TECHNOLOGY EVALUATION AND DEVELOPMENT SUB-PROGRAM

A REVIEW OF FARM-BASED SOIL CONSERVATION RESEARCH AND DEVELOPMENT

FINAL REPORT

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A REVIEW OF FARM-BASED SOIL CONSERVATION RESEARCH AND DEVELOPMENT

EXECUTIVE SUMMARY

Accelerated efforts to conserve soil and water at the farm level are essential if programs such as the Soil and Water Environmental Enhancement Program (SWEEP) are to achieve their goals of improving water quality and agricultural productivity in Southwestern Ontario.

In light of these concerns, the Technology and Evaluation (TED) componentof SWEEP initiated this study to:

- provide comprehensive information on conservation practices being tested and adopted in Ontario by farm operators experienced inconservation research and development;

- determine the reasons for choice of conservation technologies or practices within the context of particular management systems;

- to identify conservation problems that the TED program should subsequently address in its research program; and

- identify leaders in on-farm conservation who have been providing and/or are willing to provide a leadership role in technologytransfer.

Personal interviews were conducted with twenty-seven farmers who are among the leaders in the range of practices and technologies that contribute to conservation farming systems. Five of the twenty-seven participants have incorporated on-farm conservation practices into commercial-sized organic farming systems.

Survey participants have demonstrated initiative in collecting information and equipment to permit on-farm practice and technology evaluation, have integrated these measures into their management systems, and have been among the first in their locale to test and adapt the particular technology. Respondents are located in 12 counties in SouthwesternOntario.

The major data collection efforts focused on completing an inventory of conservation practices and technologies employed on-farm, as well as the problems associated with their use. This inventory included information on cropping practices, tillage and planting practices, and land management practices.

Wherever possible, use of these practices was cross-tabulated with farm physical characteristics including enterprise type, main soil type, corn heat units, drainage and slope characteristics. Based on the project objectives and the small number of survey participants, the data analysis was primarily descriptive in nature.

Respondents were asked in summary to identify and rank conservation research needs that researchers should be addressing under conservation farming systems. These are listed below in order of priority:

- weed control/herbicides
- tillage system effects/packages
- specific equipment modifications; cover crops/rotations; fertility under conservation systems
- soil biosphere changes
- variety response
- allelopathic effects of winter wheat and winter rye on succeeding crops

Recommendations to the TED Program

As a result of these and other survey findings, recommendations have been made to the TED Program in four areas of conservation research: agronomy; tillage/planting equipment and systems; technology transfer within the farm community; and, institutional and agency response.

A. Agronomy

I) Herbicides

- Application rates, timing of application and combinations of herbicides currently registered for use under conventional tillages should be thoroughly tested under a variety of soil texture and residue types within conservation tillage systems.

ii) Cover crops and rotations

- Research should be undertaken to determine:
  - the cause of, and means to alleviate allelopathic effects of healand rye stubble on succeeding crops
  - the extent of nitrogen benefits from legume crops under fall vs.spring killing and tilling
  - cover crops effective in suppressing weeds under any tillagesystem
  - effective means of controlling quackgrass in corn without usingresidual herbicides

iii) Seed varieties/Fertilizer forms and placement

- Evaluations of currently available seed varieties, and fertilizer forms and placement should be undertaken under all tillage/planting systems which alter residue management relative to conventionalsystems.

B. Tillage/Planting Equipment and Systems

I) TED, in cooperation with experienced and practicing farmers, should document the development of system packages which incorporate state-of-the-art knowledge regarding conservation tillage systems. Trouble-shooting tips and contact people to assist in problemresolution should be included.

C. Technology Transfer

I) Among Conservation Leaders

- Where possible, TED should provide support for maintaining conservation leaders on the leading edge of farm-based conservation practice and technology development. This could take the form of providing a central location for state-of-the-art conservation information, supporting publication of a newsletter, or providing funding for workshops to review advances in conservation research and development.

ii) Within the Farm Community

- TED should promote continued and expanded Soil and Crop Improvement Association conservation-oriented activities such as those currently being undertaken through the Joint Agricultural Soil and Water Conservation Program. Such endeavours facilitate information exchange between farmers with varying degrees of experience in conservation farming.

iii) Exchange Between Organic and Conservation Farmers

- TED should promote information and technology exchange between conservation and organic growers in areas of mutual interest.
- TED should also consider holding consultation with organic growers to assess the most promising conservation practices and their applicability to conventional conservation systems.

D. Institutional/Organizational Responses

I) Registration of Herbicides

- TED should encourage Agriculture Canada to take the appropriate steps to speed, where possible, the registration process of environmentally safe and effective herbicides and tank mixes for pre-plant burndown of weeds and cover crops.

ii) Communicating TED Research Mandate to Conservation Leaders

- TED should clearly articulate its mandate to conservation leaders ina way that demonstrates the necessity in the long-term for ‘statistically defensible' results.

iii) Context for Research

- TED should explore ways to expand the network of farm cooperatorswho are currently conducting on-farm research.

Furthermore, TED should consider areas of research that could be termed "farm-based evaluations" in which farmers manage the evaluation process. Compiling tillage system packages or evaluating particular equipment prototypes are possible ways farmers could contribute to this evaluation process.

1.0 INTRODUCTION

1.1 Background

In recent years, researchers and agencies involved in soil conservation and water quality improvement have pointed out the need for accelerated efforts in soil and water conservation at the farm level. Any effort which increases the level of implementation of conservation measures on farmland is essential if the Soil and Water Environmental Enhancement Program (SWEEP) is to achieve its goals of reducing phosphorus loadings to Lake Erie and improving agricultural productivity in Southwestern Ontario.

The Technology Evaluation and Development (TED) component of SWEEP is directed at field level evaluation of existing technologies, particularly development of new conservation methods under commercial farm conditions. It is essential that these new methods be widely acceptable to farm operators in order that the rate of technology transfer be as rapid aspossible.

Applied research in other settings has found that although these remedial technologies may exist on some farms, there has been little effort to understand why they were adopted, how they work, and then communicate these facts to other farmers)[1]. Increasing acceptability of conservation technologies, therefore, must be preceded by understanding the nature of these practices. Once this initial level of understanding is reached, it then becomes possible to assess how to communicate this knowledge to other farmers.

The factors which influence the ‘acceptability' of a particular conservation practice or technology, will, of course, vary from individual to individual. Some of the key influences affecting the individual's conservation decision-making process in relation to these

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[1] Personal communication with Peter Nowak, Associate Professor,University of Wisconsin, February 18, 1988.

practices or technologies have been identified by Nowak (1983) as:

- personal characteristics
- community characteristics
- costs and benefits (economics)
- physical characteristics of the farm
- technology characteristics

All of these influences are in turn, affected by the larger institutional, educational, economic and technological framework within which the individual functions. Thus, although this study focuses on understanding the 'technological' barriers which may be blocking the acceptance of specific conservation innovations, it nevertheless addresses some of the other influences which are just as likely to influence the rate of transfer of conservation technologies.

1.2 Study Objectives

Under the TED program, Agriculture Canada commissioned this study entitled, 'A Review of Farm-Based Soil Conservation Research and Development.' Its primary objectives are as follows:

- to provide comprehensive and up-to-date information on conservation practices being tested and adopted in Ontario by those experienced in conservation research and development, including cropping practices, tillage and planting practices, land management practices, and specific technologies related to each of these;

- to determine the reasons why certain technologies or mixes of technologies are chosen over others within the context of a particular management system;

- to identify conservation problems that the TED program should subsequently address in its research program; and

- to identify leaders in on-farm conservation who have been providing and/or are willing to provide a leadership role in technology transfer.

2.0 METHODOLOGY

In order to obtain enough information needed to meet the study objectives, personal interviews were conducted with farmers having considerable soil and water conservation research and development experience. Outlined in this section are the criteria for the selection of survey participants, details of the questionnaire design, the interviews, and the data dilation and analysis methods.

2.1 Identification of Survey Participants

Farmers asked to participate in the survey are leaders in the range of practices and technologies classified as conservation farming systems; these include:

- someone who, on his/her own initiative, has tracked down the necessary information and equipment to permit on-farm technology testing;

- someone who has adopted or adapted the technology to form an integral part of the overall management system over the long-run; and

- someone who is among the "first" in the locale to test and adapt the particular technology.

Also included was a sample of farmers who have incorporated soil and water conservation technologies into commercial-sized organic/ecological farming systems, and who otherwise conform to the above criteria. The Presidents of the organic/ecological farming organizations noted below provided a list of member farmers who they felt would be willing to participate in the survey.

A preliminary list of participants was compiled by Ecologistics Limited study team members who are in close communication with farmers involved in soil conservation research and development. This list was further refined through contact with the following people:

- Peter Johnson, Plant Industry Branch (MU), London;
- Adam Hayes, Soil Conservation Advisor, Ridgetown; and
- Dave Reibling (President - Organic Crop Improvement Association (OCIA)) and Lawrence Andres (President - Ecological Farmers Association of Ontario [EFAO]).

Twenty-five farmers in ‘conventional conservation' farming systems and five farmers in ‘organic' farming systems were asked to participate in the questionnaire survey. Twenty-seven farmers (twenty-two conservation and five organic) participated. For purposes of this report, the terms ‘conservation' and ‘organic' farmers will be used to differentiate between the two groups when describing their responses.

Study Area

Because the study results will be applied to the Lake Erie Basin of Southwestern Ontario, the selection of participants focused on farmers residing in Southwestern Ontario (Figure 1). Farmers residing elsewhere in the province with experience applicable to the Lake Erie Basin were also included. These individuals are also recognized for their conservation farming skills and potential leadership in developing communication networks to facilitate the technology transfer process.

STUDY AREA **figure 1**

● **location of survey participant**

key

Municipality / Township

a Brant	**g** Haldimand-Norfolk	**m** Metro-Toronto	**s** Simcoe
b Bruce	**h** Halton	**n** Middlesex	**t** Waterloo
c Dufferin	**i** Hamilton-Wentworth	**o** Niagara	**u** Wellington
d Elgin	**j** Huron	**p** Oxford	**v** York
e Essex	**k** Kent	**q** Peel	
f Grey	**l** Lambton	**r** Perth	

2.2 Questionnaire Design

The survey form (Appendix A) was designed for personal interviews. The questionnaire was comprised of six sections including:

I. Farm Characteristics
II. Soil Conservation Practices Tried or Used on a Regular Basis
III. Reasons for Using Conservation Practices
IV. Sources of Information
V. Support for Conservation Leaders and Potential "Technology Evaluation and Development" (TED) Involvement

A short mail-back section containing questions of a personal nature (Section VI) was left with the respondent to complete and mail back.

2.3 Interviews

A personal questionnaire survey was conducted with each of the survey participants in December 1987/January 1988. The interviews were preceded by a telephone call and then a letter of introduction (Appendix B) was sent, further describing the study and explaining how the farmer was selected.

Prior to the interview, all secondary source information describing soil type, drainage and topography required for Section I, Question 3 was assembled for each particular farm.

2.4 Data Compilation and Analysis

Information on completed questionnaire forms was coded and entered into a computer database for subsequent analysis.

3.0 FINDINGS

3.1 Characteristics of Farms and Farm Operators Characteristics of Farms

As noted in Table 1, respondent farms average 278 ha (687 ac) in size; the organic farmers farm size average less than half that of the conservation farmers. The proportion of land owned by the respondents approaches two-thirds of their total land base; the remainder is rented.

Sixty-three percent of all respondents are operating cash crop farms; the other enterprise types are noted in Table 1. The organic farmers as a group are more livestock-oriented compared with the conservation farmers.

Farms are fairly evenly distributed across soil types, although none of the operations have sand or silty clay loam as their main soil type. The highest proportion of farms (30%) are located on clay loam soils.

Corn heat units (CHU) averaged 2943 across all farms, ranging between 2700 and 3400. CHU for organic farms averaged about 200 less compared with theaverage for conservation farms.

The majority of respondents (74%) reported good to excellent existing drainage characteristics on their farms, with the remainder reporting fair or poorly drained conditions. The majority of farmers (59%) reported working on gently sloping land; the remainder are on flat or moderately sloping land.

Characteristics of Farm Operators

The characteristics of farm operators were compiled from the mailback section of the questionnaire. Findings can therefore only be reported forthe entire group (Table 2).

TABLE 1
CHARACTERISTICS OF FARMS

Characteristics of Farms	Conservation (N=22)	Organic (N=5)	Total (N=27)	%
Average Size of Farm (ha)	312 (771 ac)	128 (317 ac)	278 (687 ac)	
Proportion of Owned Land (%)	63	67	63	
Main Enterprise Type				
Cash Crop	16	1	17	63
Dairy	0	1	1	4
Beef	1	1	2	7
Swine	2		2	7
Poultry	1		1	4
Mixed	1	2	3	11
Vegetable	1		1	4
Main Soil Type				
Sand	0	0	0	0
Sandy Loam	3	1	4	15
Loam	4	0	4	15
Silt Loam	4	2	6	22
Silty Clay Loam	0	0	0	0
Clay Loam	7	1	8	30
Clay	4	1	5	18
Corn Heat Units				
< 2850	7	4	11	41
2850 - 3100	8	1	9	33
3150 - 3400	7	0	7	26
Average Corn Heat Units	2982	2770	2943	
Main Drainage Class				
Poor	3	1	4	15
Fair	2	1	3	11
Good	14	3	17	63
Excellent	3	0	3	11
Main Slope Class				
Flat	6	0	6	22
Gently Sloping	12	4	16	59
Moderately Sloping	4	1	5	19
Steeply Sloping	0	0	0	0

TABLE 2
CHARACTERISTICS OF FARM OPERATORS

Characteristics of Farmers (N=26)	Totals	
	N	%
Average Length of Time Farming (yrs.)	20	
Average Length of Time Conservation Farming	10	
Age Groups		
≤ 34	5	19
35 - 44	8	31
45 - 54	9	35
55+	4	15
Gross Farm Sales ($)		
< 49,000	2	8
50,000 - 99,000	3	12
100,000 - 199,000	4	15
200,000 - 400,000	10	38
> 400,000	7	27
Years of Formal Education		
Elementary School	1	4
Some High School	3	12
High School (Gr. 12, 13)	4	15
Some College or University	5	19
College or University Degree	12	46
Post-graduate Studies	1	4
Family Member Discussion - New Farming Practice		
Son/Son-in-Law	9	35*
Daughter/Daughter-in-Law	1	4
Brother/Sister	8	31
Spouse	17	65
Father	7	27
Mother	4	15
Other Family Member	1	4
None	2	8

* Sum of frequencies is more than 100% as respondents could check more than one response.

TABLE 2 (cont'd)

Characteristics of Farmers (N=26)	Totals	
	N	%
Type of Farm Business Organization		
Sole Proprietorship	8	31
Partnership (family members)	5	19
Partnership (non-family members)	0	0
Corporation (family)	13	50
Corporation (non-family)	0	0
Self-Perception as Risk-Taker		
Strongly Agree	6	23
Agree	18	69
Uncertain	0	0
Disagree	2	8
Strongly Disagree	0	0
Future Plans for Farm		
Pass on to Family Member	25	96
Sell it on Open Market	0	0
Rent to Family Members	0	0
Rent on Open Market	10	0
Other	1	4

These findings indicate that respondents are relatively well-established farmers. Respondents have been farming an average of 20 years; an average of half that length of time (10 years) is reported spent in conservation research and development. Fifty percent of the respondents are 45 years of age or older. Relatively large gross farm sales are reported, with 65 percent of the respondents indicating they grossed more than $200,000 in 1986.

Sixty-nine percent of the respondents have a level of education that includes at least some college or university; 46% have a college oruniversity degree.

Other family members are consulted when new farming practices are discussed. Two-thirds (65%) of the respondents hold discussions with their spouse; son/son-in-law (35%), brother/sister (31%) and father (27%) account for the main family members consulted.

Respondent farm businesses are organized among family members; 50% as corporations; 31% as sole proprietorships; and, 19% as partnerships. The priority of family in respondent farm business is reinforced by 96% of the respondents reporting that they plan to pass the farm on to family membersin the future.

Respondents were asked whether they see themselves as the kind of person who is willing to take a few more risks than others. Ninety-two percent of the respondents agreed or strongly agreed with this statement, suggesting that a risk-taking attitude could be contributing to their willingness to undertake conservation research and development.

3.2 Inventory of Conservation Practices and Technologies Employed On-Farm

This section of the report inventories, where appropriate, the practices and technologies that respondents have used in the past, are currently testing or have adopted as part of their overall management system. The information is presented on the basis of the types of practices under consideration: cropping practices, tillage and planting systems, and land management practices. In addition, the problems associated with the practices are discussed, as are the reported benefits of the particularpractice.

3.2.1 Cropping Practices

3.2.1.1 Crop Rotations

This study did not attempt to define rotations in terms of their soil erosion-reducing effects. Rather, information was collected on the main rotations used currently and in the past, as well as operator-perceived benefits of current rotations. Table 3 describes the main types of rotations currently used by the respondents.

TABLE 3

CROP ROTATIONS

Main Rotation	Frequency of Rotations	
	No.	%
corn/soy/winter wheat	11	41
corn/soy	5	18
hay and small grains	5	18
vegetable	1	4
other	5	18
Totals	27	99

Those respondents using a corn/soy/winter wheat rotation generally include two or three consecutive years of corn, followed by one or two years of soybeans and one year of winter wheat. Those growing only corn and soybeans were using a one year rotation. The five respondents working with a hay/small grains rotation generally keep the hay for three consecutive years; all five respondents are organic growers. The vegetable grower has his entire farm on permanent beds, growing primarily seed corn, tomatoes and two years of snap beans.

Rotations in the ‘other' category include those with corn, beans (soys and edible), small grains or clover in the rotation for varying lengths of time. One operator in this group grows corn for seven consecutive yearsbefore moving to one year each of barley and winter wheat.

The main difference between currently used rotations and past rotations is that corn was considerably more prominent in past rotations. Six respondents reported continuous corn rotations in the past; three others grew four to fourteen years of corn before other crops were included.

Reasons for Using Current Rotations

General reasons for using current rotations were solicited from the survey participants. Reasons cited were diverse. The most frequently cited reasons related to farm management - spreading risk, maintaining flexibility, spreading workload, and fitting the rotation to the tillage system used (particularly important on ridges). There was also considerable mention of the soil-building properties of crop rotations - increasing organic matter content, improving structure and tilth. Increasing soil fertility levels were also important, reflecting the benefits of using red clover as a plowdown crop, as well as the yield stimulating effects of lessening the number of years that any one crop is grown consecutively.

Less frequently cited reasons for using current rotations included weed control (primarily quackgrass control using residual herbicides in two or more years of corn), and the

reduction of insect and disease problems (reducing some pesticide costs). Erosion control was mentioned only infrequently as a direct benefit of rotating crops; however, the frequent mention of the soil-building characteristics of rotations certainly shows respondent awareness of soil degradation problems, of which erosion is apart.

This latter statement is pertinent in light of the main reasons given for shifting away from previous, more corn-based rotations. The most frequently mentioned reasons included: soil degradation (compaction, unworkability of soils, etc.); and, management reasons (hardier wheat varieties, fit rotation on ridges, etc.). Other reasons focussed on economics, including ‘poor corn production economics' and wanting to reduce ‘high input costs'.

One operator was working with a one year corn/soy rotation but has returned to growing two consecutive years of corn to control quackgrass with residual herbicides.

3.2.1.2 Cover Crops

For purposes of this survey, cover crops included 1) those planted for the express purpose of improving soil structure, increasing organic matter or protecting the soil surface, and 2) any over-wintering crops. Under this definition, 23 of the 27 respondents (85%) reported growing cover crops. All but one of these 23 farmers were growing at least one over-wintering cover crop for sale (primarily winter wheat); many were also growing other crops for their soil-building or covering qualities. The four respondents not growing cover crops are using a rotation of primarily corn and soybeans. The land base of three of these four respondents is entirely under ridge tillage, which at this point in time, tends not to be as flexible as other tillage systems for cover crop management.

The types of cover crops grown and their frequencies are provided in Table 4. Clearly, winter wheat, red clover and alfalfa are the most widely grown cover crops. Oil radish is favoured by the organic growers as a soil building crop. It is drilled into tilled small grains soil after harvest, grows through the fall and then is winter-killed, providing improved soil structure and some residue cover over winter. Other lesser grown crops are used within particular management systems; oats were reported broadcast in the fall on 550 ac of permanent vegetable beds to provide some winter cover; sorghum was grown by one operator for its organic matter as well as its role in soil nitrogen balancing for succeeding vegetable crops; and spelts (non-hybridized variety of winter wheat with a high protein content) were grown to tap into a specialty market (individuals with allergies to wheat flour are reportedly not allergic to products made of spelt flour).

Problems with Cover Crops

Problems cited by respondents regarding cover crop management are varied. Most frequently mentioned problems include:

- establishment of clover
- delayed soil drying in spring if wet conditions prevail
- some over-wintering of fall-planted cover crops expected to be winterkilled (i.e. oil radish and canola)
- weed growth if cover crop catch is poor

Some of the problems are associated with the type of tillage system used. For example, three out of four respondents citing no-till as their main system, mentioned that symptoms of allelopathic effects appeared in the corn crop following planting into spring-killed volunteer winter wheat or spring-killed red clover. This problem was alleviated by chemically killing the winter wheat or clover in the fall.

TABLE 4

FREQUENCY OF COVER CROPS GROWN

Type of Cover Crop	Conservation (N=22)	Organic (N=5)	Total (N=27)
Winter Wheat	16	4	*20*
Red Clover	13	2	15
Alfalfa	2	5	7
Canola	4	0	4
Oil Radish	0	4	4
Winter Rye	*2*	1	3
Oats	2	0	2
Spelts (non-hybridized variety of winter wheat)	0	2	2
Austrian Winter Peas	1	0	1
Fababeans	0	1	1
Red Clover and Ryegrass	0	1	1
Sorghum	0	1	1
Spring Barley	1	0	1
Volunteer Spring Grain	1	0	1
Winter Barley	0	1	1

Several respondents using chisel plough and other minimum-till systems reported plugging of chiselling and cultivating equipment under vigorous red clover growth conditions. This group of respondents also mentioned that too many trips over the field were sometimes required to prepare a seedbed following cover crops (i.e. if fall-chiselled clover revives againin the spring).

Reasons for Using Cover Crops

Those using cover crops cite very similar reasons for their use. Invariably, the general benefits of ‘soil structure improvement', ‘fertility benefits' and ‘reducing erosion' were reported by the respondents. Additional comments related to management reasons such as ‘spreading workload' and ‘diversifying income.'

3.2.1.3 Strip Cropping

Three respondents have used some form of strip cropping. Two of them manage strip crops in the conventional sense of alternating crops in 100 to 300 foot widths. Both are located on gently sloping land; one runs the strips on the contour and the other finds it difficult to do so because ofcomplex slopes.

The management problems faced by these two operators include: knowing the best location for headlands in order to minimize wasted space; working with the margins between the fields (i.e. ensuring complete tillage and weed control); and, working the side hills (equipment drift, combine inefficiency).

The third operator uses the term strip cropping to describe alternating 15 foot widths of corn and soybeans that he has maintained on ridges. The main reason for working with this cropping pattern is the yield increases he has realized on the outside rows of corn on each strip. The operator has purchased or modified all of his equipment to conform to the

15 foot width. One problem experienced with this system has been slightly reduced yields in soy beans due to shading effects by the corn.

The benefits cited by these operators include ‘compaction is confined to the headlands' and ‘reduced erosion'.

3.2.1.4 Crop Borders

Crop borders around row-cropped fields are used by four respondents, although the borders are usually restricted to headlands. The way crop borders are managed varies between operators. Three of them are using 20 to 45 foot widths of hay on headlands to protect soil structure and prevent soil erosion where headlands are steep. The fourth operator plants oats on headlands of edible bean fields. The oats are chopped as green feed for his beef cattle.

Problems with crop borders include:

- no markets for hay
- perennial weed growth
- trampling of the border crop when working with the row crop

In spite of these problems, operators continue to use crop borders to reduce erosion and compaction, and provide green feed for beef cattle onland where row crop growth is marginal.

3.2.2 Tillage and Planting Practices

References are made throughout this report to various tillage and planting systems used by the respondents. These systems, their characteristics, and the number of operators using these systems as their main systems arepresented below:

Moldboard Plough - This system includes use of the modified moldboard plough as the tool used for most primary tillage operations. Modifications of the moldboard plough include removal of trashboards, use of a narrow bottom plough (usually 14") cutting off a portion of the moldboard or replacing the bottoms with twisted shovels, sweeps or ‘Prong Points.' Three respondents report this as their main system.

Chisel Plough - This system includes use of the conventional or modified chisel plough as the tool used for most primary tillage operations. Modifications of the chisel plough include replacement of straight teeth with twisted shovel or sweep attachments. Other modifications include disc or coulter attachments on the front of the plough, with either twisted shovels or sweep attachments on the shanks. Seven respondents report this as their main system.

Minimum-Till - This system includes those operators who use a variety of tools to perform their primary tillage - heavy tandem disc, offset disc, specialized equipment (eg. on permanent beds), modified chisel plough, or some mix of the above. Eight respondents report minimum-till as their main system. Several of these operators use no-till planting equipment in the partially incorporated residue conditions characteristic of thissystem.

No-Till -This system involves a method of planting or seed drilling that requires no seedbed preparation other than that provided by various optional nonpowered attachments on the planter or seed drill itself. Four respondents report no-till as their main system.

Ridge-Till -This system involves forming a ridge of soil with a heavy duty row crop cultivator. The next crop is then planted directly into the ridge after the old crop row is scalped off. Five respondents report thisas their main planting system.

3.2.2.1 Tillage/Planting Systems and Associated Farm Characteristics

Table 5 presents the respondent farm characteristics grouped by the main tillage/planting systems they report using. Although this table is useful in describing existing farm conditions under various tillage systems and presenting some trends, generalizations can not be accurately made to the use of these systems in the broader farm community because of the small number of survey participants.

The majority of respondents (18 of 27) are working within systems which include some form of tillage - chisel plough, moldboard plough, or other combinations of minimum tillage. The other nine are involved in no-till and ridge-till systems.

Conservation farmers were represented across each of the different tillage systems; no organic farmers were working with no-till or ridge-till systems.

The majority of farmers are cash crop operators; they are represented in each of the different tillage systems. None of the other respondents reporting their main enterprise type as livestock or vegetable are in no-till or ridge-till as their main tillage system.

Main tillage systems are fairly uniformly scattered across soil types. The main exception is ridge-tillage which tends to be concentrated on the heavier soils - silt loam, clay loam and clay. No operators reporting no-till as their main system are located on clay soil as their main soil texture.

Main tillage systems are also represented across most of the corn heat unit categories. No respondents using no-till are working with 3150 or more CHU's; no respondents using mainly ridge-till are working with less than 2850 CHU's.

TABLE 5

MAIN TILLAGE SYSTEMS: BY FARM TYPE ENTERPRISE TYPE, SOILS CORN HEAT UNITS, DRAINAGE, AND SLOPE

Farm Characteristic	Main Tillage System											
	Chisel Plough		MoldBoard Plough		Minimum Tillage		No-Till		Ridge-Till		Totals	
	N	%	N	%	N	%	N	%	N	%	N	%
Number of Operators	7	26	3	11	8	30	4	15	5	18	27	100
Farm type:												
Conservation Farms	5	23	2	9	6	27	4	18	5	23	22	100
Organic Farms	2	40	1	20	2	40	0	-	0	-	5	100
Main Enterprise Type:												
Cash Crop	4	24	1	6	3	18	4	23	5	29	17	100
Other	3	30	2	20	5	50	0	-	0	-	10	100
(Livestock, veg's)												
Main Soil Type:												
Sandy Loam	1	25	0	-	1	25	2	50	0	-	4	100
Loam	1	25	1	25	2	50	0	-	0	-	4	100
Silt Loam	3	50	1	17	0	-	1	17	1	17	6	101
Clay Loam	1	13	0	-	4	50	1	13	2	25	8	101
Clay	1	20	1	20	1	20	0	-	2	40	5	100
Corn Heat Units												
Under 2850	3	27	2	18	4	36	2	18	0	-	11	99
≥2850, less than 3150	3	33	0	-	2	22	2	22	2	22	9	99
≥3150	1	14	1	14	2	29	0	-	3	43	7	100
Main Drainage Class												
Poor	1	25	1	25	0	-	0	-	2	50	4	100
Fair	2	67	0	-	1	33	0	-	0	-	3	100
Good	3	18	2	12	6	35	3	18	3	18	17	101
Excellent	1	33	0	-	1	33	1	33	0	-	3	99
Main Slope Class												100
Flat	2	33	0	-	1	17	0	-	3	50	6	101
Gentle	3	19	2	13	6	37	3	19	2	13	16	100
Moderate	2	40	1	20	1	20	1	20	0	-	5	

The majority of respondents in each of the tillage system categories are working with good or excellent soil drainage conditions. The majority of respondents in each tillage system are also working with flat or gently sloping field topography. The highest proportion of respondents in any tillage system who are on flat land occurs in the ridge-till category.

3.2.2.2 Detailed Tillage/Planting Practices and Technologies

Table 6 provides the number of operators who continue to use, are trying, or have tried and dropped, each of the detailed practices and technologies listed. Interpretation of numbers in the ‘tried and dropped' column must be done carefully. A technology was sometimes reported dropped, not because of its inherent limitations, but because of a change in tillage system which obviated its continued use or trial.

A range of experience can be noted with many of these practices and technologies. If experience with primary tillage implements and conservation planters is compared, the greatest number of operators (23) have experience with the chisel plough. This is followed by 19 operators experienced with the modified moldboard plough, 14 with the no-till planter, 12 with the no-till seed drill, and 7 with the ridge-till planter. The range of experience with specific modifications of these main implements can also be noted in Table 6.

Problems Encountered with Tillage/Planting Practices and Technologies

Problems encountered by the respondents are noted below by the general tillage practices and implements as presented in Table 6. Additional comments on the relationship of soil type to the problems discussed, are noted where trends appear.

TABLE 6

NUMBER OF OPERATORS REPORTING TILLAGE AND PLANTING TECHNOLOGY USE

Tillage Practice or Implement	Technology [1]	Continue To Use	Being Tried	Tried & Dropped	Respondents with Experience [2]
General Tillage Practices	Optimum direction of tillage	3	0	1	14
	Reduced depth of till	18	1	3	22
	Minimum number of passes	17	0	3	20
Modified Moldboard Plough					19
	With narrow bottoms (usually 14" bottoms)	4	**3**	5	12
	With trashboards removed	6	1	7	14
	With major portion of the mboard cut off	0	1	2	3
	With bottoms replaced by twisted shovels	0	0	1	1
	With bottoms replaced by sweeps	2	0	1	3
	With bottoms replaced by prong points	0	1	0	1
Chisel Plough					23
	Chisel plough (unmodified)	1	0	5	6
	With twisted shovels	0	0	5	5
	With sweeps	2	1	1	4
	Flat coulters/con. discs and Tshovels	8	0	7	15
	Flat coulters/concave discs and sweeps	4	0	4	8
Other Primary Tillage Practices	Off-set disc	2	0	2	4
	Heavy tandem disc	3	1	5	9
Secondary Tillage Practices	Field cultivator with C-tine	8	0	8	16
	Field cultivator with S-tine	9	0	7	16
	Tandem disc	14	0	3	17
	Harrows	12	0	4	16
	Packers	13	0	5	18
	Combination Unit	5	0	3	8

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[1] See Appendix A, p. 5-12 for full description of technology or practice.

[2] This column refers to the total number of operators with implement or specific technology experience as summed from the previous three columns or as otherwise derived from the survey responses.

TABLE 6 (cont'd)

Tillage Practice or Implement	Technology[1]	Continue To Use	Being Tried	Tried & Dropped	Respondents with Experience[2]
Ridge Planter Till					7
	Stabilizing units to keep planter on rge	7	0	0	7
	Ridge-cleaning units	6	0	0	6
	Oscillating depth stops - seeding units	3	0	1	4
	Changed press wheel arrangement	3	0	0	3
	Insecticide placed in front of press wls	2	0	1	3
	Insecticide placed behind press wheels	0	0	0	0
	Insecticide incorporated (chains, tines)	1	0	0	1
	Fertilizer - Liquid "pop-up" with seed	4	0	0	4
	Fertilizer - Liquid "starter" below seed	0	0	0	0
	Weights and brackets for planter frame	2	0	1	3
	Weights and brackets for planting units	0	0	0	0
	Weights and brackets for marker arms	1	0	0	1
Other Ridge-Till	Ridge-forming cultivator	7	0	0	7
Operations	Add. coulters/closing units NH3 app.	1	0	0	1
	N(28%) applicator - coult./knives	0	0	0	0
	Straw chopper on combine	3	0	0	3
	Straw chopper on combine with exten. fins	2	0	0	2
	Modified axles on combine	5	0	0	5
	Changed tire size on combine	6	0	0	6
No-Till Planter					14
	Additional toolbar	6	2	0	8
	Coult. (on toolbar) I.F.O. Fert. openers	3	1	0	4
	Coult.(on tb) IFO seed openers	1	1	0	2
	Rawson (fluted coult. on tb)	2	2	0	4
	Coult.(on planter frm) IFO seed opener	6	1	1	8
	Mechanism to move residue from row area	6	1	0	7
	OS depth stops seeding units	11	1	1	13
	Cast iron press wheels	2	0	0	2
	Changed press wheel arang(seed firm.)	1	1	0	2
	Nt-insect. placed in front of press wls	7	0	3	10

TABLE 6 (cont'd)

Tillage Practice or Implement	Technology[1]	Continue To Use	Being Tried	Tried & Dropped	Respondents with Experience[2]
No-Till Planter	Nt-insect, placed behind press wheels	0	0	0	0
cont'd	Nt-insect. incorp (chains, tines)	1	0	0	1
	Fert. as dry "starter" B/B seed	6	1	0	7
	Nt-wts & brkts - planter frame	2	1	0	3
	Nt-wts & brkts - planter units	0	0	0	0
	Nt-wts & brkts - marker arms	1	0	0	1
	Lengthened tongue	3	1	0	4
Other No-Till	Marker sys on sprayer	3	1	0	4
Cropping Operations	Add'l coult/closing units NH3 app.	1	0	0	1
	N(28%) applic. - coult./knives	2	1	0	3
	Straw chopper on combine	8	1	0	9
	Extended fins on st. chopper	5	0	0	5
	Chaff spreader	0	0	0	0
No-Till Seed Drill					12
	Wts & brkts - drill frame	2	1	2	5
	Lengthened tongue on hitch of drill	1	1	1	3
	Equipped with dry fertilizer hoppers	0	1	1	2
	Equipped with liquid fertilizer tanks	1	0	0	1
	Equipped with grass seed hoppers	4	1	1	6
	Coulters (on frame) in front of seed open	4	1	1	6
	Coulters(on frame) with seedtubes	2	0	0	2
	With press/gauge wheels	5	1	3	9
	Seed units staggered on Pframe	6	0	2	8
	Seed units in line on Pframe	1	0	2	3

General Tillage Practices -Few problems were reported for those tilling in the optimum direction. ‘Slopes too complex' or ‘angled rows atheadlands' were two problem areas mentioned.

Residue plugging of equipment was noted by several respondents tilling at reduced depth. Stalks were chopped or trash-cutting coulters were added to equipment to alleviate the problem. Two respondents who tried but dropped reduced depth tillage experienced compaction (on clay) or poor water percolation (on clay loam).

The majority of operators (17) are minimizing the number of tillage passes with few problems noted. One respondent noted a ‘poor seedbed after moldboard ploughing' with this practice. He was one of several who previously worked with a minimum number of secondary tillage passes and who have since gone to ridges.

Modified Moldboard Plough -Narrow bottoms result in corn residue plugging for at least one respondent, and land was left ‘too rough' for one who removed trashboards. Many of those who have dropped these modifications of the conventional moldboard plough have gone to no-till and ridge-till systems.

One respondent is currently experimenting with removing portions of the moldboard, but the plough reportedly does not pull straight and leaves rough ground. Similarly, the individual who replaced plough bottoms with sweeps, but subsequently dropped the technology, experienced poordraughting.

Chisel Plough -For those reporting the use of the chisel plough, or any of its modified forms, two main trends appear: soil moisture (neither too dry nor too wet) when worked is critical; and, satisfactory results are the most difficult to achieve on the heavier soils - silt loam, clay loam and clay.

For example, of the five who tried and dropped the unmodified chisel plow, three noted soil moisture-related problems. These three are located on primarily clay and clay loam soils. Other reasons for dropping include ‘bad root rot in white bean,' and ‘unnecessary cost' (went to ridges).

Other key problems with the chisel plough system centre on the roughness of land at the time of secondary tillage. These problems have been alleviated to some degree by adding an S-tine cultivator tooth between the rear chisel shanks, or by replacing twisted shovels with sweeps on therear shanks.

Other Primary Tillage Practices -Little use of the offset disc is reported by respondents. Those dropping its use have done so because of compaction and a cloddy seedbed which dried out too quickly (both respondents on silt loam). Similarly, use of the heavy tandem disc was reported restricted by compaction (on clay and clay loam). One of the operators reporting extensive use of the heavy tandem disc on corn and soybean land is located on loam soil.

Other primary tillage implements tried and dropped include the paraplow (‘clay too wet in the fall') and ploughing discs (‘poor stalk management').

Secondary Tillage Practices -The main problems with cultivators, particularly the S-tine, focus on plugging as a result of heavier surface residue. The reasons for dropping their use is reported primarily by those who changed to no-till or ridge-till systems.

Ridge-Till Planter -The key problem area reported by respondents is keeping the planter on the ridges. Means to overcome this problem include obtaining a more stable three-point hitch, using ‘ridge huggers' and adding a hydraulically-operated swinging hitch on the planter itself.

Seed coverage and firming action were reported improved by adding a device in front of the press wheels to move soil over the seed furrow, and addingtension to the press wheels.

Other Ridge-Till Operations - Respondents have modified the ridge-forming cultivator or its use to form a smaller ridge (cut ridge wings) and to reduce plugging (use 2 inch points for first cultivating pass). Improper trench closing following the application of anhydrous ammonia was alleviated by one operator by dragging a chain over the trench.

No-Till Planter -Relatively few problems were reported by operators using the no-till planter. There was a lot of interest expressed in the Rawson setup - a set of fluted coulters mounted on an additional toolbar to perform wider strip tillage than other currently-used coulters perform. In addition to those saying they are using or trying the Rawson setup, at least three operators say they will try this modification this coming crop year. Respondents expected this setup to alleviate currently experienced problems of bearings wearing out in existing coulters, and managing crop residues in the row area.

Three respondents have dropped the practice of placing insecticide in front of the press wheels in favour of placing the insecticide in thefurrow with the seed.

One respondent experiencing residence plugging of planter drive chains attached a bar across his fertilizer unit shanks to flatten corn residuefor better flow through the planter.

No problems with other no-till cropping operations were reported.

No-Till Seed Drill -The main problems experiences with the no-till seed drill relate to getting better penetration by the coulters. This problem was reported on loam, silt loam and clay loam soil textures. Operators report adding weights to the planter frame or setting springs as ‘hard' aspossible to alleviate the problems.

More plugging with residue and stones was encountered with drills setup with straight-line seeding units than setup with staggered seeding units.

3.2.2.3 Operator-Reported Benefits of Tillage Practices and Technologies

This section focuses on the operator-reported benefits of the main tillage system used, the extent of modification required, and the level ofsatisfaction with that system.

The benefits reported by the respondents are grouped below by main tillage system. Because of the few number of respondents in each category, and the variability in responses given, only the main responses are provided.

Moldboard Plough - Management reasons appear to dictate the use of the modified moldboard plough. ‘Manure management,"white beans require it,' ‘alternative equipment costs' and ‘soil (clay) requires it' were the main reasons given.

Chisel Plough- Four of the seven chisel plough operators cited ‘erosion control' as benefits of this system. Other reasons such as ‘better aerobic decomposition,"better yields' (better than disced corn; better than moldboard), and ‘still getting bugs out of no-till' were also given.

Minimum-Till - Soil condition improvements and management flexibility were the key areas of response under this system. Two of the eight respondents using this mentioned they were still developing confidence in the no-till system.

No-Till -Lower costs were most frequently mentioned as the benefits of no-till. Management versatility (‘more versatile than ridge tillage'; ‘less hired help') and ‘reducing soil loss' were also mentioned.

Ridge-Till - Similar to the responses under no-till, ridge-till benefitsfocused on lower costs and reduced soil erosion.

Respondents were asked to identify the extent to which they have had to modify their tillage systems in order to better fit their farm operation. The results in Table 7 are derived from the main tillage system reported.

There is considerable variation in the extent of modification that was felt necessary to make each of the systems work, with some reporting considerable modifications required and others with the same system reporting few, if any, modifications required. When comparing across systems, the highest proportion of respondents (63 percent) reporting ‘agreat deal or some' modifications necessary were working with minimum-till; the lowest proportion were working with the moldboard plough (33 percent).

In spite of the modifications required, a high level of satisfaction with these various systems is experienced. Table 8 describes the extent ofsatisfaction realized under these systems.

No-till and ridge-till respondents appear the most consistently satisfied with their tillage/planting systems. None of the respondents cite dissatisfaction with their system; however, one or two respondents in each of moldboard, chisel and minimum-till systems report ‘neither satisfaction or dissatisfaction' with their systems. Part of the reason for this may be their growing interest in no- and ridge-till systems as noted previously in this section.

TABLE 7

EXTENT OF TILLAGE SYSTEM MODIFICATION

Tillage System	Extent of Modification					
	Great Deal/Somewhat		Slightly/Not at All		Total	
	N	%	N	%	N	%
Moldboard	1	33	2	67	3	100
Chisel	3	43	4	57	7	100
Minimum-Till	5	63	3	37	8	100
No-Till	2	50	2	50	4	100
Ridge-Till	2	50	3	50	5	100

TABLE 8

EXTENT OF SATISFACTION WITH MAIN TILLAGE SYSTEM

Tillage System	Extent of Satisfaction						Total	
	Very/Somewhat Satisfied		Neither Satisfied/ Dissatisfied		Somewhat/Very Dissatisfied			
	N	%	N	%	N	%	N	%
Moldboard	2	67	1	33	0	0	3	100
Chisel	5	71	2	29	0	0	7	100
Minimum-Till	7	88	1	18	0	0	8	100
No-Till	4	100	0	0	0	0	4	100
Ridge-Till	5	100	0	0	0	0	5	100

3.2.3 Land Management Structures and Practices

Table 9 provides a description of the land management structures and practices, and the corresponding number of respondents who have reported them on their farms. As these structures are tailored to meet conservation needs in micro-locations, no attempt was made to correlate them with farm physical characteristics.

Those practices or structures occurring on 50% or more of the farms include:

- permanent buffer strip along watercourses
- grassed waterway
- tile outlet stabilization
- drop inlet structures
- windbreaks
- herbicides applied for conservation purposes

Other practices or structures mentioned by the respondents include berms (usually associated with drop inlet structures), catch basins, a diversion channel, and ‘float stones' (French drain or blind inlet). One operator is also doing extensive laser land levelling to systematically direct overland flow of water off-farm.

Problems Associated with Land Management Structures and Practices

Relatively few problems were associated with these structures and practices. Problems are noted by structure as follows:

Permanent Buffer Strip Along Watercourses - The need to control weeds and grasses was reported. This was accomplished by cutting for mulch or for hay.

TABLE 9

LAND MANAGEMENT PRACTICES

Land Management Practice	Continue To Use	Being Tried	Tried & Dropped
Permanent buffer strip along watercourses	18	0	0
Grassed waterway	19	0	1
Tile outlet stabilization	15	0	0
Ditch or stream bank stabilization	10	1	1
Rock chutes	6	0	0
Drop inlet structures	14	1	0
Terracing	2	0	0
Berms	3	0	0
Other land management practices	5	0	0
Buffer strip on headlands (by ditches)	1		
Diversion channel	1		
Float stone above tile (French drain)	1		
Catchbasins	1		
Laser land levelling	1		
Windbreaks	15	0	0
Modified herbicide use within conservation systems	15	1	0
Insecticide use within conservation systems	1	0	0
Fungicide use within conservation systems	0	0	0

Grassed Waterway -This practice solicited the highest number of problem responses. Silting in and erosion occurring alongside the waterway was mentioned by one-third of the 19 respondents who had grassed waterways. One respondent experienced atrazine kill in part of his waterway.

Ditch or Streambank Stabilization - One respondent suggested that the Township could do a better job of seeding down ditchbanks following cleanout. The importance of laying filter cloth under the appropriate stabilization schemes was noted by another respondent.

Drop Inlet Structures -Blowouts in undersized tile drainage systems below the inlet structure were mentioned by two respondents.

Windbreaks -Nine of the 15 respondents reported problems with windbreaks. These included: ‘weed and grass competition'; ‘finding the right tree on clay soils (white cedar)'; ‘rodent damage' and ‘establishment (use bigger stock).'

Herbicide Applied for Conservation Purposes - Two main themes characterized responses to how herbicides use is being modified within conservation systems:

a) more contact herbicides are being used in no-till and ridge-till systems as pre-plant burndown of weeds and cover crops; and

b) overall, less herbicide is being used because operators are banding herbicides (particularly in ridge-till), more spot spraying is done in ridge-till and no-till, and less overlap of spray is occurring in systems where wheel-traffic is controlled, (e.g. ridge-till, no-till, permanent vegetable beds, or where tramlines established).

Respondents were generally dissatisfied with the current registration of pesticide products for conservation cropping systems. Sixty-eight percent of the conservation farmers were ‘dissatisfied or very dissatisfied' with the status of herbicide registration; the remainder were

‘neither satisfied or dissatisfied,' with the exception of one respondent who was ‘satisfied.' This particular operator has been no-tilling for 23 years.

All of the four organic farmers who answered this question were also dissatisfied or very dissatisfied with the current status of registration. However, given their non-use of herbicides, their perspective was dissatisfaction with the fact that so many man-made compounds are already in use. Obviously, this perspective is at odds with the prevailing perspective of the conservation farmer.

Respondents were asked to provide the names of pesticides and tank mixes they would like to see approved for application to conservation systems.

The suggestions include:

- glyphosate (Roundup) + 2,4-D ester (for ‘burndown' purposes)
- 2,4-D ester + oil (for ‘burndown' purposes)
- atrazine + 2,4-D ester (for ‘burndown' purposes)
- bentazon (Basagran) + acifluorfen (Blazer) (soybean herbicide)
- triadimefon (Bayleton) ((Train fungicide)
- propiconazole (Tilt) (grain fungicide)
- alachlor (Lasso) (for price competition and weed control)
- fluazifop-butyl (Fusilade)
- clomazone Command (U.S.A.) - same as Merit (Canadian tradename, currently undergoing development)
- metolachlor (Dual) + 2,4-D
- alternatives to 2,4-D (in preparation for possible deregistration in the future)

Other Land Management Practices

Respondents were asked questions regarding manure management, as well as whether or not conservation practices were carried out on rented land.

Eight respondents indicated they are trying new ways of managing manure; half of these are organic farmers who are composting manure before field application. Two conservation farmers are irrigating liquid manure by means of a series of fixed and movable pipes which makes overland transport of manure unnecessary. The other two conservation farmers are altering their timing of application to minimize compaction.

Nineteen respondents are renting land, only two of whom are not practicing conservation on those lands. Reasons given include ‘landlords want it plowed' and ‘plan to use Soil Saver in the future.'

3.2.4 On-Farm Changes Resulting from Conservation Research and Development

Respondents were asked about the nature of the on-farm changes they have witnessed as a result of conservation research and development. Table 10 contains the types of changes respondents were asked to consider, and whether changes were positive or negative. The changes reported, particularly for soil erodability and soil quality, are admittedly subjective assessments. Several respondents in fact, expressed some frustration in not being able to assess more objectively, changes they felt were occurring in these areas.

TABLE 10
CHANGES RESULTING FROM CONSERVATION RESEARCH AND DEVELOPMENT

	Nature of the Change									
	Very Positive		Somewhat Positive		No Change		Somewhat Negative		Total	
	N	%	N	%	N	%	N	%	N	%
Soil erodability	21	78	6	22	0	0	0	0	27	100
Input costs	14	52	11	41	2	7	0	0	27	100
Soil quality	13	48	12	45	2	7	0	0	27	100
Crop yields	5	18	10	37	11	41	1	4	27	100

The most positively viewed change was soil erodability (i.e. reduced soil erosion) with 78% of the respondents citing a very positive change. Lower volumes of overland water flow and reduced wind erosion were noted as a result of conservation efforts.

Changes in input costs (i.e. reduced costs) and soil quality were viewed very positively by about 50% of the respondents. Evidence of improved soil quality included comments such as better tilth and faster percolation of surface water. Changes in crop yields were the least positively viewed, although 55% of the respondents still viewed the change somewhat or very positively.

One respondent, an organic farmer who is continuing to change land from conventional to organic agriculture, experienced a somewhat negative change in yields.

Four conservation farmers also reported very positive changes in management time that has become available to them. Two organic farmers cited very positive changes in soil life, as evidenced by increased earthworm activity and indirectly through rapid decomposition of organic matter.

Respondents were also asked to compare the extent that soil erosion was a problem on their farms before conservation practice initiation, with the extent soil conservation is a problem on-farm today. On a scale of one to five (one = not at all a problem; five = very serious problem), respondents ranked their previous erosion problems as an average of 3.4, whereas their current problems were ranked an average of 1.9. This improvement in erosion control corroborates the findings of Table 10 in which very positive changes were noted in soil erodability.

3.2.5 Most Promising Practices and Technologies

This section attempts to summarize the practices and technologies which have been most widely used or which have demonstrated potential for more widespread dissemination in the farm community.

A. Copping Practices

Crop rotations - A shift away from continuous corn has occurred. Most frequently, cash crop operators report inclusion of soybeans and winter wheat (underseeded to red clover) as a rotation which improves soil conditions and makes good farm management sense. Hay-based rotations provide good soil coverage but are best suited to livestock-based operations.

Cover crops - Wheat and red clover are the most frequently used cover crops. However, the search goes on for cover crops which grow rapidly in the fall, provide good soil coverage, but are subsequently winterkilled. Oats and oil radish (in organic systems) have been used with some success.

Strip cropping - Although infrequently reported by respondents, this practice was reported to reduce erosion where applied. A modified form of strip cropping - 15 foot widths of alternating corn and soybeans on ridges - was reported to offer yield advantages in corn and excellent winter ground cover because of the frequently alternating narrow strips of residue minimizing wind and water erosion.

B. Tillage and Planting Practices

Moldboard Plough - The narrow-bottomed plough, the plough with bottoms replaced by other attachments, or the plough with a portion of its moldboard removed, have all been reported used in conservation systems. Advantages to working with the moldboard include

possible appeal to the general farm community which is familiar with moldboard technology and use.

Chisel Plough - The most frequently used chisel ploughs reported are those with coulters or disc attachments (‘Soil Saver,' ‘Mulch Tillers'). Best results with the chisel plough appear to be on soils without moisture extremes and use on lighter soils. Modifications to achieve more level soils with this implement include adding S-tines between the rear shanks or replacing twisted shovels with sweeps on the rear shanks.

Heavy Tandem Disc -As a primary tillage implement, this is reported to work best on lighter soils and under moderate moisture conditions.

Ridge-Till Planter -Essential equipment on ridge-till planters includes stabilizing units and ridge-cleaning units. Liquid "pop-up" fertilizer placed with the seed is also commonly used. Three of the seven respondents who have some experience with the ridge-till planter have oscillating depth stops on their seeding units and have changed the press wheel arrangement for better seed firming action. The ridging system is reported to work well by operators located on poorly drained clay and clay loam soils, as well as by one operator on silt loam.

Additional efforts to maintain the planter on ridges include using Ridge Huggers (a guide wheel attachment), and adding a hydraulically swinging hitch on the planter itself. Ridge-till operators also expressed interest in incorporating more cover crops such as winter wheat into their system, possibly through using lower ridges.

No-Till Planter - Throughout the course of the interviews, it was apparent that the modifications generating the most interest among the operators was the Rawson fluted coulter setup. Ontario field experience is limited to one year as reported by several farmers; Michigan no-till farmers have considerably more experience with it. Several respondents currently using chisel plough or minimum-till systems are seriously considering switching

to no-till if the Rawson modification alleviates current residue management and seed-to-soil contact problems in no-till.

The most consistently used setup and modifications to the no-till planter include oscillating depth stops on the seeding units, additional coulters on either the planter frame or on an additional toolbar to cut residue, fertilizer placed beside and below seed, and insecticide placed in front of the press wheels. Several operators have begun placing the insecticide with the seed with no apparent negative effects to the seed and simultaneously improving operator safety.

No-Till Seed Drill -Most consistently used setups or modifications to the no-till seed drill include: coulters in front of the seed openers mounted on the planter frame; press/gauge wheels; equipped with grass seed hoppers; and having the seed units staggered (as opposed to straight-time) on the planter frame.

C. Land Management Practices

The most promising land management structures and practices must be considered within the entire cropland management context. For example, where grassed waterways were reported inadequate to control gullying under conventional tillage systems, the waterways were adequate when more surface residues under conservation tillage slowed surface runoff. On steep slopes, the use of drop inlets and berms may be the only option to prevent gullying. One operator farming long slopes was very satisfied with erosion control offered by the systematic installation of broad-based terraces.

One respondent on flat, clay soil reported the benefits of laser land levelling to alleviate wet spots and direct overland flow to grassed waterways and rock chutes.

Growing vegetables on permanent beds was reported by one operator and was viewed as an excellent cropland management practice.

Weed control under no-till and ridge-till was reported shifting from residual type herbicides to contact herbicides.

3.3 Factors Contributing to the Adoption Process

Becoming involved in conservation farming normally requires some form of adjustment to conventional farming practices and technologies. Changing such practices or entire cropland management systems requires that relatively clear reasons be provided for the individual to evaluate the benefits of such changes.

This section of the report examines some of the motivating forces which have stimulated the involvement of respondents in conservation research and development. In addition, the information and support networks available to conservation leaders are reviewed.

3.3.1 Reasons for Initial and Ongoing Involvement in Conservation Research and Development

On average, survey respondents have been involved in conservation research and development for 11 years. Respondents were asked to prioritize the reasons for initially becoming involved in this work; findings appear in Table 11.

Recognition of erosion and soil degradation occurring on their farm is cited most frequently as the most important reason for becoming involved (59%) and represents 43% of all reasons given.

Economics and good management reasons were cited second most frequently (27% of all reasons). Included within this category were comments such as ‘maintain income with lower production costs,' ‘less time and labour,' and’ management efficiency.'

TABLE 11

REASON FOR INITIAL INVOLVEMENT IN CONSERVATION

Reason for Involvement	Reason Ranked Most Important		Total No. of Times Reason Mentioned		Overall Ranking
	N	%	N	%	
Reduce Erosion/Soil Degradation	16	59	26	43	1
Economics/Good Management	8	30	16	27	2
Declining Yields	1	4	5	8	3
Stewardship/Environmental	1	4	5	8	3
Became Informed	-	-	4	7	4
Other	1	4	4	7	4
Total Reasons Given	27	101	60	100	

'Declining yields,' 'stewardship/environmental reasons,' and 'becoming informed' accounted for much lower proportions of reasons mentioned. The 'other' category included comments such as, 'personal attitude change,' 'boredom with conventional farming,' and ' have always done it.'

Clearly, recognition of soil erosion/degradation problems and consideration of the economic benefits of conservation farming systems have been the key motivating factors behind the decision of respondents to begin testing technologies and practices.

Extent of On-Farm Erosion Problems

Respondents were asked to rate the extent to which specific erosion problems were occurring on their farms before they began working with conservation practices. The responses to these problem statements are presented in Table 12.

TABLE 12

ON-FARM EROSION PROBLEMS WHEN CONSERVATION INITIATED

Type of Situation	Extent to Which Situation Existed					
	Did Not Exist/Small		Medium/Large		Total	
	N	%	N	%	N	%
a. Yield reductions due to reduced soil productivity from soil erosion	18	67	9	33	27	100
b. Increased use of fertilizer to compensate for that lost due to erosion	22	81	5	19	27	100
c. Increased machinery wear and tear due to erosion on your fields	21	78	6	22	27	100
d. Damage to young plants due to wind erosion or being covered by sediment	22	81	5	19	27	100
e. Yield reductions due to soil erosion washing pesticides on to adjacent non-compatible crops	26	96	1	4	27	100
f. Eroded soil filling in drainage ditches	17	63	10	37	27	100
g. Eroded soil carrying nutrients and pesticides into nearby streams	20	74	7	26	27	100
h. Higher costs for increased drainage ditch maintenance due to soil erosion from farm fields	19	70	8	30	27	100

All of the problem statements were viewed by two-thirds or more of the respondents to be non-existent or small. However, about one-third of the respondents felt that they were experiencing yield reductions, and eroded soil was filling in drainage ditches resulting in higher costs for drainage ditch maintenance.

The small extent to which these statements were viewed as problems would appear to conflict with the evidence in Section 3.3.1 in which erosion/degradation problems were cited as the main reason for initiating conservation practices. When respondents answered the question in this section, many reflected on their limited understanding of the pervasiveness of the erosion problem at the time of practice initiation. Rather, it was the gross erosion that they initially saw which motivated them; hence, the response in Section 3.3.1. In addition, the word erosion is used in these problem statements; several respondents identified more with soil degradation as the problem on their farms.

Ongoing Conservation Practice Evaluation Criteria

The continued development of farm-based conservation practices requires continued evaluation of currently-used practices just adopted. It is important to understand the criteria by which these practices are evaluated for two reasons. First, it points out the features of a conservation practice that needs to be given special attention in the research and development phase. The criteria that farmers consider vital need to be addressed in experimental development of new conservation practices. Second, knowing which criteria are considered important will facilitate communicating conservation practices in the farm community. These criteria can then receive special attention in any promotion or education efforts. Consequently, respondents were asked to rank the criteria which aid them in decisions regarding new practices. The results are presented in Table 13.

TABLE 13

RANKING OF EVALUATION CRITERIA FOR

CONSERVATION PRACTICE PERFORMANCE

Criteria	No. of Times Ranked First/Second	No. of Times Ranked Third/Fourth
Maintenance/Enhancement of Crop Production	19	8
Prevention of Soil Loss	15	12
Provision of Economic Returns	13	11
Ease of Use/Fits Operation	5	17

Many operators found these criteria difficult to rank because of their interrelatedness. However, ‘maintenance/enhancement of crop production' was ranked most frequently as the first or second most important criterion. This was followed relatively closely by ‘prevention of soil loss' and ‘provision of economic returns.'

‘Ease of use/fits operation' was the criterion ranked the least frequently as first or second in importance. This may reflect the willingness of the respondents to adapt the new or modified practice or technology to their management system or alternatively, adapt the management system to fit the conservation practice.

Three of the five organic growers did not consider the economic returns as a criterion important in their evaluating process. Two other criteria were suggested by the organic growers - ‘increasing humus' and ‘increasing soil life levels (e.g. earthworm activity),' each of which was ranked second in importance.

3.3.2 Sources of Information

Respondents were presented with a list of sources of information which they could have found helpful in resolving difficulties in each of three areas of conservation concern: determining the cause and extent of their soil erosion problem; knowing the best way of integrating the practices into their operation; and, knowing the costs and benefits associated with the practice. Respondents were asked to rank the three most important information sources in each area of concern.

The results are presented in Table 14. It is clear that the respondents have relied heavily on ‘themselves' and ‘other innovative farmers' as sources of information in all three categories of concern. Other innovative farmers were mentioned most frequently in helping to integrate the practice into their farm operations. Because the respondents were among the first in Ontario to begin thinking about working with conservation technologies, it is not surprising that they have relied on their own trial and error experience, as well as the experience of other like operators.

Government-related sources of information (OMAF, CAT, Conservation Authorities) were most frequently mentioned as assisting in determining the cause and extent of erosion, although the OMAF conservation advisors were cited more frequently as helping to integrate the practice on-farm and providing an understanding of the economics of the practice.

Other services of information most frequently mentioned across all three areas of concern included ‘demonstration projects and tours,' U.S. Journals,' and ‘other.' Demonstration projects and tours included locations in both Ontario and U.S., and most frequently mentioned U.S. Journals included Successful Farming, No-Till Farmer, New Farm and Soybean Digest. The ‘other' category included primarily U.S. contacts: Soil Conservation Service (SCS) and business contacts in Iowa and Wisconsin; Michigan Conservation Days; and the Louisville Farm Show.

TABLE 14

SOURCES OF INFORMATION

	Information Source	Cause and Extent of Erosion: No of respondents ranking source as No.1 (N=25)		Cause and Extent of Erosion: Total respondents mentioning source (N=25)		Integration of Practice: No of respondents ranking source as No.1 (N=27)		Integration of Practice: Total respondents mentioning source (N=27)		Economics of Practice: No of respondents ranking source as No.1 (N=23)		Economics of Practice: Total respondents mentioning source (N=23)	
		N	%	N	%	N	%	N	%	N	%	N	%
a.	Rely mostly on myself	12	48	14	56	8	30	12	44	10	43	11	48
b.	Other Innovative Farmers	2	8	4	16	12	44	16	59	6	26	7	30
c.	Equipment Dealers	1	4	1	4			3	11			2	9
d.	Other Farm Suppliers									1	4	1	4
e.	O.M.A.F. Soil Conservation Advisors	2	8	4	16	1	4	4	15	1	4	3	13
f.	Other O.M.A.F. Extension Staff	1	4	4	16			1	4			2	9
g.	Conservation Authority Staff			3	12								
h.	University of Guelph			2	8			1	4	1	4	2	9
I.	CAT (Ridgetown, etc.)	3	12	5	20	1	4	2	7			1	4
j.	Soils and Crops Improvement Assoc.			2	8			1	4				
k.	Demonstration Projects and Tours	1	4	5	20	1	4	8	30			2	9
L.	Private Consultants	1	4	1	4			3	11				
m.	"Farm and Country"							2	7				
n.	"Country Guide"							2	7				
o.	"Western Ontario Farmer"												
p.	U.S. Journals			4	16			5	19	1	4	2	9
q.	O.M.A.F. Factsheets												
r.	"O.M.A.F. News"												
s.	Radio and TV Shows												
t.	Seminars/conferences	1	4	1	4	1	4	3	11	1	4	1	4
u.	Neighbours			1	4								
v.	Other	1	4	3	12	3	11	5	19	2	9	2	9

One U.S. book mentioned by one respondent as providing many conservation answers was entitled, More Profits With Less Tillage.

Canadian farm papers and magazines, OMAF Factsheets, radio and TV shows, neighbours, and other farm suppliers were never or infrequently mentioned as sources of information.

Respondents were then asked to describe the obtainability and usefulness of the three main groups of conservation information. In answering these questions, respondents usually first thought about their early days of practice testing and the difficulty they reported having in accessing such information.

Their current assessment is somewhat more optimistic as reflected in Table 15. However, about one-quarter to one-third of the respondents still find conservation information ‘very difficult' to obtain. The information obtained is all ‘somewhat' or ‘very useful.' It would appear that respondents have been able to identify the most useful sources of information throughout the course of their trial experiences.

3.3.3 Support for Those Involved in Conservation Research and Development

Respondents were asked about the reactions of neighbours to their conservation efforts. Some positive reactions were expressed, tending to focus on the benefits of crop rotations (with red clover), chisel plowing and generally "conservation farming." Negative responses centred on messy looking fields - four respondents doing at least some no-till mentioned this criticism by neighbours. Overall, respondents reported a lot of neutral responses on the part of neighbours - a neighbour's response of "it works on your farm, but it won't work on mine" appears to be a prevailing attitude among respondent neighbours.

TABLE 15

OBTAINABILITY AND USEFULNESS OF CONSERVATION INFORMATION

Characteristics of Information	Cause and Extent of Erosion		Integration of Practice		Economics of Practice	
	N	%	N	%	N	%
Obtainability						
Easy	10	46	10	37	5	24
Same as Other Agricultural Information	6	27	8	30	11	52
Very Difficult	6	27	9	33	5	24
Totals	22	100	27	100	21	100
Usefulness						
Very	12	55	14	52	10	50
Somewhat	10	45	13	48	10	50
Not at all	0	0	0	0	0	0
Totals	22	100	27	100	20	100

However, 70% of the respondents reported that neighbours have adopted soil conservation practices which respondents use. Eight respondents said neighbours have adopted reduced tillage practices (primarily chisel plowing) four cited no-tilling, and five cited adoption of cover crop rotations. Two respondents cited neighbours who tried ridge-tilling, but dropped the system. Structure or land management practices such as terracing, laser land levelling or rock chutes were infrequently mentioned as having been adopted by neighbours.

Most of the respondents (82%) felt it very or somewhat important to feel the support of others who are involved in similar activities; the remaining 18% felt that such support was only slightly or not at all important.

Respondents were asked to provide suggestions as to how support for their efforts could be expanded. Results are provided in Table 16.

TABLE 16

WAYS TO PROVIDE SUPPORT FOR RESPONDENTS

Support Mechanism	No. of Times Mentioned N	%
Meetings/Workshops/Conferences/Seminars	26	40
Soil and Crop Improvement Association Meetings	8	12
Demonstration Tours/Plots	7	11
Increased Financial Support	7	11
Improve Communication Networks	5	8
Building Publicity	4	6
Make Equipment Available	4	6
Other	4	6
Total Support Mechanisms	65	100

Any means by which information sharing can be facilitated appears to be of high priority. If Soil and Crop Improvement Association meetings are included in the general category of meetings/workshops/conferences/ seminars, then over 50% of all ideas cited relate to this category. Seven of the suggestions within the 'meeting' category relate directly to no-till concerns (i.e. 'no-till support groups,' 'support for association between Michigan/Ontario no-tillers'). Other ideas within this category include:

- small study groups/winter workshops;
- conservation clubs;
- share knowledge of drainage/soil type impacts; and
- share technical information on machine setup

Soil and Crop Improvement Association meetings have been pulled out separately from other meetings because of their widespread presence within the farm community. Evidently, respondents see these as a context within which support is derived. More meetings "featuring conservation farmers" and "more local activity" were suggested as improvements.

Ways in which financial support would be utilized include:

- seed money for no-till clubs;
- ensure that financial incentives within the Land Stewardship Program apply to farmers providing leadership in soil conservation;
- equipment modification; and,
- Township should provide more incentive for farmers to maintain drainage ditchbanks.

Three of the five ways of improving communication networks focussed on development of an Ontario conservation newsletter or publication. An information centre was also mentioned as a means to improve information flow in general.

Publicizing ‘positive information on successful systems' and ‘providing more recognition for those trying things' are suggestions for raising the profile of respondents and systems.

In the other category, ‘incorporating organic/ecological farming principles into conventional systems' was mentioned, as was the need for a’conservation organizational structure.'

Promotion of Conservation in the Farm Community

Respondents were asked for their ideas on approaches that should be taken to promoting soil conservation in the farm community. The results are shown in Table 17.

TABLE 17

APPROACHES TO SOIL CONSERVATION PROMOTION

Approach	Approach Ranked Most Important		Total No. of Times Approach Mentioned	
	N	%	N	%
Economic Benefits	14	52	28	42
Technical Information Dissemination/Tours/Demonstrations	5	19	15	22
Stewardship/Environment Concern	4	15	10	15
Raise Awareness of Problem	4	15	5	8
Other	0	0	9	13
Total No. of Approaches	27	101	67	100

Promotion on the basis of economic benefits is of priority to survey respondents. However, within the ‘economics' grouping there are several comments which qualify such an approach to promotion; that is, economic benefits have to be proven on a farm-by-farm basis. Thus, ‘economics' is inherently tied to the second most frequently mentioned approach - ‘technical information dissemination.'

‘Stewardship/environmental concerns' and ‘raising awareness of the problems' were also mentioned by the respondents, although less frequently. ‘Other' approaches to promotion were also mentioned such as ‘promote attitude changes,' ‘make conservation psychologically attractive,' ‘make equipment available for trial,' and ‘legislate practices on highly erodible soils.'

Overall, respondents are saying that the promotion of conservation practices needs to be based on the economic and agronomic features relative to site-specific conditions. Stewardship may be important, but since most farmers already believe in stewardship, they need to be shown haw they can act on these beliefs in an economically and agronomically sound fashion. The need for promotion based on these themes is evident in the next section where research needs were identified.

3.4 Priority Research Needs Identified by Respondents

Respondents were asked to prioritize the research needs from their own experience that researchers should be addressing in relation to conservation systems. Research needs are listed in Table 18.

The ranking of research needs prioritized as number one by the respondents is similar to the ranking of all the different research needs which were mentioned. It is evident that the concern of priority in conservation farming systems is weed control and the availability, efficacy and mixes of herbicides to do the job. Other concerns related to herbicides centred on twitch grass control in one year corn, fall panicum control, rates and timing of application under heavy residue conditions and better herbicides for use in windbreaks.

Questions about tillage system impacts on the soil environment and the best tillage package for specific farm conditions were the second most frequently mentioned areas of concern. Why do certain tillage systems work on some farms and apparently not on others? What really happens to soil structure under various tillage systems and how can we measure it? The development of "conservation tillage packages" was seen as the way to provide answers to these questions.

TABLE 18

RESPONDENT-IDENTIFIED CONSERVATION RESEARCH NEEDS

Research Needs	Research Need Mentioned First		Sum of Research Needs Mentioned		Overall Ranking[a]
	N	%	N	%	
Weed Control/ Herbicides	9	36	20	25	1
Tillage System Effects/Packages	3	12	13	17	2
Equipment	3	12	9	11	3
Cover Crops/Rotations	3	12	9	11	3
Fertility	1	4	9	11	3
Earthworm/Soil Biosphere Changes	1	4	6	8	4
Variety Response	0	0	5	6	5
Allelopathy	2	8	4	5	6
Other	3	12	4	5	7
Total Needs Cited	25	100	79	99	

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[a] The 'overall ranking' is based on the most frequently mentioned research needs as noted in the previous column. The most frequently mentioned need was given a ranking of number one.

A closely-related area of research concern, and third most frequently mentioned was specific machine or equipment modification and development. Examples include:

- Rawson system research (fluted coulter setup on no-till planter) or other modifications for ‘strip' tillage;
- tillage machine for primary tillage of permanent vegetable beds;
- better implements for working in cover crops; and,
- optimal size of moldboard which leaves greater amounts of residue on the soil surface.

Cover crops/ rotations and fertility research needs ranked third, along with equipment needs. Further detail of research in these areas include:

Cover Crop/Rotations

- cover crops to suppress weeds in minimum-till and ridge-till systems;
- economics of cover crops in no-till;
- what weeds could serve as cover crops; and,
- the crop sequence that is best for the soils and most cost-effective.

Fertility

- N fertilization requirements after red clover;
- fertilizer forms and placement in no-till and ridge-till; and,
- N rates for no-tilling corn into sod and corn.

Earthworm and soil biosphere changes under various tillage systems ranked fourth overall. Comments here included:

- benefits of increased earthworm population in no-till;
- how much earthworm kill results from moldboard ploughing; and
- how to measure soil bioactivity.

Of the eight comments offered under this category, only one was provided by an organic farmer. It would appear that some conservation farmers have seen increased earthworm activity, but are wanting to know the merits of this increase.

Variety response to conservation field conditions ranked fifth. Conservation leaders are suggesting this research occur under all tillage systems, although seed varieties for no-tilling into sod were specifically mentioned. If this area of research is combined with the fertility questions mentioned previously, the overall ranking of this combination climbs to second position.

Allelopathic effects ranked sixth. Specific problems mentioned included:

- difficulty of establishing buckwheat after clover; and,
- wheat allelopathy on succeeding crops.

Research needs in the ‘other' category (three of which ranked as first priority research needs) included:

- recognition by one farmer that he has no-till information and just needs to use it;
- incorporate organic farming techniques into conventional systems; and,
- advances in biotechnology and impacts on farming systems.

Organic farmers as a group tended to report research needs in the areas of cover crop management and conservation/whole systems research. Not surprisingly, no research on herbicides or variety response to alternative tillage systems was requested by the organic farmers.

4.0 CONCLUSIONS AND RECOMMENDATIONS

A number of conclusions and recommendations can be drawn from this review of on-farm conservation practices and technology development which provide direction to ongoing and future research. These are grouped below in terms of their relevance to several areas of conservation research: agronomy; tillage/planting equipment and systems; technology transfer within the farm community; and, recommendations for institutional and agency response.

4.1 Agronomic Research

4.1.1 Herbicides

Many respondents - particularly those using no-till and ridge-till systems, those facing triazine-resistant weed populations, those chemically killing cover crops or those wishing to grow corn only one year in their rotation - are relying heavily on the use of contact as opposed to residual herbicides. Leaders generally expressed dissatisfaction with the efficacy of herbicides which are currently registered for use under conventional tillage practices but applied to residues and weed populations under conservation conditions.

It is recommended that application rates, timing of application and combinations of herbicides currently registered for use under conventional tillage systems be thoroughly tested under a variety of soil texture and residue types within conservation tillage systems. Research pertaining to more effective weed control in newly-established windbreaks should also be pursued.

4.1.2 Cover Crops and Rotations

Survey respondents cited many benefits of using rotations and cover crops including soil quality improvement and spreading workload and risk. However, problem areas were also cited suggesting several areas of research.

It is recommended that TED undertake research relating to:

a) the cause of, and means to alleviate, allelopathic effects of winter wheat and rye stubble on succeeding crops. Such research should include the optimum time of stubble/volunteer-growth tillage or chemical kill to reduce effects;

b) the extent of nitrogen benefits from legume crops under fall vs. spring killing or tilling;

c) cover crops effective in suppressing weeds under any tillage system. In particular, the organic growers cited this as a research need given their non-use of herbicides; and

d) more effective quackgrass control in corn without using residual herbicides.

4.1.3 Seed Varieties and Fertilizer Forms and Placement

Seeds and fertilizers currently used on-farm have been largely developed under conventional tillage practices which bury or incorporate the majority of crop residue and leave a fine seedbed. The use of conservation planting and tillage practices changes soil moisture, soil structure and organic matter levels. Similarly, the availability and fate of agricultural chemicals and nutrients are likely to be different under conservation systems.

To date, respondents have been using agricultural inputs developed under conventional systems and reporting yield maintenance or improvement within their conservation systems. Some modifications to fertilizer forms and placement have already occurred (eg. injection of liquid N under no-till conditions to avoid loss to air). However, many respondents are requesting that research be systematically undertaken to ensure that any yield irregularities that may be experienced are not due to inputs that are inadequately developed for their system.

It is therefore recommended that TED conduct evaluations of currently available seed varieties and fertilizer forms and placement under various tillage/planting systems. A specific need that was mentioned is for this research to occur under no-till conditions with corn and soybean varieties; however, the same need could be stated for any system in which residue management is altered relative to conventional systems.

4.2 Tillage/Planting Equipment and Systems

Survey respondents are continually examining their past and present use of equipment and planning for future uses and modifications. Generally, the respondents were on the lookout for ways to improve practices or technologies, even those which they would say they've adopted.

Although constant modifications and adjustment suggest improvements are necessary, the reported levels of satisfaction with conservation tillage and planting equipment is high. Some of the most promising practices and technologies have been noted earlier in this report.

Therefore, it is recommended that TED, in cooperation with experienced and practicing farmers, document the development of system packages which incorporate state-of-the-art

knowledge regarding conservation tillage systems. Such packages would include information on: available equipment and its adaptation necessary to fit soil texture and residue type; timing of cropping operations; appropriate agricultural chemicals, their means of application, and seed varieties; and, cost data relevant to system changes made. Trouble-shooting tips and contact people to assist in problem resolution should also be included.

With such a package in hand, the individual with little or no conservation experience would more readily consider participation in conservation farming knowing there is a comprehensive support system available to him. Those with experience would continue to provide updates to the package in his particular area of expertise.

4.3 Technology Transfer

4.3.1 Technology Transfer Among Conservation Leaders

It has been noted that most of the respondents indicated that support from others involved in similar activities was very or somewhat important. Key suggestions for increasing support among respondents included circulation of a newsletter (containing specific tillage systems information, meeting notices, etc.), formation of conservation clubs or special interest groups in local areas, and providing workshops on various aspects of conservation.

As conservation leaders are probably the most knowledgeable about the implementation of on-farm conservation practices and potentially some of the more effective promoters of these practices, it is recommended that TED provide support for maintaining conservation leaders on the leading edge of farm-based conservation practices and technology development. Possible ways of encouraging conservation leaders include:

a) provide a central location for state-of-the-art conservation information being developed in Ontario and the U.S.A., particularly where climatic and field conditions most closely resemble those of Ontario. This would relieve the search costs for some of the respondents who are constantly on the lookout for current information relevant to their particular farm situation. Documentation of ‘who is doing what' would facilitate networking among those showing leadership in conservation research and development.

B) support existing and new channels of information flow and networking between conservation leaders. This could take the form of financial support for publication of a newsletter to be circulated among conservation leaders, or providing funding for workshops to review advances in specific conservation practices and technologies.

4.3.2 Technology Transfer Within the Farm Community

Survey respondents suggested that the best way to promote conservation cropping and tillage practices is on the basis of their economic benefits resulting from reduced input costs. On the other hand, several respondents suggested that cost savings must be demonstrated on an individual farm basis over time. Expectations of instant economic advantages must be minimized to prevent farmer disillusionment with such practices.

As many of the respondents indicated involvement in local chapters of the Soils and Crops Improvement Association, and, as SCIA is recognized by farmers for its soils and crops improvement mandate, it is recommended that TED promote continued and expanded SCIA conservation-oriented activities such as those currently being undertaken through the Joint Agricultural Soil and Water Conservation Program. Within this context, additional respect for the results of the work of conservation leaders could be engendered and likelihood of practice testing by others enhanced. In addition, conservation leaders would have opportunity to

explain how they've realized economic benefits from their conservation efforts. Such local farmer-to-farmer referral and support networks have been found to provide locally relevant information that is judged to be credible and trustworthy.[1]

4.3.3 Exchange Between Organic and Conservation Farmers

A number of similar agronomic research questions related to conservation systems have been raised by both organic and conservation farmers. These include: selection of rotations and the use of cover crops to maximize fertility and weed control benefits; reduced man-made inputs while maintaining crop yields; and, the implications of increasing biological activity in soil under conservation systems.

Given these and other areas of mutual interest, it is recommended that TED promote information and technology exchange between conservation and organic farmers. Such exchanges have already occurred in Bruce County between OMAF and the Ecological Farmers Association of Ontario (EFAO).

TED should also consider holding consultations with organic growers, including on-farm visits, in order to assess the most promising conservation practices, and their applicability to conventional conservation systems.

4.4 Institutional/Organizational *Responses*

4.4.1 Registration of Herbicides

Respondents practicing no-till and ridge-till in particular, have expressed a great deal of dissatisfaction with the current registration process of pesticides (primarily herbicides) for use in these systems.

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[1] Personal communication with Peter Nowak, University of Wisconsin, February 19, 1988.

Criticisms have centred on the length of time required for registration and the open international border to American commodities, but not to the chemical used to grow those commodities. Herbicides and tank mixes for pre-plant burndown of weeds and cover crops were the most frequently requested compounds.

It is recommended that TED encourage Agriculture Canada to take the appropriate steps to speed, where possible, the registration process of such compounds. Consultations with agribusiness and the appropriate level of government should be undertaken to alleviate any bottlenecks in the system which slow the testing and release of effective and environmentally safe chemicals. Herbicides and related tank mixes, and fungicides of high research priority identified by respondents include:

- glyphosate (Roundup) + 2,4-D ester (for ‘burndown' purposes)
- 2,4-D ester + oil (for ‘burndown' purposes)
- atrazine + 2,4-D ester (for ‘burndown' purposes)
- bentazon (Basagran) + acifluorfen (Blazer) (soybean herbicide)
- triadimefon (Bayleton) (grain fungicide)
- propiconazole (Tilt) (grain fungicide)
- alachlor (Lasso) (for price competition and weed control)
- fluazifop-butyl (Fusilade)
- clomazone (Command) - same as Merit (Canadian tradename, currently undergoing development)
- metolachlor (Dual) + 2,4-D
- alternatives to 2,4-D (in preparation for possible deregistration in the future)

4.4.2 Communicating =Research Mandate to Conservation Leaders

An undercurrent of cynicism has arisen among some of the respondents regarding the ability of institution-conducted research to respond quickly to current research needs on-farm.

It is recommended that TED clearly articulate its mandate to conservation leaders in a way that demonstrates the necessity in the long-term for ºstatistically defensible' results. The role and importance of such results must be clearly stated.

Similarly, the role and importance of farm-based testing and evaluation conducted by farmers as they attempt to fine-tune systems on a daily basis must be recognized for its contribution to the advancement of conservation farming systems. Such dialogue between researchers and farmers will hopefully lead to increased respect for the constraints and prospects faced by the other.

4.4.3 Context for Research

Survey respondents have also expressed concern that research station conducted research often does not reflect the combined impact of a broad range of crop stresses that are present on-farm. Several respondents also intimated that research should occur on as many different soil types as possible to better reflect farm conditions.

It is recommended that TED continue to explore ways to expand the network of farm cooperators who are currently conducting on-farm research.

This would allow the testing of these technologies by persons who have the experience capable of adjusting the technology to local conditions. It would also serve to increase the visibility of conservation technologies to other neighbouring farmers. Information front these demonstration plots should emphasize the economic and agronomic details. Moreover, these field demonstrations would serve to increase the status of conservation leaders in their local farm communities. These demonstrations should be continued across several crop cycles to exemplify the transition process associated with adopting a new practice.

Furthermore, it is recommended that TED identify areas of research that could be termed "farm-based evaluations" in which farmers themselves "go with the research" in a way that minimizes as much as possible, the paperwork that normally accompanies "research" in its purer form. For example, soliciting farmer assistance in compiling tillage system packages, or funding special-interest groups to evaluate particular equipment prototypes are two ways TED could consider specific involvement with farmers in farm-based conservation evaluations.

4.4.4 Institution/ Agribusiness Cooperation

A recommendation regarding the establishment of a Centre for collecting state-of-the-art conservation information and playing a networking role, has already been made in Section 4.3.1. As interest in conservation farming grows, agribusiness should experience a growing demand for those products particularly tailored to conservation conditions and systems including seeds, fertilizers, pesticides and equipment.

Therefore, it is recommended that TED solicit the involvement of agribusiness in promotion of conservation farming techniques. This promotion should take place in a general sense such as in support for an information centre or multimedia public service conservation presentations, as well as within conservation system packages developed through TED initiatives.

5.0 WORKSHOP RESULTS - FARMER INPUT TO THE TED RESEARCH PROGRAM

5.1 Introduction

On March 10, 1988, a workshop to obtain farmer input to TED research program development was held at the Best Western - Lamplighter Inn in London. All farm operators who had participated in the survey (‘A Review of Farm-Based Soil Conservation Research and Development') were invited to attend the workshop, as were several Agriculture Canada, TED and OMAF administrators, and representatives of two consulting firms. A complete listing of workshop attendees is contained in Appendix C.

The main objectives of the workshop were as follows:

1) to present the findings and recommendations of this survey as contained in earlier sections of this report, and to hear TED's response to the recommendations;

2) to provide opportunity for workshop participants to prioritize TED research topics;

3) to discover the most appropriate ways in which farmers could participate in conducting on-farm conservation research.

The results of the discussion generated by these objectives are presented in the sections which follow.

5.2 Response to Survey Recommendations

The farm operators present at the workshop responded favourably to the presentation of the recommendations of the survey. Appreciation was generally expressed for the scope and comprehensiveness of the recommendations.

A representative of Ecological Services for Planning outlined TED's response to the recommendations. It was noted that all of the recommendations relating to agronomy and tillage/planting systems (Section 4.1 and 4.2 of the report) are currently being addressed by TED, with the exception of the one relating to weed control in newly-established windbreaks. This particular need had not previously been raised with TED personnel.

Some of the other recommendations contained within Sections 4.3 and 4.4 do not fall within the direct mandate of TED. However, assurances were given that wherever possible, TED would be in communication with other agencies and organizations who can take direct action on such recommendations.

5.3 Workshop Participant Prioritization of TED Research Areas

Prior to the March 10 workshop, participants received a copy of a document entitled, TED: Background and Planning Components (See Appendix D). This document outlines the background and structure of the TED program. In addition, a list of research areas previously prioritized on the basis of the first year planning process is contained in Section 4.0 of the document (Table 1, Appendix D).

The farmers at the March 10 workshop were asked to prioritize the same list based on the needs of their own farm operation. A subjective ranking of high, medium or low was assigned to each of the research areas by each of the farmer participants. A collective ‘high' ranking was given to a research area when two-thirds or more of the farmers ranked the area high.
The following areas of research were ranked ‘high' by both groups:

1) Management of variable fields (erosion and phosphorus loss under various management systems)
2) Nutrient distribution under conservation management practices

3) Weeds under reduced tillage
4) Integrated weed management: biological, cultural, field scouting, time effects.

These additional research areas were ranked high by the farmers. However, the TED planning process had not reached a consensus regarding their priority.

A. Equipment modifications and development
B. Fertilizer placement equipment: modifications and development
C. Benefits and costs associated with fertilizer placement: emphasis on phasing into conservation farming
D. Conservation tillage and water quality; macropores, improved structure and impact on herbicide and N movement.

Subsequent discussions have led to high priority rankings for research areas A and D above.

5.4 Role of Farmers in TED Research

Workshop participants were divided into small groups to discuss the specific requirements they would have from a farm management perspective, should they become involved in on-farm research. Considerations that were addressed by the groups are outlined below, as are the main points or suggestions raised as reported to the plenary from the working groups:

Technical support required to conduct research

- qualified people are needed to undertake literature reviews, research design, analysis, report writing and some of the detailed record keeping
- extra help is needed in peak labour seasons
- perhaps a Graduate Student or a consulting firm could be hired to do some of the aforementioned tasks and/or the accompanying paperwork.

Acceptable field layout

- field-size plots were cited as the preferred layout, as they could conform to existing equipment sizes (T2000-type plots which can be both hand and machine harvested), and also adequately account for field variability
- a lot of wasted land results from trying to work with small-scale plots

Data collection/record-keeping

- farmers seemed most comfortable with keeping accurate records of such things as planting and fertilization dates and rates, machine harvested yields and noting daily climatic and field conditions.
- some were willing to record rainfall/temperature data, silking times and general weed pressures, etc., but were generally not willing to collect the very detailed information (e.g. insect and plant population counts, detailed indicators of plant growth and development, etc.)

Expected levels of funding

- actual dollar figures were not suggested, as level of funding is dependent on project design, extent of farmer involvement, use of farmer's equipment, etc.

- at a minimum, funding should cover: all project-related expenses; farmer's time and inconvenience; use of farmer-owned equipment; and compensation for any project-related crop loss.

5.5 Workshop Conclusions

Within its research program, TED has a clear mandate to conduct research on-farm, involving wherever possible, the farm cooperator. At various times throughout the course of the workshop, concern was expressed by TED and other SWEEP management personnel that greater involvement of farmers in the research process must occur if this mandate is to be fulfilled.

Based on the working group discussions, it appears that the farmers' preference for research involvement is on a cooperative basis with the researcher. In other words, the farmer and researcher work together to setup the experiment on-farm, with the researcher conducting the detailed data collection and the analysis, and writing the report. Farmers were less willing to consider having the overall responsibility for conducting the research from start to finish; on the other hand, they were generally interested in doing more than simply leasing land to researchers.

One of the working groups suggested that the on-farm research could be coordinated by a consulting firm (contractor) who would look after the ‘paperwork.' Dr. Wally Findlay expanded a bit on this approach, suggesting that the contractor have overall responsibility for writing the proposal, ensuring completion of the contract and administering the appropriate funds. However, wherever possible, initiative on the part of the farmers must be encouraged, particularly in identification of a research idea of interest to the farmer, and in collection of some of the research data.

In closing, it was recognized that there are some basic constraints to greater involvement of farmers in conducting on-farm research but that there are still some untested

approaches which can be tried. One suggestion was to conduct a pilot research study which would demonstrate the interaction of a contractor, interested farmers and the researcher in carrying out a conservation research project.

Maintaining clear communication links between farmers and researchers is of primary importance in assessing the likelihood of greater cooperation in the future.

APPENDIX A

ID. Number _____

A REVIEW OF FARM-BASED SOIL CONSERVATION RESEARCH AND DEVELOPMENT INTERVIEW FORM

Date: _____

Time: _____

Respondent Name: _____

Interviewer Name: _____

A REVIEW OF FARM-BASED SOIL CONSERVATION

RESEARCH AND DEVELOPMENT

Ecologistics Limited December, 1987

I. FARM CHARACTERISTICS

1. What are the main farming activities taking place in your farm operation? (Indicate the most important with No. 1.)

_____ Dairy _____ Cash Crop (specify) _____

_____ Beef _____ Fruit or Vegetable (specify) _____

_____ Swine _____

_____ Poultry _____ Other (specify) _____

_____ Mixed (specify) _____

2. Please indicate on the map provided, the exact location of the land you are currently farming and complete the information as follows:

Name of Township _____

Lot _____

Concession _____

Total Acres _____

- owned _____
- rented _____

3. Based on available soil and drainage mapping, we have noted the following information about the physical characteristics of your farm. If you feel your farm characteristics differ from what we have noted, please mark changes and additions below or on the map provided. Also, please note any problem areas (i.e. wet areas, steep slopes) on land that you work.

Main soil type(s) _____

_____

_____

Corn heat units _____

Tile drainage (ac) _____

- systematic _____
- random _____

Drainage characteristics _____

(poor/fair/good/excellent) _____

Slope characteristics _____

(flat/slightly rolling, _____

etc.) _____

II. SOIL CONSERVATION PRACTICES TRIED OR USED ON A REGULAR BASIS

This part of the survey asks you questions about three groups of practices and how you use them:

A.. Cropping Practices

B.. Tillage and Planting Practices, and Machine Modifications

C.. Land Management Practices

A. Cropping Practices

First, let's look at some conservation cropping practices with which you may have experience.

1. a) What crop rotation do you generally use?

Crops (in sequence)	_____	_____	_____	_____
No. of years in rotation	_____	_____	_____	_____

b) For how many years have you used this rotation?
_____ No. of years

c) Why do you use this rotation?
_____
_____
_____
_____

d) What other crop rotations have you used in the past?

Crops (in sequence)	_____	_____	_____	_____
No. of years in rotation	_____	_____	_____	_____
Crops (in sequence)	_____	_____	_____	_____
No. of years in rotation	_____	_____	_____	_____

e) Why have you shifted away from these rotations to the one you now use?

_____
_____
_____
_____

f) What crop rotations might you try in the future and why?

Crop Rotation	Reason
_____	_____
_____	_____
_____	_____

2. a) What cover crops, if any, do you plant? (Cover crops include those which are killed or tilled under in the spring as well as those which are harvested the following year, i.e. winter wheat.If none, go to next question.)

_____ None

_____

_____

_____

b) On average, how many acres of the land you work is cover cropped?

_____ acres

c) For each cover crop listed above, please describe how you manage it (include time of planting, method and time of kill and/or tillage used, type of crop planted into it, planting equipment used, etc.).

Cover Crop	Management
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

d) Please identify any problems you face in working with cover crops and how you are trying to solve them.

Problem	Ways to Solve Problems
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____

e) How long have you used cover crops?

_____ years

f) Why have you continued to use cover crops?

_____

_____

_____

3. a) Have you used strip cropping?

_____ yes

_____ no (If no, go to next question)

b) For how many years have you used strip cropping?

_____ years

c) Please describe the way you have worked with strip crops.

Description of Strips

Width _____
Crop types _____
On contour or not _____
Other _____

d) Please identify any problems you have faced in working with strip crops and how you are trying to solve them?

Problem	Ways to Solve Problems
_____	_____
	_____
_____	_____
	_____

e) Why have you continued to use strip cropping?

_____
_____
_____
_____

4. a) Have you used crop borders around row-cropped fields?

_____ yes
_____ no (If no, go to next question)

b) For how many years have you used field borders?

_____ years

c) Please describe.

Description of Borders

Width _____
Crop types _____
Other _____

d) Please identify any problems you have faced in working with field borders and how you are trying to solve them?

Problem	Ways to Solve Problems
_____	_____
	_____
_____	_____
	_____

e) Why have you continued to use field borders?

_____
_____
_____
_____

B. Tillage and Planting Practices, and Machine Modifications

5. From the following list of practices and modifications, please identify those you have tried and dropped, are now trying, or are continuing . to use. (Please check appropriate lines and indicate the number of years tried or continued to use.)

a) **General Tillage Practices**	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
1. optimum direction of tillage (across slope tillage)	_____	_____	_____	_____	_____
2. reduced depth of tillage (less than 6" for primary tillage; about 3" for secondary tillage)	_____	_____	_____	_____	_____
3. minimum number of tillage passes (to leave more residue on surface at planting time)	_____	_____	_____	_____	_____
4. other (specify)	_____	_____	_____	_____	_____
Primary Tillage					
b) Moldboard Plough					
10. moldboard plough with narrow bottoms	_____	_____	_____	_____	_____
11. moldboard plough with trashboards removed	_____	_____	_____	_____	_____
12. moldboard plough with a major portion of the moldboards cut off	_____	_____	_____	_____	_____
13. moldboard plough with plough bottoms replaced by twisted shovel attachments	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
14. moldboard plough with plough bottoms replaced by sweep attachments	_____	_____	_____	_____	_____
15. moldboard plough with plough bottoms replaced by PRONG POINT attachments	_____	_____	_____	_____	_____
c) Chisel Plough					
16. chisel plough (unmodified)	_____	_____	_____	_____	_____
17. chisel plough with twisted shovels	_____	_____	_____	_____	_____
18. chisel plough with sweeps	_____	_____	_____	_____	_____
19. chisel plough with flat coulters OR concave discs AND twisted shovels	_____	_____	_____	_____	_____
20. chisel plough with flat coulters OR concave discs AND sweeps	_____	_____	_____	_____	_____
Other Primary Tillage					
21. off-set disc	_____	_____	_____	_____	_____
22. heavy tandem disc	_____	_____	_____	_____	_____
23. other (please describe) _____ _____	_____	_____	_____	_____	_____
d) Secondary Tillage					
30. field cultivator with C-tines	_____	_____	_____	_____	_____
31. field cultivator with S-tines	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
32. tandem disc	_____	_____	_____	_____	_____
33. harrows	_____	_____	_____	_____	_____
34. packers	_____	_____	_____	_____	_____
35. combination unit	_____	_____	_____	_____	_____
Planting Machine and Modifications					
e) Ridge-till Planter					
40. stabilizing units to keep planter on ridge	_____	_____	_____	_____	_____
41. ridge-cleaning units	_____	_____	_____	_____	_____
42. oscillating depth stops for seeding units	_____	_____	_____	_____	_____
43. changed press wheel arrangement for better seed firming action	_____	_____	_____	_____	_____
44. insecticide placed in front of the press wheels	_____	_____	_____	_____	_____
45. insecticide placed behind the press wheels	_____	_____	_____	_____	_____
46. insecticide incorporated by some method (eg. chains, finger tines)	_____	_____	_____	_____	_____
47. fertilizer placed as a liquid "pop-up" with the seed	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
48. fertilizer placed as a liquid "starter" below the seed	_____	_____	_____	_____	_____
49. weights and brackets for planter frame	_____	_____	_____	_____	_____
50. weights and brackets for planting units	_____	_____	_____	_____	_____
51. weights and brackets for marker arms	_____	_____	_____	_____	_____
52. other (describe) _____ _____	_____	_____	_____	_____	_____
Other Ridge Tillage Cropping Operations					
60. ridge-forming cultivator	_____	_____	_____	_____	_____
61. additional coulters and closing units on anhydrous ammonia applicator	_____	_____	_____	_____	_____
62. nitrogen (28%.) applicator equipped with coulters and knives	_____	_____	_____	_____	_____
63. straw chopper on combine	_____	_____	_____	_____	_____
64. straw chopper with extended fins on combine	_____	_____	_____	_____	_____
65. modified axles on combine	_____	_____	_____	_____	_____
66. changed tire size on combine	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
67. other (describe)	_____	_____	_____	_____	_____ _____
f) No-till Planter					
70. additional tool bar	_____	_____	_____	_____	_____ _____
71. coulters (attached to additional toolbar) running directly in front of the fertilizer openers	_____	_____	_____	_____	_____ _____
72. coulters (attached to additional toolbar) running directly in front of the seed openers	_____	_____	_____	_____	_____ _____
73. fluted coulters (mounted on additional toolbar) to perform strip tillage (Rowson set-up)	_____	_____	_____	_____	_____ _____
74. coulters (attached to original planter frame) running directly in front of the seed openers	_____	_____	_____	_____	_____ _____
75. mechanism to move crop residues out of the row area	_____	_____	_____	_____	_____ _____
76. oscillating depth stops for seeding units	_____	_____	_____	_____	_____ _____
77. cast iron press wheels	_____	_____	_____	_____	_____ _____
78. changed press wheel arrangement for better seed firming action	_____	_____	_____	_____	_____ _____
	_____	_____	_____	_____	_____ _____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
79. insecticide placed in front of the press wheels	_____	_____	_____	_____	_____
80. insecticide placed behind the press wheels	_____	_____	_____	_____	_____
81. insecticide incorporated by some method (eg. chains, finger tines)	_____	_____	_____	_____	_____
82. fertilizer placed as a dry "starter" beside and below seed	_____	_____	_____	_____	_____
83. weights and brackets for planter frame	_____	_____	_____	_____	_____
84. weights and brackets for planter units	_____	_____	_____	_____	_____
85. weights and brackets for marker arms	_____	_____	_____	_____	_____
86. lengthened tongue on hitch of planter	_____	_____	_____	_____	_____
87. other (describe) _____ _____	_____	_____	_____	_____	_____

Other No-till Cropping Operations

100. marker system on sprayer	_____	_____	_____	_____	_____
101. additional coulters and closing units on anhydrous ammonia applicator	_____	_____	_____	_____	_____
102. nitrogen (28%) applicator equipped with coulters and knives	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
103. straw chopper on combine	_____	_____	_____	_____	_____
104. straw chopper with extended fins on combine	_____	_____	_____	_____	_____
105. chaff spreader	_____	_____	_____	_____	_____
106. other (describe) _____ _____	_____	_____	_____	_____	_____
g) No-till Seed Drill					
110. weights and brackets for planter frame	_____	_____	_____	_____	_____
111. lengthened tongue on hitch of drill	_____	_____	_____	_____	_____
112. equipped with dry fertilizer hoppers	_____	_____	_____	_____	_____
113. equipped with liquid fertilizer tanks	_____	_____	_____	_____	_____
114. equipped with grass seed hoppers	_____	_____	_____	_____	_____
115. coulters (attached to original frame) running in front of seed openers	_____	_____	_____	_____	_____
116. coulters (attached to original frame) running with the seed tubes	_____	_____	_____	_____	_____
117. equipped with press/gauge wheels	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
118. seeding units staggered along main tool bar of planter frame	_____	_____	_____	_____	_____ _____
119. seeding units in a straight line along main toolbar of planter frame	_____	_____	_____	_____	_____ _____
120. other (describe) _____ _____	_____	_____	_____	_____	_____ _____

Other Cropping Operations

130. marker system on sprayer					
131. straw chopper on combine	_____	_____	_____	_____	_____ _____
132. straw chopper with extended fins on combine	_____	_____	_____	_____	_____ _____
133. chaff spreader	_____	_____	_____	_____	_____ _____

Other Machine Modifications:

134. specify _____ _____ _____ _____ _____ _____ _____ _____	_____	_____	_____	_____	_____ _____ _____ _____ _____ _____ _____ _____

6. a) For the tillage and planting system(s) which you are now using, please note the following:
(Interviewer Note: This question is needed for each tillage and planting system being used in question 5.)

System _____

b) What proportion of your farm land is cropped under this system?
_____ %

c) Why have you continued to use this system?
_____
_____

d) Please note the field conditions under which this system is being used:
_____ Soil texture (sand, loam, sandy loam, silt loam, clay loam, clay)
_____ Drainage (poor, fair, good, excellent)
_____ Crop residue type(s)
_____ Crop(s) to be planted

e) To what extent have you had to modify or adapt this system to better fit into your operation?
_____ A great deal
_____ Somewhat
_____ Only slightly
_____ Not at all (Go to next practice question)

f) How satisfied are you now with this system? (Circle one response.)

Very Satisfied				Very Dissatisfied
1	2	3	4	5

C. Land Management Practices

7. From the following list of practices, please identify those you have tried and dropped, are now trying, or are continuing to use. (Please check appropriate lines and indicate the number of years tried or continued to use.)

Practice	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
1. permanent buffer strip along watercourses	_____	_____	_____	_____	_____
2. grassed waterway	_____	_____	_____	_____	_____
3. tile outlet stabilization	_____	_____	_____	_____	_____
4. ditch or streambank stabilization	_____	_____	_____	_____	_____
5. rock chutes	_____	_____	_____	_____	_____
6. drop inlet structures	_____	_____	_____	_____	_____
7. terracing	_____	_____	_____	_____	_____
8. other structures (specify)_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
15.. windbreak (for field protection)	_____	_____	_____	_____	_____

	Never Tried (check)	Have tried (no. yrs) & dropped (yrs)	Being Tried (yrs)	Continue to use (yrs)	If practice dropped, give reason. If practice is now being tried or used regularly, note how any problems are being or have been resolved (modifications required, etc.)
Pest Control - Modified Timing and Method of Application for Conservation Purposes	_____	_____	_____	_____	_____
16. herbicides (specify use)_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
20. insecticides (specify use) _____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	
25. fungicides (specify use) _____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	

8. a) For each of the practices and modifications which you have continued to use, please note the following:
(Interviewer Note: This question is needed for each practice adopted in question 9.)
Practice _____

b) Why have you continued to use this practice?

_____
_____

c) To what extent have you had to modify or adapt this practice to better fit into your operation?

_____ A great deal
_____ Somewhat
_____ Only slightly
_____ Not at all

d) How satisfied are you now with this practice? (Circle one response.)

Very Satisfied				Very Dissatisfied
1	2	3	4	5

_____

9. Have you tried, or are you trying, any new ways of managing manure (i.e. system of storage, method of field delivery, timing of application, etc.)?

____ Yes
____ No
If yes, please describe _____

10. a) How satisfied are you with the current registration of pesticide products for on-farm use in conservation cropping systems? (Circle one response.)

Very Satisfied				Very Dissatisfied
1	2	3	4	5

b) What pesticides or tank mixes would you like to see approved for use in conservation farming?

_____
_____
_____

11. If you farm rented land, do you include any of it in your conservation practice development?

_____ yes
_____ no
If no, please explain _____
_____
_____

12. As a result of adopting the conservation practices you have mentioned in Section II, please indicate the nature of the changes occurring in the following areas:

	NATURE OF THE CHANGE				
	Positive		No	Negative	
	Very	Somewhat	No Change	Somewhat	Very
Changes in soil quality/structure	_____	_____	_____	_____	_____
Changes in soil erodability	_____	_____	_____	_____	_____
Changes in crop yields	_____	_____	_____	_____	_____
Changes in input costs	_____	_____	_____	_____	_____
Other (specify) _____	_____	_____	_____	_____	_____

Please describe in what ways these changes are occurring (include percent change in crop yields and input costs, etc.).

_____
_____
_____
_____

13. a) When you evaluate how well a specific conservation practice is working in your operation, which of the following criteria do you use in this process? (Circle all that apply)

i) The extent to which the practice keeps soil from washing andblowing on my fields.
ii) The extent to which the practice maintains or enhances the production of crops on my fields.
iii) The extent to which the practice provides economic returns when compared to the initial investment and maintenance costs.
iv) The extent to which the practice is easy to use and readily fits into my existing operation.
v) Other (specify) _____
_____
vi) Other (specify) _____
_____

b) Now would you rank the criteria that you identified by listing the roman numeral in order of importance.

1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

III. REASONS FOR USING CONSERVATION PRACTICES

1. How long have you been involved in developing conservation practices?
   _____ No. of years

2. Why did you initially become involved in developing soil conservation practices? (Please rank responses, with No. 1 as most important.)
   _____
   _____
   _____
   _____

3. Excessive soil erosion can cause a number of problems for the farm operator. To what extent did each of the following situations exist on your farm before you began working with conservation practices?

Type of Situation		Extent to Which Situation Existed			
		Did Not Exist	Small	Medium	Large
a.	Yield reductions due to reduced soil productivity from soil erosion	1	2	3	4
b.	Increased use of fertilizer to compensate for that lost due to erosion	1	2	3	4
c.	Increased machinery wear and tear due to erosion on your fields	1	2	3	4
d.	Damage to young plants due to wind erosion or being covered by sediment	1	2	3	4
e.	Yield reductions due to soil erosion washing pesticides on to adjacent non compatible crops	1	2	3	4
f.	Eroded soil filling in drainage ditches	1	2	3	4
g.	Eroded soil carrying nutrients and pesticides into nearby streams	1	2	3	4
h.	Higher costs for increased drainage ditch maintenance due to soil erosion from farm fields	1	2	3	4

4. To what extent was soil erosion a problem on your farm before you became involved in conservation farming?

Not at all				Very Serious
1	2	3	4	5

5. Overall, to what extent is soil erosion a problem in your farm operation today?

Not at all				Very Serious
1	2	3	4	5

IV. SOURCES OF INFORMATION

Earlier in the questionnaire you have identified some problem areas related to conservation practice testing and development. Listed below are some possible sources of information that could help in resolving difficulties.

a. Neighbours
b. Other Innovative Farmers
c. Equipment Dealers
d. Other Farm Suppliers (specify)
_____
e. O.M.A.F. Soil Conservation Advisors
f. Other O.M.A.F. Extension Staff
g. Conservation Authority Staff
h. University of Guelph
i. CAT (Ridgetown, etc.)
J. Soils and Crops Improvement Assoc.
k. Demonstration Projects and Tours
1) Ontario
2) U.S.
1. Private Consultants
in. "Farm and Country"
n. "Country Guide"
o. "Western Ontario Farmer"
p. U.S. Journals (specify)
_____
q. O.M.A.F. Factsheets
r. "O.M.A.F. News"
s. Radio and TV Shows
t. Seminars/conferences(specify)
_____
u. Rely mostly on myself
v. Other _____
_____

In the following questions you are asked to choose from the above list, up to three information sources most useful to you for the different types of information required:

1. a) Sometimes it is difficult for farmers to determine the extent of soil erosion problems in their farm operations. When you wanted to determine the cause and extent of your soil erosion problem, where did you go for this information or assistance? (Note source(s) of information from above list by letter, and rank in order of importance - 11 as most important.)

Source	Rank
_____	_____
_____	_____
_____	_____

b) Would you say that this information was (check one):

_____ easy to obtain
_____ about the same as other agricultural information
_____ very difficult to obtain

c) How useful was the information you obtained? (check one)

_____ very useful
_____ somewhat useful
_____ not useful at all

2. a) A number of problems can emerge in trying to fit or integrate a conservation practice into a farm operation. When you wanted to know the best way of using these conservation practices in your farm situation, where did you go for this information or assistance? (Note source(s) of information from above list by letter and rank - #1 as most important.)

Source	Rank
_____	_____
_____	_____
_____	_____

b) Would you say that this information was (check one):

_____ easy to obtain
_____ about the same as other agricultural information
_____ very difficult to obtain

c) How useful was the information you obtained? (Check one.)

_____ very useful
_____ somewhat useful
_____ not useful at all

3. a) It is very difficult to determine the costs and benefits of different conservation practices. When you wanted to know the economic costs and benefits of the conservation practices you are currently using, where did you go for this information or assistance? (Note source(s) of information from above list by letter and rank - #1 as most important.)

Source	Rank
_____	_____
_____	_____
_____	_____

b) Would you say that this information was (check one):

_____ easy to obtain
_____ about the same as other agricultural information
_____ very difficult to obtain

c) How useful was the information you obtained? (Check one.)

_____ very useful
_____ somewhat useful
_____ not useful at all

V. SUPPORT FOR CONSERVATION LEADERS AND POTENTIAL "TECHNOLOGY EVALUATION AND DEVELOPMENT" (TED) INVOLVEMENT

1. Neighbours have probably reacted in various ways to your efforts to implement conservation practices.
   a) Towards which practices have they responded favourably?

   _____
   _____

   b) If you have received positive or negative reactions, what in particular have they been critical or supportive of?

   _____
   _____

   c) Have any neighbours tested or adopted practices you have adopted?
   ____ Yes
   ____ No
   If yes, which ones?

   _____
   _____

2. On what basis do you think the implementation of conservation practices should be encouraged in the farm community? (Please rank in order of importance - #1 is most important.)

   _____
   _____
   _____
   _____

3. As you test and use conservation technologies, how important is it that you feel supported by others who are involved in similar activities? (Check one.)
   _____ very important _____ somewhat important
   _____ of little importance _____ not at all important

4. In what ways could present support (i.e. technical, financial, etc.) and information exchange among conservation leaders, be expanded? List _____

   _____
   _____
   _____
   _____

5. Are you involved in any organized or informal information sharing activities with other farmers or agency people regarding your experience with conservation practices?
   ____ Yes
   ____ No
   If yes, please indicate where or how this occurs.

   _____
   _____

6. What conservation questions or research needs do you have concerning your own farm operation that you feel require input from other researchers? (Please rank in order of importance - #1 is most important.)

_____
_____
_____
_____

7. The Technology Evaluation and Development (TED) arm of SWEEP is interested in developing a list of soil and water conservation leaders with whom they could share conservation research ideas and develop technology transfer strategies. Would you be willing to discuss with TED the possibility of your involvement with them in future information sharing programs?

____ Yes
____ No

8. TED is planning to hold a workshop in February/March 1988 with leaders in conservation farming to discuss the purpose of TED, as well as conservation research needs and priorities.

a) Would you be interested in attending?

____ yes
____ no
____ not sure

b) What questions about the SWEEP/TED program would you like to have answered at the workshop?

_____
_____
_____

c) If you were to become involved with a government-related program such as TED, in what ways would you consider participating (i.e. speaking to groups, allow on-farm conservation tour groups, etc.)?

_____
_____
_____

d) We are preparing a list of farmers who have shown leadership in developing conservation technologies. Who would you consider to be a conservation leader?

_____
_____
_____
_____

9. Closing comments you may have.

_____
_____
_____
_____

APPENDIX I

CONSENT FORM

One of the purposes of this study is to assemble information on the experiences of farmers who have shown leadership in testing and developing soil and water conservation practices. The information (excluding Section VI) will be kept in a central location such as the proposed Soil and Water Conservation Resource Centre and made available to farmers and others seeking information about conservation practices.

If there is information about your experiences that you would not want others to see, please indicate this by checking the appropriate spot below for each of the sections.

	I am not concerned about confidentiality	I want this section held confidential
Section I. FARM CHARACTERISTICS	_____	_____
Section II. PRACTICES BEING TRIED OR USED ON A REGULAR BASIS	_____	_____
Section III. REASONS FOR USING CONSERVATION PRACTICES	_____	_____
Section IV. SOURCES OF INFORMATION	_____	_____
Section V. SUPPORT FOR CONSERVATION LEADERS AND POTENTIAL TED INVOLVEMENT	_____	_____

signed _____

interviewer _____

VI. A REVIEW OF FARM-BASED SOIL CONSERVATION RESEARCH AND DEVELOPMENT - MAIL BACK SECTION

This section of the questionnaire asks you for information that will help us assess common characteristics of soil conservation leaders. Because it is of a more personal nature, it will be grouped with all others who respond and used for statistical purposes only. None of this would be reported on less than a group basis. This form will be kept on file at Ecologistics Limited and will not be forwarded to Agriculture Canada (TED).

We would appreciate if you could take a few minutes to check off the appropriate responses. Please do not write your name on the form. By mailing it to us, you will remain anonymous. Thank you very much for your assistance.

1. How many years have you been farming at your current address?
   _____ years

2. How long have you been involved in testing/developing conservation practices?
   _____ No. of years

3. To which of the following age groups do you belong?
   ____ up to age 34 ____ 45 - 54
   ____ 35 - 44 ____ 55 +

4. If you raise livestock or poultry, please indicate each type and approximate number housed at any one time.

Type	Number
_____	_____
_____	_____
_____	_____

5. In which category of gross farm sales ($ in 1986) do you belong?
   _____ less than 49,000 _____ 200,000 to 400,000
   _____ 50,000 to 99,000 _____more than 400,000
   _____ 100,000 to 199,000

6. How many years of formal education have you completed?
   _____ elementary school _____ some college or university
   _____ some high school _____ college or university degree
   _____ high school (Gr. 12 or 13) _____ post-graduate studies

7. With which family members, if any, do you usually discuss the pros and cons of a new farming practice when you are thinking about adopting it? (Check all that apply.)
   _____ son/son-in-law _____ father
   _____ daughter/daughter-in-law _____ mother
   _____ brother/sister _____ other family member (specify)
   _____ spouse _____
   _____ none of the above

8. Which of the following best describes the type of organization for your farm business?
   _____ sole proprietorship
   _____ partnership among family members
   _____ partnership among non-family members
   _____ a corporation with most of the shares owned by you and family members
   _____ a corporation with most of the shares owned by non-family other (specify)

9. Please indicate the extent to which you agree with the following statement. (Please circle one number.)

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
I regard myself as the kind of person who is willing to take a few more risks than others.	5	4	3	2	1

10. When you retire from or quit farming, what do you plan to do with your farm operation? (Check one.)

   _____ pass on to family member
   _____ sell it on the open market
   _____ rent it out to family members
   _____ rent it out on the open market
   _____ other (please specify)

APPENDIX B

November 25, 1987 17-618-00

Dear

Earlier this month you were contacted by a member of our staff about participating in a survey of soil and water conservation practices. This letter provides additional background information about the study and the reasons why you have been selected as a participant.

This study is being undertaken as part of the Soil and Water Environmental Enhancement Program (SWEEP), a joint federal-provincial initiative to improve soil and water quality in Southwestern Ontario. A brochure describing the program is enclosed.

Farmers who have shown leadership in testing and developing soil and water conservation practices can play an important role in helping to meet the program goals. The insights gained from practical, on-farm experimentation can benefit many other farmers and researchers in their quest for better soil conserving practices.

We will be conducting interviews with farmers like yourself to find out which soil and water conservation practices have been tried on farms in southern Ontario, what has or has not worked, and what conservation problems and research needs should be addressed in the SWEEP program.

You have been identified as a leader in the development of soil and water conservation practices and therefore, a person whose insights and views are of value to the farmers of Ontario. We would like to conduct a personal interview to find out about your conservation experience and to determine what, if any, future role you would consider playing in respect to the SWEEP program.

The interview would be conducted, at your convenience, in your home. It will require approximately two hours of your time.

Within the next few weeks, we will telephone you to arrange a convenient meeting time. If you have any immediate questions, please call Jean Down or **Paul** Brubacher at (519) 886-0520 (collect).

Thank you in advance for your assistance.

Sincerely,

D.R. Cressman, M.Sc., P.Ag.
President

JD/db

APPENDIX C

WORKSHOP PARTICIPANTS -
A REVIEW OF FARM-BASED SOIL CONSERVATION
RESEARCH AND DEVELOPMENT

The following individuals attended the TED-sponsored conservation workshop held March 10, 1988 in London at the Best Western - Lamplighter Inn.

Farmers

Robert de Brabandere
Eric Devlaeminck
Don Dotzert
Brian Fletcher
Charlie Grant
Bob Hart
Paisley Johnson
Don Lobb
Jack McGregor
Gerry Poedhman
Clinton Pottruff
Max Ricker
Bruce Shillinglaw
Brian Skipper
Doug Smith

Agriculture Canada

Dr. C.F. Marks, Harrow
Ms. Frances Cullen, Guelph
Dr. Wally Findlay, Harrow (TED)

Ecological Services for Planning Ltd.

David Charlton
Jerry Hagarty
Valerie Alder

Ecologistics Limited

Paul Brubacher

WORKSHOP AGENDA

FARMER RECOMMENDATIONS REGARDING
FARM-BASED SOIL CONSERVATION RESEARCH AND DEVELOPMENT
WITHIN THE TED SUB-PROGRAM OF SWEEP

DATE: Thursday, **March 10, 1988**

TIME: **9:30** a.m. to 4:30 p.m.

PLACE: **LAMPLIGHTER INN - BEST WESTERN**
591 Wellington Road South, London, Ontario (519) 681-7151
(2 ½ miles north of the 401 on the west side of Wellington Street)

9:30 a.m. INTRODUCTIONS - TED

9:45 a.m. SUMMARY of "Review of Farm-Based Soil Conservation Research and Development" - Ecologistics Ltd.

10:30 a.m. OUTLINE of the TED sub-program, including future role of farmers and reaction to the recommendations from the"Review of Farm-Based Soil Conservation Research and Development" - TED.

12:00 LUNCH (Buffet provided at Lamplighter)

1:15 p.m. FARMER REVIEW of Proposed Research in the TED program, incorporating recommendations from the "Review of Farm-Based Research, future role of farmers and focus of TED sub-program.
This discussion will result in a modified list of farmer recommendations to the TED sub-program arranged in order of priority.

4:00 p.m. SUMMARY of afternoon session.

4:30 p.m. ADJOURNMENT.

TED:

BACKGROUND AND PLANNING COMPONENTS

February, 1988
farmwksp

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1.0 INTRODUCTION

This document presents the basis for the creation of the southwestern Ontario Soil and Water Environmental Enhancement Program (SWEEP).The role of the Technology Evaluation and Development (TED) subprogram within SWEEP and its relation with the other subprograms within SWEEP are also discussed. This document summarizes information from more detailed reports written for each of the planning components of TED.

The intent is to provide general information about TED and a listing of research planned and initiated, within the context of the overall planning process.

2.0 BACKGROUND TO THE SWEEP PROGRAM

In 1978, the Canada-United States Great Lakes Water Quality Agreement called for the protection of the upper Great Lakes and for a range of measures to reduce phosphorus (P) loading to the lower Great Lakes. In October 1983, Canada and the United States agreed to further reduce annual P loading to Lake Erie by 2000 tonnes. While the United States was responsible for the reduction of 1700 tonnes of the P load, Canada was responsible for the remaining 300 tonne reduction by 1990.

FIGURE 1: Components of SWEEP (Soil & Water Environmental Enhancement Program)

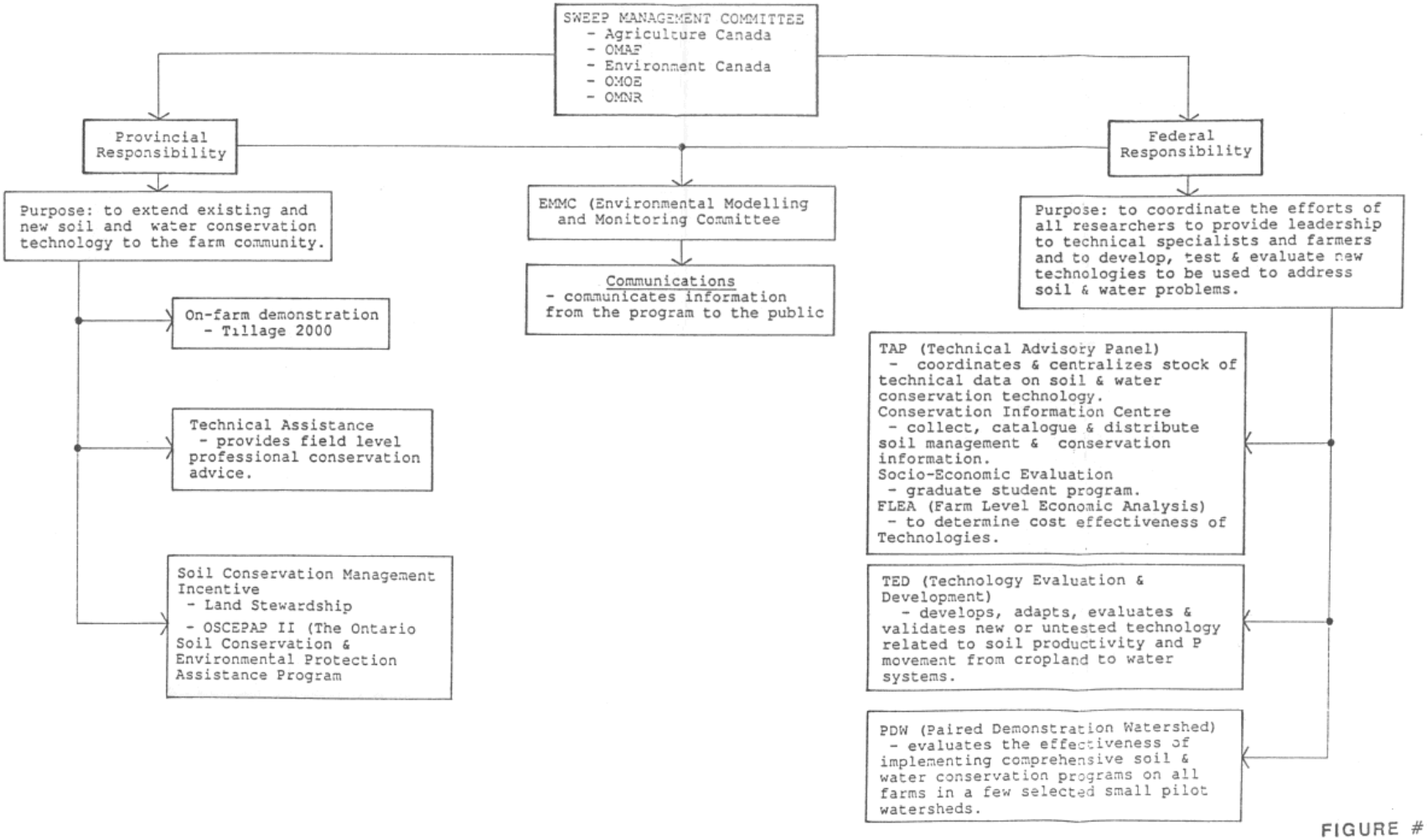

FIGURE #1

In order to achieve their goal, Canada planned to reduce the P loading from municipal and industrial sources by 100 tonnes, and to reduce the loading from agricultural cropland sources by 200 tonnes. Reduction of P from cropland was to be achieved by the improvement of soil management and conservation practices on farms in priority drainage areas.

The southwestern Ontario Soil and Water Environmental Enhancement Program (SWEEP), is comprised of both agricultural and environmental ministries of the federal and provincial governments. The provincial and federal sectors have individual and joint responsibilities in the overall program which is stratified into sub-programs as shown in Fig. 1.

3.0 TED OBJECTIVES AND APPROACH

The purpose of the Technology Evaluation and Development (TED) sub-program is to develop, adapt, and evaluate cost-effective technologies and systems that will lead to soil conservation and improved water quality. These technologies and systems should have a high probability of being successful on commercial farms, and field scale tests will therefore generally be conducted on commercial farms in priority areas. The technology or technology systems will be evaluated for their impact on both erosion and water quality and crop production. Economic benefits and costs will be evaluated by the Farm Level Economic Analysis sub-program of SWEEP.

The TED sub-program is viewed as a link between mainstream research and the farming community. The TED research must allow for pertinent farmer knowledge and experiences to be used effectively. Links between TED and technology transfer activities will be an integral part of the design. The success of these links will, in part, depend on the extent of the interest generated among farmers. Emphasis on conducting research in farmers' fields wherever feasible, and participation of farmers in workshops should generate considerable farmer interest. Ecological Services for Planning (ESP) is committed to making every effort to ensure that farmers' concerns are reflected in the research.

ESP, in planning the TED sub-program, had to define the present state of knowledge and to outline feasible achievements within the study period. ESP has accomplished these objectives with the following activities:

1. A background paper, written by the Centre for Soil and Water Conservation, examined the factors involved in the loss of productivity due to soil erosion and degradation, and the reduction of P input to surface water. Current literature, pertinent to the problems of southwestern Ontario, was reviewed and questions were developed which were used for discussion during the workshop;

2. A planning workshop involving farmers, extension personnel, economists, researchers, and policy makers;

3. Meetings with experts in specific areas and with specific interest groups;

4. A European tour to visit research facilities, view current projects, and hold discussions with experts;

5. Extensive discussion with farmers, formally and informally, including meetings and field tours with conservation farming experts in the U.S.

The background paper (Item 1) was used as a basis for discussion at the workshop. It was necessary to separate the erosion, P loss and soil productivity aspects of the problem. As a result, southwestern Ontario was stratified according to 4 physiographic regions which were characterized by the extent and nature of the erosion/productivity/P loss problem. The following are the soil-topography groupings chosen to structure the workshop discussions:

1. Flat to undulating, very fine-textured soils of southwestern Ontario, including most of Essex and Kent and parts of Middlesex, Lambton, and Elgin (flat/clayey). This area is the major source of P loading. It is characterized by heavily fertilized cash crops and a need for rapid overland drainage which results in large amounts of P in the creeks and rivers draining the area. Because of the low velocity of the surface runoff, water erosion does not appear to be a significant problem.

Productivity loss is the major problem in the next three regions:

2. Flat, undulating and gently rolling, coarse-textured soils in Norfolk and parts of Brant, Elgin, and Oxford (flat/sandy). Wind erosion is predominant. The area

is characterized by low organic matter, low clay contents, and low moisture holding capacity;

3. Rolling, medium-textured, upland soils of Middlesex, Waterloo, Perth, Oxford, Wellington, and Dufferin (rolling/loamy); and

4. Undulating to rolling, fine-textured uplands of Perth, Huron, Brant, Middlesex, Waterloo, Dufferin, and Wellington, (rolling/clay loamy).

In the fine and medium-textured uplands, erosion is mostly due to water movement. Soil particles moving downslope result in the loss of nutrients, water holding capacity, and soil structure. The high erosion in this area does not directly translate to high P loading into Lake Erie since loading depends on the proximity of the eroding lands to drainage courses.

During the two day workshop authors of the background paper and other experts chaired groups which identified and described problems, and put forth possible solutions. It was proposed by the workshop participants that a study be conducted to survey and evaluate conservation technologies being tested or used by farmers. The output of the survey was intended to lead to a choice of technologies for field testing and to aid in interpreting the results for a range of farm management situations.

4.0 THE PROPOSED RESEARCH PROGRAM

The research program was developed from an analysis of the background paper, and from information arising from the planning workshop and discussion with various expert groups. The suggested research topics have been ranked according to their relative importance based on several criteria. On evaluating a proposed research area, emphasis was placed on the probable impact of the research on TED objectives, and its links with other research within TED or in the region of interest. The remaining criteria which aided in determining the importance of a research topic were the areal extent, severity, and existing understanding of the problem, and the probability of adoption of the proposed technology. A final ranking of a research topic was determined by applying 2 factors to the score. The factors were the cost of the research versus the likelihood of results, and the limitations (eg. time) under TED.

Table 1 shows the suggestions for research assessed according to the above criteria. Topics are not rated where their importance is dependent upon the outcome of research in progress. A topic may be rated low because of the short time available to undertake the type of research in question.

TABLE 1
RESEARCH PRIORITIES FOR TED

TOPIC SOURCE (S)	PRIORITY RATING (* IN PROGRESS)
1. FARM MANAGEMENT SYSTEMS	
1.1 Management of variable fields	High
1.1.1 Erosion and phosphorous loss from slope positions *	
1.1.2 Erosion and phosphorus loss under various management systems *	
1.2 Influence of weather on choice of technologies	Medium
1.3 Survey of innovative farming practice *	High
2. CROPPING STRATEGIES	
2.1 Main crop alternatives	Low
2.3 Cover crop options and management in 'corn-bean rotations	High
2.3.1 Upland soils *	
2.3.2 Lowland soils *	
2.3.3 Field trials arising from foregoing	
2.3.4 Special studies (new varieties, management innovations)	
3. TILLAGE OPTIONS	
3.1 Residue management	Medium
3.1.1 Upland soils (emphasis on erosion)	
3.1.2 Lowland soils (emphasis on P movement)	
3.2 Equipment modifications and development	?
3.2.1 Reduce axle loadings	
3.2.2 Computer-control of inputs for management of variable fields	
3.3 Contour tillage	Low
4. FERTILITY MANAGEMENT	
4.1 Nutrient distribution under conservation management practices	High
4.2 Manure management options under conservation farming	High
4.3 Use of anhydrous ammonia in relation to P movement	Medium
4.4 Fertilizer placement equipment: modifications and development	?
4.5 Benefits and costs associated with fertilizer placement: emphasis on phasing into conservation tillage	

TABLE 1 (cont'd)
RESEARCH PRIORITIES FOR TED

TOPIC SOURCE (S)	PRIORITY RATING (* IN PROGRESS)
5. PEST CONTROL	
5.1 Weeds under reduced tillage	High
5.1.1 Chemical control: mixes, rates, time stage of main crop	
5.1.2 Control of problem weeds	
5.2 Integrated weed management: biological, cultural, field scouting, time effects	Med-High
5.3 Threshold weed levels in terms of yield and crop management	Med-High
5.4 Field trials arising from foregoing	High
5.5 Other pests (diseases, insects, molluscs)	?
6. WATER MANAGEMENT	
6.1 Land reshaping: lowlands	Medium
6.2 Increased infiltration and percolation: tile drainage, cultivation, cover crops	Medium
6.3 Structures: sediment ponds, french drains, buffer strips, berms	?
7. PROBLEM UNDERSTANDING, RESEARCH METHODS	
7.1 Erosion related to slope position *	Medium
7.2 P-delivery models/ratios	N/A
7.3 Structural degradation	?
7.3.1 Pilot study; lowlands *	
7.3.2 Effect on phosphorous; yield	
7.3.3 Remedial measures	
7.4 Conservation tillage and water quality; macropores, improved structure and impact on herbicide and N movement	
7.5 Remote sensing to monitor erosion and P movement	Medium
7.6 Wind erosion; seriousness in P movement	N/A
7.7 Allelopathic effects: causes, effects, remedies	High

5.0 RESEARCH PROJECTS ALREADY INITIATED

Of the proposed research listed in the preceding section several projects have already been initiated. The following presents the objectives of these studies.

1.1.1 and 1.1.2 Management of Farm Field Variability

This project addresses the relationship of soil/landscape variability to crop yield, P delivery and sediment production. The objectives of this research are to determine the variations in crop yield response in relation to the variability in the soil and landscape under different tillage systems, and to relate the yield response to soil properties. Relative rates of soil erosion and P delivery on various landscape positions under different tillage systems will be established. The information provided by this research should provide a basis for developing strategies for the management of farm field variability under various soil and farm management conditions.

This project is to be undertaken in conjunction with the Tillage 2000 program. The Tillage 2000 study consists of the paired sampling of conservation and conventional tillage systems within major soil landscape units on farm fields throughout southern Ontario.

1.3 A Review of Farm-Based Soil Conservation Research and Development

The objectives of this research are the identification of promising, innovative conservation practices currently being tested at the farm level, and the identification of associated problems. The study will elaborate on the motives behind the development and adaptation of conservation technologies and alternative farm systems and identify strategies to aid in the transfer of information among farmers, researchers, extension personnel, industry, and policy makers concerning these technologies. The survey will also identify a resource base of farm contacts who are leaders in technological development and who could be leaders in technology transfer. This review was completed by Ecologistics in January, 1988 and a draft report was submitted on Feb. 1, 1988.

2.3 Choice and Management of Cover Crop Species and Varieties for Use in Row-Crop Dominant Rotations

The objectives of this research include the determination of promising cover crops which can be grown in corn-bean rotations under various soil conditions and the determination of management techniques for the establishment and elimination of these cover crops. This study will investigate the effect of cover crops on yield response, harvesting, and management of the primary crop.

One cover crop study is being conducted by CMS Research Services on the upland fine to medium-textured soils in Huron and Middlesex Counties. Two separate investigations will be conducted in cooperation with interested conservation farmers to determine effects of red clover and cereal cover crops on corn growth and yield.

A second cover crop study will be undertaken by REAP (Resource Efficient Agricultural Production Canada) On-Farm Research and Demonstration. This group has been working with Southern Ontario farmers since 1986 to find solutions to reducing environmental problems without the loss of agricultural productivity. The study will be conducted on coarse and medium-textured soils of Oxford County. Research will be conducted on farms with which the group has become familiar and is comprised of a number of experiments using corn, soybean, and winter wheat main crops, and a variety of cover crops.

A third cover crop study will be initiated in the spring of 1988 on the fine-textured lowland soils of Kent and Essex Counties.

5.1 Weed Control under Conservation Farming

This research will develop an understanding of the influence of various cropping, management and environmental conditions on weed species dynamics under conservation tillage.

The Ridgetown College of Agricultural Technology will undertake 4 major studies in order to determine optimal herbicide use in conservation tillage systems. Under the various components of this research burndown and residual herbicides for legume and cereal cover crops and the antagonism of these herbicides with residual preemergence herbicides will be studied as they pertain to corn and soybeans grown in conservation tillage systems. Tank mixes of herbicides for burndown will be combined with additives to determine their effect. The role of fall application in providing burndown and weed control with winter annuals will be studied. Each study is comprised of a number of treatment combinations that will be applied to plots within farms in Huron and Kent Counties.

Further research into the identification and control of problem weed species under conservation tillage will be initiated in 1988.

7.3 Assessment of Subsoil Compaction and Structural Degradation in the Lowland Clay Soils

The relative magnitude, extent, and impact of subsoil compaction and degradation, on P delivery and crop yield response on the flat clay soils in southwestern Ontario will be investigated.

Can-Ag Enterprises has been contracted to undertake a pilot study. One of the major components of the study is the examination of topsoils and upper subsoils affected by soil degradation or compaction in farm fields representing a cross section of soils and main cropping systems. Comprehensive farmer interviews will be conducted in order to determine the extent and cause of the problem and recommended remedial measures. General interviews will be conducted in the region to determine established cropping and tillage practices and the perception of the compaction problem.

6.0 DESIGN AND PLANNING

Throughout the planning components of TED, it has been emphasized that strong links between farmers and researchers will be maintained. High priority is given to research projects that involve field scale investigation, particularly when farmer cooperation is included in the research plans.

Limited small plot, research station-based studies and laboratory experiments will be supported where required to obtain specific answers.

The design of the TED sub-program attempts to strike a balance between pure research and the demonstration approach to research. The research within the TED sub-program must be conducted in a way that provides unambiguous conclusions which can be used to predict the efficacy of these and other technologies under particular soil and farming conditions. For this reason it is essential that the results

provided by the research are statistically defensible. In order to apply the results of the effects of various technologies over the long term, and to evaluate new technologies in the future, systematic evaluations of the research results must be carried out. Otherwise, the effectiveness of a particular technology or mix of technologies cannot be determined with any degree of certainty. Since complex systems of solutions are being dealt with within the research program, defining results consistently over the range of conditions investigated will be aided by statistical analysis. In this way, some knowledge of the range of results which can be expected will be obtained.

7.0 CONCLUSIONS

It is hoped that, by providing the background and development of the TED sub-program and its relation to other sub-programs within SWEEP, farmers at the workshop will see the contribution which they can make to the ongoing planning of the TED research. Comments on the research proposed and the general direction of the TED sub-program would be welcomed at any time.

March 1, 1988
Ms. Frances Cullen
Regional Director Agriculture Development
Agriculture Canada
104 - 450 Speedvale Avenue West
Guelph, Ontario
N1H 7Y7

Dear Ms. Cullen:

We are pleased to invite you as the Co-chairperson of the Management committee for the Soil and Water Enhancement Program to this workshop to hear the recommendations of leading-edge farmers who have been involved in the planning exercises of the Technology Evaluation and Development (TED) sub-program.

An agenda and supporting documentary materials are enclosed. Please note the date and location, both of which have been altered from the first announcement.

Date: Thursday, March 10, 1988
Time: 9:30 a.m. to 4:30 p.m.
Place: Lamplighter Inn - Best Western
591 Wellington Road South,
London, Ontario

We look forward with pleasure to introducing you or your alternate during the opening session of the meeting as a guest of this working group.

Yours very truly,
W. I. Findlay
Scientific Authority (TED)

WIF:rc
ltedcc

March 1, 1988
Mr. C. F. Marks, Director
Research Station Harrow,
Ontario
NOR 1G0

Dear Mr. Marks:

We are pleased to invite you as Director of the Harrow Research Station, and the senior Manager responsible for the Technology Evaluation and Development (TED) sub-program to this workshop to hear the recommendations of leading-edge farmers who have been involved in the planning exercises of TED.

An agenda and supporting documentary materials are enclosed. Please note the date and location, both of which have been altered from the first announcement.

Date: Thursday, March 10, 1988
Time: 9:30 a.m. to 4:30 p.m.
Place: Lamplighter Inn - Best Western
591 Wellington Road South,
London, Ontario

We look forward with pleasure to introducing you or your alternate during the opening session of the meeting as a guest of this working group.

Yours very truly,
W. I. Findlay
Scientific Authority (TED)

WIF:rc
ltedmarks