were disked in the fall. None of the farmers sampled used no-till or till-plant (ridge-till) systems.

The economic comparison revealed that there were incentives for purchasing a chisel plow and modifying planters that are suitable immediately for those farms where no yield reductions, relative to conventional tillage are expected and there are no increases in other

costs such as fertilizer, herbicides or insecticides. The net gains were however small and thus it was concluded that chisel plow conservation tillage could be implemented immediately without reducing net farm income on most soil types in the watershed.

5.5.2 Berrien County

5.5.2.1 General Description

Berrien County is in the extreme southwestern part of Michigan, bordering on Lake Michigan and Indiana (see Appendix B). It has an area of 584 square miles, or 373,760 acres. Total annual precipitation is 36 inches and is evenly distributed throughout the year.

Prevailing winds from Lake Michigan moderate the air temperature, making the climate in the northern part of the county favorable for orchard crops and vineyards. The climate in the southern part of Berrien County is favorable for cash grain crops. Average temperatures in the winter are 27° F and 70° F in the summer making it slightly warmer than in the thumb area. The growing season averages 160 days in length annually (U.S.D.A.).

Most of Berrien County is gently sloping moraines and till plains with flat to nearly level lake plains and outwash plains (see Appendix B). The soils in the county range widely in texture, natural drainage, slope and other characteristics. Wetness is a major limitation to the use of many of these soils. Extensive tile drainage, however, has made the soils well suited to field crops (U.S.D.A.).

The sloping soils in Berrien County are predominantly well drained or moderately well drained and have a wide range of textures. The hazard

of water erosion is generally severe on these soils. Erosion is occurring between T and 2T on about 26% of the cropland and at a rate greater than 2T on 21% of the land.

The different soil associations of the county reflect the strong glacial influences. The glacier's retreat left deposits of glacial till; outwash deposits generally consist of layers of particles of similar size such as sandy loam, sand or other coarse particles. In Berrien County soils that formed in lacustrine deposits are coarse to fine textured. Soils in the county range from well to very poorly drained, depending on landscape position and materials in which they formed (U.S.D.A.).

About 67% of the land in Berrien County is used for cash crops and other farm enterprises. The county has two chief crops. In the north, fruit is the chief crop while in the south, corn is the most extensively grown crop but there are also large acreages of soybeans and wheat.

5.5.2.2 Profitability and Use of Tillage Practices

About 10% of the land devoted to corn, wheat and soybeans used no-till in 1983 with some ridge tilling (about 300 acres). About 45% of these fields used other forms of conservation tillage (U.S.D.A.).

For most of the major soils and rotations, the various forms of conservation tillage were shown to offer greater net returns than conventional tillage (U.S.D.A.).

5.6 SUMMARY

This study comprises both exploratory and descriptive components. A questionnaire was used in both a field study as part of a cross-sectional

analysis and in an experience survey. The sample was drawn from SCS technicians and farmers growing crops in Berrien, Saginaw, Tuscola, and Midland counties of Michigan. Chisel plow conservation tillage could be implemented in Saginaw, Tuscola, and Midland counties without much of a positive or negative effect on net farm income. For most of the major soils and rotations in Berrien county, the various forms of conservation tillage have been shown to offer greater net returns than conventional tillage (U.S.D.A.).

CHAPTER 6

SURVEY RESULTS

6.1 INTRODUCTION

In all twenty-one farmers were surveyed. Thirteen claimed to practice at least some form of conservation tillage while eight used conventional tillage practices. Four SCS technicians were also interviewed. In table 2, the results of responses to questions regarding beliefs, attitudes, behaviour and attributes from adopters of conservation tillage and non-adopters are presented and the differences in responses are noted. The experiences of SCS technicians regarding differences between these two groups are also presented in this table. Farmers' ratings of the importance of various reasons for adopting or not adopting are presented in table 3. A discussion of the results from the survey of farmers in Huron, Tuscola, Saginaw, and Berrien counties is presented in this chapter along with the remarks from Soil Conservation Service technicians according to the six different sections in the questionnaire.

6.2 DISCUSSION OF ANNUAL BENEFITS AND COSTS

6.2.1 Costs

Generally, both groups of farmers agreed that conservation tillage systems offered cost-savings relative to conventional tillage systems for a number of reasons: it prevented deposition on cropland, gullies and streambank erosion, and also decreased fuel and labor requirements for tillage operations. Those practicing conservation tillage agreed more

Table 2: Comparison of Responses Given by Farmers Using Conventional Tillage (Non-Adopters) and Conservation Tillage (Adopters) in Michigan to Questions Based on Factors Reported as Being Important in the Adoption Decision

<u>SUBJECT OF QUESTION</u>	<u>SIGNIFICANTLY DIFFERENT RESPONSE BETWEEN TWO GROUPS</u>	<u>RESPONSE OF EACH GROUP</u>	<u>RESPONSES OF EACH GROUP AS HYPOTHESIZED BY SCS</u>
I. Annual Benefits and Costs to Adoption of Cons. Tillage			
a.) Cost reductions			
- prevention of deposition on cropland	Yes (.05)	Adopters strongly agreed, non-adopters just agreed.	No-tillers agree, other tillage
- prevention of gullies and streambank erosion	Yes (.05)	Adopters strongly agreed, non-adopters just agreed.	
- decreased fuel requirements for tillage operations	No	Both just agreed	No tillers agree, other tillage about the same
- decreased labor requirements	Yes (.10)	Adopters strongly agreed non-adopters just agreed	
- decreased equipment costs	Yes (.05)	Adopters just agreed non-adopters not sure	No tillers agree, other tillage about the same
b.) Cost increases			
- increased management	Yes (.05)	Adopters strongly agreed non-adopters just agreed	No-tillers agree, other tillage about the same
- increased use of herbicides	Yes (.10)	Non-adopters strongly agreed adopters just agreed	No tillers agree, other tillage about the same
- increased use of pesticides	No	both slightly agreed	All tillage about same
- messy looking fields	Yes (.10)	Non-adopters agreed adopters disagreed	Non-adopters agree, adopters disagree
c.) Yields			
- under conservation tillage relative to under conventional tillage in short-term	No	Both thought equal non-adopters lower	Adopters same,
- higher under conservation tillage relative to under conventional tillage in long-run	Yes (.05)	Adopters strongly agreed non-adopters just agreed	Both unconcerned with future yields.
d.) Net returns			
- 5% net gain for conservation tillage	Yes (.10)	Adopters higher non-adopters lower	Adopters net gain non-adopters no net gain

Table 2: Comparison of Responses Given by Farmers Using Conventional Tillage (Non-Adopters) and Conservation Tillage (Adopters) in Michigan to Questions Based on Factors Reported as Being Important in the Adoption Decision (Cont.)

<u>SUBJECT OF QUESTION</u>	<u>SIGNIFICANTLY DIFFERENT RESPONSE BETWEEN TWO GROUPS</u>	<u>RESPONSE OF EACH GROUP</u>	<u>RESPONSES OF EACH GROUP AS HYPOTHESIZED BY SCS</u>
2. Length of Planning Period/Discount Rate of Farmer			
a.) Relative priority of soil conservation to:			
- debt reduction	No	Both equal priority	Both lower priority
- land acquisition	No	Both equal priority	Both higher priority
- increased fertilizer use	No	Both equal priority	Both higher priority
- new cropping operations	No	Both equal priority	Both higher priority
- new equipment	No	Both equal priority	Both higher priority
b.) Interest rates			
- lower interest rates facilitate adoption	Yes (.05)	Adopters agreed non-adopters not sure	Both agree
c.) Farm size			
	Yes (.05)	Adopters much larger than non-adopters	Non-adopters larger than adopters
d.) Ownership			
	Yes (.05)	Non-adopters own higher percentage than adopters	Percentage ownership same for both
e.) Gross income			
- level	Yes (.05)	Adopters more than non-adopters	Non-adopters more than adopters
f.) Off-farm income			
- percentage of total income	No	Both only small % of family income	
g. Age			
	No	Both averaged 40	

Table 2: Comparison of Responses Given by Farmers Using Conventional Tillage (Non-Adopters) and Conservation Tillage (Adopters) in Michigan to Questions Based on Factors Reported as Being Important in the Adoption Decision (Cont.)

<u>SUBJECT OF QUESTION</u>	<u>SIGNIFICANTLY DIFFERENT RESPONSE BETWEEN TWO GROUPS</u>	<u>RESPONSE OF EACH GROUP</u>	<u>RESPONSES OF EACH GROUP AS HYPOTHESIZED BY SCS</u>
3. Risk and Uncertainty Associated With Each Form of Tillage			
a.) Technological risk			
- relative riskiness of conservation tillage relative to conventional tillage	No	Both about same	Both conservation tillage more risky, no-till most risky
b.) Susceptibility of conservation tillage to economic uncertainties relative to conventional tillage			
- commodity prices	No	Both no effect	Non-adopters see more risk than adopters
- input prices	No	Both no effect	Both no-till more risky, rest the same
- interest rates	Yes (.10)	Both slight but opposite effect	Both more risky
- land values	No	Both no effect	Both more risky
c.) Risk aversion			
- approach to risk	No	Both cautious	Non-adopters more risk averse than adopters

Table 2: Comparison of Responses Given by Farmers Using Conventional Tillage (Non-Adopters) and Conservation Tillage (Adopters) in Michigan to Questions Based on Factors Reported as Being Important in the Adoption Decision (Cont.)

<u>SUBJECT OF QUESTION</u>	<u>SIGNIFICANTLY DIFFERENT RESPONSE BETWEEN TWO GROUPS</u>	<u>RESPONSE OF EACH GROUP</u>	<u>RESPONSES OF EACH GROUP AS HYPOTHESIZED BY SCS</u>
4. Amount of Information and Human Capital			
a.) Education			
- level attained	Yes (.15)	Adopters slightly more	Adopters more
b.) Amount of information sources used			
- other farmers	No	Both used some	Both used alot
- SCS	+ Yes (.05)	Adopters used alot	
- CES	Yes (.05)	Adopters used some non-adopters used only slightly	
- farm press	No	Both used some	
- farm radio	No	Both some	
- farm television	No	Both some	
- equipment dealer/manufacturer	No	Both some	Both used alot
c.) Perception of problem on farm			
- current	Yes (.05)	Adopters moderate problem non-adopters slight problem	Both not a problem
- next 10 years	Yes (.05)	Adopters moderate problem non-adopters a slight problem	Both not a problem
- next 30 years	Yes (.05)	Adopters moderate problem non-adopters a slight problem	Both not a problem
- next 50 years	Yes (.05)	Adopters moderate problem non-adopters slight problem	Both not a problem
- longer	Yes (.05)	Adopters moderate problem non-adopters slight problem	Both not a problem

Table 2: Comparison of Responses Given by Farmers Using Conventional Tillage (Non-Adopters) and Conservation Tillage (Adopters) in Michigan to Questions Based on Factors Reported as Being Important in the Adoption Decision (Cont.)

SUBJECT OF QUESTION	SIGNIFICANTLY DIFFERENT RESPONSE BETWEEN TWO GROUPS	RESPONSE OF EACH GROUP	RESPONSES OF EACH GROUP AS HYPOTHEZIZED BY SCS
5. Effects of Institutional Framework			
a.) Institutional incentives: - participation in programs - technical assistance	+ Yes (.10)	Some adopters no non-adopters	
- cost-sharing	No	Some adopters no non-adopters	
- acreage reduction - wheat	No		
- acreage reduction - feed grains	Yes (.10)		
b.) SCD incentives			
- use district equipment	Yes (.10)	Some adopters no non-adopters	
- use district leased equipment	Yes (.15)	Few adopters no non-adopters	
c.) Length of cost sharing agreements			
- longer agreements	No	Both not sure	Both disagree
d.) Issues			
- farmers should have sole financial responsibility for conservation	No	Both not sure	Both disagree
- cross-compliance with support programs	No	Both not sure	Both disagree
- should increase local nature of authority	No	Both slightly agree	

+ Due to nature of sample selection, all adopters were receiving technical assistance.

TABLE 3: Importance Values for Factors In Adoption Decision

Scale

1 - Not Important
3 - Moderately Important

2 - Slightly Important
4 - Very Important

Importance of Reasons Why Farmers Adopted

	<u>Mean Response</u>
a. Profitability of practice (savings in equipment, time, fuel, etc.)	3.4
b. Availability of cost-sharing funds	2.1
c. Availability of technical assistance	2.7
d. Recognition of erosion as a future problem on farm	3.3
e. Recognition of erosion as a current problem on farm	2.8
f. Recognition of erosion from your farm causing water quality problems	1.9

Importance of Reasons Why Farmers Didn't Adopt

	<u>Mean Response</u>
a. Not profitable	2.7
b. Too risky	1.7
c. Insufficient cost-sharing incentives	1.5
d. Do not know enough about it	3.0
e. Do not think that erosion is a problem on your land	3.5
f. Other more important farm improvements in which to invest	1.4
g. Impractical for crops on your farm	2.7
h. Impractical for soil on your farm	2.8

strongly regarding these first two sources of reduced costs. Non-adopters were unsure about equipment savings attributable to conservation tillage, unlike adopters, who were in agreement with these claims. Adopters in Berrien County more strongly agreed that conservation tillage helped prevent gullies and streambank erosion and offered decreased equipment costs than those in Huron, Tuscola and Saginaw Counties. Equipment savings may be greater due to more widespread use of no-till, as a method of conservation tillage in Berrien county relative to the other counties.

Technicians from the USDA Soil Conservation Service felt that only those practicing no-till would experience noticeable savings in equipment, labor and fuel. They thought that those chisel plowing, ridge tilling or using minimum tillage would experience only small cost-savings relative to traditional tillage methods. In Huron, Tuscola, and Saginaw counties where rotations include soybeans and dry beans, SCS personnel pointed out that conservation tillage farmers will not be able to generate reductions in expenses by selling their moldboard plow because they still need to use it in this rotation. However, they will still experience some equipment savings because the moldboard plow will last longer due to less usage. They also noted that adapting conventional planters so that they could be used as no-till planters required some increased expenditures and that new no-till planters could only be purchased at a premium over new conventional planters.

Each group of farmers agreed that conservation tillage required increased management, increased use of herbicides, and increased use of pesticides. Adopters agreed more strongly than non-adopters that

this tillage system required more management. Unlike adopters, farmers using traditional tillage systems believed that the appearance of the residue on fields where conservation tillage was practiced was a drawback to changing practices.

SCS technicians felt that no-till was recognized as requiring more management but that chisel plowing was thought to be less difficult than moldboard plowing. The increased use of herbicides was seen as a major cause of increased management for no-till. They thought that more management was required early during the "burn down" period, but once weeds were under control the level of management would decrease. They believed that most farmers would recognize that there were no greater insect problems with one technology over the other. They singled out the appearance of fields as a big deterrence to adoption.

6.2.2 Yields

Both groups of farmers surveyed perceived yields under conservation tillage in the short-run conservation tillage to be comparable to those achieved by conventional tillage. The experiences of the SCS was that adopters felt yields between the two technologies to be roughly equivalent but that non-adopters perceived there to be yield penalties associated with conservation tillage.

Farmers using conservation tillage systems felt more strongly than their counterparts that such a tillage system prevented longer-term yield losses due to topsoil loss, loss of nutrients, and deterioration of soil structure, and prevented yield losses in dry years due to higher infiltration rate and water holding capacity. According to the SCS, most

farmers in these counties do not perceive yield losses due to soil erosion on their land and thus do not see protection against erosion induced productivity losses in the future as a major benefit to practicing conservation tillage.

6.2.3 Net Returns

While non-adopters believed that conservation tillage systems would offer net returns less than 5% higher than with conventional tillage systems, adopters felt that the difference in return was actually greater than this figure. Adopters in Huron, Tuscola, and Saginaw counties felt that returns were greater than 5% while those in Berrien County felt that this figure was about right. SCS technicians had discovered that adopters generally perceived that conservation tillage offered cost-savings with no short-term yield penalties. On the other hand, they felt that non-adopters recognize conservation tillage as offering less reduction in costs than do adopters, while at the same time producing yield penalties. Subsequently, farmers stay with the conventional systems because there is no perceived net-gain or even a net loss in the short-run.

6.2.4 Importance in Adoption Decision

Those farmers who had adopted conservation tillage rated cost-savings as moderately important to very important. This was the highest rating of the factors listed as being important in the decision to adopt. The SCS technicians also felt recognition of short-term cost-savings to be the most important factor in adoption. On the other hand,

those who decided not to adopt rated unprofitability in the short-run, impracticality for crops grown on farm, and impracticality for soil on the farm as slightly to moderately important in the decision not to practice conservation tillage.

6.2.5 Relationship to Literature

The results seem to support the literature in that perceived short-term profitability is a major factor affecting the adoption of conservation tillage practices. In this case, cost-savings must be perceived to be associated with conversion to conservation tillage without loss in yield.

6.3 PLANNING PERIOD AND DISCOUNT RATE

6.3.1 Opportunity Costs

Both groups rated conservation tillage as having equal priority to other investment opportunities for their operations. Most farmers practicing conservation tillage felt that lower rates for borrowed funds would facilitate the adoption of conservation tillage, while those practicing conventional tillage were unsure of this. The technicians felt that debt reduction was a major priority on most farms but that it should not affect the adoption of conservation tillage practices (with the exception of ridge tilling) because they did not involve a large initial cash outlay. SCS felt that lower rates for borrowed funds would increase adoption as it would help lessen changeover costs.

6.3.2 Time Preference and Planning Period

Generally, adopters surveyed had larger farms and had higher gross sales than non-adopters. Non-adopters owned a higher percentage of their land than did adopters.

Ironically, technicians have found large farmers to be more reluctant than small farmers to take their advice because of attitudes that they were successful without SCS advice and that they would continue to be. Ownership was not felt to have much of an effect on whether a farmer adopted conservation tillage since the practices offered both short-run and long-run benefits.

Most farmers in both groups intended to pass their land on to their children when they retire, earn a low percentage of their income from off-farm sources, and have single proprietorships. There were no significant differences in ages between the two groups.

6.3.3 Importance in Adoption Decision

Farmers felt that recognition of soil erosion problems on their farms was almost as important a factor in their decision as was short-term profitability. Conservation tillage farmers rated recognition of erosion as a future problem on their farm as moderately to very important and the second most important reason that they decided to adopt. However, they rated recognition of erosion as a current problem on their farm as slightly less important. Non-adopters rated the absence of soil erosion problems on their land as being the most important reason that they did not adopt and the SCS also noted that this was one of the biggest factors affecting adoption.

Adopters rated erosion from their farms causing water quality problems as the least important factor of those suggested in their decision to adopt. Non-adopters rated the presence of other more important farm improvements in which to invest as the least important factor of those listed in their decision.

6.3.4 Relationship to Literature

The results indicating that recognition of soil erosion problems plays a major role in determining which tillage system is practiced agrees with results from recent literature. Likewise, the fact that high interest rates and high debt loads seem to act as deterrents to increased soil conservation was evident in both recent research and the results of this investigation. This study did not contradict the results of other studies regarding the effects of size, gross income, ownership, and age.

6.4 RISK AND UNCERTAINTY

6.4.1 Technological Risk

Generally, farmers practicing conventional or conservation tillage systems thought that the two systems were comparable in terms of technological risk. Some adopters did feel that conservation tillage was less risky because it reduced yield losses in dry years. The SCS offered a different perspective, feeling that non-adopters had a tendency to associate more risk with conservation tillage than did adopters especially due to the increased management needs of no-till.

6.4.2 Price Risk

Both groups felt that with the exception of interest rates, economic uncertainties had little effect on the relative attractiveness of conservation tillage practices. Each group perceived interest rates as having some bearing on the profitability, and thus attractiveness, of conservation tillage. However, they each saw recent trends of rising interest rates as having different effects on the relative attractiveness of the two technologies. Adopters thought that conservation tillage offered cost-savings which helped alleviate financial stress caused by rising interest rates, while non-adopters felt that short-run income was sacrificed due to yield penalties which increased cash-flow problems during such a period. Farmers practicing conservation tillage in Berrien County saw these economic uncertainties as having greater effect on the attractiveness of conservation tillage than those in Huron, Tuscola, and Saginaw counties; this might be partially explained by the higher herbicide requirements of no-till which is practiced more widely there.

The experiences of SCS technicians paralleled these results. They noted that farmers who believe that conservation tillage technology offers cost-savings see it as a more viable option with the continuation of what has come to be known as the "cost-price squeeze". They also cited rising herbicide costs as hurting no-till the most. According to the technicians non-adopters felt that conservation tillage would result in yield penalties thus hurting them even more in times of rising interest rates.

The technicians thought that most farmers in both groups would see rising interest rates as deterrents to changing conventional tillage

practices since conversion entails equipment buying. This is usually financed through borrowing, and higher rates for borrowing would increase farmers' costs. Falling land values would have a similar effect, since it means that farmers' have less equity against which to borrow.

6.4.3 Approaches to Risk

Both groups of farmers generally consider themselves to be cautious in approaching risky situations. Many adopters feel that they could reduce much of the risk associated with conservation tillage by practicing good management. They also believe that by adopting conservation tillage on a more limited trial basis, they could learn the new technology and adapt it to their operation before using it on a broader scale. Based on the experiences of SCS technicians in the counties surveyed, non-adopters tended to be more cautious and less innovative than adopters.

Those who adopt, see conservation tillage systems as a way of decreasing risk. Adopters see macro-economic variables as having a greater effect on the attractiveness of conservation tillage, and thus would be more likely to see this as causing greater future uncertainty making conservation tillage more risky. Non-adopters basically saw these variables as having little affect, and thus, though the technology has its benefits distributed in the future, it would not be any riskier.

6.4.4 Importance in Adoption Decision

On the basis of importance, farmers practicing conventional tillage rated risk as not important to slightly important. This was relatively

low compared to other possible reasons for not adopting.

6.4.5 Relationship to Literature

The results from the survey present some contradictions to the testimonials from the SCS and the literature. These sources suggest that non-adopters would associate more risk with conservation tillage and would be more risk averse than adopters whereas the survey revealed no major differences in approaches to risk between the two groups.

6.5 INFORMATION AND HUMAN CAPITAL

6.5.1 Perception of Soil Erosion Problem

Conservation tillage farmers surveyed see soil erosion to be a more serious problem, both currently and in the future, than non-adopters. This may reflect the presence of physical factors causing visible erosion, or the ability of the individual farmers to recognize soil erosion on their land and understand its effects in the future.

SCS feels that a major reason that farmers do not adopt is because they do not perceive there to be an erosion problem on their farms. Though, farmers express concern regarding erosion when talking to SCS technicians, many only felt that they had problems when gullies would actually form, and it was then that they would seek SCS assistance.

6.5.2 Technical Information

Most farmers who had switched to conservation tillage described the technical assistance provided by the Soil Conservation Service as useful, easy to understand, and not requiring a lot of time. Most non-adopters

had little experience with the SCS and had no opinions about the technical information offered.

SCS felt that problems resulted when their recommendations were incorrectly implemented. Technicians stressed the importance of good technical assistance and its proper implementation during the trial period to ensure continued use of conservation tillage practices.

The technicians were also concerned about the willingness of farmers to seek out their assistance. Part of this was the result of prevailing attitudes towards government: individuals were more likely to believe another farmer than a federal technician. Farmers also were felt to seek assistance only when serious problems, such as gullies had already occurred, instead of using technical information in a preventative way. To combat this, SCS technicians used a number of approaches to encourage farmers to develop overall conservation plans. When servicing ASCS cost-sharing agreements, technicians try to make suggestions about overall conservation measures. Also, while in most cases the SCS does not perform surveys for tile drainage, some offices still do as a way of getting on the farmer's land and making suggestions about conservation.

6.5.3 Education

Adopters generally have had some college or technical school and had slightly more education than non-adopters, who had generally finished high school. The SCS conservationists have found that those with more education were more likely to adopt. However, younger farmers, who generally have more education, are in partnership with their less-educated fathers, who still control the operations. As the sons and

daughters take over, more and more conservation tillage is being adopted.

6.5.4. Sources of Information

Both groups obtained information about conservation tillage from a wide variety of information sources. Adopters used the SCS and the State Cooperative Extension Service more than non-adopters, but due to the nature of sample selection it was virtually guaranteed that all adopters used the SCS. Adopters most often stated that the SCS was their primary source of information, while more non-adopters listed other farmers as their primary source. Berrien County adopters made greater use of information from the Cooperative Extension Service, farm radio, farm television, and equipment dealers and manufacturers than did those in Huron, Tuscola and Saginaw.

According to the SCS, other farmers represent an important source of information and influence. While the farm press has become a more important source of information, technicians sometimes question the accuracy of the information it presents. The press was perceived by technicians as sometimes presenting extreme positions which mislead farmers. This results in negative experiences with conservation tillage, and possible abandonment in some cases. However, they feel that this medium offers the benefits of broad exposure.

The SCS also identified equipment and herbicide dealers as playing an important role in the information system that supports new tillage practices. However, farmers are cautious in using this information because of the motives of the source.

6.5.5. Importance in Adoption Decision

Non-adopters felt that the second most important reason of those suggested in the questionnaire that they did not adopt was that they do not know enough about conservation tillage. On the other hand, adopters felt that the availability of technical assistance was only moderately important to their decision to adopt conservation tillage.

6.5.6 Relationship to Literature

These results are consistent with the literature. Higher levels of information and education encourage the adoption of conservation tillage when it is profitable.

6.6 INSTITUTIONAL STRUCTURE

6.6.1 Institutional Incentives

Most conservation tillage farmers participated in both government conservation-related and acreage-reduction programs, while most non-adopters did not participate in either of these programs. Adopters feel that the subsidies offer them an extra incentive to adopt, but that they were not crucial for the decision.

Both groups had mixed feelings about the length of cost-sharing agreements. Those that wanted longer-term agreements felt that it would offer a longer (and thus more accurate) trial period. Those that argued against longer term agreements preferred the flexibility of shorter term agreements.

All counties involved in the study had some special arrangements to make conservation tillage equipment available to farmers, farmers

practicing conservation tillage did not use it much. It was felt that this would encourage farmers to try the new technique without any initial outlay.

The SCS felt that commodity programs have encouraged more soil erosion as they encouraged farmers to bring in marginal, erosive land. Cost-sharing for tillage practices is used as an extra incentive to farmers to try the practices and help them with some of the initial expenses but to get farmers to adopt a practice, there must be enough incentive to use it without cost-sharing. Technicians felt that three year agreements would be hard to apply to rotations, and were thus unfeasible.

They also thought that SCD arrangements for conservation tillage equipment use encouraged farmers to try practices by reducing the risk associated with large initial outlays for equipment. For ridge tilling, on the other hand, counties do not own the necessary ridge-making, seeding and harvesting equipment.

6.6.2 Importance in Adoption Decision

While adopters rate the availability of technical assistance as being moderately important in their adoption decision, they rated cost-sharing as only slightly important. Similarly, non-adopters ranked insufficient cost-sharing funds as the second least important factor in their adoption decision of those suggested.

6.6.3 Relationship to Literature

Survey results support previous results. Government cost-sharing and technical assistance play a role in the adoption decision. However, they do not seem to play a major role.

6.6.4. Policy Issues

Both groups of farmers were divided or not sure about the suggestion that financial responsibility should rest with the farmer and not with society as a whole. They reacted similarly to the idea of having eligibility for price and income support programs to follow recommended soil conservation measures. Farmers from both groups were unsure as to whether various conservation tillage practices should be eligible for cost-sharing. Most farmers felt that SCD should have more authority to adapt programs to local conditions, though many non-adopters were unfamiliar with the SCD operations.

SCS technicians feel that responsibility for soil conservation should not be placed solely on farmers because broader interests are at stake. While cross-compliance strategies which are incentive programs where the farmer receives extra benefits from other agricultural programs for keeping soil losses below an acceptable level or loses benefits for not meeting soil loss requirements (Libby, 1985) would be tough to get passed, SCS felt that soil losses should be within allowable limits if they desire a crop subsidy (Most would fall within allowable limits, but such a measure would be an incentive to those that don't).

The divisions on the policy issues surrounding soil conservation were evident. This was especially true on the issues of the availability

of cost-sharing and cross-compliance.

CHAPTER 7

PRINCIPAL FINDINGS, IMPLICATIONS FOR PROGRAM APPROACHES AND IMPORTANT ELEMENTS FOR SOIL AND WATER CONSERVATION PROGRAMS

7.1 PRINCIPAL FINDINGS REGARDING ADOPTION BEHAVIOUR IN HURON, TUSCOLA, SAGINAW AND BERRIEN COUNTIES OF MICHIGAN

7.1.1 Maximization of Net Returns

While farmers have many motives affecting their decisions, farmers generally do respond to the incentives of cost, yield, and price. Investment in each tillage system results in a different flow of benefits and costs. Generally, adoption of conservation tillage seems to depend most heavily upon perceptions that there will be immediate cost-savings with no loss in current yields relative to conventional tillage. Perceptions are influenced by information and also by the physical circumstances facing the farmer. Perception of a soil erosion problem was also important in the decision to adopt conservation tillage since it meant that this technology would offer higher productivity levels in the future relative to conventional tillage. However, most farmers are uncertain about the presence of soil erosion on their farms and its effects on future yields. Farmers place greater emphasis on current versus future returns due to the presence of high interest rates, high debt loads and uncertainties regarding future economic conditions.

7.1.2 Short-term Cost-savings and Yields

Adoption seems to depend most heavily on farmers believing in the short-term that conversion results in some cost-savings and that there will be no loss in yield (see tables 1, 2, & 3). Adopters and

non-adopters have different perceptions regarding costs and yields under conservation tillage.

Education levels and the availability of information affect farmers' perceptions of short-term cost-savings and short-term yields under alternative tillage systems. When there are short-term returns offered by conservation tillage, greater education and availability of information encourage greater adoption.

Actual short-term cost-savings and yields are determined by a number of factors. Studies have shown soil temperature following planting; soil moisture availability throughout the growing season; weed and insect problems, and control measures; fertility and liming programs; soil management group and drainage; cropping system; and machinery and labor requirements to play major roles.

7.1.3 Perception of Soil Erosion Problems and Implications for Long-Term Benefits

The perception that soil erosion is a problem in a farmer's operation and that conservation tillage would better maintain soil productivity and thus provide higher future productivity is also important in the adoption decision. Adopters differ from non-adopters in that they perceive greater soil erosion problems on their land and accordingly, they feel more strongly that conservation tillage will protect against future yield losses due to soil erosion (see tables 1, 2, & 3). Perceptions regarding soil erosion levels and the effect of conservation tillage on reducing soil losses and maintaining productivity are greatly influenced by education and the availability of information

as well as actual erosion levels. Actual erosion levels are determined by topography, soils, weather, and management practices. Most farmers are uncertain about the presence of soil erosion on their farms and its effects on future yields.

Current high interest rates and debt levels emphasize short-term returns and heavily discount future benefits attributable to maintained productivity. However, the presence of some non-profit motives such as concern for future generations or for the environment (water quality) encourage slightly longer planning periods.

7.1.4 Risk and Uncertainty

Risk averse farmers are less likely to adopt conservation tillage because it is generally perceived to be a riskier technology than conventional tillage. Reduced tillage places the greater demands on management and because it is the newer of the two technologies. Non-adopters tend to be more risk averse than adopters. Greater information and education reduce the risks involved with adoption. However, this does not seem to be a major reason why farmers do not adopt conservation tillage.

7.2 IMPLICATIONS OF FINDINGS REGARDING ADOPTION BEHAVIOUR FOR PROGRAMS TO ENCOURAGE GREATER ADOPTION OF CONSERVATION TILLAGE

7.2.1 General Approaches to Encourage Conservation

There are a number of different approaches currently being discussed or that have been tried in the past to encourage the adoption of conservation measures. The findings regarding adoption behaviour in this

study have important implications for these different approaches.

Some suggest that profit maximization is only one of many goals that most farmers embrace and that other goals including independence, maintenance of a style and quality of life, maintenance of social standing in their community and meeting challenges should be incorporated into programs. Such programs might include selecting certain farmers for out-reach programs, placing demonstration practices on the farms of recognized community leaders, putting greater emphasis on the diffusion of knowledge, offering technical assistance that allows a farmer to learn the appropriate technical skills, and providing follow-up assistance in conservation programs.

Traditionally, attention has been given to those variables that influence the costs and benefits of soil conservation because farmers were viewed as profit maximizers. Farmers have had implicit user rights to the property they own which allows them to let soil erode if they wish and thus considerable emphasis is put on whether or not there is market failure. Due to this view, cost-sharing, technical assistance and educational programs have formed the basis for past soil conservation policy. They attempt to raise the farmer's benefits and lower his/her costs of soil conservation.

Another perspective focuses attention on the policy questions of changing property rights and the implications of such modifications for existing rules of ownership. This perspective examines the impact of current policies and institutions on farmers' practices and the impact of those practices on natural resource quality and quantity. It addresses issues such as social values and the equitable distribution of resources

among generations. This modified perspective examines the distribution of benefits and costs of soil erosion and conservation including its effects on water quality as well as the role of institutional incentives.

7.2.2 Programs Exploiting Multiple Goals of Farmers

While many motives influence farmers' decisions, maximizing net returns in response to cost, yield and price seems to be the primary motive of farmers when adopting conservation tillage. Thus programs which encourage adoption based on non-profit motives will not be as effective as those based on profit motives. Incentives of price, cost and yield deserve primary attention when designing programs to promote the adoption of conservation tillage.

7.2.3 Informational Programs

Programs which concentrate on providing farmers with information regarding short-term cost-savings and favorable yields due to conversion tend to correspond more closely to the findings of this study regarding adoption behaviour. Such programs should concentrate on helping farmers to select the most cost-effective approach and provide follow-up assistance.

Due to the impact of specific locational factors such as topography, climate, soils, and cropping systems among others on the net returns and thus adoption of conservation tillage, there are merits to administering these programs locally. There is also a need for more soils and crop data and farm specific data to support such an approach.

There are some important concerns which determine the effectiveness

of this approach. Conversion may not always result in cost-savings and may result in yield reductions because these are highly dependent on rotations, soils, weather and management. Returns vary from county to county and field to field. In Berrien County of Michigan, previous research has indicated that converting to conservation tillage offers some reductions in costs while offering no yield penalties. However, in Huron, Tuscola, and Saginaw Counties of Michigan, a study has shown that chisel plow technology could be implemented with no net loss in income. Even when it has been shown that there is a net return to conversion, farmers are reluctant to believe these results and thus do not adopt.

Programs offering technical assistance that allow a farmer to learn the appropriate skills to use the new technology play an important role in the adoption decision. Such information helps the farmer select and achieve the most cost-effective method of conservation tillage for his own unique circumstances; it reduces the risk of not implementing the technology properly, and helps him cope with problems which occur down the road following adoption. Basically, it reduces the risk of adoption and ensures that farmers continue to use conservation tillage after the initial trial period.

7.2.4 Subsidization

While providing cost-sharing to farmers who adopt conservation tillage lowers the costs and raises the benefits of adoption, most farmers attach little importance to it in their adoption decision. This may be due to the temporary nature of cost-sharing. It does encourage a trial period, but adoption and prolonged use of conservation tillage

depends on more permanent incentives.

7.2.5 Mandatory Approaches

The current set of institutions could be altered to affect the relatively short-term benefits of the alternative tillage systems which are so important in the adoption decision. This approach addresses issues such as water quality and an equitable distribution of resources among generations by examining the distribution of benefits and costs of soil erosion and conservation as well as the role of institutional incentives.

7.2.5.1 Regulation

Outright regulation against erosion exceeding a predetermined level based on the relationship between soil erosion and water quality or maintenance of current levels of soil productivity is one alternative (Libby, 1985). A farmer would be taxed for each ton of soil lost or paid for each ton of soil saved on the basis of soil losses estimated by the Universal Soil Loss Equation (USLE) relative to some accepted level such as T-values.⁸ The appeal of this strategy rests with the direct tie it provides between payments (taxes) and soil conserved (soil depleted) (Batie, 1983). The regulatory and penalty provisions of the State of Iowa's programs are frequently recognized as being the best example of

⁸ These are defined as the maximum annual soil losses that can be sustained without adversely affecting the productivity of the land. They are meant to represent the maximum soil losses that allow the maintenance of existing soil levels but many question its actual ability to do so.

this approach.⁹

However, there are a number of problems associated with this approach. Few complaints have been filed so far by Iowa Soil Conservation Districts because of their desire to maintain popularity with their constituency. The administrative and enforcement costs are large as SCD's in Iowa have found that their funds and expertise are usually fully utilized in voluntary arrangements with little left over to pursue violators. Accurately measuring soil losses on a field per-field basis amounts to a very difficult task. Lastly, there will be a lot of opposition to imposing any further financial hardships on farms by such actions. The model state act which led to the Iowa statutes dealt with this last issue by exempting land disturbing activities caused by agriculture from the penalty provisions unless the operator received at least fifty-percent cost-sharing funds to implement the farm's conservation plan.

7.2.5.2 Cross-compliance

Cross-compliance measures represent perhaps the most attractive set of soil conservation options. In effect, these strategies are incentive programs where the farmer receives extra benefits from other agricultural programs for keeping soil losses below an acceptable level or loses benefits for not meeting soil loss requirements (Libby, 1985). While most farms would have acceptable soil losses, such a program would have the greatest effects on those farmers at the margin who have unacceptable

⁹ See Appendix A.

soil losses. Cross-compliance still leaves the choice regarding tillage practices up to the farmer but it raises the cost to the farmer of not conserving soil. Conservation tillage should be adopted on a broader basis because it represents the most cost-effective way for a farmer to retain eligibility for positive incentive programs.

Program candidates for cross-compliance need to offer farmers whose lands have serious erosion problems, positive net benefits. Price support and acreage diversion programs are good candidates for cross-compliance because they apply to most of those crops grown in those regions of Michigan where the most serious erosion problems. Also, they would provide participating farmers with positive net benefits due to current persistent low commodity prices. Stabilization programs in Canada would make good candidates for the similar reasons.

There are numerous other programs that could be considered such as loan and credit programs. Requirements to qualify for reduced interest rate loans could include that farmers be in compliance with a soil conservation plan or implement those practices which are relatively low cost such as conservation tillage (Batie, 1983). In Wisconsin, a farmer is eligible for the special farmland preservation tax incentive only if he is in compliance with a farm conservation plan. Michigan's farmland and open space preservation act (PA-116) is similar to the Wisconsin program but it does not have the soil conservation requirement (Libby, 1985).

The administrative and enforcement costs of this approach deserve serious consideration. Its political acceptability is also of concern due to the mixed responses to such an approach observed in this and other

surveys.

7.3 IMPORTANT ELEMENTS FOR SOIL AND WATER CONSERVATION PROGRAMS IN SOUTHWESTERN ONTARIO BASED ON THE MICHIGAN EXPERIENCE

Establishing the nature of the problem is of utmost importance to the development of soil and water conservation programs in Southwestern Ontario: is it primarily water quality degradation or declining soil productivity? This has vital implications for the goals and objectives of such programs.

If non-point water pollution resulting from agricultural runoff is deemed the primary problem, then these relationships must be quantified to establish tolerable levels of soil runoff to meet water quality standards. This has proven to be a difficult task and there has been little work done on it to this point.

If programs are established to deal with maintaining soil productivity for future generations, then criteria need to be established for soil loss tolerances which represent maintenance of long-run productivity. These criteria must reflect the effect of soil losses on yields, and the impact of technology on crop yields. The costs and benefits of soil maintenance should also be included if they are also to represent economic conditions.

Establishing criteria for soil loss tolerances will help target resources to those areas having the worst soil erosion problems and contributing the most to water quality degradation. The effects of topography, climate, soil types, cropping practices and proximity to water bodies give these problems a regional nature and thus they deserve

a regional approach. Southwestern Ontario has been targeted as a region with serious soil erosion and water quality problems.

Incentives to adopt conservation practices deserve a major focus in soil conservation and water quality programs. Programs need to ensure that there are short-term net returns or economic incentives to the adoption of conservation practices. Conservation tillage should be emphasized in programs as a technique to control erosion because it is the most cost-effective measure available.

There needs to be a great deal of research into the factors influencing cost, yield, and profit per hectare for alternative tillage/planting systems in the Southwestern Ontario region. If incentives do exist to adopting conservation tillage measures, then informational and technical assistance programs should be considered. However, if no such incentives are present currently, new incentives to adoption or disincentives to non-adoption should be created. Cross-compliance strategies may represent an attractive way to achieve this. Such an approach requires that particular attention be given to program candidates that provide positive net returns and have a high level of participation in the region of concern being Southwestern Ontario.

Technical assistance should be another vital component of a soil and water conservation program. It would encourage the best application of soil conservation techniques to achieve tolerable soil losses while at the same time helping the farmer gain the maximum economic benefits. As well, it would help reduce the farmer's risk of using a new technology. Again, due to the regional nature of factors affecting profit, cost,

yield and soil erosion, technical assistance should be provided on a local or regional basis.

Lastly, a system of monitoring and evaluation should be built into the program to ensure that program goals and objectives are and continue to be met. Program incentives deserve careful attention to ensure that they keep encouraging farmers to maintain soil losses at a tolerable level.

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APPENDIX A

APPENDIX A
THE IOWA STATUTES

Only four states--Iowa, Michigan, Pennsylvania, and South Dakota--have statutes for soil erosion and sedimentation control that regulate agricultural land and practices. While some states, such as New York, Ohio, Minnesota, and Illinois appear to regulate agricultural lands, the statutes have no enforcement or penalty provisions.

Of the four states with regulatory and penalty provisions, Iowa has the longest history. Its program is frequently recognized as being the most successful and best designed. Iowa's statute was the first of the statewide sediment control statutes to regulate agriculture and has served in part as a model for other states. It concentrates on maintaining soil productivity through soil conservation while Pennsylvania's focusses on water quality (Batie, 1983).

The 1971 statute resulted when an Iowa Drainage Laws Committee was formed to examine the rapidly rising costs for reclaiming drainage structures impaired by sedimentation and they decided that the interrelationships between drainage, flood control, water pollution, erosion, and soil conservation demanded a comprehensive approach (Batie, 1983). In 1973, Iowa added appropriations for State-funded cost-sharing for soil conservation practices and in 1980 increased the State's regulatory powers.

The new statute and the modifications that followed gave the soil conservation districts new authority to classify, to establish soil loss limits for different soil classes (T-values), and to require owners to

employ soil and water conservation practices (Batie, 1983). The districts are empowered to inspect land for violations of soil loss limits on the basis of complaints from those whose land is being damaged from sediments or if there is evidence that more than twice the allowable rate of erosion is occurring. They cannot, however, require operators to refrain from fall plowing and, provided that the applicable T-values are achieved, districts cannot specify the practices that a farmer must use.

Few complaints have been filed by SCD's so far due to a number of factors. The desire for districts to maintain popularity with their constituency discourages them from pursuing such action. Also, SCD funds and expertise are usually fully utilized in voluntary arrangements with little left over to aggressively pursue violators.

APPENDIX B

APPENDIX B

SOIL MAPS FOR HURON AND BERRIEN COUNTY

GENERAL SOIL MAP HURON COUNTY, MICHIGAN

Scale 1:253,440
1 0 1 2 3 4 Miles

SOIL LEGEND

NEARLY LEVEL TO ROLLING SOILS THAT HAVE A MEDIUM TEXTURED SURFACE LAYER AND MEDIUM TEXTURED OR MODERATELY FINE TEXTURED SUBSOIL

- 1 Shebeen-Kilmanagh: Nearly level and gently undulating, somewhat poorly drained and poorly drained soils that formed in firm glacial till
- 2 Aubisque-Fillon: Nearly level and gently undulating, moderately well drained and poorly drained soils that formed in firm glacial till
- 3 Grindstone-Kilmanagh: Nearly level and gently undulating, moderately well drained and poorly drained soils that formed in firm glacial till
- 4 Quigley-Londo-Parkhill: Nearly level to rolling, well drained to very poorly drained soils that formed in glacial till

NEARLY LEVEL TO GENTLY ROLLING SOILS THAT HAVE A DOMINANTLY COARSE TEXTURED SURFACE LAYER AND SUBSOIL

- 5 Covert-Plainfield-Tobico: Nearly level to moderately sloping, excessively drained, moderately well drained, poorly drained, and very poorly drained soils that formed in glacial drift
- 6 Avoca-Pipestone-Covert: Nearly level or gently sloping, moderately well drained and somewhat poorly drained soils that formed in glacial drift
- 7 Boyer-Tobico: Nearly level to gently rolling, well drained, poorly drained, and very poorly drained soils that formed in glacioluvial sediments

NEARLY LEVEL, CALDCAREOUS SOILS THAT HAVE A MEDIUM TEXTURED SURFACE LAYER AND SUBSOIL

- 8 Sanilac-Bach: Nearly level, somewhat poorly drained, poorly drained, and very poorly drained soils that formed in lacustrine sediments
- 9 Tappan: Nearly level, poorly drained soil that formed in glacial till

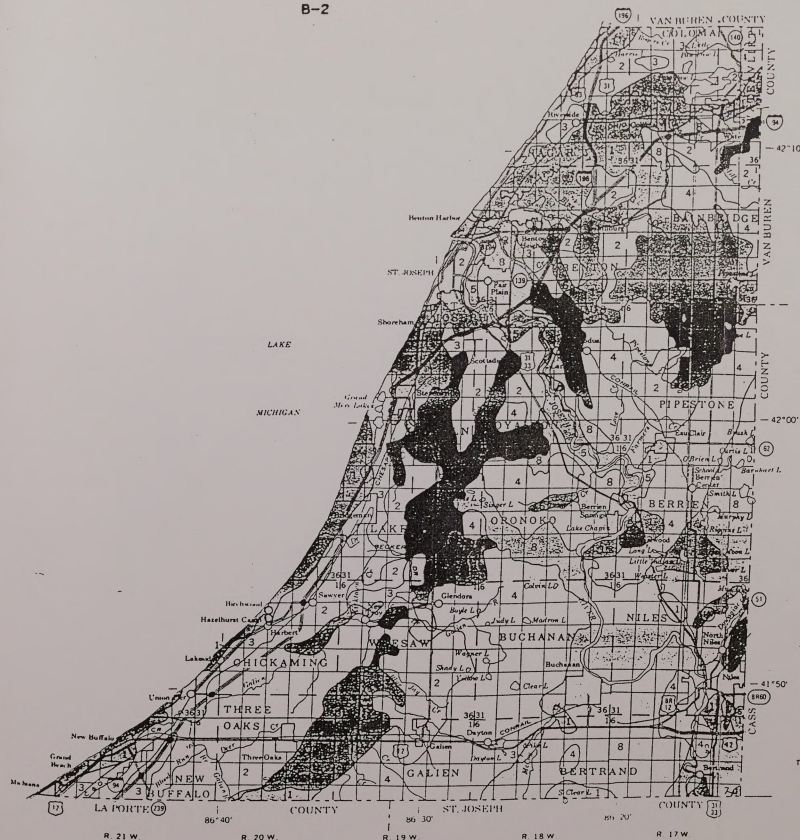
Compiled 1978



Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED

Township	4	5	4	3	2	1
7	8	9	10	11	12	
18	17	16	15	14	13	
19	20	21	22	23	24	
30	29	28	27	26	25	
31	32	33	34	35	36	



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP BERRIEN COUNTY, MICHIGAN

Scale 1:253,440
0 1 2 3 4 Miles
0 1 2 3 4 5 6 Kilometers

SOIL LEGEND*

- Spinks-Oakville-Oshtemo association. Nearly level to very steep, well drained, sandy and loamy soils on moraines, till plains, outwash plains, and beach ridges.
- Blount-Rumr association. Nearly level and gently sloping, somewhat poorly drained, loamy and sandy soils on till plains and moraines.
- Morocco-Thetford-Granby association. Nearly level, somewhat poorly drained and poorly drained, sandy soils on moraines, till plains, outwash plains, lake plains, and beach ridges.
- Rudeles-Oakville-Oshtemo association. Nearly level to very steep, well drained, loamy soils on outwash plains, moraines, and till plains.
- Sheels-Cahoon-Abscota association. Nearly level and gently sloping, poorly drained to moderately well drained, silty and loamy soils on flood plains.
- Pella-Kibbe association. Nearly level, poorly drained and somewhat poorly drained, silty and loamy soils on outwash plains, lake plains, and dells.
- Brady-Monitor-Gifford association. Nearly level, somewhat poorly drained and very poorly drained, loamy soils on outwash plains, dells, and lake plains.
- Oakville-Oshtemo association. Nearly level to steep, well drained, loamy soils on outwash plains and moraines.

*Texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

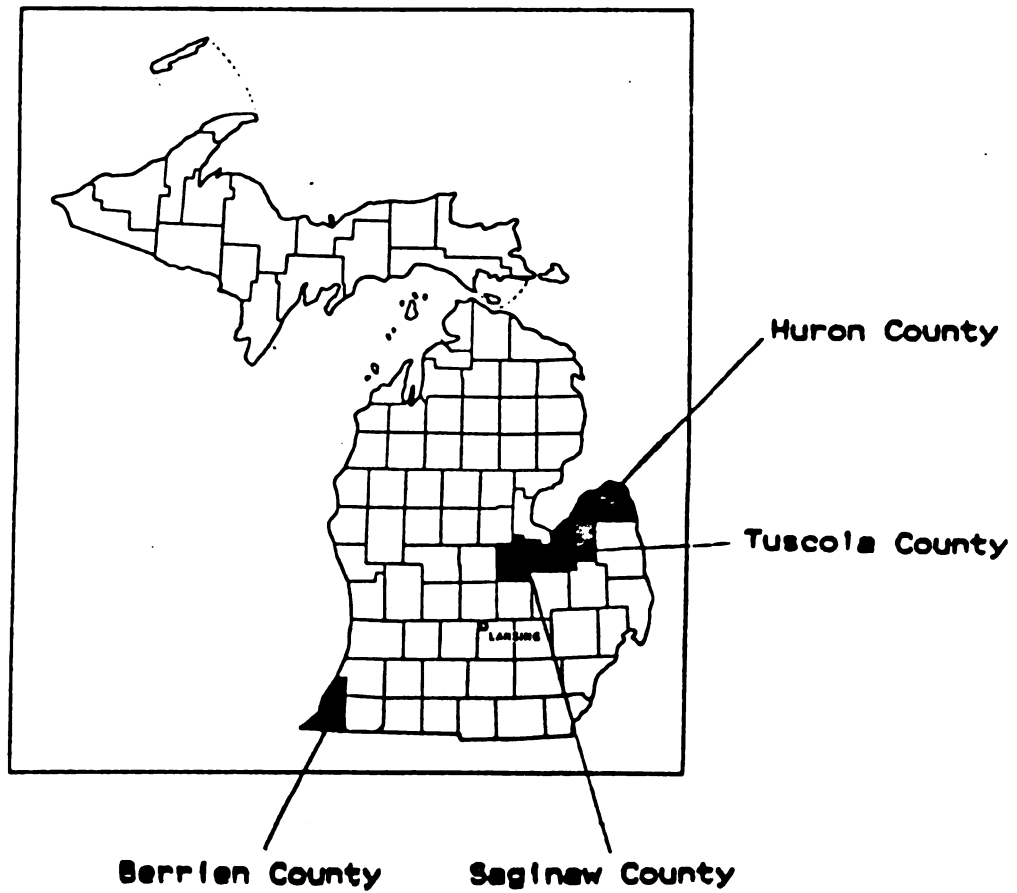
Compiled 1975

Each area outlined on this map consists of more than one kind of soil. The map is thus made for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

Location of Berrien, Saginaw, Tuscola and Huron Counties in Michigan



APPENDIX C

FARMER SURVEY REGARDING ADOPTION OF CONSERVATION TILLAGE

Do you now practice conservation tillage on your farm? _____

Section 1: Annual Costs And Benefits

- 1) The following have been suggested as annual cost-reductions that result from practicing conservation tillage as opposed to conventional tillage. To what extent do you agree or disagree with each.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

- a) Prevention of deposition on cropland. _____
- b) Prevention of gullies and streambank erosion. _____
- c) Decreased fuel requirements for tillage operations. _____
- d) Decreased labor requirements for tillage operations. _____
- f) Decreased equipment costs. _____
- g) Other. _____

- 2) The following have been suggested as some cost increases associated with practicing conservation tillage instead of conventional tillage. To what extent do you agree or disagree with

each?

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

- a) Increased management. _____
- b) Increased use of herbicides. _____
- c) Increased use of pesticides. _____
- d) Messy looking fields. _____
- e) Other. _____

- 3) If practiced correctly, what kind of yields can be achieved under conservation tillage systems relative to conventional tillage. Discuss.

- 1 -- much higher
- 2 -- higher
- 3 -- same
- 4 -- lower
- 5 -- much lower

- 4) To what extent do you agree or disagree that relative to conventional tillage systems, conservation tillage systems prevent yield losses due: to topsoil loss, loss of nutrients, lower

infiltration rate and water holding capacity, and deterioration of soil structure.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

5) It has been suggested that there is an overall net return of 5% annually as a result of practicing conservation tillage instead of conventional tillage. What do you think that the actual net return is compared to this figure?

- 1 -- much higher
- 2 -- higher
- 3 -- the same
- 4 -- lower
- 5 -- much lower

Section 2. Risk And Uncertainty

1) How much risk do you associate with conservation tillage relative to conservation tillage. Discuss.

- 1 -- a lot more risk
- 2 -- more risk
- 3 -- about same risk

4 -- less risk

5 -- alot less risk

- 2) How do you feel that the following economic trends affect the attractiveness of converting to conservation tillage. Discuss.

1 -- more attractive

2 -- no effect

3 -- less attractive

a) Falling commodity prices. _____

b) Increasing input prices. _____

c) Increasing interest rates. _____

d) Falling land values. _____

e) Other. _____

- 3) How do you generally approach risky situations?

1 -- take big chances

2 -- take small chances

3 -- cautious

4 -- avoid taking risks altogether

5 -- other

Section 3. Information And Human Capital

- 1) Check below your opinions about the technical assistance available through the Soil Conservation Service. Discuss.

- a) 1 -- useful
 2 -- not useful
 3 -- no opinion
- b) 1 -- not time consuming
 2 -- time consuming
 3 -- no opinion
- c) 1 -- easy to understand
 2 -- complicated
 3 -- no opinion

2) What was the last year of school you completed?

- 1 -- grade school
- 2 -- some high school
- 3 -- high school graduate
- 4 -- some college or technical school
- 5 -- graduated from college

3) How much have you used the following sources of information about
conservation tillage?

- 1 -- a lot
- 2 -- some
- 3 -- never

a) Other farmers. _____

- b) SCS. _____
- c) CES. _____
- d) Farm press. _____
- e) Farm radio. _____
- f) Farm television. _____
- g) Equipment Dealer/Manufacturer. _____
- h) Other. _____

4) Which has been your primary source of information?

Section 4: Institutional Framework

Section 4a.: Institutional Incentives

1) Which of the following programs do you participate in?

1 -- yes

2 -- no

- a) Technical assistance. _____
- b) Cost-sharing. _____
- c) Acreage reduction (wheat). _____
- d) Acreage reduction (feed grains). _____
- e) Other. _____

2) Cost-sharing agreements should be longer than a one-year term.

Discuss.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

3) What special incentives for practicing conservation tillage offered in your Soil Conservation Districts do you make use of?

- 1 -- yes
- 2 -- no

- a) Leasing arrangements for no-till planters or drill._____
- b) Leasing arrangements for no-till planter or drill and driver.___
- c) District owned planter or drill._____
- d) Other._____

Section 4b.: Policy Issues

1) Farmers and not society as a whole, should have an obligation to conserve soil in order to reduce water pollution and to protect soil productivity for future generations. Discuss.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

- 2) To help achieve national and state soil erosion goals, each farmer should be required to follow recommended soil conservation measures for his farm to qualify for price and income support programs.

Discuss.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

- 3) To what extent do you agree or disagree that cost-sharing funds should be made available for the following conservation practices?

Discuss.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

- a) Chisel Plowing. _____
- b) No-till planting. _____
- c) Ridge tilling. _____
- d) Strip tillage. _____
- e) Other. _____

- 4) Soil Conservation Districts should have more authority than they presently have in deciding which practices are eligible for cost-sharing. Discuss.

- 1 -- strongly agree
- 2 -- agree
- 3 -- not sure
- 4 -- disagree
- 5 -- strongly disagree

Section 6: Planning Period And Discount Rate

- 1) To what extent is soil erosion a problem on the land you farm? Discuss.

- 1 -- serious problem
- 2 -- moderate problem
- 3 -- slight problem
- 4 -- not a problem

- a) Currently. _____
- b) Over the next ten years. _____
- c) Over the next thirty years. _____
- d) Over the next fifty years. _____
- e) Longer. _____

- 2) How do other opportunities for improvement in your operation compare

to conserving soil? Discuss.

1 -- higher priority

2 -- equal priority

3 -- lower priority

a) Debt reduction. _____

b) Land acquisition. _____

c) Increased use of fertilizer. _____

d) New cropping operations. _____

e) New equipment. _____

f) Other. _____

3) Lower rates for borrowed funds would facilitate the adoption of conservation tillage. Discuss.

1 -- strongly agree

2 -- agree

3 -- not sure

4 -- disagree

5 -- strongly disagree

4) Number Of Acres Farmed (including government idled acres) in 1984. __

5) Percent of land farmed that you own. _____

6) What do you think will happen to your land when you retire from

farming?

- 1 -- pass it on to family member
- 2 -- sell it for agricultural use
- 3 -- sell it for non-agricultural use
- 4 -- rent it
- 5 -- other

7) Approximate annual gross sales from your farm in recent years:

- 1 -- less than \$40,000
- 2 -- \$40,000 to \$200,000
- 3 -- more than \$200,000

8) If you or members of your family were employed off the farm, what percent of your total farm income in 1983 came from off-farm employment and investments?

- 1 -- less than 25%
- 2 -- 25%-49%
- 3 -- 50%-74%
- 4 -- 75%-100%

9) Is your farm:

- 1 -- single proprietorship
- 2 -- partnership

3 -- corporation

10) Age. _____

Section 6: Summary

1) If you now practice conservation tillage, how important were the following factors in your decision to practice conservation tillage? Discuss.

1 -- not important

2 -- slightly important

3 -- moderately important

4 -- very important

a) Profitability of practice(savings in equip., time, fuel, etc.).

b) Availability of cost-sharing funds. _____

c) Availability of technical assistance. _____

d) Recognition of erosion as a future problem on farm. _____

e) Recognition of erosion as a current problem on farm. _____

f) Recognition of erosion from farm causing water quality problems. _____

2) If you do not now practice conservation tillage, how important were

the following factors in the decision not to adopt conservation tillage? Discuss.

- 1 -- not important
- 2 -- slightly important
- 3 -- moderately important
- 4 -- very important

- a) Not profitable._____
- b) Too risky._____
- c) Insufficient cost-sharing incentives._____
- d) Do not know enough about it._____
- e) Do not think that erosion is a problem on land._____
- f) Other more important farm improvements in which to invest.____
- g) Impractical for crops on your farm._____
- h) Impractical for soil on your farm._____
- i) Other._____

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