UNDERSTANDING
SOIL CONSERVATION BEHAVIOUR

A Critical Review

by

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PREFACE

If the substantive steps being taken to reduce soil erosion from Canadian farms are to be successful, it is essential that they be based on a clear understanding of the processes, influences, and attitudes affecting the soil conservation behaviour of farmers. Nowhere is the research on this question pulled together in one place.

This volume is primarily a critical assessment of previous research on the adoption of soil conservation practices. It is concerned with work that has explored the cultural aspects of soil conservation in attempts to reduce land degradation. Many processes contribute to soil erosion and thus off-farm impacts. This paper addresses conservation practices to reduce water-borne soil erosion in particular. Our level of inquiry is primarily the individual actions of the farmer. The focus is decidedly southern Ontario; however, the scope of our findings and suggestions is broad in application.

While the major content of this paper is not new, its comprehensive approach to a complex problem is. Most efforts to understand soil conservation behaviour to date have been fragmented, not because of lack of intent but due to a tendency to focus on only one aspect of the problem. We hope that this volume will provide practitioners and farmers alike with information and insights to aid in the encouragement of soil conservation and to provide new directions for the development and promotion of a land stewardship ethic.

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An attempt has been made to accurately represent the position of the various authors reviewed. Any errors or misrepresentations in this volume are of course the responsibility of its authors.

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INTRODUCTION

PROBLEM STATEMENT

Land degradation poses many challenges for farmers, planners, decision-makers, and researchers. Discussion of land degradation tends to focus on causes, consequences, and remedial measures for soil acidification, salinization, compaction, erosion by wind and water, and soil organic matter and nutrient decreases. Much research has been devoted to the issue of water-related soil erosion in particular.

Water-related soil erosion has long been recognized as a critical problem spawning serious environmental and economic consequences. Researchers and farmers have developed technologies and farming practices to reduce the impacts of soil erosion both on and off the farm. Governments, most notably in the United States, have exerted enormous effort in attempting to curb soil losses primarily by encouraging the use of soil conserving practices at the farm-level through extension efforts. Yet, soil conservation efforts have not met with broad success, and erosion continues to be a serious environmental problem.

Since the 1950s most agricultural extension efforts in Canada have been production based. Recently, the focused has shifted slightly to conservation. While there has been a research tradition in the U.S. devoted to understanding factors influencing the soil conservation behaviour of farmers, this has not been the case in Canada. Canadian professionals do not have access to Canadian baseline research to provide insights for encouraging farmer conservation effort. Certain commonalities exist between our nations and some research results can be transposed to Canada. However, there are enough differences in cultural background and institutional arrangements to warrant a distinct Canadian investigation.

PURPOSE

This is a background document prepared as part of an inter-disciplinary research project designed to probe for solutions to reduce land degradation in Canada. The purpose of this paper is to critically assess literature related to soil conservation behaviour. By reviewing factors thought to affect an individual's adoption and use of soil conservation practices it is hoped that a comprehensive model of farmer land stewardship behaviour can be developed to aid in suggesting definitive solutions to the broad concerns of water-related soil erosion in Canada.

OBJECTIVES

The overriding goal of this document is to lay the groundwork for further research in Canada relating to encouraging soil stewardship. Specifically, this paper has three major objectives.

1. To critically review and assess models of farmer behaviour designed to explain factors affecting the adoption of conservation practices on the farm.
2. To assess the empirical results of research designed to identify factors significantly associated with soil conservation behaviour.
3. To identify shortcomings in policy approaches to soil stewardship promotion.

PAPER ORGANIZATION

This volume contains five chapters. The next chapter introduces the reader to the dimensions and influences on land degradation and provides a means of capsulizing the focus of past research. Chapter three is a broad-scale survey of the dominant paradigms of soil conservation behaviour, founded primarily on adoption-diffusion models. Various approaches are presented and critiqued on their conceptual and analytical basis. Focusing on a more limited scale, chapter four examines in considerable detail the empirical results of research on the influences of specific factors on the adoption and use of soil conservation measures. This chapter concludes with an assessment of the significance of various groups of influences and highlights some shortcomings that should be addressed in future research.

The basis of policy is often the results of empirical studies, such as those presented in chapter four. Chapter five is concerned with policy. A comprehensive inventory of possible policy responses for enhancing soil conservation is presented. In the final chapter, past policy approaches are reviewed in light of knowledge gained by the research described in the previous two chapters. To what extent have policy approaches utilized insights gained and how can policy be modified to increase efficacy? Some possible cross-sectoral policy conflicts are postulated.

Further research is planned to develop a detailed conceptual model and evaluate which factors relate to soil conservation behaviour in a southern Ontario context.

CHAPTER TWO

LAND DEGRADATION: BACKGROUND TO A RESEARCH PROBLEM

Nutrient leaching, acidification, and soil erosion are environmental processes that occur regardless of human activity. The degree to which these processes can reduce the productive potential of land resources and/or cause pollution is dependent on the nature and extent of human interference. The term degradation implies social and economic components that relate to a reduction in rank relative to a set of actual or possible land uses (Blaikie and Brookfield, 1987). It is useful to view degradation as a process and not a state. Degradation occurs when the combination of human and natural forces results in a lowering of the capability of the land base for a set of possible uses. In other words the choice of possible alternatives to which the land can be put is diminished.

Land degradation may or may not be interpreted as a problem contingent upon the perspective one adopts. Blaikie and Brookfield (1987) touch on two such divergent views based on social relationships to the environment. If one views the world as a place of abundant land resources and holds an ethic based on ultimate faith in technology to compensate for lost productivity (Kirby and Blyth, 1987) from poor land management practices, then land degradation is not a problem. If a technological solution is not considered ideal, or if technology exists but is not being used, then the converse paradigm is adopted and land degradation becomes problematic.

It is not sufficient to say that land degradation is a problem. When land degradation becomes a problem, or to avoid land degradation becoming one, it is necessary to view the situation as multi-dimensional. However, most past research efforts have tented to be limited in focus. Land degradation is an issue with two primary component parts: biophysical and cultural. Researchers have tended to divide the cultural component into economic, and social causes, concerns and impacts.

A BIOPHYSICAL PROBLEM

With the exception of its relation to water quality, a number of attempts have been made in Canada in recent years to document the nature and extent of biophysical land degradation. Wall and Driver (1982) published one of the earliest attempts to estimate the impact of soil erosion in Ontario and estimated a figure of $68 million for total yearly on-farm costs. The Senate Standing Committee (1984) made a well-publicized review of nation-wide degradation problems in "Soil at Risk". These were followed by more thorough attempts to assess the nature and extent of the on- and off-farm biophysical impacts of land degradation in western (Prairie Farm Rehabilitation Administration 1982; Anderson and Knapik, 1984) and eastern Canada (Fox and Coote, 1986; Miller, 1986). Dumanski et al. (1986) reviewed the status of soil conservation and land degradation in Canada relative to the agricultural land base and provided a useful summary of much of the physically-based research conducted prior to 1986.

Land base characteristics and uses are not uniformly or systematically dispersed on the landscape. Physical problems associated with various manifestations of land degradation create on-site damages, for example productivity losses and increased costs of production, as well as off-site damages such as a reduction in water quality (Ribaudo, 1986). Yet, it is difficult to establish relationships between these two sets of impacts. In many instances the two impacts do not coincide (Ribaudo, 1986; Dickson and Fox, 1988). For example, while soil erosion can affect water quality, the relationship is not always linear. Land with severe erosion problems does not always have a severe impact on water quality unless the area in question is proximate to watercourses (Thames River Implementation Committee, 1982). The lack of clear causal relationships makes the task of assigning responsibility for abatement excessively difficult.

While estimates of the on- and off-farm impacts have varied widely, most researchers are in agreement that the off-farm impacts are of major concern. Food production potential loss from erosion, for southern Ontario, has been shown to be almost negligible (Smit et al., 1988); however the total cost of land degradation to Canadians has been estimated at $1.3 billion annually (Science Council of Canada, 1986).

Other problems include methods of measurement and perceptions of physical impacts. Often farmers are aware of degradation problems to some extent and a number have made changes in their tillage practices (Wall et al., 1985); yet, farmers and technicians tend to arrive at different assessments of degradation severity (Osterman, and Hicks 1988).

A CULTURAL PROBLEM

Economic Aspects

There are three primary economic dimensions of agricultural land degradation:

1. the economic cost to the farmer;
2. the economic cost to society; and
3. the overall economic environment which imposes constraints on farmer action or which imposes demands that are more immediately significant to the farmer.

Economically focused literature related to soil degradation on agricultural lands has had two major thrusts. The first has concentrated on the broad costs borne by the farmer and society at large of continued degradation of soil resources (Wall and Driver, 1982; Anderson and Knapik, 1984; Senate Standing Committee, 1984; Dumanski et al., 1986; Fox and Coote, 1986; Miller, 1986; Science Council of Canada, 1986). The second orientation has examined the cost and benefits to individual farmers and society of implementing remedial measures (tillage and rotations) to curb land degradation, primarily from soil erosion at both production and policy levels (Seitz et al., 1979; Ketcheson and Stonehouse, 1983; Stonehouse, 1983; Seecharan et al., 1985; Girt, 1986; Stonehouse et al., 1987; Zantinge et al., 1986; Henderson and Stonehouse, 1988; Stonehouse et al., 1988).

The distribution of the costs and benefits of land degradation and soil conservation are not well understood as of yet. Preliminary estimates by Fox and Coote (1986) showed that the off-farm costs of soil erosion were substantial. If these are accurate, then society may stand to be the greatest beneficiary of efforts to control soil erosion (Dickson and Fox, 1988). In many cases the off-site costs and benefits of soil erosion and erosion control are greater than the on-site costs and benefits (Ribaudo, 1986). In a study of three watersheds in southwest Ontario, it was found that the off-farm costs of soil erosion were substantially greater than the on-farm costs per hectare (Dickson and Fox, 1988). It also seems that the areas which are economically important in terms of off-site damages, and which therefore, have greater potential benefit to society from erosion control, are not always coincident with the areas which show significant on-site erosion damages (Ribaudo, 1986).

Literature on the broad extent and costs of land degradation is characterized by a wide range of estimated values and has consequently been criticized for poor data quality, inconsistency in measurement approaches and economic rigour, and conceptual foundation (Van Kooten and Furtan, 1987; Dickson and Fox, 1988). While these authors do not suggest definitive mechanics for arriving at more accurate measurements, they do suggest more integrated options for analyzing the situation. Attempts to address land degradation problems when they exist must also consider the broad economic environment. There are characteristics of the economic environment in which a farmer must operate which contribute to land degradation. This facet of the problem has not received the same discussion in the literature as the other dimensions. Dickinson et al. (1987, p. 42) state that "over the past decade the economics of farming have not been conducive to lengthy planning horizons and thus have not been conducive to adopting soil erosion control practices." Moreover, it appears to be economically beneficial for farmers to exploit soil resources since they can transfer the capital loss to society (Seecharan, et al., 1985). The economic question, in these situations, then becomes one of how to transfer the capital loss back to the source. Others suggest that farmers are aware of the problem of soil erosion but fail to respond to erosion problems because the cost and benefits of erosion control are not reflected in the price of their land (Nowak 1983; Barrows and Gardner 1987). If we are to understand the economic roots of land degradation we must be able to differentiate between land degradation which has resulted for reasons of income maintenance (i.e. necessity) from that which has occurred as a result of opportunity for capital gain (Blaikie and Brookfield, 1987).

The argument put forward then is that the problem of land degradation is not a matter of ignorance but primarily one of economics. However, there are farmers who have voluntarily adopted conservation strategies on their farms, even when the economics of doing so are unclear or uncertain. There are many reasons put forward which assume economic rationality on the part of farmers, but is this a valid assumption? There are other motivational factors beyond those subsumed by neoclassical economic models which affect individual and societal behaviour (for example, Batie, 1986; Lovejoy and Napier, 1986; Connolly and Hilts, 1987; Setia 1987). Economic influences are critical in land degradation analysis; however, given our definition of land degradation, a strict economic orientation is too narrow a focus to aid in arriving at broad reduction of negative impacts.

Social Aspects

Farmers in Ontario, and elsewhere, are generally aware of soil erosion and other land degradation problems yet, widespread implementation of conservation measures has not occurred (Wall et al., 1985; Coleman and Roberts, 1987). Napier and Camboni (1988) and Blaikie and Brookfield (1987) have stated that soil conservation is a sociological problem more than a technological one since lack of awareness of soil erosion problems and ignorance of technological solutions and government programs do not appear to be problematic; however, getting people to do something about it is.

While technological-based solutions are an important and sometimes necessary condition for the resolution of land degradation problems, they are not a sufficient condition (Lovejoy and Napier, 1986). The use to which land is put is largely socially determined. The definition and perception of land degradation is socially determined (Blaikie and Brookfield, 1987). Perception or recognition of a problem is the first step to implementation of remedial measures (Rogers and Shoemaker, 1971; Rogers, 1983; Culver and Seecharan, 1986) and factors influencing problem recognition are largely social in nature.

Current socio-economic conditions place the farmer in a particularly difficult situation. He or she must choose between protecting the soil resource or maximizing output to survive economically. This dilemma is compounded by the non-farm community which demands and expects farmers will produce abundant, low-cost food while bearing the costs related to the stewardship of land resources (Swanson et al., 1986). Implementing a programme for land stewardship then can be a difficult proposition given current societal constraints and priorities, and should not be seen entirely as the responsibility of the farm community.

If we are going to redefine soil erosion as a social problem we will need to develop new conceptual frameworks and analyses which will account for the social as well as the economic impacts of the problem (Blaikie and Brookfield, 1987). The adoption-diffusion paradigm has, in part, been used successfully to address this issue (Rogers and Shoemaker, 1971, Rogers, 1983). As we shall see later, adoption-diffusion research has been criticized for focusing on individual farmer perception and attitudes, and the role information plays in the adoption process. On the whole this research has neglected structural issues. Others (Lovejoy and Napier, 1986) have attempted to deal with this shortcoming by studying how conservation decisions are made on the farm and focusing on behaviourial changes rather than solely on measures of attitude.

An Integrated Perspective

Our orientation is predominantly social science in nature. While we recognize the potential severity of the direct on-farm impacts of unchecked, accelerated land degradation, however, our attention is focused on the broad societal concerns of off-farm consequences. As the soil loss deemed necessary to cause off-farm externalities is not as high as that which could cause a reduction in productivity, a focus on societal impacts will also ensure future productive capacity.

Land degradation is conceptualized as being inter-related with a broad range of global resource problems. Land degradation, climate change, population growth, deforestation, acid rain, toxic waste, resource depletion, species extinction, and so on are symptoms of a world order that raises doubts over our ability to maintain the biosphere as the inheritance for future generations. For much of our history the land has been treated as an infinite resource. The time has come to take stock of our environment and ensure that it is managed in such a way that the future quality of life be sustained.

Human activity, be it agricultural, financial, or industrial must be sustainable into the future. This requires an integration of conservation and development (IUCN, 1980). The operationalization of sustainability is a complex and renewed field of investigation. Specific objectives must be set and assessed. It is not our purpose to embark on a debate over operationalizing and measuring sustainable development objectives. Rather, we recognize sustainability as a concept within which specific goals for the development of humankind can be addressed. Most discussion of sustainability has centred on agriculture systems (for example, Bidwell 1986; Blaikie and Brookfield 1987; Hendrix et al. 1988; Rodale 1988). Sustainability can only be achieved when applied to the complete social system (Rodale 1988) and not just to those components of it which interact with the land in a productive capacity.

Past research attempting to find solutions to land degradation in general, and soil erosion in particular, has been sectoral. If real progress is to be made in reducing the impacts of soil erosion what is needed is an integrated perspective within which to conceptualize variables and explore possible solutions (Francis and Clegg, 1988). An integrated approach would include the biological, economic, social and political dimensions for analysis. Drawing on ecological concepts, agricultural production needs to be studied and managed as a system rather than by component parts (Barbier, 1987; Hallberg and Logan, 1988).

We agree with Bentley and Leskiw (1984) that three broad categories of factors influence land management practices and farm productivity; 1) factors within the domain of the farmer, 2) within the public domain, and 3) external or natural factors and that they operate at varying scales of influence. These three components cannot be addressed in isolation, but rather an attempt should be made to break down sectoral interests and approach the issue in a comprehensive manner (Lowitt, 1985). We will argue in this paper that concerted efforts must be made on all three levels to address issues of land degradation. A farmer must produce within a specific regional biophysical setting. Society, through institutions and policies, creates a social context within which individual actions are constrained. Finally, the individual is left to mediate the influences of each of the other components to meet his or her responsibilities. The challenge remaining is to organize these influences into a comprehensive model that explains soil conservation behaviour.

SUMMARY

This chapter has attempted to introduce the reader to the broad dimensions of land degradation. While two primary dimensions were addressed, it was also noted that researchers have generally addressed the issues within sectoral disciplinary boundaries. Such a stance, in our view, is not appropriate if broad solutions are to be developed and tried. Following from this, the argument was put

forward that an integrated approach to land degradation needs to be adopted as the framework for analysis.

The challenge is to organize these influential variables into a conceptual model that explains farm-level conservation behaviour. It has been noted that the availability of technology is not a problem. Technology exists to reduce soil erosion, yet it is not being practised as widely as some might wish. A number of authors have already attempted to construct models that explain why conservation practices and technology are adopted and used by some and not others. Some of these attempts have met with more success than others. In the next chapter we review and critique models which attempt to explain the adoption of conservation practices, as well as discuss the various factors thought to control farmer behaviour.

CHAPTER THREE

EXPLAINING THE ADOPTION OF CONSERVATION PRACTICES:

INTRODUCTION

Land management is as an integral part of farm management. As such, farmers need access to financial and technical resources to ensure effective management of their land resource (Blaikie and Brookfield, 1987). There is a wide variety of land management practices which are appropriate for soil conservation. These measures range from structural (e.g. terracing, drop inlets, grassed waterways, etc.) to behaviourial (e.g. rotations, underseeding, plowdown crops, tillage, etc.). The installation of structures or use of new tillage equipment can be very costly, while changes in behaviour often require little cash outlay but may nonetheless have extensive economic implications (Baffoe et al., 1986; Stonehouse et al., 1987; Henderson and Stonehouse, 1988). There are other land management options available for the control of land degradation and soil erosion that have received little attention in the literature. Agroforestry (Gordon and Williams, 1988), woodlots, the maintenance of fencerows and wildlife habitat are some examples.

Appropriate soil conservation practices are very site-specific in nature (Seecharan et al. 1985; Madden and Dobbs 1988). Thus, there can be great variability of results in erosion control, crop yields, and farm profits from implementing any number of conservation practices or systems on the variable conditions of the landscape (Seitz et al., 1979; Ketcheson and Stonehouse, 1983; Stonehouse 1983; Seecharan et al., 1985; Girt, 1986; Stonehouse et al., 1987; Zantinge et al., 1986; Madden and Dobbs, 1988; Henderson and Stonehouse, 1988; Stonehouse et al., 1988). This variability necessitates flexibility in the promotion and implementation of remedial measures. It is important, therefore, that evaluations of new technologies be made on a site-by-site basis (Madden and Dobbs, 1988).

Adequate technologies and practices exist which, when appropriately applied, can reduce land degradation generally, and soil erosion specifically. Yet, as previously noted, availability does not necessarily translate to use. Early government efforts in the promotion of soil conservation in the U.S. were predominantly physically-based (Earle et al., 1979). Recognition of the importance of social variables resulted in a plentitude of research focused on understanding and explaining factors which affect or control a farmer's decision to use or not to use soil conservation practices (for example, Pampel and van Es, 1977; Ervin and Ervin, 1982; Bultena and Hoiberg, 1983; Korsching et al., 1983; Napier et al., 1984; Carlson and Dillman, 1986; Swanson et al., 1986; Nowak, 1987). An understanding of the process of voluntary adoption is thought necessary to facilitate the design of government policy and programs to effectively address society's need for a sustainable agricultural production system and a protected environment.

Research on soil conservation behaviour has drawn extensively on the adoption-diffusion paradigm (Rogers, 1971, 1983; Brown, 1982). Some have focused on specific influences (Carlson and Dillman, 1983; Lee, 1983; Epplin and Tice, 1986; Macartney, 1987; van Es and Tsoukalas, 1987); others have tried to tackle aggregate effects (Ervin and Ervin, 1982; Bultena and Hoiberg, 1983; Napier et al., 1984); and still others have proposed alternative models within which to view the

decision-making process (Batie, 1986; Lovejoy and Napier, 1986). There has been a tendency to approach much of this research from either a confined sociological or a narrow economic perspective.

Broadly, the conventional models of the adoption/decision-making process can be arranged in a four-tiered typology. Briefly these models are:

1) the traditional adoption-diffusion model;
2) the traditional economic constraint/decision-making model;
3) a revised adoption-diffusion model; and
4) the macrostructural model.

What follows is a brief explanation of each of these models. This overview is followed by an assessment of the strengths and limitations of each of these approaches.

REVIEWING THE MODELS

Traditional Adoption-Diffusion Model:

While the origins of adoption-diffusion research can be traced to the early twentieth century, the majority of research has been concentrated since 1950 (Jones, 1967). More recently, ideas on the adoption and diffusion of innovations (items, practices, ideas, or philosophies) have been crystallized by Rogers (1962 and 1983) and Rogers and Shoemaker (1971) who define the five critical stages of the "innovation/decision process" as: 1) knowledge, 2) persuasion, 3) decision, 4) implementation, and 5) confirmation (Figure 1).

Each individual or group passes through these five stages in the process of making a decision to adopt or reject a particular innovation. The adoption/decision-making process is driven by the influences of the characteristics of the decision-making unit (individual, community, society), the actual and perceived characteristics of the innovation (relative advantage, complexity, compatibility, etc.), and the nature of the communication channels by which information and opinions are transmitted (mass media and interpersonal).

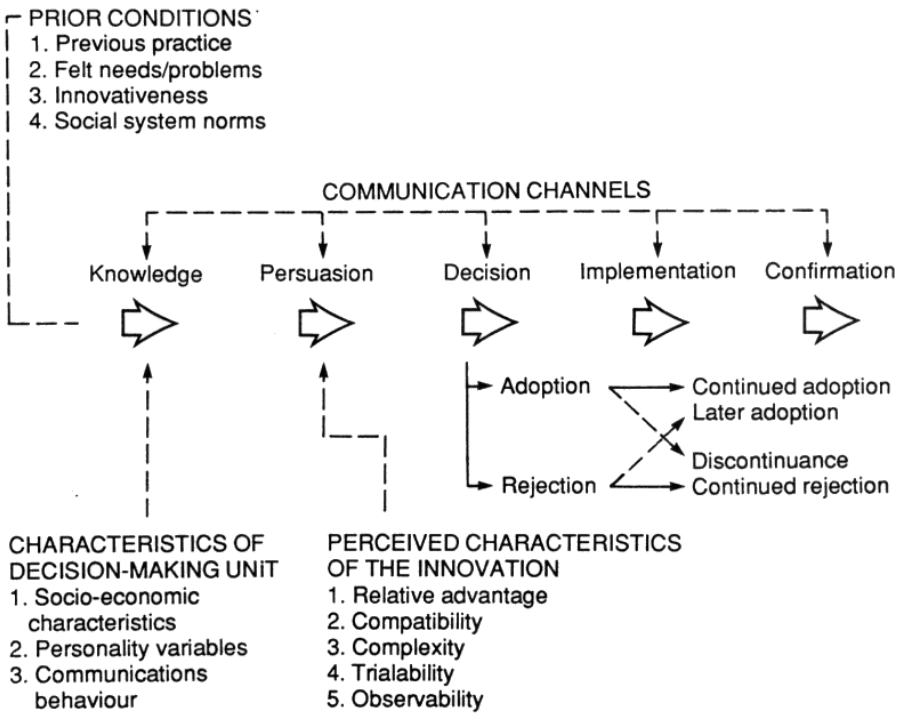

Figure 1: Traditional Adoption-Diffusion Model *(From Diffusion of Innovations, Third Edition, by Everett N. Rogers. Copyright c 1962, 1971, 1983 by The Free Press, a Division of Mac millan Inc. Redrawn with permission of the publisher.)*

This model assumes that an innovation diffuses contagiously across space as an increasing number of individuals or groups adopt the innovation over time. The adoption and diffusion of innovations is a function of the innovation itself, the adopter, the adopter's perception of the innovation, and occurs within the context of a social system (Jones, 1967) (Figure 2).

While originally designed to model the adoption and use of mass innovations, adoption-diffusion theory has been applied extensively by American rural sociologists attempting to understand the particular patterns of adoption of agricultural conservation practices (Jones, 1967). This research has quite successfully explained the adoption of commercial farm practices and guided the design and implementation of many planned change programs (Pampel and van Es, 1977).

Napier et al. (1984) outlined the basics of the adoption-diffusion paradigm as it has traditionally been applied to soil conservation practices. This model assumed that adoption behaviour is primarily controlled by exposure to information; therefore, in practice the diffusion of new technologies or innovations can be encouraged by assisting in the flow of information to potential adopters (Jolly et al., 1985). With enough information, favourable attitudes toward the practice develop and adoption follow. Thus, soil conservation practices are believed to be rejected by many farmers because there is insufficient information and assistance available to adequately evaluate and experiment with the innovations (Nowak, 1987).

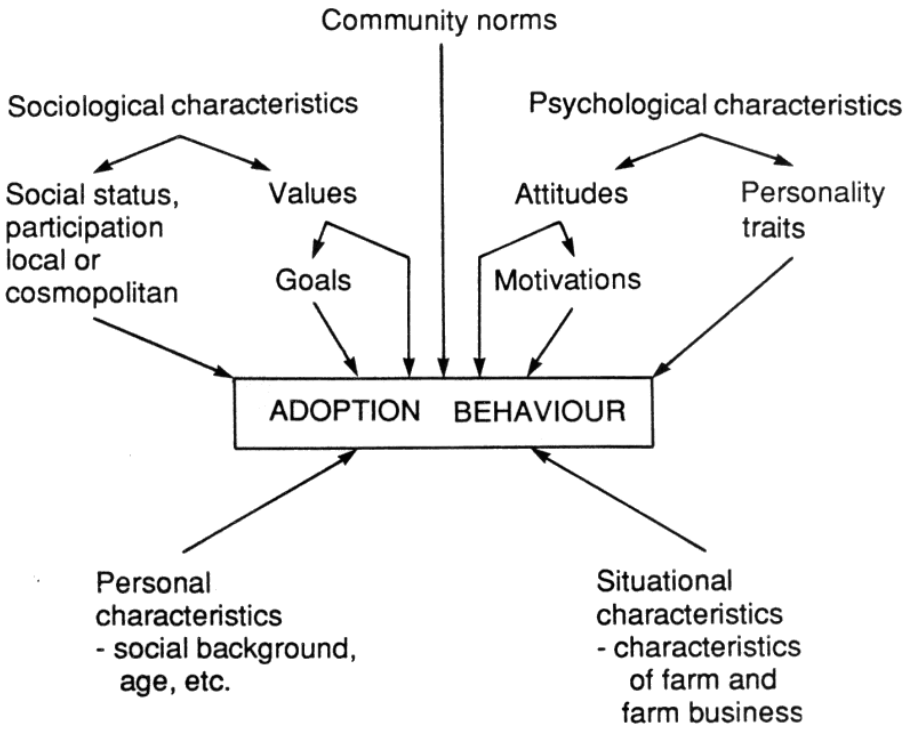

Figure 2: **Influences on Adoption Behaviour** *(Redrawn from Jones, Gwyn E. (1967) with permission of World Agricultural Economics and Rural Sociology Abstracts and CAB International Wallingford, Oxon, U.K.)*

Variables included in this specification of the model tend to measure farmers' perceptions of the problem and their awareness of the potential solutions available. These make up a subset of the range of factors or variables discussed by Rogers (1983), Brown (1982) and Jones (1967), and include primarily individual socioeconomic characteristics and personal factors such as age, education, leadership ability, social status, etc. Socio-demographic factors affect adoption since they affect exposure to information. No explicit motivational assumptions of individuals are made in this model. The major assumption, however, is that adoption is an individualistic, economically-based decision which results in an individual net benefit.

Economic Constraint Model:

The economic constraint model of the adoption-diffusion process is based on a simple economic decision-making model employed by economists. This model assumes that farmers make land use decisions based on a motive of profit maximization within certain economic, technological and institutional constraints (Van Kooten, 1986). Decisions to degrade or conserve the soil resource are made in this same decision-making environment (Van Kooten, 1986). The economic model tends to focus on the profitability of new technology. If a new technology is more profitable than an existing one, then rationality dictates it should be adopted. Economic analysis of adoption and diffusion concentrates on economic incentives to adopt soil conservation practices as they enhance the profitability of an innovation and thus adoption (Jolly et al., 1985).

This model further assumes that adoption behaviour is primarily a factor of ability-to- act; adoption is not limited by desire to act but by limited economic resources, and access to capital and land resources are seen as the main constraining factors to the widespread adoption of soil conservation practices (Napier et al., 1984). Unlike the traditional adoption-diffusion model, the economic constraint model includes an explicit motivational assumption. The farmer is viewed as a profit-maximizer and conservation is viewed as another input among which to choose in finding the optimal agricultural production process (Batie, 1986). Soil conservation practices are seen as being rejected by many farmers because there is no immediate financial incentive to adopt them (Nowak, 1987). Moreover, the ability of farmers to externalize the costs of soil erosion weakens any financial incentive to reduce land degradation (Nowak, 1987). If soil conservation practices are not used it is because they are: 1) not profitable, 2) not adequately or accurately assessed by the farmer, or 3) because of the failure of the market to account for the long-term costs of soil erosion (Batie, 1986).

Common sets of variables included in this model are: 1) various costs and benefits of soil conservation practices relative to conventional farm practices, 2) long-term changes in productivity which will affect revenues, 3) changes in input requirements which will affect costs, and 4) an appropriate discount rate so that future revenues and costs can be assessed against their present value.

Revised Applications of the Adoption-Diffusion Model:

Following various methodological and theoretical critiques of the traditional diffusion model (Pampel and van Es, 1977; Nowak, 1983; van Es, 1983; Heffernan, 1984) revised applications have been proposed. Of paramount concern has been the appropriateness of applying the traditional model to conservation innovations. For example, Pampel and van Es (1977) suggested factors which influence the adoption of environmentally related innovations are different than those which affect the adoption of commercial innovations because environmental innovations are quite different in their characteristics. They pointed to the need to modify adoption-diffusion models to accommodate the multidimensional nature of adoption behaviour and to use previous research findings with extreme care when applying them to environmentally related practices like soil conservation, as these do not tend to bring immediate benefit.

Revised approaches have recognized and included a broader range of factors than those included traditionally. Some have modified the model to account for economic factors which have been found to be important in the economic constraint model, while others (such as Green and Heffernan, 1987 and Ervin and Ervin, 1982) have attempted to measure and incorporate perceptions related to land degradation/soil conservation practices. These revisions have built on past experience and have gone beyond the earlier simplistic assumptions.

Nowak (1983) modified Rogers' traditional adoption-diffusion model to incorporate assumptions deemed requisite for its application to soil conservation practices (Figure 3). He has revised the model to represent the constrained environment in which the farmer must operate. This model recognizes soil conservation as a part of a system in which adoption cannot be measured by simple dichotomous terms like adoption or rejection (use and nonuse), but rather as a dynamic system continually evolving. Building upon Rogers' knowledge and utilization stages, Nowak extended the model to explicitly incorporate an adaptation stage.

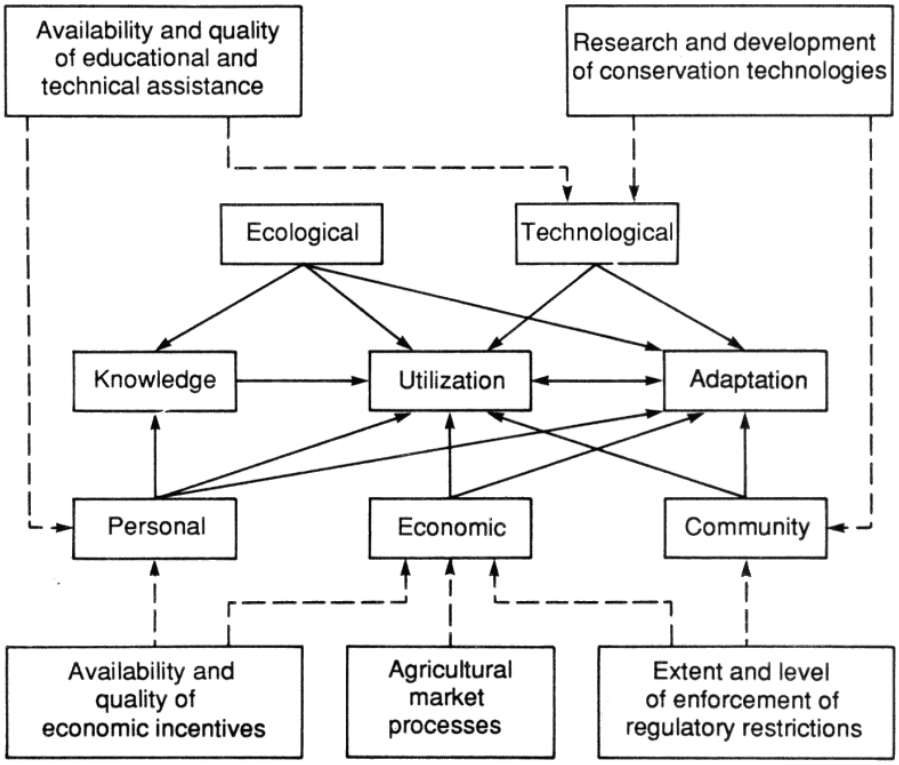

Figure **3: Nowak's Model** *(Redrawn from Nowak P.J. (1983a) with permission of The Rural Sociologist.)*

Although acknowledged by Rogers as a continuation of the implementation stage, Nowak's explicit delineation of adaptation as a process unto itself is a useful distinction. He stated that the continued use of soil conservation technology depends upon the successful completion of this three-stage process of knowledge, utilization AND adaptation by which the agronomic and economic efficiency of the innovation is improved.

Ervin and Ervin (1982) developed a similar model which would simultaneously account for the roles of personal, physical, economic and institutional factors as they influence the adoption decision-making process. This was something that had been missing previously. They took the measurement of adoption (as a dependent variable) further than Nowak by conceptualizing it as the effectiveness of the effort expended on soil conservation. Ervin and Ervin's model is illustrated in Figure 4.

In essence, these revised models are hybrids of the traditional and economic constraint models designed to address the short-comings of earlier models. They attempt to incorporate alternative goals to profit maximization, discordance between perceptions and reality, and some limited community and institutional factors. These models build on the insights of the diffusion and economic perspectives in a complementary, rather than a competing, way (Nowak, 1987). However, these models have not systematically addressed policy and political parameters.

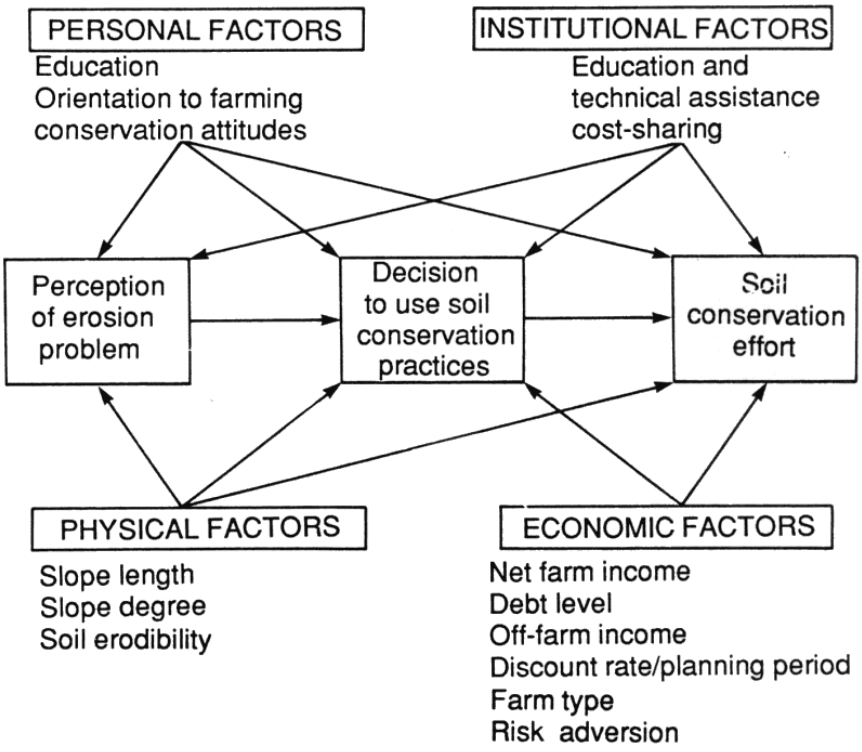

Figure 4: Ervin and Ervin's Model *(Redrawn from Ervin, C.E. and Ervin, D.E. (1982) with permission of the University of Wisconsin Press.)*

Alternative Structural Model:

Many government programs based on these aforementioned models have failed to achieve the results expected. One possible explanation is that these models have failed to explain the decision-making process for soil conservation practices. These models assume that voluntary promotion of soil conservation was appropriate and justified because it was in the economic and moral interest of farmers to comply. They also assume that technology alone would provide the answers to erosion problems. In response to this failure an alternative perspective has emerged (Bromely, 1982; Batie, 1986; Lovejoy and Napier, 1986; Repetto, 1986).

This alternative perspective, herein called the macrostructural approach, is based on the premise that land degradation problems, and the slow adoption of soil conservation practices, are rooted in the prevailing arrangement of agriculture as an institution more so than in individual attitudes and decisions (Lovejoy and Napier, 1986; Batie 1986). It is the broad political, economic, and institutional factors which have been held constant in the more traditional analyses which are envisaged to be the more important in resolving land degradation and soil conservation problems (Batie, 1986). This new perspective "suggests that more attention must be given to the policy question of property rights and the implications that flow from modifications in the existing rules of ownership. . . . It also recognizes the impact of current policies and farmers' practices on resource quality and quantity but does not emphasize the impact of policies and practices on farmers' income and production. Finally, this perspective strongly suggests the current institutions influence farmers'

practices and stresses the impact of practices on environmental policy" (Lovejoy and Napier, 1986:309).

One reason farmers reject soil conservation practices is that the institutional, economic and social structures of agriculture, in combination with national and world economies, are configured in such a way that farmers, wishing to remain competitive, or even survive, have no choice but to degrade the natural resource base. If this is the case, then past efforts directed at persuading individual farmers to conserve have been in vain. For example, when farmers have been subsidized and encouraged to produce continuous row crops, and to remove fencerows to make way for larger-scale equipment, it is surprising that you get any voluntary soil conservation at all. The variables which have been examined using this approach, and which have been assumed as given in the traditional perspectives, include institutional design, property rights, taxation, government roles, values, and social equity (Batie, 1986).

ASSESSING THE MODELS

Research which has sought to explain a farmer's decision to use soil conservation practices suffers from two conceptual problems (Ervin and Ervin, 1982). First, there has been a lack of an integrated model which explains the adoption and use of soil conservation practices which includes economic, diffusion, and structural variables. Second, adoption and use of soil conservation practices has been measured with different instruments rendering much of the work incomparable.

The models addressed here can be broken into two types. The first we call 'diffusion-based', and include the traditional and the revised adoption-diffusion model as well as the economic constraint model. The second group we simply refer to as `macrostructural'.

We will begin by examining the diffusion-based models. We consider not only the models' underlying assumptions, but also problems associated with their application to soil conservation specifically. Finally, we focus on the limitations of the structural approach. This section concludes by calling for an integrated approach to the concept of soil erosion.

Diffusion-Based Models

Conceptually Based Critique

The traditional application of the adoption-diffusion model has been used as the justification for the design of numerous educationally-based soil conservation programs (Green and Heffernan, 1987). These programs have been based on the assumption that awareness of a problem will be followed by action to correct it. This approach is flawed because it assumes that: 1) decision-makers are perfectly rational, 2) new behaviour (via an innovation) will result in individual economic gain, and 3) decision-makers are not constrained in their behaviour. These assumptions are not necessarily applicable to resource conservation problems (Pampel and van Es, 1977). While farmers may be rational, they may not be so in a strict economic sense in that they are not necessarily profit maximizers. Additionally, conservation may result in individual gain but future economic benefits tend to be discounted at too high levels to bring significant return in the near future. Finally, there

is evidence to suggest that farmers are constrained in their behaviour (Nowak, 1984; Batie, 1986; Lovejoy and Napier 1986). For example, there exists a plethora of government programs in Canada directed at the farm community, the majority of which are production related. In some instances conditions may be such that a farmer has "no choice" but to conduct undesirable practices in order to ensure reception of program benefits and thus continuance in farming. Similarly, while a farmer may wish to adopt a conservation system this desire can be constrained by ability to secure capital backing, perceptions of risk, or lack of information.

If incentives to change land management practices are applied in a voluntary scheme the diffusion-based models may still be applicable as participation may still yield financial benefits (van Es, 1983). Conversely, where soil conservation practices are promoted on their societal merits in reducing off-farm impacts and thus imply social rates of discount, or where programs are mandatory, the model is invalidated (van Es, 1983).

The traditional model effectively distinguishes between different groups of people based on their degree of innovativeness. Groups are classed as 'innovators', 'early adopters', 'early majority', 'late majority' and 'laggards' according to socio-economic, personality, and communication behaviour characteristics specific to each group (Rogers, 1983). This model has been useful in explaining why all do not adopt an innovation instantaneously and more useful in describing the diffusion process. It is clear, however, that as a predictive tool of behaviour change, much variance is still unexplained. Diffusion-based research has also suffered the lack of a coordinated approach in application. Many studies have attempted to estimate the likelihood of adoption or to predict it. It is unclear whether this research is examining the probability or the rate of adoption. If the end goal is to increase the adoption rate and not turn every farmer into an innovator then a distinction must be made among groups of individuals. This distinction cannot be made if adopter categories are ignored and individuals are instead lumped into dichotomous groups based on use or non-use of conservation measures.

Nowak (1987) has observed that studies (including his own) have not adequately conceptualized and measured the adoption and diffusion of conservation practices. Most of the criticisms of the model have concentrated on how the model has been used rather than on the model itself (Nowak 1987). Critics have not rejected the traditional adoption-diffusion model, but simplifications of it which have not included the essential dimensions of the model as it was first conceived. These oversights include broad macro-economic and macro-social parameters.

We note that the economic and adoption-diffusion models approach the adoption of soil conservation from the micro level, that is at the level of the local farm community and individual farmer. While some societal or macro level factors have been included, they are still analyzed within the voluntaristic framework. While Ervin and Ervin rightly highlight this methodological issue, these models are limited in that they do not account for the structural factors in a comprehensive way. While they are more robust than previous attempts, the approach is still largely individualistic. Factors like education and cost-sharing are not truly macro variables, unless viewed as societal institutions.

Research reportings have tended to condense descriptions of these models into brief book chapters, or journal articles, venues which do not allow for a full development of the theory behind the empirical results. Subsequently, readers may have received a false impression. Nowak (1983) cautioned that the model cannot be naively and mechanically applied. He noted that adoption-diffusion models have significant limitations which must be considered before they are employed to stimulate the rate of change in soil use practices.

Measurement Critiques

The diffusion-based literature is characterized by an inconsistency in explanatory results. For example, Napier et al. (1984) investigated whether diffusion or economic constraint variables better explained adoption of conservation tillage practices. They concluded that, compared to the economic variables, diffusion-type variables were of little utility in explaining adoption of tillage practices. Conversely, Nowak (1987) conducted a similar study and concluded that the economic variables were less important than the diffusion variables. He determined however, that both economic and diffusion factors were important predictors in the adoption of soil conservation practices. These conflicting results have been due to inconsistent and often inadequate measurement of study variables (Ervin and Ervin, 1982; Norris and Batie, 1987).

Perhaps the variable that has been measured with the greatest inconsistency is adoption. For many studies adoption has been treated as the dependant variable for analysis. Some studies have measured adoption as the number of practices or specific tillage implements employed, but this has not assessed the correct or effective use of such practices/implements. Nowak (1983) has stated that research should be more specific when measuring the use of a particular production practice or implement than simply asking if it is used, or assessing the number of times a group of practices are used. To understand the extent of adoption it is important to know where it is occurring relative to areas of high soil erosion. Conservation is not an either/or situation but rather a system or process. Adoption, therefore, cannot be measured in such simplistic, dichotomous terms as adoption or rejection (Nowak, 1983). To overcome this problem Ervin and Ervin (1982) have devised a useful typology of adoption measurement that allows a fuller understanding of the components of the process.

Zimmerman (1988) used type of primary tillage implement employed as a measure of conservation tillage adoption. A number of previous studies have used percent residue cover. Zimmerman found that adoption of conservation tillage among a group of randomly selected farmers was greater than found in other studies. Again, such inconsistency highlights the importance of selecting an appropriate measure of conservation tillage use/effort and/or adoption of a conservation practice. She also noted that farmers tend to overestimate the amount of residue cover that is left on their fields. What is needed is an objective measure which would alleviate problems of discordance between perceptual and objective measures of adoption of conservation tillage. Nowak (1987) has employed a useful conservation index in an attempt to address the aforementioned problem.

Measurement of independent variables has also been problematic. Zimmerman (1988) employed a measure of management skills which she included as a factor, or variable, influencing the adoption process. With regard to financial variables, we note a general tendency to focus on gross

income, farm size or an ability to invest as measures of the farm financial situation (Nowak, 1987). However, these seem to us to be inadequate for the stated purposes. Financial health might better be measured with an indication of net income rather than gross income as this measure would provide a more accurate indication of potential to invest, or through an accounting measure of business health such as debt level or leverage (See the section in Chapter Four titled "Significance of Specific Variables: Farm Income or Financial Situation" below).

Some, if not most, studies do not seem to have addressed questions of farm type, soil erosion potential, and actual soil erosion problems when assessing differences between adopters and nonadopters. This is important because, for example, a beef farmer may already have a crop rotation which reduces soil erosion so that there is no need to consider no-till, or a farm may not have a soil erosion problem or potential problem. Norris and Batie (1987) have noted this lack of measurement of erosion potential and have developed good measures of it and their other independent variables. Their research is well documented, and they provide the reader with a methodological rationale for their choice of independent variables. Ervin and Ervin (1982) also have included a good discussion of the variables they used and how they were measured.

Macrostructural Model

The macrostructural model represents a fundamentally different view of factors controlling land degradation and influencing the adoption of soil conservation measures. It is society which influences the individual, rather than society being the product of individual choices. This model is relatively new and research has been exploratory. The macrostructural model makes the assumption that if the structure of the system is right, in the way that institutions impact on the individual, then soil conservation will follow. This view, however, does not consider the impact of individual responsibility.

This model directly addresses the role of values and goals in soil conservation, rather than assuming them to be constant or inert. Unlike the individual voluntaristic perspective profit maximization is not assumed to be the goal of individuals and society. Nor does it assume that institutions are currently in their optimal form. In fact, many of these macrostructural factors are also implicit in Rogers' model of the adoption and diffusion of innovations. Rogers' model is an individual or group decision-making model, but also considers the structural and institutional environment and its role in shaping the values, priorities and goals of individuals and groups within society.

Swanson et al. (1986) suggest that individual characteristics such as those found in the traditional adoption-diffusion model, as well as some structural factors, need to be accounted for in models of the adoption process. Adoption-type variables such as personal and farm characteristics are necessary, but not sufficient to explain adoption behaviour. There are elements in the overall structure and make-up of society which mitigate against soil conservation and there are individual characteristics which do the same. From an individual point of view, there is a need for those concerned with the stewardship of our land resource base and the sustainability of our agricultural system to do all that is possible to encourage the adoption and diffusion of soil conservation

practices by developing appropriate educational, assistance and incentive packages. There is also a concurrent requirement to develop a social and economic system the structure of which encourages individuals to act according to principles of good stewardship.

SUMMARY

This chapter has presented a brief overview of the broad paradigms explaining the use of soil conservation practices. These models were grouped into two categories, diffusion-based and macrostructural. Diffusion-based models are rooted in the adoption-diffusion process championed by Everett Rogers. The structural model, while recognizing the utility of the adoption paradigm, asserts that the institutional make-up and interrelations of whole societies must also be considered as controlling individual behaviour. Diffusion-based models have been criticized primarily for their lack of comprehensiveness in conceptual approach and inconsistency in research design. The macrostructural model is a recent phenomenon and as such its empirical approach has been exploratory if not editorial.

These paradigms have been used as conceptual frameworks for empirical testing of influences on individuals, and consequent policy recommendations. In the next chapter we look specifically at the results deemed to significantly influence the adoption and use of various soil conservation practices.

CHAPTER FOUR

FACTORS AFFECTING THE ADOPTION AND USE OF SOIL CONSERVATION PRACTICES

INTRODUCTION

In the previous chapter we examined and assessed the broad paradigms of adoption-diffusion research related to soil conservation practices. This chapter has two primary objectives. The first is to outline the major recent research findings related to factors affecting adoption decisions of soil conservation practices. Second, an attempt will be made to specify the relative importance of the factors discussed. As past research has measured a variety of dependent variables, the criteria used as a measure of adoption and the type(s) of practice(s) considered will also be specified where possible. The first part of the chapter presents an overview of areas of research. In the next section a full range of individual variables is critically assessed.

In recent years there has been considerable research, particularly in the United States, into the factors which affect the adoption of various soil conservation practices. Napier et al. (1984) have suggested that this recent research emphasis has been partially stimulated by government. Funds to provide incentives to farmers to adopt soil conservation practices are limited and mandatory regulations are politically unpopular; therefore, ways must be found to motivate farmers to change their farming practices without the use of bribes or force. Additionally, program funding must be allocated and used efficiently. In order to target funds effectively, an understanding of the process by which farmers make decisions to adopt conservation practices and the factors constraining their actions and decisions is critical. Furthermore, if legislation proves necessary to modify individual behaviour into that which conforms to the best interests of society, then it will be important to do so in the least offensive and most efficient manner. Finally, there are purely scientific reasons to understand the factors which affect adoption decisions, one of which is the process of empirical model development and validation.

RECENT RESEARCH RESULTS

Prior to the recent proliferation of research on the adoption and diffusion of conservation-related agricultural practices, Jones (1967) reviewed the literature on the adoption and diffusion of general agricultural practices. He grouped the factors which had been studied as follows:

1) situational characteristics: farm & farm business;

2) personal characteristics: social background, age, etc.;

3) sociological characteristics: social status, social participation;

4) socio-psychological variables: values and goals; attitudes and motivations, and;

5) the nature of the community: norms, institutional and organizational characteristics.

Jones' thorough specification of the important groups of factors can be used as a bench mark against which to assess the comprehensiveness of much of the recent work pertaining to the use of soil conservation practices. Research since that time has also attempted to assess the importance of groups of these factors on an individuals' decision-making process. However, the particular direction seems to have been dependent upon the particular purpose and perspective of the researcher(s).

The work to date has ranged from investigations of the sociological differences between adopters and nonadopters of a particular tillage practice to the development and testing of models of adoption behaviour which account for a range of possible factors. Most attempt, to some degree, to draw program or policy implications from their research results even when they do not specifically set out to evaluate policy options. We briefly outline here examples of the range of work done and factors investigated by researchers.

Recent reviews have investigated specific factors affecting the use of soil conservation practices. Culver and Seecharan (1986), categorized factors affecting the adoption of soil conservation practices as: 1) physical factors, 2) economic factors, 3) personal factors, 4) type of farm, 5) type and form of information, and 6) the availability of an economically and technically feasible solution. More recently, Dickinson et al. (1987) categorized the factors affecting the adoption or nonadoption of soil conservation practices as: 1) socio-economic barriers, 2) individual characteristics of farmers and 3) economic or managerial "realities" such as short run cost, managerial complexity, and real or perceived risk of new technology or practices.

Many have taken an approach similar to that of Bultena and Hoiberg (1983) and studied personal, attitudinal and farm characteristics of adopters and nonadopters of various conservation tillage techniques or other conservation practices. Carlson and Dillman (1986) for example, compared socioeconomic characteristics, perceptions about soil erosion, perceptions about no-till, motivations for use of no-till, assessment of the future of no-till, and information sources and their importance between users and non-users of no-till systems.

More recently, some researchers have questioned whether it is appropriate to group all soil conservation practices together and whether conclusions drawn for one conservation practice can be extrapolated to other practices. For example, Nowak (1987) considered the adoption of profitable and unprofitable soil conservation technologies. He looked for relationships between two groups of practices and three broad types of factors: 1) diffusion-type (i.e. information), 2) economic (i.e. farm-firm), and 3) ecological (i.e. land-use intensity, land quality, and soil erosion rates). Similar work was done by Norris and Batie (1987), who considered social and economic characteristics of farmers, their contact with agencies and the erosion potential of their land in a study which assessed whether or not the same factors affected the adoption of conservation tillage as affect other conservation practices. Conservation tillage was separated from other soil conservation practices since it appeared to be a profitable practice in the short run for farmers in Virginia. In their work they were careful to measure conservation effort as well as the decision to adopt, something few other researchers have done.

Others have noted the importance of attitudes and perceptions of soil erosion, land degradation problems, and potential solutions of either particular practices or soil conservation programs and

policies. Christensen and Norris (1983) reviewed the research on farmer's attitudes towards the use of soil conservation practices to control nonpoint source pollution and suggested some policy implications of their findings. They discussed existing attitudes toward the problem of nonpoint pollution, control measures, and government options for action. Influential factors were grouped into four categories: 1) personal characteristics, 2) institutional characteristics, 3) physical characteristics, and 4) economic characteristics. Napier and Camboni (1988) studied attitudes toward a proposed conservation program similar to the Conservation Reserve Program in the United States. Their intent was to determine which diffusion related concepts would predict attitudes toward such a program. The range of factors they included was very narrow, given the findings of other researchers, since they did not include any demographic or socioeconomic variables in their analysis. The results of their work may not be generalized since they assessed only a very specific program which, unlike most soil conservation programs, involved no change in farming practices.

Some research has shown that the perception of a problem is the first step toward its resolution. If this is the case, then it is worthwhile to consider the factors which affect the perception of problems. Green and Heffernan (1987) examined the effect of economic and social factors on perception and awareness of soil erosion problems rather than factors affecting adoption itself. Their hypothesis was that these factors were influential at the perception stage as well as the adoption stage of the decision-making process.

The final area of research has been directed towards either estimating a function which would predict the likelihood of adoption or explicitly testing a proposed model of the adoption process. Earle et al. (1979) examined socio-economic and situational variables and developed a function which predicts the likelihood (probability) of adoption of soil conservation measures. Likelihood was measured as a farmer's intention to adopt any of a group of soil conservation measures. Ervin and Ervin (1982) developed and tested a conceptual model of the farmer's decision to use soil conservation practices. Broad factors included as independent variables were: 1) personal, 2) physical, 3) economic, and 4) institutional. The dependent variables considered were: 1) perception of the degree of soil erosion problem, 2) decision to use soil conservation practices, and 3) soil conservation effort.

Blaikie and Brookfield (1987) noted that both macro and micro variables need to be accounted for when considering the factors which affect the adoption of soil conservation practices. The structural forces underlying the decision process are as important as the technological problems and considerations which are involved. Only recently, however, have macro variables such as the structure of agriculture, or the economy in general, been explicitly considered in soil conservation research. The scale of factors which will be relevant will include the context of decision-makers, conditions of access to resources, the ability of land managers to apply what they know or can learn, and the willingness of land managers to apply what they know or can learn (Blaikie and Brookfield, 1987).

Significance of Specific Variables

The following section describes the significance accorded by various researchers to the influence of selected variables on the adoption/decision-making process. We caution the reader that interpretive comparisons should consider the variability of specific methodologies and analytical techniques employed before conclusions are drawn. While specific results may differ due to

methodological differences, some trends emerge that will provide important guidelines for future researchers to build on.

Age:

Culver and Seecharan (1986) concluded that younger farmers were more likely to perceive that soil erosion was a problem, that conservation measures are profitable, and that the risk associated with adopting new practices is therefore justified. This conclusion was supported by the findings of Bultena and Hoiberg (1983), discovered that younger farmers were more likely to adopt conservation tillage than older ones. In another study, Carlson and Dillman (1986) found that early adopters of no-till were either younger or older than nonusers of no-till. Christensen and Norris (1983) noted that younger farmers are more likely to recognize nonpoint source pollution problems. However, they found that age was directly related to implementation of BMP's (Best Management Practices) to control pollution. They posited that this anomaly was related to the larger financial constraints faced by younger farmers. Green and Heffernan (1987) found that age was positively related to adoption, but negatively related to a farmer's perception of the extent of soil erosion. Others have found age to be significantly, but negatively related to the effort put into conservation tillage, but not significant for the effort put into other conservation practices (Norris and Batie, 1987).

Education:

The majority of evidence suggests that, similar to age, educational level has a positive relationship on the use of soil conservation practices. Earle et al. (1979), for example, found that higher educational level was associated with stronger intentions to adopt soil conservation in general. Others have shown that better educated farmers were more likely to adopt conservation tillage (Bultena and Hoiberg, 1983) and early adopters of no-till had more education than nonusers (Carlson and Dillman, 1986). Similarly, Christensen and Norris (1983) concluded that education was positively related to the adoption of BMP's for the control of pollution. Lack of education was found to be one reason for indifferent or negative farmer attitudes toward soil conservation in southwestern Ontario (Sadler Richards, 1983). Lack of education limited farmer's knowledge and awareness of the concepts of soil conservation, thus they were unable to recognize soil erosion problems when they existed. Finally, Ervin and Ervin (1982) concluded that education was significantly related to the adoption of soil conservation in the three models they tested.

Some evidence has suggested that there may be some important interactions between education and other variables. Green and Heffernan (1987) found that education was positively related to the adoption of soil conservation practices and to the perception of an erosion problem but negatively related to the perceived extent of the problem. Pampel and van Es (1977) stated that education is related to the adoption of commercial practices but not the adoption of environmental ones. In the work of Norris and Batie (1987) education was found to have a significant negative impact on conservation effort as measured by conservation expenditures in general, while it was not significantly related to conservation tillage effort (Norris and Batie, 1987).

Years Farming:

There has been little discussion of the role of experience or years farming in the literature to date. Christensen and Norris (1983) found that farmers with more experience were more likely to adhere to traditional practices and therefore, less likely to adopt BMP's. Conversely, Pampel and van Es (1977) conclude that years farming is positively related to the adoption of environmental practices, but not to the adoption of commercial practices. Such evidence as exists is not conclusive and a more thorough investigation should be undertaken to determine the relative importance of this factor.

Management Skills

Little work has been done to assess the importance of this factor. Its importance will depend upon the complexity of the soil conservation practice or technology being considered. In one study, more efficient farmers (as measured by the use of double cropping), and presumably more skilled, had stronger intentions to adopt soil conservation (Earle et al., 1979) Zimmerman (1988) found that innovators had significantly higher farm management shills (as measured by a complexity index) than a group of randomly sampled farmers. In his discussion of possible modifications to the traditional adoption-diffusion model, Nowak (1983) noted the importance of farm management skills in the adoption of soil conservation practices. This is especially true, since conservation practices place additional demands on farmers' managerial skills in an already risky occupation.

Farm Size:

Earle et al. (1979) determined that larger farm size was associated with stronger intentions to adopt soil conservation. Farmers with larger farms were more likely to adopt conservation tillage (Bultena and Hoiberg, 1983), and early adopters of no-till farmed more land than nonusers (Carlson and Dillman, 1986). Christensen and Norris (1983) concluded that farm size was related to the importance farmers placed on conservation. Finally, Norris and Batie (1987) showed that farm size, as measured by acreage cropped, was significantly and positively related to conservation effort for both conservation expenditures in general and for conservation tillage acreage. They also noted that farm size (and off-farm work which had a negative impact), was the only factor found to have the same impact on conservation effort for the two categories of conservation practices they considered.

Although much of the research specifies a positive relationship between farm size and the adoption of soil conservation practices, Culver and Seecharan (1986) state that there are differing views among researchers. Christensen and Norris (1983) note that one study found no difference in the adoption of soil conservation among farms of different sizes. Another study found farm size was a significant factor in predicting the adoption of commercial practices, but not environmental ones (Pampel and van Es, 1977). These discrepancies may be related to measurement inconsistencies mentioned earlier.

Farm Type:

Culver and Seecharan (1986) have noted that farm type, as denoted by major enterprise, will be important in the adoption of soil conservation practices because the ease with which the necessary practices can be integrated into an existing operation will depend on the type of farm operation in place. Christensen and Norris (1983) have stated that there is less adoption of BMP's for cash grain farms than other farm types due to the inherent short-run profit goal of these operations. They also note that there is less adoption of BMP's for family farms than for non-family farms since family farms tend to be smaller and have less capital to invest (Christensen and Norris, 1983). Perhaps the most significant findings are those of Ervin and Ervin (1982) who found that farm type (measured by whether or not it was a cash grain farm) was not significant in the perception model of adoption. For both the number of practices model and the conservation effort model, however, the type of farm was significantly (but negatively) correlated with the adoption of soil conservation practices. That is, non cash-crop farms were more likely to be conservers than cash-crop farms.

Farm Income or Financial Situation:

Several different, and therefore noncommensurable, measures have been used to define farm financial situation. Measures have included net or gross farm income, growth of income over time, debt level, capital available, and off-farm income. Measures of gross farm income are the most common as it is the easiest and least offensive to collect. Higher gross incomes have been shown to be significantly related to the adoption of conservation tillage (Bultena and Hoiberg, 1983; Smithers and Smit, 1989). Similarly, Carlson and Dillman (1986) found that early adopters of no-till had higher gross incomes than nonusers of no-till. Gross farm income has also been positively correlated with the perception of soil erosion problems, the perceived extent of the problems, and the adoption of soil conservation practices (Green and Heffernan, 1987). Pampel and van Es (1977) found a positive farm financial situation, as measured by sales and by capital, significant in predicting the adoption of commercial practices, but not environmental ones.

Less commonly used measures of financial situation have shown similar relationships as those mentioned above. Farmers whose income was increasing with time had stronger intentions to adopt soil conservation (Earle et al., 1979). Less directly related to adoption are the conclusions of Christensen and Norris (1983) that economic rank has a positive effect on acceptance of risks. This conclusion is relevant to the adoption of soil conservation practices since there is always a certain amount of risk associated with the adoption of new practices. (see RISK below)

Norris and Batie (1987) used net farm income, debt level, and the presence of off-farm employment as measures of farm financial situation. They found that net farm income was significantly and positively related to conservation effort in general, but negatively related to conservation tillage. Debt level was significantly and negatively related to conservation effort in general but not significant for conservation tillage. Norris and Batie also found that the presence of off-farm employment was negatively and significantly related to both conservation expenditures in general and conservation tillage acreage specifically.

Nowak (1987) noted that gross farm income is often used as a measure of "ability to invest" in agricultural technologies. Although most researchers use this as a measure of financial situation, it is questionable whether this is a suitable surrogate. While such a measure is nonetheless an indicator of capital stock, given other considerations it might be more appropriately termed 'potential to invest'. Some suggest that gross farm income is used because farmers are sensitive to questions related to their net farm income. However, Norris and Batie (1987) reported no difficulty collecting this information. A measure of net farm income and/or of debt level is, in our opinion, a far better indication of financial health and ability to invest than gross farm income.

These results indicate that financial constraints are important for the implementation of conservation practices in general, while the adoption of conservation tillage tends not to be constrained by either income or debt (Norris and Batie, 1987).

Farm Organizational Structure:

The type of organizational structure in place will, in part, influence land management practices, farm planning strategies, and goals of an operation. For example, a very different view of the land and the farming business is likely to occur between a family and a commercial farm where there are often differential priorities regarding the intensity with which the land is farmed. Few studies have considered organizational structure as a potentially influential variable. Early adopters of no-till were more likely to be a family corporation as opposed to a family farm (Carlson and Dillman, 1986). Christensen and Norris (1983) note an indirect effect of organizational structure on the adoption of soil conservation practices. They concluded that the lower adoption of BMP's for pollution control among family farms than among non-family farms occurred because they were smaller and had less investment capital.

Risk:

Culver and Seecharan (1986) state that there is considerable uncertainty associated with the costs and benefits of soil conservation measures. The amount of risk or uncertainty associated with a farmer's immediate decision-making environment, affects the length of the planning horizon. When uncertainty is low, planning horizons lengthen. The economically tolerable amount of soil erosion declines rapidly as the planning horizon lengthens (Dickinson et al., 1987). This observation is supported by Bultena and Hoiberg (1983) who found that those more disposed to accepting risk (financial or other) were more likely to adopt conservation tillage. However, not only the attitude to risk in general but also the perceived riskiness of the practice itself in terms of yield and/or income is important (Christensen and Norris, 1983). For example, no-till was perceived by most farmers to be risky, according to Christensen and Norris (1983).

When Ervin and Ervin (1982) evaluated the importance of several factors in three different models of adoption, they found that risk was a significant factor for the number of practices model but not for either the perception or conservation effort of adoption (Ervin and Ervin, 1982). Other research has shown that favourable attitudes towards a proposed soil conservation program were related to the perception that the adoption of soil conservation practices was not risky (Napier and Camboni, 1988).

In addition to the risk and uncertainty encountered in the technical and biological realms, wherein the techniques may not be well refined or the outcomes are uncertain, there are risks associated with other areas of one's life. One might well ask whether the uncertainties of life are such that non-adoption of soil conservation practices, for whatever reason, occurs because individuals have insufficient energy left over to consider new things.

Awareness or Perception of Erosion Problems:

Evidence from an Ontario survey of cropping, tillage and land management practices has demonstrated that farmers are generally aware of existing and potential soil erosion, soil compaction and soil structure problems on their farms (Wall et al., 1985). However their perception of the extent and magnitude of erosion's effects are questionable. Approximately two-thirds of farmers surveyed in the Thames River basin of Ontario felt that farming activities played a minor role in water pollution problems and 95% felt that their present farm practices were adequate to control water pollution (Thames River Implementation Committee, 1978). There appears, therefore, to be only a general awareness of land degradation problems among farmers. This is nonetheless an important observation, since awareness of a problem is hypothesized by many to be the first step in the process of adopting practices to mitigate against the problem (Ervin and Ervin, 1982; Christensen and Norris 1983; Culver and Seecharan, 1986; Green and Heffernan, 1987).

While there is a general awareness by farmers of broad impacts of agricultural activities, there is evidence to suggest that they may not accurately perceive soil losses on their farms (Culver and Seecharan, 1986; Smithers and Smit, 1989). Christensen and Norris (1983) found that there was a general perception that problems existed, but there was hesitancy among farmers to admit that there was any relationship between pollution in general and the situation on their own farm in particular. It appears that farmers more accurately perceive soil erosion potential than the actual soil loss (Green and Heffernan, 1987). Farmers tend to evaluate the problem of soil erosion by its effect on yields, costs, revenues, profits (i.e. the on-farm effects). Since these effects are not immediately obvious, the net result is that farmers arrive at a different assessment of the extent of the problem than, for example, government technical advisors (Christensen and Norris, 1983; Zimmerman 1988). It is only when physical damage to the soil becomes a hinderance to machinery, or when yields decline, that farmers often realize a problem exists.

Awareness of soil erosion problems has been shown to be positively correlated to the adoption of soil conservation practices. Bultena and Hoiberg (1983) found that farmers who were more aware of an erosion problem were more likely to adopt conservation tillage. Ervin and Ervin (1982) found that perception of soil erosion problems was a significant factor for both the number of practices used and the conservation effort expended. They stated that perception of the problem enhances and reinforces conservation effort. In other research, it appeared that farmers who perceived soil erosion as a relatively serious problem had greater intentions to adopt soil conservation (Earle et al., 1979). Though not a strict measure of adoption, favourable attitudes towards a proposed soil conservation program were shown to be related to perception of soil erosion problems, an attitude that soil erosion should have a high priority for action, and the extent of severely eroded land on the farm (Napier and Camboni, 1988). Norris and Batie (1987) demonstrated that perception of soil erosion problems had

a significant and positive impact on conservation expenditure in general, but had no significant influence on the use of conservation tillage.

Green and Heffernan (1987) demonstrated a positive correlation between perceptions of soil erosion problems and farm sales, erosion potential, and education. Perception of the extent of the problem was positively correlated with farm sales and total acreage, but negatively correlated with age and education. This research approach was limited since the authors do not appear to take into account whether or not the farmers are already practising some form of soil erosion control on their farms. Farm management history would affect perception of the extent of the problem.

Some research has shown that early adopters and nonusers of no-till had very similar attitudes about soil erosion (Carlson and Dillman, 1986). There were also few differences in their assessment of the importance of certain factors in controlling it. Users of no-till had a broader perspective on soil erosion problems and a better perception of its indirect impacts than nonusers. Not surprisingly, Zimmerman (1988) found that innovators (those who participated in the Tillage 2000 program) were more aware of soil erosion problems, and their perceptions were more accurate than a randomly selected group of farmers.

The absence of soil conservation practices on a farm does not necessarily imply that farmers are unaware or unconcerned about land degradation problems (Swanson et al., 1986). The same may also be true for pollution problems. Rickson and Stabler (1985) found that where farmers were concerned about lake pollution, they were reluctant to pay for its abatement since they could not see themselves as responsible. The authors concluded that farmers were constrained by their perception and experience of soil erosion's contribution to the problem. If farmers perceive that they have already adopted conservation practices (e.g. conservation tillage), or perceive that they do not have a problem, then attempts to affect their conservation behaviour may prove futile (Zimmerman, 1988).

Finally, in any discussion of the role of awareness or perception of a problem in the adoption or decision-making process the level of inquiry must be explicitly defined. Is it on- or off-farm problems on which we are assessing the farmer's awareness and perceptions? Are the problems those of soil erosion in general, or specific to the farmer's own farm? Is it non-point source pollution in general, or is it off-farm pollution caused by the farmer's own farm practices? A differentiation must be maintained between farmer's perception and awareness of soil erosion problems and/or nonpoint source pollution in general and their perception and awareness of soil erosion problems on their own farms and/or pollution caused by their farms.

Awareness or Perception of Soil Conservation Measures:

As noted above, individuals make decisions about changing farming practices based on their perceptions of the situation or the innovation at hand. The benefits of soil conservation practices are not always clearly evident (Dickinson et al., 1987). Where clear assessments of costs and benefits are not readily available, it is more difficult for individual decision-makers to develop accurate perceptions of an innovation and its potential impact on their operation.

Farmer's perceptions of a practice can differ widely from its actual characteristics (Jones, 1967). Jones addressed the importance of the potential adopter's perception of an innovation in general terms. Perceived characteristics of an innovation that affect adoption are:

1. socio-technical: degree of newness, perceived complexity, degrees of discomfort, divisibility, visibility, compatibility with existing methods, and;
2. socio-economic: costs and returns are not always perceived similarly by farmers and social factors may modify the importance of economic considerations or perceptions of the advantages of adoption.

Research on the perception of practices or innovations has been limited to date. What has been done has demonstrated the importance of awareness and perceptions (positive and negative) of innovations in the adoption decision-making process. An individual must be aware and reasonably comfortable with an innovation and its basic characteristics before adoption can be seriously considered. Christensen and Norris (1983) have suggested that a hesitant attitude toward mitigating a problem is caused by limited awareness concerning the nature of the problem, and a lack of awareness of available programs and options (practices or innovations) to address the situation.

Simple awareness is irrelevant without an indication of whether one perceives the innovation or practice positively or negatively. Positive views of possible measures for the control of erosion were felt by Christensen and Norris (1983) to depend upon:

1. the practice's perceived **effectiveness** (which is a function of the available information about it, and previous experience with it by the potential users);

2. the perceived risks to yield and income of using the practice (e.g. no-till was perceived by most to be risky over conventional practices); and

3. the perceptions of the **benefits** derived from use (which are not always understood).

They noted a tendency for soil erosion control measures to be adopted more for economic reasons than environmental quality improvement motives. Decisions were based more on production considerations than on those derived from a conservation ethic. Such conclusions raise policy considerations as to whether voluntary promotion is a viable method of encouraging widespread adoption of remedial measures where warranted.

Examples from current research support the above observations. Napier and Camboni (1988) discovered that favourable attitudes towards a proposed conservation program were positively affected by farmer's perceptions of those practices. In particular the perception of risks associated with practice adoption were most significant. In other work, users of no-till were shown to be more likely to assess (or perceive) no-till as requiring fewer inputs and earning greater net returns than nonusers (Carlson and Dillman, 1986). No-till users were more likely to have a positive assessment of no-till, and to view it as a way to farm more efficiently.

Caution must be exercised in any attempt to draw conclusions from statements such as the above. For example, was no-till actually more financially rewarding for these farmers in their particular setting, or only perceived to be? Did these views about no-till develop before or after adoption of the practice? In Zimmerman's work (1988), innovators were found not only to have a higher rate of adoption of conservation tillage than the general farming population, but also a more accurate perception of what conservation tillage involved. Again, this does not give us an indication as to whether they perceived conservation tillage more accurately prior to adoption, whether this was a factor in adoption, or simply the result of the adoption and continued use of the practices.

Negative experiences with conservation tillage and misconceptions about the economic viability of technologies were related to indifferent or negative farmer attitudes towards soil conservation (Sadler Richards, 1983). The Thames River Implementation Committee (1982) concluded that in some cases the most effective practices for controlling soil erosion were those which the farmer was the least willing to spend money on. This resistance to invest was caused in part by a lack of understanding of the erosion and sedimentation process, as well as possible control measures (Thames River Implementation Committee, 1982). They concluded that, under these constraints, demonstrations of effective soil erosion control measures were needed to avoid misconceptions about the practices.

Much of the perception research conducted on the factors which affect the adoption or decision-making process has assessed the farmer's perceptions of soil conservation practices, the severity of erosion problems, whether they are doing something about it, and what they are doing. It seems to us that perceptions of the innovation are at least as important as the actual characteristics of the innovation itself.

Attitude Towards Soil Erosion and Soil Conservation:

Attitudes toward something are different than awareness about, or perceptions of the item in question. Knowledge about something is necessary prior to having an attitude towards it, but questions (in a survey, for example) which assess awareness or perceptions do not necessarily provide information vis-a-vis an individual's attitude toward the item in question. A person might perceive that a soil erosion control practice is not economically justifiable, but this does not necessarily mean that he/she will have a negative attitude towards the practice; as it may be the best solution available. Similarly, a person may have a positive attitude towards soil conservation and conservation practices in general, but may not perceive the problems or solutions accurately. Conversely, it is possible for an individual to accurately perceive the extent of soil erosion problems and not care about them enough to do anything about them (in other words, to have a negative attitude toward soil conservation).

There are many instances where attitudes follow from perceptions. For example, indifferent or negative attitudes toward conservation tillage (which would affect adoption rates) were found related to lack of education about the problem, misconceptions about the economics of potential solutions, or negative past experiences with conservation tillage (Sadler Richards, 1983). Although attitudes toward the adoption of soil conservation practices in southwestern Ontario were such that fewer than one half of farmers wanted to adopt new practices, farmers indicated the most favourable attitudes towards better tillage techniques and new or improved crop rotations when considering new

practices for soil conservation (Wall et al., 1985). In other words, negative attitudes in one area do not necessarily imply the same for others.

Napier and Camboni (1988) found that attitudes toward a proposed soil conservation program were significantly influenced by a number of factors. Favourable attitudes were related to perception of soil erosion problems, belief that soil erosion should have a high priority, belief that individual farmers should not have to internalize the costs of soil conservation programs, and the perception that the adoption of soil conservation practices was not risky. Conversely, those who believed that no one had the right to tell them what types of farming practices they could use on their land held less favourable attitudes to the program. Attitudes toward soil conservation practices, programs and policies and to soil conservation in general are a function of not only perceptions of the situation and the options available, but also individual values and priorities.

Lovejoy and Napier (1986) observed that past efforts at promoting soil conservation focused on the provision of information to farmers in an attempt to change their attitudes. They note, however, that attitudes and behaviour are not perfectly correlated and suggest that there ought to be a focus on behaviourial change in conservation programs. In cases where one's actions do not coincide with one's attitudes, it may be that there are other factors affecting one's ability to act on desires (Swanson et al., 1986). "Constraints of one kind or another may prevent farmers or ranchers from behaving in a manner consistent with their attitudes" (Lovejoy and Napier, 1986). Constraints may include farm structure factors (e.g., access to land and capital), as well as structural barriers in the industry and society in general (Swanson et al., 1986). An example of this sort of behavioural constraint comes from an Ohio study where it was found that farmers concerned about the environment were also the most concerned about the risk associated with the adoption items (Swanson et al., 1986). Though respondents had favourable attitudes toward the environment, it may be that their attitudes to risk inhibited the adoption of practices which would reflect their environmental concerns.

From the above discussion it is important to realize that, while attitudes may influence some behaviours, attitudes and behaviour do not necessarily correlate well. When this is true, measurement of attitudes and subsequent attempts to change them may be largely irrelevant exercises and it may be more rewarding to focus on behaviourial change and constraints directly.

Current Adoption of Soil Conservation Practices:

In southwestern Ontario, approximately one third of farmers have changed their tillage practices in the past 5 years, the majority doing so for land degradation-related reasons (Wall et al., 1985). The same study found that most farmers in the region also practised a crop rotation which includes cereals, a crop rotation which has some value in reducing soil erosion from that which would exist with row crops alone. Current use of soil conservation practices is a significant factor in the adoption of other rotations.

Norris and Batie (1987) found that the existence of a conservation plan was significantly and positively related to conservation effort (as measured by expenditures on soil conservation). Similarly, Christensen and Norris (1983) found that those currently practising some soil conservation were more likely to adopt additional practices; as they seem to have the ability to see the need and have

experience with the technology and the kind of results it produces (Christensen and Norris, 1983). Conversely, Napier and Camboni (1988) found that farming practices currently in use were poor predictors of farmer's attitudes towards a proposed conservation program. They add that this may not all be negative since it may mean that there is good potential for new programs to involve farmers who are not currently using soil conservation practices.

From the opposite perspective, the fact farmers were currently using other conservation practices was one reason for non-adoption of conservation tillage in a randomly selected group of farmers in Ontario (Zimmerman, 1988). This does not mean that farmers already practising some form of soil conservation view other measures negatively, but only that they may not consider additional practices necessary when current ones are felt to be effective. If farmers perceive that they have already adopted conservation practices (e.g. conservation tillage) that have remedied a situation, when further efforts are actually warranted incentives to change conservation behaviour may prove futile (Zimmerman, 1988).

These observations indicate that those who have successfully adopted conservation practices will be more likely to adopt other practices in the future. Adoption of other practices in the future will depend, however, on the farmer's assessment of the need to do so which, in turn, depends on his/her **perception** (positive and negative) of his/her current use of conservation practices.

Community Attitudes About Soil Conservation:

Bultena and Hoiberg (1983) found that those who perceived a high degree of local acceptance of reduced tillage were more likely to adopt conservation tillage practices. In their final report, the Thames River Implementation Committee (1982) noted the importance of local community involvement in promoting and implementing measures to control nonpoint source pollution. Community participation undoubtedly fosters positive attitudes on the part of individuals and reinforces an adopter's self-image. Bultena and Hoiberg's (1983) findings are important in that they show that the wider social context is important in the adoption/decision-making process. This is a consideration which has been largely ignored by most researchers in the field of soil conservation until recently. This is just one example of the general lack of macro scale variables in soil conservation adoption research.

Soil Erosion Potential:

Most research has demonstrated a positive relationship between the soil erosion potential of a farmer's land base and her/his adoption of soil conservation practices. Green and Heffernan (1987) noted that the actual soil erosion potential of the land was significantly correlated with the perception of the soil erosion problems, and the adoption of soil conservation measures. In another instance the adoption of BMP's was more likely among farmers with steep-sloped land (Christensen and Norris, 1983). Bultena and Hoiberg (1983) found that those who farmed land with greater erosion potential were more likely to adopt conservation tillage. Similarly, Ervin and Ervin (1982), found that potential for soil erosion was significantly associated with perception of an erosion problem and conservation effort expended, but not on the number of practices used.

Contrary to these findings Norris and Batie (1987) found a significant, but negative, relationship between the effort expended on conservation tillage and the potential for soil erosion. There was no significant relationship between soil erosion potential and conservation expenditures in general. They suggested that this negative correlation may point to a need to contact farmers in severely affected areas directly if the severe soil erosion problems are to be solved.

Farm soil erosion potential, whether perceived or actual, and the degree to which it is actually a problem would intuitively be significant factors influencing the adoption of soil conservation practices. However, these two variables are absent from a number of research reports.

Land Tenure:

Christensen and Norris (1983) reported that the majority of the literature indicates that land tenure has an effect on soil conservation. Soil conservation practices are not employed as extensively on rented land. Tenancy arrangements influence adoption of soil conservation since North American leases rarely compensate tenants for improvements made, or penalize them for degradation (Culver and Seecharan, 1986; van Vuuren and Ysselstein, 1986). The proportion of land rented by a farmer has been found to be significantly and negatively related to conservation expenditures (Norris and Batie, 1987). van Vuuren and Ysselstein (1986) demonstrated that farmers managed their owned land differently than their rented land. Rented land tended to be of lower quality and more in need of ameliorative practices, yet less likely to receive upgrading practices. They concluded therefore, that land rental has a negative effect on soil conservation and long-term productivity.

Like much of the research into factors affecting the adoption of soil conservation practices, there are several pieces of work which report conflicting results. Earle et al. (1979) found that land tenure was not significantly related to strength of intention to adopt soil conservation practices. Norris and Batie (1987) found that there was no relationship between tenancy and the use of conservation tillage specifically. They suggest that this was because conservation tillage was a profitable practice in the study area when used properly. In another study, early adopters of no-till rented more land than nonusers (Carlson and Dillman, 1986). In Canada, Smithers and Smit (1989) found a significant relationship between increasing amounts of rented land and a higher level of conservation practice use. These authors suggested however, that this relationship was undoubtedly related to farm size. Finally, Bultena and Hoiberg (1983) showed that tenure status was not related to the adoption of conservation tillage. They found, however, that those who rent land were also those who were most disposed to adopt reduced tillage due to other personal factors. This may be the reason for the positive relationship between tenure and soil conservation in some situations.

Various criteria have been used to measure the relationship between land tenure arrangements and adoption of soil conservation practices. Some researchers have compared the use of owned land with the same farmer's use of rented land. Is this the same as comparing the land use practices of farmers with different proportions of the land they use being rented land? If the adoption of soil

conservation is measured by the number of practices used, or as the use of a particular implement, does this carry much meaning compared to a measure which accounts for the percentage of a farmer's land which is farmed with conservation methods? In land rental situations, little account is taken of the impact of the proximity of rented land to a farmer's own home farm on his decision to use soil conservation or cropping practices. Few North American studies consider tenure measurement beyond nominal rental. Evidence from Australia suggests strongly that security of tenure rather than the form of the arrangement is an important factor (Blaikie and Brookfield, 1987).

The impact of farmer's land tenure circumstances on their use of soil conservation practices is inconclusive at present. There appear to be some strong interrelationships with other variables such as age, education, and farm size which favour the adoption of soil conservation practices.

Kinship Relationships:

The relationship between the possibility of intergenerational transfer of property and the way in which land is managed has not been well explored to date. Kinship is often simply measured by asking individuals if they farm with a relative or not. This variable has been studied because it is assumed that family ties support the expectation of an intergenerational transfer of property, and thus a propensity for current operators to have a longer planning horizon for soil conservation. A recent study in southern Ontario now raise doubts about this assumption (Smithers and Smit, 1989) where 40% of farmers indicated that they did not expect or want family members to become involved in farming as a career upon their retirement.

One study noted that where expectations of intergenerational transfer existed there was a positive and significant impact on conservation tillage acreage, but none for conservation expenditure in general (Norris and Batie, 1987). Similarly, Carlson and Dillman (1983) reported a positive relationship between kinship relationships and innovation and use of soil conservation practices, but acknowledged the regional specificity of their findings. Contrary to these findings van Es and Tsoukalas (1987) concluded that no relationship was evident between kinship and soil conservation innovativeness and use. They found that kinship correlation was contingent upon a perception of soil erosion as a threat to long-term soil productivity.

Motivations for Soil Conservation:

Motivations are assumed to be an important factor influencing individual actions and decisions. There has been a tendency in economic research to assume that the only goal which individuals pursue is that of profit maximization and that this goal motivates all decisions. Traditional adoption-diffusion research does not explicitly define goals or motivational assumptions. In some adoption-diffusion research, however, motivations are explicitly defined as a variable in the adoption decision-making process. Nowak (1987) suggests that we cannot assume that the adoption of conservation practices is motivated by economic rationality alone. Green and Heffernan (1987) suggest that most studies assume that profit maximization or environmental concern are the only motivating factors for farmers. Pampel

and van Es (1977) found environmental concern to be an important motivational factor possibly influenced by farmer's orientation to agriculture.

Three broad classes of motivations addressed are generally: 1) economic, 2) environmental and 3) other. While economic motives have been the major research focus, they are not the only driving forces behind soil conservation. Both Zimmerman (1988) and Carlson and Dillman (1986) found the desire to improve soil structure, and to reduce or control erosion, were important motivations which are not solely economic in origin. Norris and Batie (1987) noted that there was a difference in the factors which were significant in their impact on conservation effort in general and on conservation tillage specifically. Conservation tillage was a potentially profitable practice in the study area, unlike the other conservation practices they considered. Farmer's motives need to be considered for the adoption of each practice, since they may be different for each erosion control practice (Norris and Batie, 1987), and, we might add, for different farmers too.

Other authors have examined cultural groups to gain insights into additional motives for conservation behaviour (Stinner and Hesterman, 1988). Stewardship can also be a motivational factor for some (Connolly and Hilts, 1987). They noted that motives may be either extrinsic or intrinsic. Extrinsic motivation refers to that which is externally derived (e.g. by a government subsidy) and requires continual reinforcement, while intrinsic motivation comes from the behaviour or innovation itself. They believe that intrinsic motivation is the most sure basis for the longer term adoption of a specific behaviour since it results from some internal conviction rather than the continued existence of some external program or incentive.

Orientation to Agriculture and Farming:

Pampel and van Es (1977) measured orientation to farming as one of three possible explanations of adoptive behaviour. For them, orientation to farming was measured as either a "business orientation" or a "way-of-life orientation". Their data indicated that "orientation to farming" was more significantly related to the adoption of different types of conservation practices than either "psychological innovativeness" or "profitability orientation". Taylor and Miller (1978) also found orientation to farming to be significantly related to the adoption of soil conservation practices. While these findings suggest that orientation to farming is a significant factor in the adoption/ decision-making process, more adequate specification of the variable needs to be done before valid conclusions can be drawn (Ervin and Ervin, 1982).

Availability of and Access to Assistance:

Assistance to farmers can take many forms; financial, technical information and advice. The availability of technical and financial assistance has an impact on the ability of farmers to do something about the problems they face (Christensen and Norris, 1983). Farmers considering the adoption of soil conservation practices reported that lack of available knowledge, assistance and/or equipment was an important reason that they would not adopt such practices (Wall et al., 1985).

A key factor in many programs designed to promote the adoption and diffusion of agricultural (and more specifically, soil conservation related) innovations is the provision of information to farmers. This information is designed to educate farmers about soil erosion problems and possible solutions which are available via the adoption of particular practices. While production innovations have received the most attention (e.g., Webster, 1986), it is surprising that more research has not been done into the availability of and access to information on conservation practices. Little has been done to investigate the communication channels, by which such information is distributed and decisions made.

Research has shown that the type and form of information is relevant to adoption rates (Culver and Seecharan, 1986). Lack of available knowledge (Culver and Seecharan, 1986) and access to knowledge (Christensen and Norris, 1983) have been shown to reduce adoption of conservation practices. Farmers considering the adoption of soil conservation practices reported that lack of available knowledge, assistance and/or equipment were important reasons that they would not adopt (Wall et al., 1985). The most important information channels for farmers who have adopted soil and water conservation practices were personal experience, farm media (newspapers and journals) and meetings (Wall et al., 1985) and not government.

The type of information access which a farmer has will depend upon his/her personal characteristics and connectivity to communication channels (Jones, 1967). These communication channels have been shown to be different for different categories of adopters (Jones, 1967). While awareness may come through the mass media, decisive positive or negative influences to change behaviour often arise through inter-personal communications. Role leadership is often diffuse in the farming community, and subsequently hard to measure. Discussion of differences in communication channels for different categories of individuals exists, but is limited. For example, Blackburn et aL (1982) examined communication channels for small farmers in Ontario and found that those receptive to farm improvements had utilized available information sources more than other groups.

Information programs have been instituted to motivate individuals on the basis of what has been shown to motivate innovators. We wonder whether it might be efficacious to tailor information programs and use the communication channels which are of the most importance to similar groups of farmers. In this way the needs and obstacles of later adopters and laggards could be addressed (Roling, 1988).

Cost sharing, another common form of assistance, was found to be a significant factor in a model which measured the adoption of soil conservation practices in terms of conservation effort, but not in models which relied on perception or number of practices to measure adoption (Ervin and Ervin, 1982). On the contrary, Norris and Batie (1987) discovered that the existence of cost-sharing programs did not have a significant impact on adoption as measured by conservation effort. They question, however, whether this was because the amount was too small to affect the affordability of the soil conservation practices available.

Good technical advice can be an important stimulus to adoption of soil conservation practices. An Ontario study found that in some cases the main stimulus for farmers to adopt soil conservation

practices was the availability of good technical assistance (Thames River Implementation Committee, 1982). These results suggest that farmers who already have a favourable attitude towards good stewardship practices, the control of soil erosion, and non-point source pollution, were willing to act in a like manner when they were given advice as to how to do so.

Profitability of a Practice:

It is clear that the use (or non-use) of some practices is economically motivated (Christensen and Norris, 1983) since the presence of a favourable cost/benefit ratio has been shown to favour adoption (Culver and Seecharan, 1986). Zimmerman (1988) stated that the cost of equipment, and therefore, the profitability of the practice, was one reason given by a randomly selected group of farmers for not adopting conservation tillage. In a survey of farming practices in southern Ontario, most farmers who were considering the adoption of soil conservation practices reported that the reason they would not adopt them was due to the perceived poor economics of the practices (Wall et al., 1985).

Although there is fairly conclusive evidence that the profitability of practices is an important factor in the decision-making process, what is less certain is actual profitability of various practices and technologies. In research which used the SOILEC model to assess annualized long-term costs and benefits of farm practices, the net on-farm benefits of adopting conservation tillage were found to be slightly negative in three watersheds in southwestern Ontario (Dickson and Fox, 1988). The implication is that farmers are acting rationally in an economic sense when they do not adopt conservation tillage. Using the same SOILEC model, Seecharan et al. (1985) concluded that in Ontario and Quebec there are some alternative cropping and tillage systems which yield comparable net returns to the conventional system, but with a tolerable level of soil loss. They point out, however, that the lack of quantitative information with respect to the short and long-run economic costs and benefits of soil conservation practices, vis-a-vis conventional practices, is a major contributing factor to the low adoption rate which has been observed. However, as Dickson and Fox (1988) note, yield reductions will decline, potentially increasing profitability, as farmers develop and refine the management skills required to use conservation tillage effectively.

For practices which are profitable locally, it has been shown that their adoption was significantly related to diffusion-type variables (Nowak, 1987). The same was not found to be true for unprofitable practices. Similarly, in an area where conservation tillage was potentially a profitable practice, adoption was not constrained by the same factors as for conservation expenditures in general (Norris and Batie, 1987). Since conservation tillage was profitable, such variables as erosion potential and perception of the problem were not correlated with the adoption of the practice (Norris and Batie, 1987). It appears that the relative importance of the various factors which affect adoption and the appropriate type of model to use may differ according to profitability.

The perception of the profitability of soil conservation practices affects the perception of the problem as well as the adoption of soil conservation practices (Green and Heffernan, 1987). Given the paucity of valid cost/benefit data for various conservation practices, the ambiguity of the results so far,

and the site-specific impact of soil conservation practices, it may be that a positive perception of economic cost/benefit will affect farmer decision-making more so than the actual result.

Noteworthy is an observation related to the way in which many of the economic evaluations are conducted. In most cases, the economics of certain components of a system have been evaluated. However, as we pointed out earlier, sustainable agricultural practices are components of a system. If conservation tillage, for example, is to be properly and adequately employed on a farm, then the whole system must be adjusted to account for this fact. Other inputs must be adjusted to their optimum level under the alternative system if a fair assessment is to be made. In addition, as Nowak (1988) indicates, there are costs to farmers who degrade the soil to maximize production (or profits) which are not contained in the standard economic analysis. This problem arises partly because it is convenient to obtain and evaluate the costs of soil conservation practices, but it is not so convenient to calculate the costs of excessive erosion (Nowak, 1988). Assessing the profitability of a soil conservation practice (or, better, a soil conservation system) is no simple task and there are many factors which must be appropriately addressed.

Characteristics of Innovations:

Innovations possess characteristics that make them more or less likely to be widely adopted (Rogers, 1983; White, 1985; Webster, 1986). These include, for example, the ease with which they may be integrated into the existing farming system or the degree of individual effort (mental and physical) required to master the item. Jolly et al. (1985) have provided some helpful suggestions for distinguishing among the key characteristics of a technology which may affect adoption. By classifying them as either (1) direct superior, (2) direct inferior, or (3) indirect, one is readily able to predict the likelihood of adoption. Inferior and superior are defined on the basis of whether or not net economic benefits of the new technology are greater than the existing technology, while direct and indirect are defined by where benefits occur (i.e. on-farm or off-farm). They concluded that, "when direct economic benefits are absent, the economic and sociological models of adoption appear to break down" (Jolly et al., 1985).

There is far more to the bundle of characteristics which make up a technology than simply the cost/benefit of its use. Dickinson et al. (1987), for example, note that the managerial complexity of the technology or set of practices is an important factor in determining whether or not a practice or set of practices will be adopted. We also suggest that the importance of this managerial complexity factor will vary with education, ability, and experience of the user. Therefore, there is a need to relate the characteristics of the innovation under consideration to the socio-economic characteristics of the potential adopter. We would add that the perceived characteristics of the innovation are as important as the actual characteristics of it.

Factors influencing the adoption of conservation tillage have been found to be different than those for other conservation practices (Norris and Batie, 1987 and Nowak, 1987). The implication is that the results of studies which group them all together cannot be generalized. Nor will an analysis of the factors which affect the adoption of conservation tillage necessarily be valid for the adoption of other conservation practices.

The Larger Economic and Social Environment:

The microeconomic situation on the farm is affected to a large degree by the general macroeconomic climate of the agriculture sector and the national and world economies as a whole. The larger economic environment, therefore, affects the adoption of soil conservation practices indirectly through its effect on the farm's specific economic situation. The same macroeconomic environment will affect different farmers in different ways depending on specific personal and situational factors which are exogenous to the larger economic and social environment.

The organization and structure of the agricultural industry dictates the behaviour of farmers to some extent (Swanson et al., 1986). Tax policy, farm support programs and the agricultural treadmill are barriers to soil conservation. Constraints of one kind or another can prevent farmers from behaving consistently with their attitudes (Lovejoy and Napier, 1986). During periods of uncertainty in the industry, farming decisions are often made for the purpose of maximizing short-run profits (Swanson et al., 1986). Therefore, when the agricultural economy or the economy as a whole is in flux, especially on the downward side, the adoption of practices which affect the long-term sustainability of the farm is not as critical as is achieving short-run survival.

The characteristics of society play a role in environmental degradation (Blaikie and Brookfield, 1987). For this reason, it is difficult to solve environmental problems without addressing the structural issues as well as the individual ones. To date, little empirical work has been done to investigate the role of structural factors in the adoption decision-making process. Batie (1986), Lovejoy and Napier (1986), Norris and Batie (1987), and Swanson et al. (1986), for example, have made a major contribution by highlighting these macro variables as a vital research direction.

ASSESSING THE RESULTS

From the preceding discussion it is evident that an array of factors has been considered by researchers to describe and explain reasons for the existence of land degradation problems, factors influencing the decision-making process of farmers and affecting the adoption of soil conservation technologies, and reassess why soil conservation practices are not more widely used. As an example of the variety of definitions and measurement criteria used, we offer the following list. Among the research we have reviewed, researchers have studied the adoption of:

- soil conservation;
- no-till;
- minimum tillage;
- conservation tillage as opposed to conventional tillage;
- Best Management Practices (BMP's) as opposed to traditional practices; structural erosion control measures;
- non-structural erosion control measures;

as defined/measured by:

- intention to adopt;
- number of conservation practices used;
- use of a particular practice;
- ownership of an implement or set of implements;
- amount of residue cover left on the soil surface -- actual or perceived;
- problem recognition or perception;
- attitude towards soil conservation or conservation practices;
- expenditure on conservation practices;
- conservation effort, as measured by the effectiveness of soil erosion control; and
- amount of pollution control achieved.

Each researcher or group of researchers has defined the problem of land degradation or soil erosion somewhat differently, studied a different combination of factors or variables, and arrived at different, sometimes contradictory, conclusions. The challenge is to decipher, interpret, and apply these results to gain a comprehensive understanding of factors affecting land degradation and soil erosion. Only in this manner can progress be made in finding solutions to problems associated with land degradation generally, and soil erosion specifically.

Variation in methodology has proven problematic. First, because policy-makers and extension personnel have different perceptions of the factors which influence decisions than farmers, the adoption of BMP's by farmers has been hampered (Christensen and Norris, 1983). The same applies to the entire range of practices which are available for farmers to control soil erosion and land degradation. While individual practices tend to have different characteristics, studies tend to aggregate soil conservation practices together when measuring the adoption of soil conservation. Differing characteristics of soil conservation practices are not a problem in and of themselves, provided that the factors which affect their adoption are similar. However, it has been demonstrated that the factors influencing the adoption of conservation tillage were found to be different than those for other conservation practices (Norris and Batie, 1987). The implication of these findings is that results of studies which group all conservation practices together cannot be generalized. Conversely, conclusions reached from the analysis of the factors affecting conservation tillage alone may not necessarily be applicable to the adoption of other conservation practices. Nowak (1987) obtained similar results for profitable and unprofitable practices. What requires consideration is whether there are similar sorts of differences between other conservation measures.

Previous research has focused on diffusion-type variables which describe the potential adopters of an innovation. According to Rogers (1983), these include a variety of socio-economic characteristics, personality variables and a person's communication behaviour. The previous section included a large number of socio-economic characteristics, but none of the others listed by Rogers. It also seemed that those approaching the problem of land degradation and soil erosion from an adoption-diffusion or sociological perspective concentrated on how the various socio-economic characteristics influence a farmer's awareness or perception of soil erosion problems. Awareness of the fundamentals of no-till was found to be generally good. Lacking was assistance for adapting the technology to specific situations (Carlson and Dillman, 1986). Culver and Seecharan (1986) concluded

that, while awareness was an essential precondition to the adoption of soil conservation practices, it must be such that soil conservation is viewed as a priority. The recognition of a problem is the first step in adoption (Culver and Seecharan, 1986), but other factors must be considered as well. Financial ability to take action is also important (Culver and Seecharan, 1986), and was included by Rogers (1983), but has been largely ignored by most who have used an adoption-diffusion approach. For the most part, gross farm income has been used as a weak proxy.

There is more to promoting the adoption of soil conservation practices than generating awareness in the farm community alone. Norris and Batie (1987) showed that perception of the problem is necessary for adoption to take place, but since use of conservation tillage was found to be negatively related to erosion potential not all who have a problem will seek to do something and may need to be encouraged personally. They also concluded that there appeared to be significant financial constraints to the adoption of conservation practices in general, but not for conservation tillage specifically. They posit that soil conservation policy will need to be flexible to accommodate the diversity of farmers and their conservation needs if programs are to be effective.

Perhaps it would be well to ask whether it is that the solutions are not economically viable or that the motives people have (or that we are promoting) are inappropriate for a sustainable, soil conserving agricultural system. The assumption of most economic analysis (and the implicit assumption of most adoption-diffusion analysis) is that individuals throughout society are motivated by profit and we therefore promote and evaluate behaviour based on how it contributes to this goal. This is an assumption which has failed to recognize other goals, be they parallel or alternate. Do we, by the type of analysis we undertake, and the kind of recommendations we make, promote a particular goal or motive for action? Perhaps we ought to consider promoting (or at least accommodating or conducting analysis based on) other goals/motives for action which are consistent with an ecologically sound, and therefore sustainable, agricultural system (not only among farmers but among society at large as well).

Researchers have had a considerable range of success at statistically accounting for the observed variation in the independent variable (some measure of the adoption of soil conservation). How does the amount of variation explained by the models which use diffusion-type variables differ from those which use or include other categories of variables or factors?

Earle et al. (1979) were able to explain 80% of the variation in predicting adoption/nonadoption of soil conservation with a function based on diffusion-type variables. They were measuring intention to adopt and not actual behaviour. Do the two coincide? Some have found that there is not a very good correlation and others have found that even when farmers say they have adopted soil conservation practices, they are not necessarily employing them effectively. Another example of a model using diffusion-type variables is found in the work of Napier and Camboni (1988). Their model explained 22% of the variation using diffusion-type variables. We wonder, however, how this would compare to a similar model using other variables. Given the amount of unexplained variance in this type of model, Swanson et al. (1986) concluded that personal and farm characteristics alone were inadequate to explain the frequency of use of conservation tillage. Pampel and van Es (1977), using diffusion-type measures, were better able to predict the adoption of commercial practices than environmental

practices. These results suggested that the traditional adoption models left out factors which are significant for the adoption of environmentally beneficial practices.

In response to these sorts of limitations, Norris and Batie (1987) developed a model which explained 79% of the variation for conservation in general and 89% for conservation tillage. This model had both economic and social (diffusion-type) variables. They seem to have much more successfully explained the amount of observed variation as compared to the work of Napier and Camboni (1988). The implication is that models which have included only typical adoption-diffusion type variables are less successful than models which are more comprehensive.

Ervin and Ervin (1982) have commented on the innovation-diffusion research done by two research teams in particular (Pampel and van Es, 1977 and Taylor and Miller, 1978). These studies found orientation to farming to be associated with the adoption of what they refer to as environmental practices, reflecting the non-commercial nature of environmental practices. Economic or commercial orientation is a variable related to the adoption behaviour of individuals in the adoption-diffusion model of Rogers (1983). Pampel and van Es (1977) found that farmers tended to be innovative with respect to commercial practices or environmental practices but not both and that the significant factors were different for the two groups of practices. For commercial practices, capital, farm size, farm sales and education were significant, but not years farming and land rental. Only years farming was significant for environmental practices. However, Ervin and Ervin (1982) are of the opinion that the measure of orientation used in the two studies was not ideal. Ervin and Ervin (1982) state that results using diffusion theory are inconclusive. Their opinion is that part of the problem is that the two studies had inadequate measures of monetary incentives, farming orientation and physical need for soil conservation.

The problem of adequate specification of variables was recognized and discussed by Nowak (1987) and Norris and Batie (1987). Many previous studies have had significant limitations in their approach (Norris and Batie, 1987). Norris and Batie are of the opinion that most models of farmer's conservation behaviour only analyze one aspect of the conservation decision process. Unlike Ervin and Ervin (1982), they grouped many types of conservation practices together without considering whether or not they were viewed to be the same by farmers. Few studies have included the actual erosion potential of the land as a decision factor although it is undoubtedly important in the adoption decision and in the amount of effort that will be put into conservation by a farmer.

The work of Ervin and Ervin (1982) included the development and testing of a model which included factors other than the ones traditionally studied by those with an adoption-diffusion perspective. They found that economic factors were more important in explaining the adoption of soil conservation when adoption was measured as conservation effort than when it was measured as the number of practices used. However, a subgroup of economic factors did not exert strong statistical effects (Ervin and Ervin, 1982). They found that different factors were important for non-structural erosion control measures (such as contouring, minimum tillage, and crop rotations) than for structural measures. The importance of education and perception was noteworthy for non-structural measures (Ervin and Ervin, 1982). They suggest that non-economic variables, other than those included, could

be significant, for example, personal values toward soil conservation deriving from family, ethnicity, and/or religion (Ervin and Ervin, 1982).

Nowak (1987) notes that both economic (farm-firm) and diffusion (information) factors are important in predicting the adoption of soil conservation practices. He feels that insights from socioeconomic research ought to help those who use the economic model and who tend to treat farmers as a homogeneous group. In his opinion, soil and water conservation practices cannot be treated as a unidimensional technology. He found, for example, that diffusion type variables were significant in explaining the adoption of conservation tillage (a profitable practice in the study area he used), but not unprofitable practices. Nowak's findings did not explicitly support those of Pampel and van Es (1977) who concluded that diffusion concepts did not apply to conservation practices, but agreed that the tenor of the findings confirmed that different factors are important for different types of innovations.

If we are to understand the decision-making process related to soil conservation technology there must be precise definition of model assumptions and measurement variables. The measurement of factors affecting the adoption of soil conservation practices is not only a function of the problem itself, but is influenced by social and economic factors as well (Green and Heffernan, 1987). Most of the research using the traditional adoption model overlooks this consideration. It also overlooks the problem of transition from one farming method to another. In the adoption of sustainable agricultural practices, of which soil conservation practices are a part, one of the factors which has not been considered at all in the research is the transitional difficulty faced by farmers. It is likely that the difficulty which change presents will play a role in the adoption/decision-making process since there are better and worse ways to make the transition to good stewardship practices.

Finally, there is a variety of adoption situations which are possible, according to Jones (1967). These situations are: (1) voluntary/optional, (2) by directive, (3) by coercion, (4) within existing groupings, and (5) formation of new groups. Jones' list is not comprehensive and emphasizes the institutional environment. There are other adoption situations which are a function of other aspects of the external environment. In discussing the factors which affect the adoption of soil conservation practices we must keep in mind that the situations will differ and the factors which are important in one situation may not be in another. Whatever model is specified and factors are included "research techniques must be sophisticated enough to distinguish critical differences in the nature of the technology as well as the institutional context, physical setting, and farm-firm features" (Nowak, 1987, p.218).

SUMMARY

At the beginning of this chapter we listed Jones' (1967) grouping of the factors which have been studied. Several of his groups of factors have not been adequately addressed as to their role in the adoption of soil conservation practices. Our assessment is presented below.

1. Situational Characteristics	Fairly complete discussion.
2. Personal Characteristics	Fairly complete discussion
3. Sociological Characteristics	Not well discussed. Social participation has been dealt with to some extent in papers which recognize the importance of media contact and involvement in farm organizations as important characteristics of those who are more likely to adopt. Social status is not mentioned.
4. Socio-psychological variables	Values and goals only discussed in terms of orientation to farming, and then only in a limited way. Attitudes fairly extensively discussed, but not motivations.
5. Nature of the Community	Limited to discussion of the economic environment and constraints. Some discussion of community attitudes and adoption levels (Bultena and Hoiberg, 1983) and government institutions, and their possible policy conflicts.

Finding the factors which are significantly different between adopters and non-adopters of soil conservation practices is not the same as finding what it is that determined whether one adopted a practice or not. The adoption-diffusion model suggests that adopters and non-adopters (or later adopters) are different, and influenced by different factors. Therefore, a program to encourage adoption which works on the factors which were significantly different for innovators and early adopters may be of little use to members of the other groups (Röling, 1988). In the literature on adoption of soil conservation practices there is imprecision in describing adopters and non-adopters in that the distinction in the adoption-diffusion model between innovators, early adopters, early majority, late majority and laggards (Rogers, 1983) is usually overlooked. Can these categories be used to design a program to improve the adoption rate among the community in general, beyond simply showing that innovators and the general community are different and therefore need different programs if the adoption of soil conservation practices is to be assisted effectively? Can these factors properly be referred to as factors affecting adoption, as they are in most of the literature, or ought they to be thought of as factors associated with adoption? If viewed as factors associated with adoption, they can be helpful in predicting the likelihood of adoption, but they are not necessarily determining factors in

the decision to adopt. Is it, perhaps, better to recognize that all farmers are not innovators, and won't ever be. Getting the innovators to adopt is easy, it is the others to which we must turn our attention.

There are various ways of understanding the decision-making process of individuals. Programs which seek to promote the adoption of soil conservation practices must see that potential adopters:

1. are **aware --** of the problem itself and that a solution exists;

2. have a **felt need** -- for a solution to the problem;

3. have a **commitment** -- to seek a solution to the problem;

4. have the **capacity** -- to effect the solution (if not it will be ineffectively implemented or aborted -- capacity is defined in terms of skills, knowledge, dollars, and influence on individuals and institutions) (Korsching and Nowak, 1983).

These can be seen as the key elements or steps in the decision-making process from the point of view of the decision-maker, whether they are an individual or group. In other words they are the necessary conditions for a decision to be made to adopt a practice, group of practices, or a particular perspective or philosophy. Each of the various factors which have been discussed in this and the previous section, whether at the micro or macro scale, have an effect on one or more of these key elements in the adoption/decision-making process of an individual or group.

The discussion of macro or structural variables is largely absent from the preceding discussion. To date, there are few, if any, concrete research findings showing their importance. Rather, there are the beginnings of discussion as to their possible importance in the adoption decision-making process and some fairly well-developed policy suggestions which take them into account implicitly, if not explicitly. There is, in our opinion, a need to directly and explicitly evaluate the importance of this group of factors (or this dimension of the groups of factors) in a research framework. This process has begun with the work of authors like Batie, Lovejoy, and Napier. We see this as an avenue well worth perusing in future research while not neglecting the valuable and complementary findings of much previous research work.

Many government policies designed to encourage the adoption of soil conservation practices by farmers have been formulated based on the results of research presented in this chapter. In the next chapter we review the main policy approaches to soil conservation in light of insights gained from this chapter.

CHAPTER FIVE

CONSIDERATIONS IN POLICY DESIGN FOR SOIL CONSERVATION

It is apparent that past approaches to reducing off-farm impacts of soil erosion have not met with wide success. It is obvious to us that a rethinking of past approaches combined with the genesis and refinement of new perspectives is requisite to efficient and effective control of off-farm impacts of soil erosion. The purpose of this chapter, therefore, is to review the implications of recent insights gained from research on factors affecting the adoption of soil conservation practices and propose recommendations for enhancing the design and effectiveness of soil conservation policies. Following traditional policy paradigms for soil conservation, a sizeable portion of the literature has been devoted to themes of education, assistance, and incentive programs, reflecting the extensive use of voluntaristic prescriptions. Less has been written on the areas of targeting, cross-compliance and regulatory action which reflect more the macro-structural perspective.

POLICY OPTIONS

An established precedent exists for public intervention in the agricultural sector. Governments are therefore limited in how they can respond to problems of soil erosion. While a range of policy options for intervention exists, trade-offs between optimal policy effectiveness of any intervention and a general concern for public welfare must be evaluated before action can be taken. Regulation of individuals, for example, might prove the most effective way of curbing soil loss and thus off-farm impacts but, given the status quo, may not be the most acceptable. Below we provide a cursory outline of the major existing policy options available and discuss their applicability for implementation.

Education and Demonstration Programs:

Historically, the most common public intervention has been education programs which were initiated to combat land degradation and promote the use of soil conservation practices. Past programs have focused attention on raising awareness of the visible aspects of severe gully erosion and other degradation problems rather than the more common but equally serious sheet and rill erosion. The impact of this strategy, according to Nowak (1983), may have been to foster a false impression that gully erosion is the only erosion. This may have given farmers a false sense of security and affirmed the use of poor practices in areas where dramatic erosion was not evident.

Regardless of possible detrimental impacts, education has greatly contributed to fostering general awareness of soil degradation problems. Education efforts in the future might more effectively be tailored to individual farmers to deal with problems on THEIR farms (Norris and Batie, 1987). Green and Heffernan (1987) have noted that education alone is not enough to change behaviour as the ability to perceive the existence and extent of a soil erosion problem is also affected by social and

economic factors. We have previously noted that such factors are generally not accounted for in the traditional adoption-diffusion model, and yet, this paradigm has formed the basis of most policy rationale.

Some farmers tend to overestimate the amount of residue left on their fields (Zimmerman, 1988). Because crop residue is often the criterion used to define conservation tillage, both their perception of the need for additional conservation practices and assessment of conservation effort and effectiveness will be inaccurate. If no ongoing degradation is perceived then future conservation information and education programs will not be relevant to farmers (Zimmerman, 1988). Consequently, for various reasons, not all farmers who have a problem will perceive it and they may therefore have to be approached directly/specifically about it (Christensen and Norris, 1983; Norris and Batie, 1987), something which government programs generally do not make allowance for.

Little information is available to guide adopters along the adjustment path when new systems of production are introduced (Jolly et al., 1985). Information on system profitability may not be valued by a producer wanting to know what the initial steps to changing practices should be. Since change is a risky business, especially if taken in large increments, it may prove to be helpful to break the transitional process down into small, manageable pieces which can be implemented sequentially to reach the desired goal (Van Patter et al., 1989).

It has been said that a picture is worth a thousand words. This is certainly true in the implementation of soil conservation practices. The most effective measures of soil erosion control need to be demonstrated so that farmers can see and understand exactly how it is that they work to control the process (Thames River Implementation Committee, 1982). It is important to carefully select farmers who are to participate in the program if a farm demonstration program is to be effective. Innovators (as defined in the adoption-diffusion model) may prove to be so outside the mainstream of the farming community that the majority of farmers will not follow them, while the early adopters may prove to be the ones who will be really helpful in communicating with the general farming community. Most of us learn from our peers better than we do from someone whom we perceive to be different from ourselves. Demonstration farms have been used as one means of farmers being able to learn from other farmers.

Unless cost-sharing is a component of programs, the effectiveness of education and technical assistance efforts will be limited by the financial resources of a farmer. Similarly, cost sharing programs will be ineffective where the requisite human capital is also limiting. Korsching and Nowak (1983) observed that farmers with the least management ability were the least likely to find educational programs acceptable. They add that these are the very same people which these programs are typically aimed at (the laggards in the adoption-diffusion model). Therefore, if education and technical assistance programs are to be effective, they will have to be oriented to the needs and abilities of smaller producers. While this point is well taken, we question whether it is fair to assume that it is the small-scale operators who have limited skills and management abilities.

Financial Incentives and Assistance:

Historically, financial incentives have had little impact on the adoption of soil conservation practices (Christensen and Norris, 1983), which begs the question whether dollar allotments have been adequate. To the contrary, the Thames River Implementation Committee (1978) found that farmers who were most willing to cooperate in a subsidized program to promote the adoption of soil conservation practices to control water pollution were also those who were the most willing to pay for the cost themselves anyway. It may be that the effectiveness of incentive programs varies for different types of soil conservation practices or for different types of adopters (i.e. innovators). Norris and Batie (1987) concluded that there appeared to be significant constraints to the adoption of conservation practices in general; therefore, financial assistance ought to help improve the adoption rate. However, for conservation tillage, which was deemed a profitable practice in their study area, financial assistance was not found to have a significant impact on the effort expended on conservation tillage.

In Ontario, where the cost of reducing soil loss can be significant, financial assistance may be required to facilitate the adjustment process (Seecharan et al., 1985). Dickson and Fox (1988) and Prato (1987) present strong arguments for public intervention through an incentive program. A subsidy sufficient to cover the increased cost to the farmer of adopting soil conservation practices (such as those provided by the Land Stewardship Program in Ontario) would result in an off-farm benefit to society of approximately twice the amount of the incentive (Dickson and Fox, 1988). In addition, direct costs to farmers would decline with increased experience. However, the most efficient and equitable form and financial composition (i.e. who pays and who benefits) of any particular intervention mechanism, for example, tax credit or direct subsidy, is still a matter of debate (van Vuuren, 1986). The impacts of any particular policy instrument will be variable to the farmer and society and the choice will depend on a priorization of objectives. However, Bohl (1987) has shown that by examining on-farm costs and benefits alone, there is no policy instrument that could be used to successfully encourage land conservation efforts.

If the number of applications is any indication, the Land Stewardship Program in Ontario has been well received by farmers. Despite this success some concerns have been expressed about soil loss eligibility criteria. Funds have been allocated proportionately by row crop acreage across counties irrespective of the nature of land degradation problems or their potential contribution to nonpoint-source pollution. In some areas low soil erosion levels significantly impact on the watershed due to the proximity of farms to watercourses. In other areas of the province, soil erosion is much greater and has a significant impact on crop yields, but makes little or no contribution to off-farm pollution levels. To date soil erosion reduction objectives have not been indicated, but if they are to effectively reduce erosion and pollution, soil loss eligibility criteria will need to be set for different regions and situations.

As funding for this program is limited, not all farmers who apply will benefit. While this may not be popular in the short term, the long-term benefits may be the demonstration effect to neighbouring farms. Perhaps the greatest impact on conservation behaviour from this program will be due to its administrative structure. The Land Stewardship Program is innovative in that projects and funding allocations are administered primarily by local committees composed of farmers. This is the

first time to our knowledge that such an arrangement has existed in Canadian agriculture. It has been suggested that farmers are only in this program for the money and that they will return to profit maximizing practices when the program is terminated. We are more optimistic and see that the benefits of experience with different practices and equipment, as well as self-image pressures associated with peer supervision will only enhance and promote responsible land management practices on the farm. Conservation practices place additional demands on a farmer's managerial skills in an already risky occupation (Nowak, 1983). While the use of good stewardship practices may result in a secure and productive farm future, there are nonetheless considerable risks in the short term associated with experimentation and adoption of soil conservation practices. Policy has not addressed risk attitudes of farmers to any degree (Ervin and Ervin, 1982; McSweeny and Kramer, 1986). When a recommended soil conservation measure is not adopted by an individual, it may not be due to lack of intent but rather be controlled by uncertainty. As government has done with the production component of agriculture, policy must be designed to reduce short run risk associated with changes in farming practices if stewardship of resources is to result in the long run. In this manner longer-term planning horizons can be promoted. These considerations should be orientated to the various stages of a farmer's need and adoption experience.

Targeting:

Where the concern about soil erosion and other forms of land degradation arises out of water quality concerns it is important to give priority to those areas which are highest in both gross erosion potential and terrain transport capacity (Thames River Implementation Committee, 1982). Targeting refers to the policy or practice of directing funds or program benefits toward those areas with the greatest need rather than equally allocating funding among all regions.

If the on-site and off-site damages from land degradation and soil erosion were coincident targeting would be greatly simplified (Ribaudo, 1986), but responsibility for off-farm damages is nonetheless difficult to attribute to a particular source (Manning, 1988). The use of on-site criteria alone for targeting erosion control efforts in the United States would mean that only a few of the regions which are important in terms of off-site erosion damages would be identified for targeting. Therefore, where on- and off-site damages are not coincident and off-site benefits are significant, inefficient allocation of public resources will occur (Ribaudo, 1986). Ontario's Land Stewardship Program has allocated funds proportionately by percent row crops in each county. While this is a somewhat improved method over universality, because soil and management characteristics were not evaluated, it is unclear whether funds were delivered where they were needed most.

Cross-Compliance:

Cross-compliance for soil conservation is a policy option that makes the receipt of benefits from other agricultural programs contingent on the adoption of soil conservation practices or participation in conservation programs. It is reported to be viewed favourably by farmers in the United States (Christensen and Norris, 1983) and Canada (Focus Group, 1988. personal communication). The provisions of the 1985 Farm Bill in the U.S. included a cross-compliance requirement for the first time in history.

Cross-compliance, like targeting, arises from a desire to affect behaviour directly and is supported by studies which come from the alternative, macrostructural perspective (Batie, 1986). There have been a few studies done to date which assess the pros and cons of cross-compliance (Harrington et al., 1985; Batie and Sappington, 1986; McSweeny and Kramer, 1986). Some concerns have been raised as to its effectiveness should the commodity program benefits it is tied to decline (Batie and Sappington, 1986). Similarly, operators who do not participate in the commodity programs will not feel the impact of a cross-compliance program and many of them have the more erodible lands (Lovejoy and Napier, 1986).

To date there are no cross-compliance programs in Canada that we are aware of. However, a recent survey of farmers in southern Ontario indicated that cross-compliance was preferred rather than direct regulatory intervention (Focus Group, 1988. personal communication). There are, however, a number of income stabilization and risk reduction programs administered by Agriculture Canada which would easily lend themselves to conditions of cross-compliance. These include; crop insurance, farm improvement loans, and the tree distribution program of the Prairie Farm Rehabilitation Administration, in addition to the Agricultural Stabilization Act and farm property tax rebates.

Landlord-Tenant Agreements:

Many farmers who rent land from others for production purposes do not manage the land the same as that which they own. As the majority of lease arrangements are arranged annually and verbally, renters are generally insecure and uncertain about continued access to these lands. Several studies have suggested the importance of appropriate leasing arrangements so that tenants are able to benefit from soil conservation practices which they implement (Christensen and Norris, 1983, Derr, 1987, Norris and Batie, 1987, and van Vuuren and Ysselstein, 1986). A recent study in Canada suggested conservation leases as one means of inducing responsible practices on highly erodible land (Duff, 1987). Although there are no binding provisions in Canada that require conservation leases a number of organizations do so on their own. For example the Upper Thames River Conservation Authority rents out approximately 2,000 acres of agricultural land each year. Tenants must commit to a binding farm plan specifying crop types and management practices to be utilized (Fish, 1989).

We see conservation leases as a viable way to achieve some soil conservation goals in the short term. This would be particularly attractive for government agencies who rent out agricultural land. Little agricultural research in this area has been undertaken to date. However, some valuable insights might be gained from the experiences of organizations such as Wildlife Habitat Canada and Ducks Unlimited who regularly engage in binding conservation agreements with landowners.

Regulation:

The regulatory approach to reducing land degradation has been shown to be unpopular with farmers in the United States (Christensen and Norris, 1983 and Korsching and Nowak, 1983) and Canada (Smithers and Smit, 1989; Focus Group, 1988. personal communication). Moreover, a recent Canadian study has demonstrated that such an approach is economically infeasible to implement (Bohl, 1987). A precedent exists in the industrial and manufacturing sectors with pollution regulations for the

curtailing of individual actions in the agricultural sector; and has been incorporated into the revised Alberta Soil Conservation Act. This act has provision for the enforcement of penalties for careless soil management causing excessive erosion. The structure of agriculture is being intensified toward large capital intensive holdings. For purposes of definition, many farms could now be considered as industrial. Batie (1986) asks the question: Why should farmers be treated any differently than any other business in their treatment of the environment? The farming community is generally cognizant of these attitudes and, in Canada at least, would move to self-regulation over legislative control.

POLICY INSIGHTS

Most farmers have very clear views on acceptable ways governments may be involved in their decision-making. This is particularly true in the United States. Christensen and Norris (1983) found that the attitude of farmers toward government involvement varied individually; however, as a group, farmers generally preferred policies which allowed them to retain flexibility in their decision-making. They were opposed to soil loss limits, possibly due to concerns about equity as the financial burden would be greater for those who have greater soil loss problems. Farmers also disliked mandatory programs which do not provide some form of cost-sharing, but were much more likely to accept regulations if they were administered by local government. Conversely, Korsching and Nowak (1983) reported that farmers were more amenable to government involvement in soil conservation than in other areas and that they preferred government policies which allowed them to keep their independence by not being compulsory.

In Canada the central policy thrust has been on improving adoption rates of soil conservation practices (Culver and Seecharan, 1986). Financial and technical assistance measures (education and incentives) are preferred to penalties and regulations. The adoption process is complex and dictates that a variety of program instruments be used. Selecting program instruments which consider individual variability in socio-economic attributes should result in higher adoption rates (Culver and Seecharan, 1986). Policy, therefore, needs to be flexible so that it can be applied in a variety of situations (Christensen and Norris, 1983). Given the physiographic and sociological mosaic of the Canadian landscape, an array of mutually supporting policies will be required to implement effective soil conservation programs (Seecharan et al., 1985). Various policy proposals must be evaluated on the basis of equity, cost, complexity of administration, and the difficulty of targeting (Culver and Seecharan, 1986).

The nature of government assistance may have to vary depending on operator and operation characteristics. Research comparing the impacts of a variety of factors on soil conservation has shown factors significantly associated with the use of conservation tillage are different than for other conservation practices (Norris and Batie, 1987). Pampel and van Es (1977) warned that experience gained in the promotion of commercial innovations may be a poor predictor of the adoption of environmental innovations. We note that voluntary compliance strategies which promote the adoption of practices in the area of environmental quality must carefully consider the characteristics of the innovations they promote. Ervin and Ervin (1982) have identified an important theoretical distinction between the number of conservation practices used by farmers and the level of their soil conservation effort. They feel that if the goals of policy are to reduce erosion on farm land then one should look into

the factors which influence conservation effort as well as those which influence the adoption and use of conservation practices.

Lovejoy and Napier (1986) have observed that attitudes and behaviour are not perfectly correlated. Consequently, working solely to change attitudes (through the provision of information, for example) would be insufficient to combat soil erosion/land degradation problems. The focus should be on effecting behaviourial changes. Undoubtedly "constraints of one kind or another may prevent farmers or ranchers from behaving in a manner consistent with their attitudes", as previously noted (Lovejoy and Napier, 1986:306). It is the reduction of constraints affecting behaviour upon which governments must turn their attention in order to reduce soil losses.

Most past government soil conservation policy has not incorporated insights from previous research. For example, programs tend to be universally applied even if it is quite apparent from much research that a more selective approach would be more effective (Ervin and Ervin, 1982; Korsching and Nowak, 1983; Kerns and Kramer 1985; Harrington et al., 1985; Napier 1987, Roling, 1988). While this appears equitable and therefore, politically popular, it nonetheless ignores the heterogenous composition of farmers and farming communities. Korsching and Nowak (1983) have discussed why this variation has been ignored by government. First, conservation policy generally is based on the assumption that all potential adopters act rationally; however, rationality can be defined and assessed ecologically, economically, or socially. Policy usually assumes economic rationality, which implies that a net benefit from the implementation of the practice must be sufficient to overcome a negative net benefit to assure adoption. Secondly, it is assumed that all farmers have equal access to knowledge and information. Finally, it is assumed that individuals act independently, unaffected by their social system. These assumptions tend to minimize critical differences among the farming population thereby reducing effectiveness of public policy.

POLICY BARRIERS

Despite a recognition of the potential severity of the impacts of eroding soils, wide spread solutions at all levels (regional to national) have only begun to germinate. This is particulary true in the Canadian context. Nonetheless, some significant steps are under way, for example, the Land Stewardship Program (LSP) and the Soil and Water Environmental Enhancement Program (SWEEP) in Ontario, and the revised Soil Conservation Act in Alberta. Given current federal involvement in agriculture in Canada, a coordinated, comprehensive strategy should be developed to address land degradation concerns. However, there are a number of barriers and conflicts at the policy level that have constrained, and will continue to inhibit, solutions.

Throughout this paper numerous limitations of approaches attempting to derive solutions to soil erosion problems have been highlighted. Manning (1988) has synthesized some major constraints to a comprehensive federal response to soil conservation in Canada. These barriers include;

1) limitations in perspective, spatially, temporally, and disciplinarily;

2) gaps in evidence on the nature and extent of damage and impact;
3) difficulty in identifying causation and assigning responsibility;
4) reaching consensus on remedial measures;
5) fragmentation of soil conservation responsibilities and objectives; and
6) overall institutional fragmentation in goal setting and short-term planning horizons.

We would lengthen this list to include possible policy conflicts. There are a number of government policies whose influence may mitigate against land stewardship practices (Pidgeon, 1984; Bond et al., 1986). For example, numerous subsidies and stabilization programs administered by Agriculture Canada, by reducing risk to farmers, have the potential to not only promote the continuous cropping of certain crops (e.g. corn and soybeans) but also encourage production on marginal lands, thereby potentially increasing soil erosion in these areas. In any integrated approach to land management at a federal level, inconsistencies in policy and program objectives should be corrected. Finally we question the basis of policy decisions. Specifically, concern is expressed on the criterion by which policies are designed and evaluated. Policy must be accountable, and the most convenient measure of accountability is the dollar. Decisions can be precisely evaluated on the dollar amounts expended and the net dollar value received by constituents. This paper has demonstrated the need to incorporate non-economic considerations in policy goals, decisions and evaluations. However, "new ideas are hard to integrate with existing institution because the older institutions were manifest in relationships that wore a path across the landscape, known to the participants by heart" (Rodd and Wright 1985:14).

STRATEGIC DIRECTIONS

Lovejoy and Napier (1986) have proposed some specific conservation strategies which are consistent with the sociological insights gained from previous research. These suggestions are based on a recognition of soil erosion having predominantly social roots rather than technological ones. This perspective therefore focuses on HOW soil conservation decisions are made. Their suggestions are as follows.

1. Develop programs which reduce macroeconomic and macro-social constraints on farmers or which implement solutions within them.

2. Effectively coordinate programs among various levels of government and institutions involved in soil conservation.

3. Evaluate carefully the type of information provided to clients and the means used to disseminate it. Since farmers are a heterogeneous group with varying socioeconomic characteristics information sources which are suitable to one group may not be to another nor may one form of media reach all groups. Farmers also have varying needs and abilities. There is a need to focus on creating action on soil conservation, since our goal is to alter behaviour and not attitudes alone. We need conservation people with the necessary skills to do this (more than technical knowledge).

4. Conservation professionals must know who their clients are, whom they are helping, whom they are protecting (whether it be farmers from themselves, consumers from future food shortages, water users, or other government units from sediment damage, etc.). The answers to these questions will affect programs, targeting, etc. and need to be found before strategies to address the problems are developed.

5. Facilitate cooperation by including local citizens in decision-making. This makes for a more successful program.

The observations of Korsching and Nowak (1983) and Pharo (1982) are also helpful for the design of programs of planned change be they educational or regulatory in nature. For such programs to be potentially effective Korsching and Nowak stated that adopters of the soil conservation practice(s) must:

1. be aware of the problem itself and that a solution exists;

2. have a felt need for a solution to the problem;

3. have a commitment to seek a solution to the problem; and,

4. have the capacity to effect the solution. If not, it will be ineffectively implemented and likely abandoned. Capacity can be measured in terms of skills, knowledge, dollars and influence.

Soil conservation practices are often considered simply as economic inputs into the agricultural production process. Land stewardship and soil conservation are, however, particular philosophical approaches to agricultural production. The producer who holds to these perspectives will weigh the various input options differently (or at least will consider some additional factors in the decision/evaluation process) than the predominant agricultural perspective in North America today. The agricultural industry as an institution operates primarily in a manner that we feel is inconsistent with long-term stewardship goals. With these considerations in mind, government policy needs to reduce barriers to the adoption of good land management practices where desire exists and to educate others on the merits of such endeavour.

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