TECHNOLOGY TRANSFER REPORT SUMMARIES

SOIL AND WATER
ENVIRONMENTAL ENHANCEMENT PROGRAM
(SWEEP)

FINAL REPORT

March, 1993

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INTRODUCTION

A/ THE SOIL AND WATER ENVIRONMENTAL ENHANCEMENT PROGRAM (SWEEP)

Purpose

- To reduce phosphorous loading in the Lake Erie basin by 200 tonnes per year by 1990, from non-point agricultural cropland sources.

- To maintain or improve the productivity of southwestern Ontario agriculture by reducing or arresting soil erosion and degradation.

Background

The impetus for the program was the Canada-U.S. Great Lakes Water Quality Agreement, calling for a reduction in phosphorous pollution in the Lake Erie basin of 2000 tonnes per year.

Canada agreed to reduce phosphorous run-off by 300 tonnes per year -- 200 from agricultural cropland sources and 100 from industrial and municipal sources by 1990.

The achievement of these reductions over five years would improve water quality for drinking, recreation and fishing. Improved soil conservation practices to reduce phosphorous run-off would benefit farmers greatly in crop yield increases and in cost savings from more efficient soil management.

In order to accomplish the program objectives, Canada and Ontario carried out five year programs of co-ordinated and complementary activities with farmers, farm and other organizations. These programs were intended to build up a stock of technology that could be extended to farmers now and in the future.

Federal Responsibilities

1. Technology Assessment Panel, Conservation Information Bureau and Socio-Economic Evaluation

a) Technology Assessment Panel

Made up of leading soil and water specialists and farm community representatives, the technology assessment panel was responsible for assessing the suitability of soil conservation equipment and cropping methods for Ontario farmers. The panel also assessed research results from federal, provincial, university and private sector establishments.

b) Soil and Water Conservation Information Bureau

The Soil and Water Conservation Information Bureau was set up to collect, catalogue, store and distribute technical data on soil conservation. The bureau produced a newsletter for farmers, set up several databases of soil and water information and helped to organize the Innovative Farmers of Ontario - No-till, Ridge till Workshop for four years.

3. Socio-Economic Evaluation

Studies were funded to examine the impact of current programs on the adoption of conservation technologies, and how these programs could be improved.

4. Technology Evaluation and Development

Centred at Agriculture Canada's Harrow, Ontario, Research Station, this project provided funding for the development, adaption, evaluation and the opportunity for validation of new or untested technology related to soil productivity and to phosphorus and chemical movement from cropland to water systems. The areas covered under soil productivity included soil and water conservation cropping, conservation planting, conservation tillage equipment, and soil drainage. Where possible, it was conducted with the co-operation of farmers under commercial farm conditions.

5. Pilot Watershed Study

This program looked at the effectiveness of introducing comprehensive soil and water conservation practices to the farms in a small test watershed and comparing them to a control watershed. The three paired watersheds were located in southwestern Ontario: Kettle Creek, between St. Thomas and London; Pittock, north of Woodstock; and Essex, just east of the town of Essex. Water quality and quantities were monitored by the federal and provincial Environment ministries.

Provincial Responsibilities

The Ontario Ministry of Agriculture and Food (OMAF) enhanced its existing soil and water program capability using SWEEP in three ways: through local demonstrations, through technical assistance and through soil and water conservation management incentives.

1. Local Demonstrations

To promote wider adoption of proven soil and water conservation technology, many soil and crop management demonstrations were implemented. These demonstrations were mostly side-by-side plots, comparing cropping rotations, and various tillage and cultural practices.

An additional demonstration project, called Tillage 2000, was established on 30-40 farm sites for five years to examine the effects of conservation tillage practices and crop rotations and provide data to shape these practices for the year 2000.

2. Technical Assistance

Field level professional conservation advice was provided to farmers by ministry staff with expertise in soils and crops, soil conservation, soil and water engineering and farm management. OMAF also assisted farmers in organizing field days demonstrating soil and water conservation management practices, and workshops to discuss local problems.

A number of factsheets, videos and brochures were produced on erosion control structures and conservation tillage.

3. Management Incentives

To reduce phosphorous loading of water systems, financial incentives were directed toward controlling the movement of water and sediment from lands that are intensively cropped. Soil erosion in ditches and on stream banks delivers sediment and phosphorous to the streams.

The five-year $25.5 million Ontario Soil Conservation and Environmental Protection Assistance Program (OSCEPAP) was made part of SWEEP and extended for two years to 1990 to operate for the full five years of the joint agreement. OSCEPAP provided advice, demonstrations and grants to farmers on manure management, erosion control and alternative cropping practices.

B/ THE TECHNOLOGY TRANSFER COMMITTEE

Research often provides information which helps us to further our understanding of a particular situation. Rarely is a large amount of money spent in one area of study. The Soil and Water Environmental Enhancement Program (SWEEP) was able to devote a sizeable amount of money to further our understanding in the areas of soil movement/loss, soil conservation and water quality.

The research components of SWEEP produced close to a hundred reports. To most people that amount of paper is overwhelming. Often research is written up in a report that sits on someone's shelf and is not used because it takes too much time to read through the report to find the useful information. The Technology Transfer Committee (TTC) was formed to try to sift through the SWEEP reports and pull out the useful information.

The TTC was formed by combining the staff resources of the Resources Management Branch and the Plant Industry Branch of the Ontario Ministry of Agriculture and Food (OMAF), then adding the Soil and Water Conservation Information Bureau (SWCIB), the secretary of the Technology Assessment Panel (TAP) and the Scientific Authority of the Technology Evaluation and Development (TED) component of SWEEP. The goal of the committee was to summarize each of the SWEEP reports and put them in a format that was useful for extension staff, researchers and agribusiness.

Included on the format chosen were key words so the summaries could be included in the SWCIB database. In addition to the summary section a comments section was included to give the reviewer an opportunity to combine his/her knowledge and experience with the results of the study. It also allowed the reviewer to indicate what parts of the study have direct practical application in the field. Associated SWEEP and Land Stewardship Program Research were included to direct the reader to other sources of information on the topic. Future research was added because the committee thought that the person reviewing a report would have a good idea if further research was warranted in that area.

C/ LOCATION OF SWEEP AND LAND STEWARDSHIP PROGRAM REPORTS

1. SWEEP REPORTS

SWEEP reports can be obtained by contacting:

Agri Food Development Branch
Agriculture Canada
174 Stone Road West
Guelph, Ontario
(519) 837-9400

SWEEP Reports are also available for loan from libraries at the following institutions:

University of Guelph, Guelph, Ontario
Harrow Research Station, Agriculture Canada, Harrow, Ontario
Central Experimental Farm, Agriculture Canada, Ottawa, Ontario
Ridgetown College of Agricultural Technology, Ridgetown, Ontario
Alfred College of Agriculture and Food Technology, Alfred, Ontario
Centralia College of Agricultural Technology, Huron Park, Ontario
Kemptville College of Agricultural Technology, Kemptville, Ontario
New Liskeard College of Agricultural Technology, New Liskeard, Ontario

2. LAND STEWARDSHIP PROGRAM REPORTS

See Appendix I

3. TILLAGE 2000 FINAL REPORT

The Tillage 2000 Final Report can be obtained by contacting:

Resources Management Branch
Ontario Ministry of Agriculture and Food
P O Box 1030 52 Royal Road
Guelph, Ontario N1H 1G3
(519) 767-3561

4. SWEEP Technology Transfer Report Summaries

The summaries included in this report are in a database at:
Soil and Water Conservation Information Bureau
Richards Building
University of Guelph
Guelph, Ontario
N1G 2W1
(519) 767-5020

Report # 0

Report Name: Cropping, Tillage and Land Management Practices In Southwestern Ontario 1986

Researcher: Dell Coleman, Inland Waters/Lands Directorate, Environment Canada, Canada Centre for Inland Waters, Burlington, and Peter Roberts, Soil and Water Management Branch, OMAF, Guelph

Date: March, 1987

Key Words: tillage, cropping practices, erosion control, survey, interview, phosphorous, monitoring

Summary: The object of the survey was to develop a data base to serve as a benchmark to be used in future evaluations of SWEEP.

In 1986, 1,115 on-farm interviews were conducted in the 13 county, SWEEP area. Information relating to crop rotations, type and timing of tillage and planting practices, land management, drainage (natural and installed), and application rates of soil amendments was gathered.

The predominant farm type in the SWEEP area was cash crop followed by dairy and mixed farming. The predominant farm size was 40 to 99 hectares with 100 to 199 hectares being the next most common. The dominant crops were corn and soybeans. In the SWEEP area 15% of those interviewed installed erosion control structures on the farm. Of those the most common was the vegetative buffer strip.

The survey results indicated that the main form of primary tillage was moldboard plough in the fall. Phosphorous fertilizer was applied based on experience. The main reason given for changing the cropping or tillage system was, in descending order: economic, to reduce erosion or a change in crops, enterprise or landbase. Most tillage systems were conventional and were implemented irrespective of slope. Less than 20% practised other forms of erosion control. Of farmers surveyed, 40% used manure, but only 14% reported incorporation within 24 hrs. Some spread during the winter. Most other nutrient management practices were done by experience rather than by advice.

Comments: Information could be used for future programming. The researchers could have compared the survey results to the targets for soil conservation in the province to identify areas where programs should be targeted.

An attempt is made to determine if erosion control is taking place where it is most critical. External physiographic data was run through the USLE Model. While this is important for the targeting of future programs or for program evaluation some fundamental assumptions of the Universal Soil Loss Equation were neglected. The estimates for soil loss in this context could be in error by an order of magnitude and should be referenced to only in this light.

A study with this design may unintentionally omit areas where erosion control has been more readily adopted. Extrapolation of the survey results could be limited.

Associated SWEEP/LSP Research:

SWEEP Report # 6 - A Survey of Crop Residue in Southwestern Ontario 1987

SWEEP Report # 78- Changes in Cropping, Tillage and Land Management Practices in Southwestern Ontario for 1986 and 1991

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required - a follow up survey was done in 1991.

Report # 1

Report Name: Tillage 2000 and Its Effect on Awareness of Conservation Tillage

Researcher: Kathleen Zimmerman, Dr. D.J. Blackburn, Dr. J.C.M. Shute, Dr. R.G. Kachanoski, University of Guelph

Date: March, 1988

Key Words: conservation tillage, Tillage 2000, adoption of tillage

Summary: This study surveyed 16 Tillage 2000 cooperators and 107 randomly sampled farmers in the SWEEP watershed to examine factors that motivate farmers to adopt conservation tillage. Specifically, the study focused on the adoption of conservation tillage practices in conjunction with the Tillage 2000 demonstration project. It was hoped the results of the study could be used to develop more effective educational programs and incentives for higher levels of adoption of conservation tillage.

The results of the study indicated that the motivating factor for involvement in Tillage 2000 was to experiment with and/or learn as much as possible about conservation tillage. A larger percentage of the Tillage 2000 cooperators observed both wind and water erosion on their farm compared to the randomly selected farmers. Because of their increased awareness of erosion, this may have influenced the Tillage 2000 farmers higher adoption rates of using conservation tillage. The Tillage 2000 cooperators had more formal education than the randomly selected farmers and it was concluded that this was a significant factor in the adoption of conservation tillage. Age did not play a role in the adoption rate.

Tillage 2000 has not had a great impact on tillage practices in southwestern Ontario although the program had only had one year of data when this study was conducted.

The study recommends that a clear term be used to define conservation tillage to avoid misperceptions. Emphasis should be placed on the fact that conservation tillage is a system that may take a few years to learn. More efforts are needed to make Ontario farmers aware of local tillage research and how it applies to their farm situation. Extension staff should make farmers aware of conservation tillage equipment that is available for loan, rent or custom operators that have this equipment so they can try the practice first. Also, the innovators should be recognized as a valuable source of information for beginning farmers.

Comments: Although the study had potential to be good, it should have been conducted closer to the end of the Tillage 2000 program (when more consistent results were reported) to see if the general farming community followed the program and adopted conservation tillage. T-2000 was intended as an on-farm research and development project and was not necessarily targeted to make farmers and neighbours more aware of conservation tillage.

The most significant finding is that more work is needed to make farmers aware of conservation tillage.

Associated SWEEP/LSP Research:

SWEEP Report # 0 -	Cropping, Tillage and Land Management Practices in Southwestern Ontario, 1986
SWEEP Report # 8 -	Social Structure and the Choice of Cropping Technology: Influence of Personal Networks on the Decision to Adopt Conservation Tillage
SWEEP Report # 9 -	Conservation Practices in Southwestern Ontario Agriculture: Barriers to Adoption
SWEEP Report # 20 -	Conservation Tillage Equipment: Availability, Utilization and Needs

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None needed.

Report # 2

Report Name: A Review of Farm-Based Soil Conservation Research and Development

Researcher: D. Cressman, Ecologistics Limited, Waterloo, Ont.

Date: March, 1988

Key Words: soil conservation, conservation practices, research, ridge till, no-till, technology transfer, organic, tillage equipment, crop rotation, cover crops, planting equipment

Summary: The objectives of the study are:

1) to provide comprehensive information on conservation practices being tested and adopted in Ontario by farm operators experienced in conservation research and development
2) to determine the reasons for choice of conservation technologies or practices within the context of particular management systems
3) to identify conservation problems that the TED program should subsequently address in its research program
4) to identify leaders in on-farm conservation who have been providing and/or willing to provide a leadership role in technology transfer

A survey was conducted with twenty-seven farmers who were among the leaders in the range of practices and technologies that contribute to conservation farming systems. Personal interviews and a workshop was held to help collect this data and summarize it in a form TED could use.

The following points are the needs the farmers felt should be addressed by TED:

A) Research Needs

1) Herbicides - look at application rates, timing of application and combinations of herbicides currently registered for use under conventional tillage systems and thoroughly test them under a variety of soil texture and residue types within conservation tillage systems.

- more effective weed control in newly established windbreaks should also be pursued
- more effective quackgrass control in corn without using residual herbicides

2) Cover Crops and Rotations

- the cause of, and means to alleviate, allelopathic effects of winter wheat and rye stubble on succeeding crops
- nitrogen benefits from legume crops under fall vs. spring killing or tilling
- cover crops effective in suppressing weeds under any tillage system

3) Seed Varieties and Fertilizer Form and Placement

- evaluate currently available seed varieties and fertilizer type and placement under various tillage/planting system particularly no-till in corn and soybeans

4) **Tillage/Planting Equipment and Systems**

- document the development of conservation systems with farmers which includes "state of the art" knowledge
- packages should include information on: available equipment and the modifications necessary to work in different soil textures and residue types, timing of operations, appropriate agricultural chemicals, their means of application, seed varieties, cost data relevant to system changes, trouble shooting tips and contact people to assist in problem resolution

At the workshop the areas of research that were ranked high include:

- management of variable fields (erosion, phosphorus loss under various management systems)
- nutrient distribution under conservation management practices
- weeds under reduced tillage
- integrated weed management: biological, cultural, field scouting, time effects
- equipment modifications and development
- fertilizer placement equipment: modifications and development
- benefits and costs associated with fertilizer placement: emphasis on phasing into conservation farming
- conservation tillage and water quality: macropores, improved structure and impact on herbicide and N movement

The role of farmers in TED research was discussed. Topics covered included technical support required to conduct research, acceptable field lay out, data collection/record keeping, expected levels of funding. Greater involvement of farmers in the research process must occur if this mandate is to be fulfilled. Farmers' preference for research involvement is on a cooperative basis with the researcher so they have some say in experimental design and set-up.... not just leasing the land to researchers.

B) Technology Transfer

1) **Among Conservation Leaders**

- provide support for maintaining conservation leaders on the leading edge of farm-based conservation practices and technology development
- provide a central location for state-of-the-art conservation information being developed in Ontario and USA
- documentation of "who is doing what" would facilitate networking among those showing leadership in conservation research and development
- financial support for publication of a newsletter to be circulated to conservation leaders
- provide funding for workshops to review advances in specific conservation practices and technologies

2) **Within the Farm Community**

- promote continued and expanded Ontario Soil and Crop Improvement Association conservation oriented activities such as those currently being undertaken through the Joint Agricultural Soil & Water Conservation Program
- local farmer to farmer referral and support networks have been found to provide locally relevant information that is judged to be credible and trustworthy

3) **Between Organic and Conservation Farmers**

- promote information and technology exchange between conservation and organic farmers
- hold consultations with organic growers including on-farm visits, to assess the most promising conservation practices and their applicability to conventional conservation systems

C) Institutional/Organizational Responses

1) **Registration of Herbicides**

- encourage Ag Canada to take the appropriate steps to speed the registration process of compounds
- a list was provided that included tank mixes, new chemicals and fungicides that are important in conservation crop production systems

2) **Communicating TED Research Mandate to Conservation Leaders**

- articulate its mandate to conservation leaders in a way that demonstrates the necessity in the long-term for "statistically defensible" results
- 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

3) **Context for Research**

- explore ways to expand the network of farm cooperators who are currently conducting on-farm research

4) **Institution/Agribusiness Cooperation**

- solicit the involvement of agribusiness in promotion of conservation farming techniques ie. through an information centre or multi-media public service conservation presentations

Comments: The report gives a good summary of the conservation practices used by the leading farmers at the time of the survey. The reader must keep in mind that the survey was of a select small group for a fairly specific purpose and so the results would not have a broad application. Many of the research recommendations were included in the TED component. This would suggest that this exercise was useful and did provide valuable input for TED.

The technology transfer recommendations do not take into account another component of SWEEP. The Technical Assistance component (OMAF) was running Tillage 2000, monitoring progress in research and attempting to facilitate the flow of information between farmers and was beginning the development of systems packages.

Associated SWEEP/LSP Research:

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required. The evaluation of SWEEP should help document whether or not TED research hit the target audience and what further research needs should be addressed to further conservation farming and environmental sustainability.

Report # 3

Report Name: An Economic Assessment Of The Distribution Of Benefits Arising From Adoption Of Conservation Tillage Practices In Crop Production In Southwestern Ontario

Researcher: Edward J. Dickson and Glenn Fox, Department of Agricultural Economics and Business, University of Guelph

Date: March, 1988

Key Words: economics, cost-benefit analysis, policy, on-farm costs, off-farm costs, conservation tillage, soil erosion

Summary: The intent of this study was to determine the relative cost-benefits of soil erosion control by conservation tillage. There are measurable costs and benefits on and off the farm. It was the thesis of the authors that off-farm benefits far exceed on-farm benefits and, as such, public policy should reflect this.

The researchers chose three representative watersheds in Southwestern Ontario for their study. The on-farm portion of the study involved gathering sufficient cropping and economic information to predict the relative cost and benefits of conventional and conservation cropping/tillage systems using the Soil Conservation Economic (SOILEC) model. The Guelph model for evaluating the effects of Agricultural Management Systems on Erosion and Sedimentation (GAMES) was used to predict sediment loadings to surface waters from several cropping and tillage system scenarios. External data from OMAF statistics and University of Guelph research publications were used where local data was unavailable. Models were run to determine relative costs, net returns and benefit/cost ratios. Off-farm cost were expressed in terms of loss to fisheries, water treatment costs and other damages such as contaminants in sediment.

The authors concluded that: conservation tillage is the most cost-effective tillage system in most of the watershed areas; yield losses from conservation tillage exceeded labour and energy savings; off-farm benefits outweigh on-farm benefits; public policy should be directed to compensate on-farm economic losses with financial assistance; and, financial assistance programs should be targeted to areas where off-farm benefit/cost ratios exceed on-farm benefit/cost ratios.

Comments: The rationale for this work and the research work itself was sound and well integrated.

There are several concerns:

1) the authors position inadvertently dismisses present efforts to develop cost-effective conservation technologies. Their assumption that reduced tillage = reduced yields = reduced profits is invalid. Release of this information has already caused misconceptions in the countryside ;

2) there appears to be a degree of bias in the literature reviewed which implied that the research results were inevitable;

3) the operational definition for No-till reflects research done at Elora but not on-farm research results from the Tillage 2000 program. "No-till" in Ontario does allow for minimal within row tillage and residue management. The yield and cost/benefit analysis is considerably better for this, more representative form of `No-Till';

4) there continues to be controversy regarding on-farm economics of conservation practices. There is no evidence of specific cost items included in this document to ascertain the validity of the model used; and,

5) economics is an important motivator for change but does not entirely explain the behaviour of farmers.

This work should not be considered as the definitive work on economic analysis of conservation tillage.

The most significant finding was the verification that planting or drilling into high crop residue cover without proper residue management results in lower yields and returns when compared to conventional practices.

Associated SWEEP/LSP Research:

OMAF -	Tillage - 2000 Final Report
SWEEP Report # 7 -	Sources of Motivation in the Adoption of Conservation Tillage
SWEEP Report # 8 -	Social Structure and the Choice of Cropping Technology: Influence of Personal Networks on the Decision to Adopt Conservation Tillage
SWEEP Report # 9 -	Conservation Practices in Southwestern Ontario : Barriers to Adoption
SWEEP Report #10 -	An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1988)
SWEEP Report #11 -	An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1989)

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(B) There is a need for more research into integrated approaches to modelling resource, farm management and economic data for the purposes of extension and program planning.

Report # 4

Report Name: Assessment of Soil Compaction and Structural Degradation in the Lowland Clay Soils

Researcher: L. Leskiw, Can-Ag Enterprises, Guelph, Ontario

Date: May, 1988

Key Words: compaction, yield reduction, compaction measurement, visual symptoms, causes of compaction, extent of compaction, lowland soils, clay soils, clay loam soils

Summary: Five methods were used to assess compaction: visual observations, bulk density, hand and cone penetrometer measurements, and detailed descriptions of soil peds and pores. The visual assessment which considered layering, structural deformation, rooting patterns, number and continuity of pores, void characteristics, observed differences between horizons and consistency within a field was a useful method for assessing compaction problems.

The study determined that 50-70% of the clay and clay loam soils in Middlesex, Lambton, Essex, Kent and Elgin are affected by compaction. Of this total, 25% were severely compacted and 75% were moderately affected.

Farmer opinion (from interviews) was that compaction caused reduced yields of 12% for moderately compacted soils and 25% for severely compacted soils. Increased soil erosion and phosphorous loadings as a result of compaction were estimated using the USLE and census data.

Factors found to contribute to compaction were the size of the tractor, number of passes and the crops grown (silage corn and tomatoes > row crops > small grains > forages).

Comments: This report contains a good literature review on compaction.

The study considered compaction only below the plow layer, in the 15-30 cm depth. The effect of manure application was not specifically considered (although axle loads were considered).

Associated SWEEP/LSP Research:

SWEEP Report # 16 - Effects of Subsoiling on Corn Yields and Soil Conditions in Southwestern Ontario

SWEEP Report # 24 - Investigation of Soil and Crop Responses to Fall Subsoiling in Southwestern Ontario

LSP Research - The Effects of Soil Compaction on the Production of Processing Vegetables and Field Crops - A Review

LSP Research - Management of Fine Textured Poorly Drained Soils For Intensive Agriculture

LSP Research -	Management of Fine Textured Poorly Drained Soils For Intensive Agriculture: Characterization of a Forage Factor - Part I & II
LSP Research -	Improving the Degraded Structure of Fine Textured Soils With Deep Tillage and Grass and Legume Crops
LSP Research -	Improving the Degraded Structure of a Clay Loam Soil With Deep Tillage & Grass & Legume Crops
LSP Research -	Crop Production With A No-Traffic Tillage System
LSP Research -	The Effects of Soil Compaction on the Production of Processing Vegetables and Field Crops - A Review

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) Refinement of visual methods for quickly assessing the extent of compaction and compaction hazard. Compaction research trials evaluating the actual extent of yield reduction in corn and soybeans.

Report # 5

Report Name: Survey of Southwestern Ontario Farmers For the Evaluation of SWEEP

Researcher: Ronald B. Compton, The ARA Consulting Group Inc. formerly The DPA Group Inc., Toronto, Ontario

Date: June, 1988

Key Words: program evaluation, questionnaire, survey, SWEEP, awareness, soil quality, water quality, conservation ethic

Summary: The purpose of the study was to determine from the farmers of the SWEEP area: their level of awareness regarding soil and water quality issues, attitudes towards conservation and the extent of the conservation ethic.

A questionnaire was mailed to 1,196 farms representative of the enterprise mix and income levels of the 13 counties in the SWEEP area in 1987. A response rate of 20% or 241 farmers replied to the 7 page questionnaire. The questionnaire had two sections : one on the applicants demographic and farm information and the second asked questions regarding attitudes, knowledge and perceptions.

Data analyses were rather simple. Most multiple response and likert scale information was presented in terms of the percentage of responses. Qualitative responses were listed in the reports appendix. Multivariate analyses were not conducted due to a lack of 'in-depth' information from each applicant.

The results suggest an inherent stewardship ethic with survey respondents. The respondents to this survey were aware and concerned about soil and water quality problems on their farms. Soil erosion and compaction were noted concerns mentioned by most respondents. Most farmers are trying to address these problems with conservation practices such as crop rotation, tile drainage and windbreaks. Fewer were practising conservation tillage, no-till or had erosion control structures. Farmers consider soil and water problems in their farm planning but find that barriers to change, particularly financial, prevent them from effectively addressing the problems.

Comments: The investigators are forthcoming with the limitations of mailed questionnaires. Mailed questionnaires are not designed for in-depth case study work : the interpretation of multi-variate analyses based on questionnaire data is limited. Further, questionnaires are answered mostly by those with special interest in the topic area or by those with something to say: this makes extrapolation of the results questionable. Moreover, this was considered a baseline study, with full intentions to re-survey after SWEEP is finished. Considering the limitations of this instrument together with the fact it would be difficult to attain objectivity, randomness and a comparable group - it is questionable why this instrument was chosen for this purpose.

The investigators do, however, recognize the limitations of this form of study and provide helpful insight and verifications regarding the attitudes and perceptions of some SWEEP area farmers.

Associated SWEEP/LSP Research:

SWEEP Report # 0 - Cropping, Tillage and Land Management Practices in Southwestern Ontario, 1986
SWEEP Report # 6 - A Survey of Crop Residue In Southwestern Ontario
SWEEP Report # 8 - Social Structure and the Choice of Cropping Technology : Influence of Personal Networks on the Decision to Adopt Conservation Tillage
SWEEP Report # 9 - Conservation Practices in Southwestern Ontario : Barriers to Adoption

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

Further study is planned at the end of the SWEEP to contrast results from this study.

<u>Report # 6</u>

Report Name: A Survey of Crop Residue in Southwestern Ontario 1987

Researcher: Peter Roberts, Soil and Water Management Branch, Ontario Ministry of Agriculture and Food, and Dell Coleman, Inland Waters/Lands Directorate, Environment Canada, Centre for Inland Water, Burlington

Date: March, 1988

Key Words: residue, windshield survey, tillage systems, crop rotations, reduced tillage, no-till, ridge tillage

Summary: In 1987 a windshield survey was conducted to provide a detailed data base of the percent residue cover for various cropping and tillage systems. The information will serve as a benchmark against which the effect of implementing soil and water management practices can be evaluated. The survey was conducted by driving a predetermined random route twice through the SWEEP watershed counties with stops every 0.8 km to record cropland information. Information recorded at each site included: present crop, residue levels before and after secondary tillage, and tillage type. An attempt was made to include a representative subsample from the survey conducted in 1986 - "Cropping, Tillage, and Land Management Practices" to allow comparisons between the data.

The results indicated that 16% of the fields have 20% or more residue cover and 10% of the fields have over 30%. Conventional tillage occurred most often (72.8%) while 18.6% of fields were not tilled and 8% were reduced tilled and 0.5% were ridge tilled. Almost all the conventional tilled fields were in the 0-15% residue cover category while the reduced tilled fields fell into the 15-30% and 30-45% categories. The predominant crop was corn (26.3%) followed by hay or forage (20.9%), fall grain (12.5%) and spring grain (11.99%).

Comments: As with any survey this one has limitations in the accuracy of the reporting as most observations were made from the car (surveyors went into 1 in 10 fields) and this distorts the residue cover amounts.

Associated SWEEP/LSP Research:

SWEEP Report # 0 - Cropping, Tillage and Land Management Practices in Southwestern Ontario, 1986

Future Research: **( ) indicates the reviewers suggestion for priority, A - high, C - low.**

(A) A similar survey should be conducted in the final year of SWEEP to see if the objectives of SWEEP have been met for Ontario.

Report # 7

Report Name: Sources of Motivation in the Adoption of Conservation Tillage

Researcher: Stephen Connolly & Professor Stewart Hilts

Date: December, 1988

Key Words: Adoption - Diffusion model, Socio-economic and behavioral factors, Motivational Factors, Cluster Analysis, Need Theory & Constructs of Motivation and Behavioral Practices.

Summary: This study was an exploratory study that provided an examination of perceptions and motivating factors in agriculture and conservation and specifically conservation tillage. It applied a set of analytical tools - a phenomenological model of experience and perception instead of the traditional behavioral approach -an adoption-diffusion model. To the authors' knowledge the former had not been applied to the questions of agriculture and conservation.

The study widely criticized use of the five-stage model of the innovation-decision process on the grounds that use of such a model allows researchers to develop "neat" research agendas that are not really relevant to what was really happening in terms of agriculture and conservation. That is, its basis lacks complexity and dynamicism and is unsuitable for explaining the process & predicting the outcome of introducing a new technology (conservation tillage) to a target audience (farmers).
The authors cite research that discredits the use of adoption diffusion models as measures of why farmers adopt conservation measures. The main contentions of why this classical Adoption - Diffusion model can be ineffective was summarized as:

1. A-D research appears to be pro-innovation and observable events are the adoption or diffusion, <u>not</u> the non-adoption or non-diffusion of innovations,

2. A-D research emphasizes the role and responsibility of the individual as the decision maker while excluding consideration of larger issues namely social, economic and political environments that the individual inhabits,

3. A-D research does not handle well the dimension of time. This is related to problems of objectivity and the accuracy of recall and memory among respondents and,

4. A-D research does not allow for analysis of causality.

The report cited several research works of the critical rural sociological approach that opposed the structured functionalist approach (classical rural sociologist approach) and stressed a need to modify the Adoption-Diffusion model so it was equipped to handle better environmental concerns such as conservation tillage. The concept proposed to examine the adoption of conservation tillage they put forth was still based upon choices made by the individual operator, yet it more specifically identifies external factors that influence their choices, namely educational infrastructure, policy environment, market and regulations. The authors of this report documented many studies which emphasized that conservation technologies tend to be complexes of technology and technique, rather than discrete inventions to which the traditional A-D model is best suited to interpret. They illustrated well that conservation technologies are believed to not be simply adopted or not adopted but evolve & mutate to meet local conditions. As a result, **utilization and adaption** replace "adoption" as the product of the process.

The report reviewed other adoption research that related the adoption of conservation technologies (soil loss measures/awareness of ecological concerns, conservation tillage & farm enterprise and sales) in terms of such dependent and independent variables as age, education, aversion to risk and characteristics of farm operations; all demonstrated inconclusive or conflicting results and were unable to reflect ethical or moral concerns. Further, they were oriented to action or behaviours rather than underlying perceptions and beliefs. The authors proposed and tested a model (on a small sample) that was felt to be a better fit and more reflective to the perceptions and experience associated with the adoption and diffusion of resource conservation technologies.

This proposed alternative model, a phenomenological model, although more humane and informative, though perhaps less conclusive, attempts to link motivation and needs theory (community belonging & esteem), as well as the theory of Personal Constructs - a theory of cognition, perception and individual experience. Their study, a mail-out questionnaire regarding motivation was administered to individuals who had previously participated in an earlier extensive survey (OIP survey) of cropping and conservation practices. A random selection of 400 of 1029 previous respondents resulted in 107 completed questionnaires for a response rate of 28%. The previous OIP survey cited economic reasons as the most important if not the only source of motivation in farming. This SWEEP research chose to de-emphasize economics and sought to describe the relationships between economics and Maslovian needs theory. The questionnaire, consisting of 3 sections attempted to co-relate sustainability, community, leadership and stewardship and ranked 19 practices, behaviours and ideas. As well, the farmers were asked to supply socioeconomic information.

Major Findings:

Behavioral data were drawn from the OIP survey results and a series of 4 indices (cropping practice index, tillage practice index a second tillage index and a surface drainage index and an index of observed problems) were developed to simplify analysis of the raw data. Simple correlations of socio-economic variables and tillage and conservation behaviour were performed on the data set in an attempt to group respondents according to apparent differences in perception or motivation. The analytical techniques of Multi-dimensional scaling (MDS), a weighting measure and cluster analysis were used to produce and analyze aggregate maps of motivations and perceptions in terms of their similarities and differences. The full data set was found to contain 4 valid clusters. An examination of each of these clusters showed that the structure of perceptions and motivation regarding agriculture and conservation was complex and variable. The clusters appear to be largely differentiated by the degree to which farm survival at a personal level is a motivating factor. For example **a strong motivator is characterized by:**

1. Those farmers who appear to be most strongly motivated by survival tend to be the youngest, least educated and least experienced, and farming the largest acreage. These farmers

showed average to good cropping, rotation and tillage practices though they use the least number of water management practices.

Less strongly motivated farmers are characterized by:

2. Those farmers who have the highest average education, and farm the smallest acreage. They showed average to good rotation, cropping and tillage practices and use the greatest number of water management practices.

The role of stewardship does not appear to be a well developed source of motivation. The authors considered it as being viewed as a normative thing that farmers do rather than the antithesis of economic behaviour. Moreover, stewardship does not appear to strongly differentiate groups of farmers. The concept of farm survival appears to have dominated the process of clustering. Of all the sources of motivation evaluated by the farmers, farm survival at the personal level appears to be the most significant.

Comments: Although the results of this study are not definitive it does provide a fresh approach to examining the reasons why and how conservation tillage and practices are adopted. Further, it verifies other work clarifying that farm finance is not the prime motivator: motivation is complex. This study suggests that to effect change proper situational analysis is a prerequisite.

The most significant finding is that farm survival at the personal level is the prime motivator for changes towards soil and water conservation.

Associated SWEEP/LSP Research:

SWEEP Report # 9 - Conservation Practices in Southwestern Ontario Agriculture: Barriers to Adoption
SWEEP Report # 0 - Cropping, Tillage & Land Management Practices in Southwestern Ontario, 1986
SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from Adoption of Conservation Tillage Practices in Crop Production in Southwestern Ontario.
SWEEP Report # 6 - A Survey of Crop Residue in Southwestern Ontario, 1987
SWEEP Report # 8 - Social Structure and the Choice of Cropping Technology: Influence of Personal Networks on the Decision to Adopt Conservation Tillage.
LSP Research - Differences In Soil Conservation Between Operator Owned And Rented Land

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C- low.

(C) The structure of perceptions and motivation regarding agriculture and conservation is complex and variable. Additional studies using similar techniques should be tried again in order to test, refute and or improve their model with standard hypotheses on a larger sample in order to draw reliable conclusions regarding perceptions and motivation with respect to the adoption of conservation farming practices. It would also be instructive if future studies of a similar nature examined the adoption of conservation farming practices with respect to farm enterprise type.

Report # 8

Report Name: Social Structure and the Choice of Cropping Technology: Influence of Personal Networks on the Decision to Adopt Conservation Tillage

Researcher: G.K. Warriner and G.M. Moul, Department of Sociology, University of Waterloo

Date: June, 1989

Key Words: adoption, conservation technology, social structure, survey, adoption diffusion models, social networks, farmer attitudes

Summary: The intent of this study was to explore the factors affecting the decisions of producers regarding conservation technology. The goals of the study were: 1) to determine the influence of social structure on producers' decisions; 2) to define composition of reference groups; 3) to assess the relative influence of environmental, social, personal and business factors on decisions for changing cropping technologies; 4) to contrast the above with traits of known adopters; and 5) to establish the relative rates of adoption of conservation practices. A multi-faceted approach was chosen to address the diversity of factors identified.

A mailed questionnaire containing over 200 questions was mailed to two groups of cash-crop farmers in the SWEEP area: a randomly selected group of 497 grain producers (probability sample) and a purposive sample of 85 producers known to have practised conservation tillage. Following a cull process to eliminate unusable returns, 259 probability and 55 conserver, for a total of 314 of the 350 returned questionnaires (return rate of 60.2%) were found to be acceptable to be used in the database. The questionnaires and findings are categorized into the following areas: farm characteristics, household composition, soil and erodibility conditions, farming practices, attitudes and personal networks.

1. Farm Characteristics - most features were similar between the two groups except that the conserver group had on average larger farms and lower return on their investments in 1987.

2. Operator/ Household - most features were similar except that conservers were younger and better educated and predicted more often that the farm would stay in the family.

3. Soil Characteristics - conserver farmers had soil features with a high potential for erosion and had changed practices because they had observed erosion and had decided to take responsibility. It is postulated that the probability group may not be able to recognize erosion problems and there exists a causal relationship between this and motivation for change.

4. Conservation Practices - although more conserver farmers use conservation or no tillage more frequently than the probability sample, most farmers use a variety of tillage methods and planting methods (nearly one-half of the probability sample reported using some sort of

conservation tillage in 1987). At this time people were experimenting or had selected tillage/cropping practices to reflect the range of conditions they farmed.

5. Attitudes - the conserver group had a stronger stewardship ethic and commitment to innovation in conservation than the probability group. Recognition or acknowledgement of soil problems was once again correlated with belief and commitment for change.

6. The social network - peer pressure was found to have a positive influence on adoption rates. Both groups rank the relative importance of information sources in a descending order of importance as follows: personal experience, their neighbours, the farm media, specialists, agribusiness representatives, farm organizations, family and spouse. Larger networks were positively correlated with adoption of conservation tillage. Smaller groups had a tendency to be closed. Thus, if another farmer is the best source of information for other farmers, those with conservers in their network would have a higher probability of adopting.

Comments: The strength of this study was that the approach reflected the very nature of the phenomena itself; multifaceted. Financial or personal characteristics alone do not explain an individual producers reason to change. Of note they recommend:

1) Farmers need to understand, be able to recognize and feel comfortable admitting to problems on their farm before considering changes to their operations. This should be central to conservation/environmental farm planning exercises.

2) The stewardship ethic is as important as financial considerations when fostering change - it should be fostered in conservation programming.

3) The role of the extension agent in conservation has been verified as to support innovators and leaders in their trials and to promote their leadership in their community, to provide the farm press with accurate information and case studies and to work with agri-business and farm organizations to promote conservation practices and beliefs.

Associated SWEEP/LSP Research:

SWEEP Report # 0 - Cropping, Tillage and Land Management Practices in Southwestern Ontario, 1986
SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from the Adoption of Conservation Practices in Crop Production In Southwestern Ontario SWEEP Report # 6 - A Survey of Crop Residue In Southwestern Ontario, 1987
SWEEP Report # 7 - Sources of Motivation in the Adoption of Conservation Tillage
SWEEP Report # 9 - Conservation Practices in Southwestern Ontario: Barriers to Adoption
LSP Research - Differences in Soil Conservation Between Operator Owned and Rented Land

Future Research: **( ) indicates reviewers suggestion for priority, A-high, C-low.**

(C) Similar work should be initiated to determine if other areas of conservation (pollution control, nutrient management, etc.) follow similar trends of adoption and diffusion.

Report # 9

Report Name: Conservation Practices in Southwestern Ontario: Barriers to Adoption

Researcher: John Smithers and Barry Smit, University of Guelph

Date: January, 1989

Key Words: adoption, soil conservation, extension, program planning, awareness, technology transfer

Summary: The intent of this study was to determine for the SWEEP area: the nature and extent of the adoption of conservation technology; the barriers to adoption; and, the preferences for policy options to address these.

The literature review provided a detailed and comprehensive framework for this multi-disciplinary study. Mailed questionnaires, interviews with non-respondents and secondary data were used to conduct the study in the counties of Kent and Oxford. Binary methods of data collection (yes/no) were used to ascertain level of adoption: ordinal approaches (sliding scales) would have provided more information. The data were analyzed by using tabulations, summaries of qualitative data, calculations of soil erodibility and multivariate techniques to compare responses of producers grouped by likelihood for adoption.

The results included the perceptions of the respondents together with the relation of responses to personal, business and biophysical characteristics. Respondents stated their reasons for adoption (in descending order of importance) as: a long-term investment; to address immediate resource degradation problems; to lower production costs; to improve soil resources; and, an orientation towards stewardship. The following features had significant influence on adoption: farm size, awareness and perception of problems, age of producer, membership in farm organizations, concerns about the environment and land ownership. Respondents stated that their barriers to adoption included:
no need for change; inadequacy of technologies; financial and, difficulty of incorporating changes in existing systems. Other features from the database were inferred to be related to barriers to adoption such as lack of land, lack of capital, age, and may include failure to recognize problems, lack of knowledge and lack of concern. The farmers interviewed identified prerequisites for adoption such as verification that the technologies work, higher profits in agriculture, financial and technical assistance, and demonstrated need for change.

Comments: For producers :

- money is not the only barrier to change (see above)
- pride or knowledge are likely barriers to change on the farm
- your neighbours change for economic, environmental and personal reasons
- soil conservation is not just for cash croppers
- learn more about a "systems" approach and develop one for your operation

- ! learn from others - get involved - support your local Soil and Crop Improvement Association

For government agencies :

- ! education and technical assistance (including technology development) are specified and inferred prerequisites to change
- ! financial assistance is important but cannot be independent of education and technical assistance
- ! continue to foster systems approach to development and extension work
- ! focus on those most able/likely to change
- ! technologies must work before farmers will implement them

For researchers :

- ! comprehensive literature reviews are a prerequisite to effective research
- ! integrated approaches provide more applicable results

Associated SWEEP/LSP Research:

SWEEP Report # 3 - An Economic Assessment of the Distribution of benefits Arising from the Adoption of Conservation Practices in Crop Production In Southwestern Ontario

SWEEP Report # 7 - Sources of Motivation in the Adoption of Conservation Tillage

SWEEP Report # 8 - Social Structure and the choice of Cropping Technology: Influence of Personal Networks on the Decision to Adopt Conservation Tillage

LSP Research - Differences in Soil Conservation Between Operator Owned and Rented Land

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(C) This approach is appropriate for further research regarding other areas in agriculture and environmental quality. A follow-up or complementary study to examine the adoption of waste, pest, water and nutrient management would provide useful direction for future programming.

Report # 10

Report Name: An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1988)

Researcher: Richard Haack, Deloitte Haskins & Sells, Guelph, Ontario

Date: August, 1989

Key Words: conventional tillage, conservation tillage, costs, returns, economics, corn, soybeans, winter wheat, barley, reduced tillage, minimum tillage, yields, no-till, fuel, labour, risk, model, Tillage 2000, revenue

Summary: The main objective of this study was to test the data management system, and economic evaluation models Deloitte Haskins & Sells developed for the SWEEP program. The Tillage 2000 data was used for the test. The test would allow evaluation of ease of operation, accuracy of results and the need for refinements to the model. The other objective of the project was to provide stakeholders with preliminary economic evaluation results of Tillage 2000 in a manner that will be consistent with the results to be generated for the rest of the SWEEP program.

The Tillage 2000 data from 1986-1988 was analyzed for corn, soybeans, winter wheat, and barley. The range of tillage systems used in T-2000 were grouped into three classifications: conventional tillage (CT), reduced tillage (RT) and no-till (NT). The data for corn was analyzed two ways: 1) paired, where side-by-side treatments of CT-RT, CT-NT, RT-NT were kept together and 2) aggregate, the data was put into one of the classifications and analyzed across all fields. The other crops were analyzed by method 2 due to the lack of data on those crops. The machinery costs for corn were also calculated two different ways: 1) purchase price - based on purchase price, age, interest rate and annual usage and 2) trade-in value. The trade-in value approach lowered the machinery cost component somewhat and narrowed the range of cost variability between farms.

The data management system performed well and provided necessary calculations for the financial simulation.

The study found that the adoption of reduced tillage practices produced generally higher yields and higher net return per acre in corn, barley, and winter wheat. In soybeans, yields and net returns were marginally lower than conventional practices. No-till practices typically resulted in marginally lower yields and higher input costs per acre. At the same time significant machinery and labour savings resulted in significantly higher net returns per acre compared to conventional and reduced tillage practices in winter wheat and equivalent net returns to conventional practices in corn.

The returns to labour for no-till and reduced tillage practices tended to generate equivalent results particularly for corn. However, in winter wheat returns to labour with no-till exceeded reduced and conventional tillage practices. The financial risk analysis for alternative tillage practices on corn indicates that reduced tillage is the least risky and that conventional and no-till practices are

equivalent, with respect to net returns per acre. However, with respect to returns to labour, no-till is least risky compared to reduced and conventional tillage practices.

For soybeans only, it appears that conventional tillage practices generate higher net returns per acre compared to current reduced or no-till practices, however, the difference between conventional and reduced is marginal and likely not significant. Using the returns to labour criteria for soybeans, reduced tillage provided higher returns compared to conventional tillage practices. The use of "paired" or "unpaired" Tillage 2000 data for corn provided similar results, and did not affect the general conclusions of the economic analysis.

The authors concluded that there appears to be no ideal way of incorporating a calculation of machinery costs into an evaluation of net returns, particularly when comparing field based demonstration plots.

Comments:

The report porvides a reasonable overview of the economics of tillage systems. However, the shortage of data for all crops particulary for no-till result in numbers that are somewhat different than U.S. studies. Concerning data analysis method 2: aggregating observations into groups of no-till, reduced till and conventional till has the advantage of increasing the sample size but has the disadvantage of masking the effect if soil type and other site and management factors. The paired results were similar to the unpaired results but normally that would not be expected. There were difficulties in determining realistic machinery costs.

The winter wheat data appears to have a slight interpretation problem as cost of spring operations is higher in the spring than fall for reduced till and no-till. This does not affect the final outcome just those individual costs. Also the fertilizer costs for winter wheat appear to be at least double what one would expect.

It is interesting to note that no-till yields could be as much as 5 bu/ac. lower than conventional tillage and still have similar or higher net returns. Also the results show the high return to labour of no-till systems in particular. This would be of interest to farmers who may wish to spend their limited time farming more acres, running a livestock enterprise or working off-farm etc. Generally the results are encouraging.

Associated SWEEP/LSP Research:

SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from Adoption of Conservation Tillage Practices in Crop Production in Southwestern Ontario
SWEEP Report # 11 - An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1989)
SWEEP Report # 15 - An Annotated Bibliography of Socio-Economic Soil and Water Conservation Research
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(B) The Tillage 2000 data from the five years of the study could be analyzed. More studies need to be done into the economics of conservation, the risks involved and the costs of switching systems. The analysis could be repeated with a large group of farmers with several years of experience to give a more realistic picture of the economics of conservation tillage systems.

Report # 11

Report Name: An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1989)

Researcher: Richard Haack, Deloitte & Touche, Guelph, Ontario

Date: August, 1990

Key Words: conventional tillage, conservation tillage, costs, returns, economics, corn, soybeans, winter wheat, small grains, reduced tillage, minimum tillage, yields, no-till, fuel, labour, risk, model, Tillage 2000, revenue

Summary: The objectives of this project were:

1) To test the data management system and economic evaluation models developed by Deloitte & Touche for the farm level economic impact assessment of alternative soil conservation practices.

2) To provide stakeholders with preliminary economic evaluation results of Tillage 2000 in a manner that will be consistent with the results to be generated for the rest of the SWEEP program.

A similar study was done on the 1986-1988 Tillage 2000 data and the results are found in SWEEP Report # 10.

The Tillage 2000 data from 1986-1989 was analyzed for corn, soybeans, winter wheat, and spring grains. The range of tillage systems used in T-2000 were grouped into three classifications: conventional tillage (CT), reduced tillage (RT) and no-till (NT). The data for corn was analyzed two ways: 1) paired, where side-by-side treatments of CT-RT, CT-NT, RT-NT were kept together and 2) aggregate, the data was put into one of the classifications and analyzed across all fields. The other crops were analyzed by method 2 due to the lack of data on those crops. The machinery costs for corn were also calculated two different ways: 1) purchase price - based on purchase price, age, interest rate and annual usage and 2) trade-in value. The trade-in value approach lowered the machinery cost component somewhat and narrowed the range of cost variability between farms.

The study found that the adoption of no-till practices produced equivalent net returns per acre in corn to conventional tillage. The adoption of reduced tillage practices produced generally higher yields and higher net returns per acre in wheat. On soybeans and spring grains, yields and net returns were lower for conservation tillage practices than conventional practices. Overall, although no-till practices resulted in marginally lower yields and higher input costs per acre, a significant machinery and labour savings with no-till resulted in significantly higher net returns per hour compared to conventional practices in corn and wheat.

For soybeans and spring grains, conventional tillage practices generated higher net returns per acre compared to reduced or no-till practices, however, the difference between conventional and reduced was marginal and likely not significant given the small number of observations. The authors concluded

that there appears to be no ideal way of incorporating a calculation of machinery costs into an evaluation of net returns, particularly when comparing field based demonstration plots.

The results of this analysis differ from the previous report as follows:
(i) no-till produced the equivalent net returns per acre for corn compared to conventional tillage practices;
(ii) conventional tillage produced the highest net returns to labour for soybeans;
(iii) conventional tillage produced the highest net returns per acre for spring grains; and
(iv) reduced tillage produced the highest net returns per acre for wheat.

Comments:

The Tillage 2000 database is reliable but it is important to remember that most of the cooperators had little experience with conservation tillage before starting the project. This has a number of implications with respect to weed control. Higher herbicide rates, poor timing of herbicide application poor, choice of herbicide and rescue treatments often resulted in higher herbicide costs for conservation tillage particularly in no-till. These extra costs ranged from $2 - 5 for corn, $5 - 25 for soybeans, $5 - 17 for small grains, $0 - 2 for winter wheat. Concerning data analysis method 2: aggregating observations into groups of no-till, reduced till and conventional till has the advantage of increasing the sample size but has the disadvantage of masking the effect if soil type and other site and management factors. The paired results were similar to the unpaired results but normally that would not be expected. There were difficulties in determining realistic machinery costs.

Weed control (particularly in soybeans) combined with poor planter set-up and other management problems can have a negative effect on yield. The results of the analysis probably provide a good idea of the economics during the transition period from conventional tillage to conservation tillage. Other studies and experienced conservation farmers report equal or better yields and net returns for conservation tillage compared to conventional. They also report that weed control costs are similar or lower after a few years.

Interestingly, the results show the high return to labour of no-till systems in particular. This would be of interest to farmers who may wish to spend their limited time farming more acres, running a livestock enterprise or working off-farm etc.

The winter wheat data appears to have similar problems in this study as in the last study (spring operation costs higher than fall and high fertilizer costs).

Associated SWEEP/LSP Research:

SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from Adoption of Conservation Tillage Practices in Crop Production in Southwestern Ontario
SWEEP Report # 10 - An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1988)
SWEEP Report # 15 - An Annotated Bibliography of Socio-Economic Soil and Water Conservation Research
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(B) The Tillage 2000 data from the five years of the study could be analyzed. More studies need to be done into the economics of conservation, the risks involved and the costs of switching systems. Study tied into herbicide research.

Report # 12

Report Name: Choice and Management of Cover Crop Species and Varieties for Use in Row Crop Dominant Rotations

Researcher: R. Samson, C. Foulds, Dr. D. Patriquin, Resource Efficient Agricultural Production (REAP) - Canada, Ste. Anne-de-Bellevue, Quebec

Date: May, 1990

Key Words: cover crops, corn, interseeding, ryegrass, weed suppression, soybeans, winter barley, rye, relay cropping, ground cover, winter wheat, catch crop, red clover, hairy vetch, oilseed radish

Summary: The study was conducted in three separate parts.

A. The two year study evaluated different ryegrass cultivars as interseeded crops into standing corn. The ryegrass was broadcast into standing corn at the five leaf stage of the corn (after the critical period for weed control). Weed control prior to ryegrass planting was accomplished by banded herbicide plus cultivation.

Ryegrass establishment was variable, and was negligible in corn yielding over 10 tonnes per hectare. In lower yielding fields, the interseed reduced weed biomass by up to 50%, proportional to ryegrass growth. There were no significant corn yield differences with any of the treatments.

B. This study looked at different methods of managing rye mulched or winter barley grain crops in a soybean production system. Treatments for rye included mowing at heading, plowing or disking and then planting soybeans into the resulting residue. Regrowth of the rye, planter operation and final soybean yields were monitored.

Relay cropping soybeans into winter barley harvested as high moisture grain was not successful. Barley yields were low and inconsistent, and soybeans did not provide any grain yield.

C. For this study different methods of winter wheat establishment were compared following soybeans. Also different types of interseedings and catch crops in cereals were compared. There was no difference in wheat establishment or yield with the methods used (aerial seeding, no-till, conventional tillage). Post harvest weed growth or red clover interseeding were not affected by the establishment method.

Hairy vetch as an interseeded crop, or oilseed radish planted after cereal harvest were shown to have some potential for nutrient cycling to the next crop. Hairy vetch appeared to release larger amounts of nitrogen to the following corn crop, more than other legume crops. Oilseed

radish was able to absorb large quantities of nitrogen from manure in late summer and release it the following spring.

Comments: There appears to be a number of concerns with the various parts of this study.

A. Weed seed production was not measured and weed growth was not monitored in subsequent crops to determine if there were any long-term weed control benefit. The issue of nitrates was not addressed. However, the total biomass (weeds plus ryegrass) was not significantly affected, and therefore would not expect nitrate uptake to be increased by adding the ryegrass crop.

B. Killing rye by mowing was not compared to the usual practice of herbicide burn down, which would provide weed suppression without rye regrowth. Failure to obtain good stands because of poor drill operation made interpretation of the results difficult.

C. Springs cereals as a potential crop for nutrient cycling were not studied. These crops may be just as effective at a lower cost to the producer. The fertilizer response curves shown in the report indicate that the maximum yield had not been reached at the nitrogen levels used, therefore it is difficult to determine if the nitrogen release came from the catch crops.

Associated SWEEP/LSP Research:

SWEEP Report # 27 - Cereal Cover Crop Study
SWEEP Report # 29 - The Effect of Organic Mulches on Soil Moisture and Crop Growth
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems
SWEEP Report # 36 - Red Clover Cover Crop Studies 1987 - 1990
SWEEP Report # 43 - The Use of Cover Crops for Nutrient Conservation
SWEEP Report # 52 - Field Scale Tests of Cover Crops I and II
SWEEP Report #57A- Field Testing of Cover Crop Systems for Corn and Soybean Production
LSP Research - Crop Rotations & Cover Crop Effects On Erosion Control, Tomato Yields & Soil Properties In Southwestern Ontario
LSP Research - A Cover Cropping Strategy For First Early Potato Production

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 13

Report Name: The Effect of Moldboard Shape on the Residue Management Potential of the Moldboard Plow

Researcher: J. Sadler Richards, Conservation Management Systems, Ecologistics Limited, Waterloo, Ontario

Date: July, 1990
Key Words: moldboard plow, conservation tillage, modified moldboard plow, residue management

Summary: A one year modified moldboard plow trial was conducted comparing three makes of plows. Since standard plows were designed to bury all surface residue, each plow was modified by removing a portion of the moldboard bottom to retain surface residue. The objective of the trial was to document the potential for a modified moldboard plow to attain a minimum of 20% of the soil surface covered with residue after planting.

The reasons for using the moldboard plow in this study are as follows: i) it is a low cost modification; ii) it is easily integrated with most operations; and, iii) no significant loss in yield is anticipated.

Three makes of plows were evaluated in the study with three cuts to each plow. Numerous measurements were taken in each plot - after primary tillage, secondary tillage and after planting. The trials were conducted on clay loam and clay soils in three locations and two different crops.

Although, after primary tillage 20-30% residue levels were attained, none of the plows were able to meet the minimum 20% after planting guidelines necessary to qualify them as conservation tillage systems.

Comments: Advantages

- the smaller the moldboard the more residue left after plowing

Disadvantages

- modified moldboard plow fails to achieve the minimum 20% residue cover after planting
- the smaller the moldboard the rougher th soil surface after plowing
- study reveals some of the changes in draft which may be encountered when modifying the moldboard plow

Associated SWEEP/LSP Research:

SWEEP Report # 6 - A Survey of Crop Residue in Southwestern Ontario 1987
SWEEP Report # 31- Field Scale Tests of Modified Moldboard Plow

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**
None required.

Report # 14

Report Name: The Effect of Terraces on Phosphorus Movement

Researcher: K.J. McKague et.al., Ecologistics Ltd., Waterloo, Ont.
Date: July, 1990
Key Words: soil erosion, structural erosion control, phosphorus, sediment, monitoring, run-off, water quality, terraces

Summary: Three sets of experiments were implemented to study the methods of monitoring the effectiveness of an erosion control structure for sediment ponding and run-off water quality. Laboratory tests examined a range of monitoring technologies. The most promising of these was field tested. The results of the only storm event measurable during an eight-month period were compared with the results of predictive erosion and run-off models (AGNPS, CREAMS, and SEDCAD).

The Water and Sediment Control Basin (WASCOB) monitored was found to be 10 to 15% efficient at trapping sediment and phosphorus from the one run-off event that occurred. The report emphasizes to erosion control designers the importance of the trade-off of allowing sufficient ponding time without causing excessive crop damage.

Comments: The laboratory and computer modelling aspects of the study should prove to be useful to researchers and those monitoring soil erosion and agricultural water quality. The single storm event renders the field testing portion of the study inconclusive and not particularly useful. It is anticipated that useful information regarding monitoring will be forthcoming from SWEEP Watershed studies.
Of possible interest to producers and conservationists is the reinforcement of the recommendation for careful planning and expert design in erosion control systems.

Associated SWEEP/LSP Research:

SWEEP Report # 45 - Management of Farm Field Variability III. Effect of Tillage Systems on Soil and Phosphorus Loss.
SWEEP Report # 53 - Phosphorus Movement in Soil as a Function of Phosphorus Solubility & Reactivity.
SWEEP Report # 60 - The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters, A. - Soil Erosion, Phosphorus Loss and Corn Yield, B.- Herbicide Losses.

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**
(C) More data from several storm events are required to determine relative effectiveness of terraces as erosion control measures. Further methods research and development is required to determine the relative effectiveness of erosion control systems. This will be of particular concern as increasing emphasis is placed on conservation and environmental farm planning in the very near future.

Report # 15

Report Name: An Annotated Bibliography of Socio-Economic Soil and Water Conservation Research

Researcher: D. Cressman, Ecologistics Limited, Waterloo, Ont.

Date: August, 1990

Key Words: bibliography, social, economic, soil, water, conservation, research, adoption

Summary: The three objectives of this study were to:

a) Conduct an intensive bibliographic search of the relevant literature sources on the social and economic factors which are believed to contribute to the adoption of soil and water conservation practices.
b) Present the findings in a computerized, annotated bibliography.
c) Analyze the research conducted to date and identify the gaps in socio- economic regarding the adoption of agricultural soil and water conservation practices.

The search was limited to North American socio-economic soil and water conservation experience from 1970 onwards. The search was further restricted to "hard" scientific research (journals, etc.), emphasis on the 1980's, and grey literature, including the popular farm press, was excluded. The databases searched are listed as well as key descriptors/search terms applied to the annotations. A total of 255 records are included in the bibliography and it was compiled on the bibliographic software package PROCITE. These are listed in appendix B of the report. A copy of the PROCITE database is housed in the Soil and Water Conservation Information Bureau, University of Guelph.

A workshop was held to identify the socio-economic research gaps in the province. The workshop participants included researchers, extension personnel and program managers, conservation farmers, as well as Ecologistics staff. Twelve questions were developed for discussion at the workshop. The questions were taken largely from the further study indicated in the research papers in the bibliography. A total of nineteen topic areas were derived from the discussion and were then ranked.

The four highest ranked issues were as follows:(all had equal scores) account for risk in economic analyses, the need for integrated research, off-site considerations in public policy and policy designed according to the nature of the problem. The next highest ranked (again with equal scores) were: biophysical limitations to economic research, evaluation of policy instruments and evaluation of applicability of U.S. findings.

The final part of the study summarizes the research questions or needs which have emerged from various elements of the study. The research needs were summarized in five areas: research, design and approach, policy, economics and technology transfer.

Comments: The report should prove to be a useful reference for the research community, policy, researchers and conservationists. Much is known about socio-economic fundamentals. There exists a need to link the most applicable of these to practice.

Associated SWEEP/LSP Research:

SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from Adoption of Conservation Tillage Practices in Crop Production in Southwestern Ontario
SWEEP Report # 7 - Sources of Motivation in the Adoption of Conservation Tillage
SWEEP Report # 8 - Social Structure and the Choice of Cropping Technology: Influence of Personal Networks on the Decision to Adopt Conservation Tillage
SWEEP Report # 9 - Conservation Practices in Southwestern Ontario Agriculture: Barriers to Adoption

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) The report identifies a number of areas that require further research.

Report # 16

Report Name: Effects of Subsoiling On Corn Yields and Soil Conditions In Southwestern Ontario

Researcher: L. Leskiw, A. Laycock, Can-Ag Enterprises, Guelph, Ontario

Date: September, 1990

Key Words: post-emergence subsoiling, B.C. Sub-mulcher, corn, yields, compaction, inter-row subsoiling

Summary: A one year subsoiling trial was conducted in June 1988 in corn at two depths, 18 cm and 31 cm using a B.C. Sub-mulcher in the Kent County area. Five different methods were used to assess soil compaction including visual observations, bulk density, hand and cone penetrometer measurements and detailed descriptions of soil peds and pores.

Soil conditions were dry at the time of subsoiling and continued dry for the remainder of the growing season. Shallow subsoiling (18 cm) reduced corn yields while deeper subsoiling did not, on average, have any effect. Two sites were determined to be severely compacted, yields did increase with the deep subsoiling. Soil conditions were improved in a 20 cm wide strip in the area of the shank path.

Comments: This study was limited to one season only. Other compaction studies would suggest that improvements in soil conditions as a result of subsoiling are normally short lived.
The effect of subsoiling is highly dependent on soil moisture conditions at the time of subsoiling and during the following growing season.

Associated SWEEP/LSP Research:

SWEEP Report # 4 - The Assessment of Soil Compaction and Structural Degradation in the Lowland Clay Soils.
SWEEP Report #24 - Investigation of Soil and Crop Response to Fall Subsoiling in Southwestern Ontario.
LSP Research - Management of Fine Textured Poorly Drained Soils For Intensive Agriculture.
LSP Research - Management of Fine Textured Poorly Drained Soils For Intensive Agriculture: Characterization Of A Forage Factor - Part I and II
LSP Research - Improving the Degraded Structure Of Fine Textured Soils With Deep Tillage And Grass And Legume Crops
LSP Research - Improving The Degraded Structure Of A Clay Loam Soil With Deep Tillage & Grass & Legume Crops
LSP Research - Crop Production With A No-Traffic Tillage System

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**
None required.

Report # 17

Report Name: Effect of Ammonia on Soil Properties and Relevance to Soil and Water Quality

Researcher: D. Cressman et al., Ecologistics Ltd., Waterloo, Ontario

Date: October, 1990

Key Words: soil quality, nitrogen, anhydrous ammonia, soil erosion, soil pH

Summary: Two laboratory experiments were designed to verify possible harmful side-effects of anhydrous ammonia (AA) application. According to past research, there is evidence that AA will raise soil pH, increase ammonia to toxic levels in the soil, destroy soil fauna and reduce structural stability . To test this, measurements of soil pH, ammonium and nitrate nitrogen, other nutrient levels, microbial activity, clay dispersion and soil structural stability were taken at several depth intervals over time.

The findings suggest that microbial activity is reduced initially by toxic levels of ammonia gas and/or nitrite levels but resumes after nitrogen is converted to more available forms or is lost from the system. Soil structural formation is temporarily decreased but resumes at normal development rates after microbial activity resumes. Other nutrient levels are not likely to be affected in the ammonia-N band.

Comments: Under laboratory conditions, AA has little net negative effect upon soil quality. Rainfall simulation in similar conditions may have verified these conclusions.

However, field conditions are far more complex. The long-term effects of continued use on soil fauna needs to be examined. The effect of ammonia on soil biology could be difficult to isolate from that of tillage, pesticides and other factors. Further, it would be difficult to contrast changes in soil quality in the field. Tillage and cropping practices may overshadow AA 's contribution to soil degradation.

The only practical tip from this work might be : continual use of AA may be harmful to your soil - try other forms and timing of N application. [The Ontario Ministry of Agriculture and Food already strongly advocates crop rotation for many reasons - particularly in grain-based cropping systems. This practical tip is not new.]

Associated SWEEP/LSP Research:

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(A) Field research would be useful to understand N - cycle but marginally useful to improve our understanding of soil quality.

Report # 18

Report Name: Effects of Management on Soil Hydraulic Properties

Researcher: B. O'Neill, Dr. R.G. Kachanoski, Dr.D.E. Elrick
Dept. of Land Resource Science, University of Guelph

Date: September, 1990

Key Words: run-off, infiltration rate, minimum tillage, moldboard plough, no-till, porosity, Guelph Pressure Infiltrometer, erosion, bulk density

Summary: Previous U.S. research has shown conflicting results regarding the effect of conventional tillage on infiltration, saturated hydraulic conductivity values and run-off.

The purpose of the study was to further the development of the Guelph Pressure Infiltrometer as a tool to accurately assess the effects of tillage systems on soil hydraulic properties.

Detailed measurements were taken three times during the year using the Guelph Pressure Infiltrometer, intact soil cores, and rainfall simulation. At one long-term no-till site (9 years), the measurements showed that the no-till had a higher bulk density, lower total porosity, lower macro-porosity, lower saturated hydraulic conductivity, shorter time to ponding and lower infiltration rates compared to the moldboard treatment. Similar observations were made at a second site comparing no-till and minimum tillage. While the run-off from no-till sites was higher due to decreased infiltration, the amount of soil loss was lower than either the minimum till or the moldboard treatments.

There were no differences in surface hydraulic properties between no-till and other tillage systems or between minimum till and moldboard tillage at the four remaining sites.

The Guelph Pressure Infiltrometer was shown to be a good in situ method for determining the effect of management on surface hydraulic properties.

Comments: The title was misleading as the study mainly focused on the development of the Guelph Pressure Infiltrometer. The collection of data on the effects of management on soil hydraulic properties was secondary. The effect of tillage in soil hydraulic properties may be site specific and vary depending on factors such as soil type, organic matter level, earthworm populations, crop rotations, etc.

Associated SWEEP/LSP Research:

SWEEP Report # 30 - The Response of Soil Microflora and Fauna to Spring Plowing of Zerotill and Pasture Soils

Future Research: **( ) indicates the reviewers suggestion for priority, A - high, C - low.**

(A) Further research is needed to determine the effect of tillage on infiltration, run-off, macroporosity and other soil hydraulic properties at different locations with varying soil types, management histories, etc.

Report # 19

Report Name: Studies On The Control of Problem Weed Species In Conservation Tillage Systems

Researcher: Dr. B.L. Frick, Southwestern Ontario Agricultural Research Corporation (SWOARC), Harrow, Ontario

Date: September, 1990

Key Words: corn, soybeans, winter wheat, no-till, survey, weed species, weed density, conventional tillage, conservation tillage, herbicide, inter-row cultivation

Summary: The objectives of the study were:

- to determine the weed species likely to be the greatest problem under various conservation tillage systems, and to see if their stages of growth differ between tillage systems.

- to examine the susceptibility of problem weeds to control by herbicide and tillage methods available in conservation tillage systems.

- to recommend weed management strategies for field testing.

A total of 593 fields of corn, soybeans and winter wheat in southwestern Ontario were surveyed in 1988 and 1989. The three tillage systems surveyed were conventional, conservation (minimum) and no-till.

The same weed species were found in all tillage systems, but there was a slight variation in their frequency of occurrence and density. The weed species that occurred most frequently in all tillage systems were green foxtail, lamb's-quarters, redroot pigweed, common ragweed, quackgrass and dandelions. No-till and conservation tillage fields had higher overall weed densities than conventional fields. Quackgrass and dandelions decreased in frequency and density with time in no-till or conservation tillage.

Lamb's-quarters, redroot pigweed and velvetleaf were at similar growth stages in each tillage system. Green foxtail and common ragweed emerged later in no-till than conventional. Perennials emerged at about the same time in all systems, but grew more slowly in conventional tillage than in no-till. Dandelions flowered most often in no-till fields and least often in conventional fields.

The increased use of burndown treatments and decreased use of soil incorporated herbicides were the only differences in herbicide use between tillage systems. Autumn burial generally decreased the survival of seeds of perennial species but not of seeds of annual species. Roots of perennial weeds had a lower survival rate when brought to the surface in the fall versus fall burial.

Laboratory work was conducted to simulate depth of seed germination and mechanical methods of weed control. Increased seed depth decreased annual seed germination, however increased the survival of some perennial weeds. All mechanical damage treatments reduced survival of annuals compared to undisturbed plants. Reduction of survival rates was more pronounced with shallow cutting or inversion than with deep cutting. For perennials shallow cutting or inversion treatments were most effective 3 to 4 weeks after planting. This seemed to be related to depletion of root reserves used for top growth that weakened the plants. Simulated inter-row cultivation was an effective control method for annual weeds but had only a short term effect on perennials. In general weed species were not substantially different in different tillage systems and, therefore weed control should not be any more difficult in reduced tillage systems.

Comments: The survey showed only slight differences between tillage systems. In other field studies shifts toward more perennials and fewer annual weeds have been observed in no-till. Many experienced farmers report that weed control is not any more difficult and in fact may be easier than conventional systems. The study did agree with that observation. The lab studies could use some field data to back up the results.

Associated SWEEP/LSP Research:

SWEEP Report #19A- Weeds of Corn, Soybean and Winter Wheat Fields Under Conventional, Conservation and No-Till Management Systems In 1988 and 1989

SWEEP Report #32 - Optimal Herbicide Use in Conservation Tillage Systems

SWEEP Report #48 - The Feasibility of Band Spray Application in Conjunction with Inter-row Cultivation in No-till Corn

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(C) Conduct field studies of the lab work.

Report # 19A

Report Name: Weeds of corn, soybean, and winter wheat fields under conventional, conservation, and no-till management systems in Southwestern Ontario - 1988 and 1989

Researcher: Frick, B., Crop Development Centre, University of Saskatchewan, Saskatoon; Thomas, A.G., and Wise, R.F., Agriculture Canada, Research Station, Regina, Saskatchewan.

Date: November, 1990

Key Words: corn, soybeans, winter wheat, no-till, survey, weed species, weed density, conventional tillage, conservation tillage, herbicide

Summary: This report takes a lot of the information that is found in SWEEP Report # 19 and presents it in the Agriculture Canada Weed Survey Series format. The tables, figures and appendices contained in this publication contain the raw survey data that could not be included in Report # 19. The results of the survey are detailed in the first section, the results of the questionnaire survey are in the second section and an appendix of field survey summary tables is found at the back.

The field survey was conducted after all spring and early summer herbicides had been applied so it reflects the weed populations which escaped control. Generally the survey found that the weed community did not change significantly among tillage systems but final overall densities were somewhat larger with less tillage.

The questionnaire results found the differences among management systems were minimal, therefore large scale changes in weed problems were not associated with the management systems.

Comments: The report contains a lot of information that could be further analyzed to give more insight into the weed populations and shifts in southwestern Ontario. The questionnaire provides useful information on herbicide usage, tillage implements used, number of tillage passes and timing of herbicide application.

Associated SWEEP/LSP Research:

SWEEP Report #19 - Studies on the Control of Problem Weed Species in Conservation Tillage Systems;
SWEEP Report #32 - Optimal Herbicide Use in Conservation Tillage Systems;
SWEEP Report #48 - The Feasibility of Band Spray Application in Conjunction with Inter-row Cultivation in No-till Corn.

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) Conduct follow up surveys five years later.

Report # 20

Report Name: Conservation Tillage Equipment: Availability, Utilization and Needs

Researcher: James White, Ph.D., Bruce McCorquodale, P.Ag., InfoResults Limited, Brampton, Ont.

Date: May 13, 1991

Key Words: survey, equipment, conservation tillage, farmers, manufacturers, equipment dealers, extension personnel, modifications, planters, drills, adoption, availability, needs

Summary: This study was conducted on the premise that some Ontario farmers are understood to have stated that the machinery industry has not responded to their needs as quickly as they would have liked. A personal interview or telephone survey was done to see if the availability of appropriate machinery may be one of the constraints in the adoption of conservation tillage practices by Ontario farmers. The objectives of the study were to: document the farmers' level of interest in conservation tillage and tillage equipment; determine the availability of different types of machinery; determine what modifications farmers have made; establish what manufacturers have done and are considering; and explore ways the government could assist innovators. Due to the small sample size of 58 respondents statistical tests were not considered appropriate. The results therefore represent a qualitative rather than quantitative description of the state of conservation farming in Ontario.

The following groups were interviewed using a standard questionnaire: 19 farmers, 10 extension personnel, 18 equipment dealers and distributors and 11 equipment manufacturers. The study concluded that the adoption of conservation farming is not being seriously impeded by a lack of appropriate equipment. A lack of knowledge, and tradition appear to be greater problems than appropriate equipment. Cost was also a factor. The study also found that the success or failure of conservation tillage depends primarily on where the seed, fertilizer and herbicides are placed in the soil. Those interviewed felt that this area still had the most problems and warranted further research. There also appears to be a need for more information on the operation of various planters on different soil types with varying amounts of residue.

Although research findings documented a majority of dealers do not appear to be expanding into new lines of conservation equipment, the machinery industry, encompassing manufacturers, importers, fabricators and dealers, appear to be interested in being made more aware of and involved in conservation farming. However, the study found that they are not presently well informed regarding government programs in Ontario.

It was suggested that governments role (provincial and federal) is one of communication to promote conservation tillage. The study found that manufacturers need to be made more aware of programs,

achievements and opportunities, while farmers need more "hands on" information and demonstrations especially in relation to how to plant in residues.

The study recommends increased communications with the farm machinery industry. This could be done primarily through contacts with various industry organizations by SWEEP personnel. Increasing on-farm demonstrations using various types of planting equipment and continuing land stewardship type programs were also recommended. The final recommendation is to maintain activities which provide information to farmers, especially the "how to do it" type of information.

Comments: The study does a reasonable job of evaluating the availability, utilization and needs relating to conservation tillage equipment for those interviewed. The authors mention that the group surveyed were fairly knowledgeable about conservation tillage and therefore the results should be used only in that context. A survey of those less familiar with conservation tillage may have produced very different results.

The study has achieved its goal and objectives. For two main reasons: One: The project was an initial effort to determine whether or not needs were met for farmers, extension personnel, equipment dealers and manufacturers, regarding information about and the use of conservation equipment. This question we feel has been adequately answered. Secondly: farmers for this study were selected on the basis of their innovativeness and willingness to explore new cropping practices - they were leading edge cash crop farmers. Setting up a research design that would look at a more representative sample would provide less conclusive results because many of the farmers questioned would have more of a limited knowledge of or interest in the latest conservation tillage equipment.

Associated SWEEP/LSP Research:

SWEEP Report # 7 - Sources of Motivation in the Adoption of Conservation Tillage
SWEEP Report # 9 - Conservation Practices in Southwestern Ontario Agriculture: Barriers to Adoption

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

None required.

Report # 21

Report Name: Efficiency of Residue Management for Providing Optimal Corn Growing Conditions in a Non-tilled Sandy Loam

Researcher: Dr. M.C. Fortin, Southwestern Ontario Agricultural Research Corporation (SWOARC), Harrow, Ontario

Date: March, 1991

Key Words: crop residue, corn, no-till, conventional tillage, soil temperature, soil moisture, early plant development, phytotoxicity, trash whippers, hybrid variability, bulk density, emergence, residue management

Summary: The goal of the one year study was to determine whether:

1) removal of crop residues from the row would increase the rate of early corn development.
2) presence of residues in the soil would improve the water status of sandy soil.
3) two hybrids would perform similarly for a second year in a different location.

The residue management treatments used in the study were: conventional tillage (spring moldboard), first year no-till (residue untouched, residue removed, residue removed from row area).

Residue management (complete removal of residue) affected corn emergence. Removing residue from the row area did not result in earlier emergence when compared to no-till. Growth stages were different for the various tillage systems. The data shows the differences are due to soil temperature. Plant growth in the no-till treatments was similar or better than the conventional treatment in all cases. There was little difference in the soil water content in the rows regardless of whether residue was removed. However, the no-till treatments had significantly higher interrow water contents than did the conventional treatment. This difference could be due to the absence of tillage in the fall and spring rather than the presence of residues on the surface. Droughty soils benefited to a limited degree with no tillage.

Of the two hybrids studied, Pioneer 3790 is more sensitive to seed zone environmental conditions than 3902 and may not be suited to no-till conditions. Both hybrids showed negative correlation with soil water content and no correlation with seed depth or bulk density.

The study did show that corn planted into canola residue may have been delayed by a factor other than soil temperature. More study is needed to determine if there are potential allelopathic chemicals released from the canola residue.

Comments: Good information in this study although it should have been carried out for a longer time period (longer than 1 year).

Associated SWEEP/LSP Research:

SWEEP Report # 59 -	Evaluation of 58 Commercial Corn Hybrids (2850 CHU to 3450 CHU) in two Conservation Tillage Systems and Conventional Tillage in Kent County, Southwestern Ontario
SWEEP Report # 22 -	Field Emergence Predictors for Grain Corn Under No-till Management
SWEEP Report # 56 -	Yield Reduction Effects of Crop Residues in Conservation Tillage
SWEEP Report #57B-	Effect of Winter Rye Mulches and Fertilizer Amendments on Nutrient and Weed Dynamics in No-till Soybeans.

Future Research: **(   ) indicates reviewers suggestion for priority, A - high, C - low.**

(B) Research into allelopathic affects of different residues (canola). The study should be carried out for a longer period of time and on several soil types.

Report # 22

Report Name: Field Emergence Predictors for Grain Corn Under No-till Management

Researcher: Dr. H.J. Hope, R. Maamari, for Southwestern Ontario Agricultural Research Corporation (SWOARC), Harrow, Ont.

Date: May, 1992

Key Words: corn hybrids, no-till, emergence, cold tolerance, germination, early growth, root growth, coleoptile

Summary: This study was initiated to determine how cold tolerance of corn hybrids might best be determined. The objective of these determinations was to make a predictor of successful field emergence available to growers who could then select the hybrids best adapted to their individual no-till management system. This report includes the findings of two sets of low temperature experiments and also includes a brief report on a field emergence experiment performed by a farm group in 1988.

In the first experiment 15 hybrids were studied. Germination was measured at 25^{0}C, root and shoot germination and 1 cm shoot production at 11^{0}C and seedling growth at 12^{0}C. Germination was uniformly high, most exceeded 90%. The time to production of a 1 cm coleoptile was found to be the best predictor of cold tolerance under NT management practices because it gives a measure of low temperature tolerance to both germination and early growth. The addition of time-to-root-germination as a second constraint serves to identify the elite members within a population of above average hybrids.

In the second experiment one hundred and twenty-two corn hybrids were evaluated during the summer of 1991. Results indicated that of the 122 hybrids tested the majority germinated under average to better than average conditions of temperature. At 25 degrees C germination of 92% was observed. A broad genetic range is found in the response of root and coleoptile to cold stress during germination at 11 degrees C. The study suggests that the cold tolerance predictor be: [(1 x % Day 5 germination) + (3 x % Day 22 germination)]/4.

Significant correlation was found between time-to-50% 1 cm coleoptile production and the difference between field emergence under NT and CT (1988 field experiment).

Comments: These studies have developed a cold tolerance predictor for corn hybrids but field studies are needed to verify the results. It is essential that recommendations do not come from this report alone but field data be used as well. Cold tolerance is only 1 factor to consider when selecting a hybrid - yield, stalk strength, etc., are also important.

Associated SWEEP/LSP Research:

SWEEP Report # 59 - Evaluation of 58 Commercial Corn Hybrids (2850 CHU to 3450 CHU) in Two Conservation Tillage Systems and Conventional Tillage in Kent County, Southwestern Ontario

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) Verify the accuracy of the test with field evaluations of the hybrids under no-till conditions. Continue to evaluate the hybrids on the Ontario Corn Committee performance list and provide recommendations for farmers.

Report # 23

Report Name: Processes Involved in Mobilization of Phosphorus in Different Farming Systems in Southwestern Ontario: Nutrient Levels In Plant Tissues and Soils.

Researcher: A. Abboud, Resource Efficient Agricultural Production (REAP)- Canada, Ste. Anne de Bellevue, Quebec

Date: March, 1991

Key Words: organic farming, conventional farming, rock phosphorous, tillage, green manure, compost

Summary: Mobilization of phosphate was examined on six farm management systems, ranging from long term organic to moderately intensive conventional. Three other experiments examined the affect of crop, soil and residue management, on mobilization of phosphate on a long term organic farm.

The experiments covered the following topics:

1) Responses to different phosphorous fertilizers (0-46-0, compost, rock P) in organic and conventional farming systems.

   ! There did not appear to be a pronounced difference between farming systems in response to the different types of P fertilizers.

2) Effect of three tillage/barley straw treatments on soil P and crop nutrition. The field was divided into 9 strips which were moldboard plowed (no straw), disced (no straw), disced (barley straw). In 1988 four treatments were superimposed onto the main treatments, (no fertilizers, superphosphate, rock phosphate, and compost).

   ! The straw disced in treatment increased soil P one year after the treatment compared to no straw disced or plowed.

3) Effects of green manuring and rock phosphate on P nutrition of different crops. The treatments were rock phosphate and no rock phosphate with the following green manures: oilseed radish, buckwheat, faba beans and weeds.

   ! Rock phosphate increased soil P levels while green manuring did not increase soil P levels.

4) Effects of carbon additions on nitrogen fixation and P nutrition of hairy vetch and following crops. The treatments were oat hulls incorporated and no oat hulls, with rock phosphate and no rock phosphate.

! Addition of oat hulls improved the total uptake of N, P, K, and Ca in vetch. No response in sunflowers.

Comments:

The following concerns were not covered in the report.

- ! Variation which occurred within the organic and the conventional farms
- ! What effect does soil type have on the availability and uptake of P?

- ! Is there really a difference between treatments (sodium bicarbonate showed no differences) or was the positive response shown by the resin test used to illustrate a difference.
- ! Why was the straw not worked in with the plow, part of the treatment?
- ! Weed suppression by oat hulls (5 & 10 t/ha) could better explain the nutrient uptake by vetch.

The sodium bicarbonate test for phosphorus reflects what is happening in Ontario soils more accurately than the resin test.

Associated SWEEP/LSP Research:

SWEEP Report # 14 - The Effect of Terraces on Phosphorus Movement
SWEEP Report # 35 - Nutrient Distribution and Stratification Resulting from Conservation Farming
SWEEP Report # 53 - Phosphorus Movement in Soil as a Function of Phosphorus Solubility and Reactivity
SWEEP Report # 60 - The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters, A. Soil Erosion, Phosphorus Losses and Corn Yield, B. Herbicide Losses
SWEEP Report # 45 - Management of Farm Field Variability III. Effect of Tillage Systems on Soil and Phosphorus Loss

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 24

Report Name: Investigation of Soil and Crop Response to Fall Subsoiling in Southwestern Ontario

Researcher: L. Leskiw, A. Laycock, Can-Ag Enterprises, Guelph, Ontario

Date: August, 1991

Key Words: fall subsoiling, compaction, yields, Tye Paratill, B.C. Sub-mulcher, Strohm aerator, compaction measurement

Summary: This study examined the effect of fall subsoiling on the yield and response of the subsequent crop and soil structure. Three subsoilers were compared--the Tye Paratill, B.C. Sub-mulcher and the Strohm aerator. Fourteen fields in Kent County were subsoiled to a depth of approximately 30 cm in the fall of 1989 following soybean or winter wheat harvest. Field length strips (0.5-1 km long and 10 or 20 m wide), two replicates each, were established to monitor effectiveness of each implement and a control.

Soils in each strip were examined to determine the degree and characteristics of compaction shortly after subsoiling in 1989 and again after the 1990 harvest. Measurements included hand and cone penetrometer readings, soil bulk densities on control plots and detailed visual inspection of structure and pores.

The 1990 crop yields were measured by the farmers using weigh wagons. Farmers shared their experience with respect to workability of the soils, ponding, and their evaluation of degree of compaction. All inputs including field operations, fertilizer and herbicide inputs and general crop performance were recorded.

Soil compaction was rated moderate on eleven fields, slight to moderate on one and moderate to severe on two. Twelve of the fields were clayey (clay loams, silty clays and silty clay loams), the other two were sandy loams.

There were significant changes in soil conditions with the different subsoilers, however, only two fields showed a substantial yield increase. Overall, there was no significant yield response in 1990 to the 1989 subsoiling. Moisture conditions throughout the 1990 growing seasons were good, therefore the benefits of subsoil alleviation would not likely be evident.

The Paratill was the most effective implement in reducing soil compaction. The only residual effects seen in the fall of 1990 were on plots in conservation tillage. In 1989 after the subsoiling operation, four farmers fall plowed their fields as deep as they had been subsoiled. A lack of yield response on these fields may be due to the deep plowing (their normal practice).

Response to subsoiling has not been clearly measurable or predictable.

Comments: This experiment was only one year in duration. Only two of the sites were determined to be more than moderately compacted. Response to subsoiling will depend on the severity of the compaction, soil moisture conditions at the time of subsoiling, depth of plowing and weather conditions in the growing season following fall subsoiling.

An interesting observation by the researchers was that farmers who were shallow plowing were more likely to have a compaction problem than those who were plowing to the bottom of the topsoil-subsoil interface.

Associated SWEEP/LSP Research:

SWEEP Report # 4 - Assessment of Soil Compaction and Structural Degradation in the Lowland Clay Soils
SWEEP Report # 16 - Effects of Subsoiling on Corn Yields and Soil Conditions in Southwestern Ontario
LSP Research - Management Of Fine Textured Poorly Drained Soils For Intensive Agriculture
LSP Research - Management Of Fine Textured Poorly Drained Soils For Intensive Agriculture: Characterization Of A Forage Factor - Parts I and II
LSP Research - Improving The Degraded Structure Of Fine Textured Soils With Deep Tillage and Grass and Legume Crops
LSP Research - Improving The Degraded Structure Of A Clay Loam Soil With Deep Tillage & Grass & Legume Crops
LSP Research - Crop Production With A No-Traffic Tillage System

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low**

None required.

Report # 25

Report Name: The Development and Testing of a Dry Fertilizer Placement Machine

Researcher: Doug Albin and Till-Tech Systems Limited, St. Thomas, Ontario

Date: August, 1992

Key Words: urea placement, dry fertilizer injection, 28% nitrogen, urea, zone tillage, timing, sidedress, coulter till, no-till, nitrogen, equipment, corn, yield

Summary: The objective of this 2 year study was to test a machine designed to inject dry forms of nitrogen in no-till or reduce-till systems.

The success of the new machine was assessed by comparing its performance to the standard 28% nitrogen injected mid-row. Performance was based on collecting and evaluating data with regards to: yield, biomass, and nitrogen budget.

Year one of the study compared injection of liquid 28% N and dry urea at two different application times (planting and 6-leaf growth stage). The urea was placed 25 cm from plants on both sides (split application). The liquid 28% N was injected between the rows at the midpoint (approximately 45 cm from the plant). Year one results indicated liquid 28% nitrogen showed no significant yield increase. The trial results also indicated a trend to higher yields when fertilizer was applied at planting as opposed to the 6-leaf stage.

In year 2 of the study it was decided that the urea treatment would have 20% of the total N applied as starter N (Ammonium Nitrate) to try to offset the slight yield disadvantage measured in year 1. Yield results for year 2 demonstrated a significant yield advantage for the urea injection system.

With the dry unit actually out performing the 28% system, the researchers concluded the system was a success.

Comments: The study goes beyond the testing and development of a dry fertilizer placement machine.

The comparable performance of the urea system could be attributed to some combination of split placement (both sides of row), and starter N in ammonium nitrate for 20% of total N.

- treat the study as two separate year trials since both the treatments and actual machine changed significantly from year 1 to year 2.
- the trial results focus as much on product placement as product type.
- placement for liquid 28% N was 45 cm off the row.
- in year 1, placement for urea was 25 cm off the row.
- in year 2, the urea treatment received a boost with an ammonium nitrate starter.

Associated SWEEP/LSP Research:

SWEEP Report # 28 - The Effect of Split Applications of Nitrogen On Corn Yield Under Ridge and No-till Conditions.

SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program

LSP Research - Nitrogen Research With Corn Using Conservation Tillage

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required. Research evaluating the best placement and timing of nitrogen applications in conservation tillage systems is on going.

Report # 26

Report Name: The Use of Kelp and Molasses in an Aeration Tillage System

Researcher: J. Sadler Richards, Conservation Management Systems, Lucan, Ontario

Date: July, 1991

Key Words: organic farming, aeration tillage, kelp, molasses, low input farming, Aerway system, soybeans

Summary: This 2 year study was carried out in Oxford county on 2 farm sites. The objectives of the study are:

1) to determine the effect of kelp and/or molasses on main crop growth and seed yield.
2) to prepare preliminary conclusions on the efficacy of kelp and/or molasses as essential practices within the Aer-way system of low input crop production.

In 1990 additional treatments using the 71B fertilizer solution were studied. Two farms with 2 sites/farm were used each year with four treatments in year one and 6 treatments in year 2.

The parameters evaluated included soil texture, soil fertility, max and min. temperatures, precipitation, emergence, plant height, growth stages, and yield.

The conclusions from the study were: 1) no significant difference in emergence between treatments, 2) no significant difference in height of soybeans 2 weeks after planting, 3) no significant difference in vegetative or reproductive growth between treatments, 4) no significant difference in yields amongst the treatments. Therefore the use of kelp and/or molasses and/or 71B fertilizer solution as a seed or foliar treatment on a one year application basis did not significantly affect growth and yield of soybeans in an Aer-way production system

Comments: The researchers believe the study should continue for at least 3 years to see if there is accumulative affect of using kelp and/or molasses over a period of time. Costs were not evaluated with this report but if future research is to take place economics should be taken into account for the added expense of foliar treatments and material cost.

Associated SWEEP/LSP Research:

SWEEP Report # 50 - Evaluation of the Ontario Biological Aeration Tillage Association Approach to Low Input Farming

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) Continue research on additives over a number of years to see if there is/is not a benefit and include an economic analysis.

Report # 27

Report Name: Cereal Cover Crop Study

Researcher: J. Sadler Richards, Conservation Management Systems - A Division of Ecologistics Ltd., Lucan, Ontario

Date: July, 1991

Key Words: cover crop, cereal, erosion control, conservation cropping, residue cover

Summary: A two year study evaluated the performance of various cereal crops in producing residue and their subsequent ability to decrease the potential for erosion.

This study indicated that winter rye, spring barley and spring oats seeded at soybean leaf drop or at harvest increased soil residue cover in the winter or early spring when compared to soybean stubble alone. After planting, the differences in soil surface residue levels were insignificant.

Barley, and to a lesser extent oats, "seeded at harvest" followed by seeding at leaf drop resulted in optimum corn growth and yield when compared to treated plots. In general, no significant yield increases were realized when compared with the check.

The main objective of the study was to determine if any of these systems could improve on the residue protection offered by untilled soybean stubble. Simulated rainfall run-off plots indicated no significant improvement in erosion control between any of the plots.

Comments:

ADVANTAGES: Cereal cover crops may be of value when entering a reduced tillage situation with little or no residue (ie. minimum tillage in white bean stubble).

DRAWBACKS: Traditionally fall has a high demand on labour. This system may further stress an overloaded system. Increased input cost with no increase in either yield or erosion protection. Cover crops may complicate weed control strategies.

Associated SWEEP/LSP Research:

SWEEP Report # 12 - Choice and Management of Cover Crop Species and Varieties for Use in Row Crop Dominant Rotations
SWEEP Report # 36 - Red Clover Cover Crop Studies, 1987-1990
SWEEP Report # 43 - The Use of Cover Crops for Nutrient Conservation
LSP Research - Crop Rotations & Cover Crop Effects On Erosion Control, Tomato Yields & Soil Properties In Southwestern Ontario
LSP Research - A Cover Cropping Strategy For First Early Potato Production

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 28

Report Name: The Effect of Split Applications of Nitrogen on Corn Yield Under Ridge and No-till Conditions

Researcher: B. Shillinglaw, J. McGregor, Southwestern Ontario Agricultural Research Corporation, Harrow, Ont.

Date: October, 1991

Key Words: nitrogen, split application, no-till, ridge tillage, corn, yields

Summary: Split nitrogen application systems on corn were experimented with in this one year study to examine the effects of 3 proportions of nitrogen (0, 20 and 40% applied at planting time) on corn yields. The actual amounts of nitrogen applied to the plots were 160 kg N/ha, of which three rates, 0, 30, 60 kg N/ha were applied in a starter band with 28% N and the remainder applied at side-dressing conventionally (splits 0/160, 30/130, 60/100). The objective of the study was to determine the probable optimum quantity of nitrogen to be applied in advance of the sidedress application in a no-till and ridge till system. Measurements taken on yield and leaf samples were analyzed for nitrogen content.

The results of the leaf analysis showed that in a no-till system the 30/130 split nitrogen application had significantly lower ear leaf nitrogen then the 0/160 and the 60/100 application amounts. In the ridge till system the 30/130 split nitrogen resulted in the highest levels of ear leaf nitrogen.

There was no effect from either the nitrogen treatments or the timing of nitrogen application on grain yields in either the no-till or ridge till systems. No yield advantage or disadvantage showed up from splitting the nitrogen application.

Comments: Because 1988 was a very dry year, it is likely that moisture was a more limiting factor in this trial than was nitrogen. Therefore, no conclusion regarding the benefit from the split application of nitrogen, in no-till or ridge till, should be drawn from this study. Additional work will be required to determine if such benefits exist.

Associated SWEEP/LSP Research:

SWEEP Report # 25 - The Development and Testing of a Dry Fertilizer Placement Machine
SWEEP Report # 35 - Nutrient Distribution and Stratification Resulting from Conservation Farming
SWEEP Report # 51 - Loss of Nitrogen by Microbial Denitrification, Nitrification, Surface and Tile Runoff: Relation to Tillage Methods
LSP Research - Nitrogen Research with Corn Using Conservation Tillage
LSP Research - Nitrogen Conserving Farm Systems

LSP Research - Cropping And Soil Management Effects On The Dynamics Of Crop Residue Derived-N On The Coarse Textured Soils In Southern Ontario

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

None required. More work on split applications of nitrogen in corn under conservation tillage on various soil types is being done.

Report # 29

Report Name: The Effect Of Organic Mulches On Soil Moisture and Crop Growth

Researcher: Dr. T.J. Gillespie, Dr. C.J. Swanton, C.S. Wagner Riddle, University of Guelph

Date: August, 1991

Key Words: cover crop, soybeans, winter rye, soil water, soil temperature, timing, spring growth, fall, model, SOYGRO

Summary: The study examined no-till soybeans and winter rye cover crop on clay, loam and sandy soils. The objective was to study early versus late killing of fall planted rye; the effect of rye mulch on soybean growth and yield; soil water content and temperature. The use of modelling to predict the effect of rye mulch on soybean growth under various spring weather conditions was also examined.

The rye mulch/soybean system proved satisfactory for sandy and loam soils. Excess fall moisture and winter kill, on the clay soil site, interfered with crop establishment. Planter problems, and slug damage decreased soybean yield on mulched plots. The results on the clay site were not encouraging.

Rye mulch amounts larger than 2000 kg/ha did not significantly increase the percentage of ground cover, and little is gained by delaying kill to obtain larger amounts. Soil drying rates generally showed no difference between early and late killing dates. Extreme temperatures were measured more frequently under bare soil conditions. However, over the entire growing season, the temperature difference was limited to a small percentage of hours. The change in soil water content and temperature due to the rye mulch did not significantly increase or decrease soybean yield.

When other benefits of no-till are considered, for example reduced erosion and weed suppression, the study recommended that rye mulch be used in no-till soybeans.

The model, when given the variables obtained from the field study, performed well as a predictor of soybean growth and soil moisture for bare and covered soil.

Comments: The title of the study may be misleading. The study furthers research on growth models, however, there seems to be little in the way of practical advice for farmers. The field study was used to compare the accuracy of the model predictions and not to determine the benefits or effectiveness of using residue management for soybeans. No effort was made to determine the feasibility of producing high amounts of mulch prior to spring planting or planting into excessive levels of residue.

The use of a rye-soybean rotation, or part of a rotation, is not representative of rotations in the Norfolk area. It is also questionable as to whether this type of rotation is representative of Ontario.

Associated SWEEP/LSP Research:

SWEEP Report # 12 - Choice and Management of Cover Crop Species and Varieties for Use in Row Crop Dominant Rotations
SWEEP Report # 27 - Cereal Cover Crop Study
SWEEP Report # 52 - Field Scale Tests of Cover Crops I and II

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) Should soil moisture conditions (excess or deficiency) in various tillage regions become an important issue, then future research should be directed at those soil and crop rotation combinations of concern. These combinations should, however, be representative of Ontario conditions and current practices.

Report # 30

Report Name: The Response of Soil Microflora and Fauna to Spring Plowing of Zero-till and Pasture Soils

Researcher: P. Neave, Dr. V. Thomas, Department of Zoology, University of Guelph
Date: October, 1991
Key Words: soil microbiology, soil biology, soil quality, no-till, pasture soils, spring plowing, earthworms, nematodes, cryptozoic invertebrates, mites, springtails, bulk density, infiltration, soil temperature

Summary: A one year study using soil organisms to contrast the agro-ecosystem stability in an undisturbed pasture with a zero-till winter wheat field in plowed and unplowed plots. Four treatments were studied: a pasture field and a zerotill field; each of these were split in half, one side was moldboard plowed and the other was left unplowed. Numerous parameters were evaluated and results are as follows:

1) Abundance of nematodes - The number of nematodes was initially higher in zero-till than in pasture but towards the end of the growing season nematode numbers were higher in pasture soil. Number of nematodes correlated with saturated hydraulic conductivity in pasture soil, therefore in this soil, pore size might be limiting the activity of nematodes.

2 Earthworms - The number of earthworms in all sample plots were at a maximum at the end of the season (November). At the end of the season the number of earthworms in unplowed pasture soil was more than double that in unplowed zero-till soil. Pasture soil may take several years for populations to return. Earthworm populations do not appear to recover fully from plowing even after six months.

1) Cryptozoic invertebrates - The abundance of invertebrates was generally low in the spring, high in the summer and low again in late fall. There was no significant difference among plots. Slugs were similar in numbers in pasture and zero-till plots. The highest numbers were in plowed pasture and unplowed zero-till soils at the end of the sampling period. Similar trends were found for sowbugs except the number of sowbugs were higher in unplowed pasture than in plowed soil in mid-summer.

4) Mites and springtails - The occurrence of mites and springtails were similar in all plots. The average number of animals in unplowed pasture and zero-till was higher in the surface soil (0-5cm). In plowed pasture and zero-till the numbers were found at greater depths (5-15cm). Tillage alone doesn't influence distribution of mites. Changes in the soil after tillage has a greater influence.

5) Soil Biomass - Soil biomass was almost always higher in pasture soil regardless of whether it was plowed or unplowed. Soil biomass C:P ratios were generally higher in pasture soil than in zero-till.

6) Litter decomposition rate (LDR) - The LDR was higher in zero-till plowed soil than in pasture plowed soil 39 and 69 days after plowing.

7) Dry Bulk Density (DBD) - DBD was similar in unplowed and plowed pasture soils and was significantly higher in zero-till unplowed versus plowed soil.

8) Infiltration rate - Infiltration rate was higher in unplowed pasture and zero-till soils than in plowed soils. The average infiltration rate increased with increasing earthworm numbers and earthworm mass. The higher infiltration rate in unplowed soils at this site could be due to biopores transmitting more water than macropores.

9) Soil temperature in the plowed zero-till and plowed pasture soils had higher temperatures than unplowed soils. This difference disappeared by late summer.

10) Water content - There was no significant difference in water content amongst the plots.

11) Stability - Return times of population parameters were faster in zero-till soil. The zero-till community was more stable (by definition) than the pasture community.

12) Diversity as measured by richness (number of species per catch) and evenness were the same in zero-till and pasture soils.

Some conclusions from the report are:
1) Plowing reduces earthworm populations (even after six months) and reduces the water infiltration rate.
2) The study shows a long time is required for zero-till soil to "peak" biologically.
3) The zero-till community is more stable than the pasture community.

Comments:

This is a good report (although very technical) with some interesting trends showing up. From this report it would seem that we should not be recommending to plow zero-till soil 4-5 years into the system to mix the soil. This would harm earthworm numbers and infiltration rates. It is important to note that our soils tend to be very stable ecosystems and return times for organisms are relatively quick after cultivation (except for earthworms).

Associated SWEEP/LSP Research:

SWEEP Report #47 - The Effect of Woodlot Borders and Crop Residue on the Distribution of Invertebrates in Agroecosystems.
SWEEP Report #37 - Effects of Tillage on the Quality and Quantity of Surface and Subsurface Drainage Water: Uplands.
LSP Research - Response Of The Soil Microflora and Fauna To Spring Plowing Of Zerotill And Pasture Soils.

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) Future research into soil life should differentiate, where possible, amongst soil organisms which are beneficial to agriculture and those that are not. It would be interesting to see differences amongst zero-till, minimum till and moldboard plow systems examined.

Report # 31

Report Name: Field Scale Tests of the Modified Moldboard Plow

Researcher: J. Sadler Richards, Conservation Management Systems, Lucan, Ontario

Date: October, 1991

Key Words: modified moldboard plow, minimum tillage, equipment modification, residue management

Summary: This research project is a continuation of work done in 1988 which looked at modifications to the shapes of three moldboard types (general purpose, high speed, and European) commonly used in Ontario. This study evaluated the residue management potential capabilities of different configurations of the modified moldboard. The field scale trial was carried out at four different sites within Perth, Middlesex, and Kent counties.

The objectives of the study were to:

1) Demonstrate the effect of moldboard modifications on the amount of grain corn residue cover left on the soil surface.
2) Demonstrate these effects relative to: different models of moldboard plows, different bottom widths, different plow depths and different soil and field conditions.
3) Monitor the effects of moldboard modification treatments on soil residue cover, crop growth and yield.
4) Prepare preliminary guidelines on the settings and adjustments of certain moldboard plows with the goal of optimizing residue management potential.

Observations and measurements were taken on:

1) Moldboard plow mechanical performance
2) Soil moisture content and bulk density
3) Soil surface residue cover
4) Soybean plant stand
5) Soybean plant height
6) Soybean final plant population
7) Plant lodging
8) Yield and moisture content

The conclusions from the report are that there are no significant differences for any of the parameters measured. At all of the sites, the modifications to the moldboard plow did not significantly change the amount of residue left on the soil surface.

Comments: The study shows that modifications to the moldboard plow do not enhance residue cover and certainly don't achieve the 20-30% residue cover (after planting) needed for erosion control.

Associated SWEEP/LSP Research:

SWEEP Report # 6 - A Survey of Crop Residue in Southwestern Ontario, 1987
SWEEP Report # 13 - The Effect of Moldboard Shape on the Residue Management Potential of the Moldboard Plow
SWEEP Report #N/A- Conservation Tillage Handbook - Equipment Modifications and Practical Tips

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 32

Report Name: Optimal Herbicide Use In Conservation Tillage Systems

Researcher: J.E. Shaw, Ridgetown College of Agricultural Technology, Ridgetown, Dr. C.J. Swanton, V.S. Malik, University of Guelph, Ontario

Date: August, 1991

Key Words: cover crops, conservation tillage, corn, soybeans, winter wheat, herbicide, burndown, quackgrass, no-till, weed control, ridge till, fuel, labour, returns, risk, economics, banding, inter-row cultivation, chisel plow, conventional, Tillage 2000

Summary: The goal of the study was to develop weed control recommendations for farmers using conservation tillage systems. Research was also conducted to optimize herbicide inputs by developing an integrated weed management system for no-till corn. The following are the studies conducted under each of the six objectives:

1) Burndown and Residual Herbicides for Legume and Cereal Cover Crop Planted to Corn and Soybeans

The following field experiments were done to study the effectiveness of various herbicides for burndown of cover crops:

a) established alfalfa burndown in no-till soybeans

- glyphosate (tank-mixed with metolachlor, metribuzin, linuron, dicamba or 2,4-D LV ester and amine)and amitrole-t (with linuron or metribuzin) were tested at various rates.
- most provided good to excellent control of alfalfa, quackgrass and some other weeds.

b) winter wheat cover crop control in soybeans

- DPX Y6202-31, glufosinate, glyphosate and paraquat were tested, linuron and metolachlor were applied as preemergence to soybeans
- glyphosate and paraquat provided excellent season long control of winter wheat seedlings
- DPX Y6202-31 and glufosinate provided variable control
- excellent annual weed control was provided by linuron and metolachlor

c) winter wheat burndown with glyphosate

- glyphosate was applied at four rates to control established winter wheat
- later stages of wheat growth required higher rates of glyphosate

d) red clover burndown in corn

- most treatments provided good control of red clover
- atrazine or metolachlor without a burndown did not provide sufficient control

e) established alfalfa control in no-till corn

- glufosinate plus atrazine was most consistent in controlling alfalfa and quackgrass
  - control of quackgrass and alfalfa varied with other treatments

Recommendations based on the above experiments are provided.

2) Antagonism of Burndown Herbicides with Residual Herbicides in Conservation Tillage Systems

a) paraquat and glufosinate antagonism with residual herbicides in no-till corn

- paraquat, glufosinate and metolachlor plus atrazine or cyanazine plus additives provided excellent weed burndown

b) glyphosate antagonism with residual herbicides in no-till corn

- glyphosate was applied at four rates to evaluate the potential for antagonism when tank-mixed with atrazine or cyanazine, residual herbicide metolachlor was applied to all treatments
- burndown of annual weeds was not affected with the above combinations but burndown of weeds was affected when dicamba replaced atrazine or cyanazine

c) paraquat and glufosinate antagonism with residual herbicides in no-till soybeans

- paraquat and glufosinate were tank-mixed and applied separately with metolachlor, metribuzin, linuron, chloramben or metobromuron
- excellent weed burndown was recorded on all treatments except paraquat plus chloramben or linuron plus oil

d) glyphosate antagonism with residual herbicides on no-till soybeans

- glyphosate was applied at four rates to evaluate the potential for antagonism when tank-mixed with metribuzin or linuron
- glyphosate at lower rates when tank-mixed with metribuzin provided lower initial burndown as did glyphosate plus liquid or dry formulations of linuron

e) compatibility of burndown and residual herbicides for quackgrass control

- quackgrass control ratings are given for tank-mixes of glyphosate, paraquat or glufosinate with linuron, atrazine, metribuzin, metolachlor, 2,4-D amine, 2,4-D ester or dicamba

Recommendations based on the above experiments are provided as is the performance of the residual herbicides.

3) Impacts of Tank-mixes of Burndown and Residual Herbicides with Additives on Weed Control in Conservation Tillage Systems

a) the role of additives with residual herbicides in corn

- the additives tested when used with different herbicides provided excellent initial weed burndown and excellent season long control of grassy and broadleaf weeds
- excellent initial burndown and subsequent weed control were facilitated by fertilizer based additives, however there were some escapes

b) herbicides for burndown and residual control of annual weeds in no-till corn

- residual herbicides provided satisfactory to excellent burndown of annual and perennial weed species, satisfactory to excellent control of emerging broad-leaved weeds and excellent control of late emerging grasses

c) annual weed control in no-till corn by residual herbicides applied with additives

- all treatments provided excellent annual weed control the first year but results were variable the second year
- additives had no impact on weed control

d) burndown and residual weed control in soybeans

- excellent weed burndown was achieved by various combinations of herbicides in this experiment
- results varied for broad-leaf and grassy weed control

e) annual weed control in no-till soybeans by residual herbicides applied with additives

- weeds escapes varied with herbicide used

f) preemergence and postemergence herbicides for control of quackgrass

- spring applications of glyphosate or quizalofop gave better quackgrass control than fall applications but glyphosate gave better season long control
- glyphosate or quizalofop as pre-harvest applications had better early season quackgrass control than post-harvest

Recommendations based on the above experiments are provided.

4) Integrated Weed Management in No-till Cropping Systems

a) Tillage 2000: weed control under various tillage systems

- S there was no significant tillage by crop interaction on crop yield
- S corn yield losses due to uncontrolled weeds were greatest in the no-till system

b) effect of tillage on control of quackgrass

- S fall tillage (moldboard or soil-saver) controls quackgrass better than spring tillage and moldboard gave greater control than the soil-saver
- S most of the rhizomes are found within the top 7.5 cm. of the soil surface in no-till
- S reduced and no-till systems have an increased reliance on glyphosate for quackgrass control

c) residual effect of 2,4-D on soybeans

- S field experiments were conducted to investigate the effects of 2,4-D applied prior to planting on soybean yields
- S no visible injury was observed from carry-over of 2,4-D on soybeans in either year of the experiment
- S there were no yield reductions in the first year
- S in year two soybean yields were significantly reduced on the same day if soybean planting or treatments where 2,4-D amine salts were sprayed one week prior to soybean planting

d) the integration of banded herbicide applications and inter-row cultivation in no-till corn production

- S corn yield was equivalent regardless of whether herbicides were applied as a band or broadcast treatment at all sites
- S banding herbicides results in an approximate 60% reduction in herbicide use

Recommendations based on the above experiments are provided.

Note: Yield, herbicide rates and control information is provided for all experiments.

5) Cost/benefit Ratio and Associated Risk of Weed Control Strategies Under Various Tillage Systems

a) economic comparison of alternate tillage systems under risk

- S conventional, chisel plow, ridge till and no-till systems on clay and sand soils were studied for 200, 400 and 600 acre farm sizes
- S a ranking of the systems was done on the basis of risk
- S ridge till system was generally the dominant tillage system for all farm scenarios considered but the limited source of ridge till yield data may unfairly weight this particular system
- S no-till systems on clay loam soils were more dominant in the risk preferring range
- S risk averse individuals would prefer the mouldboard or chisel plow on clay soils
- S ridge till and no-till were the dominant systems on sandy soils

b) minimum costs of alternative tillage systems

- conventional, chisel plow, ridge till and no-till systems on clay and sand soils were studied for 200, 400 and 600 acre farm sizes
- total farm costs and machinery costs were higher for moldboard and chisel plow systems but variable costs were higher for the no-till and ridge till systems
- annual labour costs were reduced by 61% for reduced tillage and by 26% during the critical spring period, opportunity costs for the savings in labour are calculated

Comments:

This is an excellent report that provides much needed information on weed control in conservation tillage. There is a lot of information in this report that warrants a closer look by those making herbicide recommendations. The herbicide recommendations at the end of each group of experiments are very useful. The economic studies provide some interesting information on the costs of the different tillage systems. The risk analysis is a different way of looking at what systems a farmer may choose.

Associated SWEEP/LSP Research:

SWEEP Report # 10 & 11 -	An Economic Evaluation of Tillage 2000 Demonstration Plot Data
SWEEP Report # 19 -	Studies on the Control of Problem Weed Species in Conservation Tillage Systems
SWEEP Report # 19A -	Weeds of Corn, Soybean, and Winter Wheat Fields Under Conservation and No-till Management Systems In 1988 and 1989.
SWEEP Report # 48 -	The Feasibility of Band Spray Application in Conjunction with Inter-row Cultivation in No-till Corn.

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) Some of the studies could use another year or two to verify the results

Report # 33

Report Name: Development Of A Computer-Based Farm Decision Support Framework (Phase I)

Researcher: Robbert Associates, Ottawa, Ontario
Date: October, 1991
Key Words: model, economics, yield, organic matter, corn, soil loss, no-till, farm management

Summary: A computer model was developed to simulate the effect of farm management techniques. The program is intended to support the analysis of alternative farm management strategies. The Farm Management Framework consists of five components (cropping, livestock, crop and manure balance, equipment and farm finance). The model simulates farm operations for a period of fifty years from the present, with calculations made every year.

An artificial farm consisting of four 40 hectare fields was created. Each field was similar in size, soil type and organic matter content but differed in topography. Two scenarios were run: 1. continuous corn grown on all four fields using conventional tillage and 2. corn underseeded with rye grown on all four fields using no-till cultivation. The output, in the form of graphs, provides an interesting picture of what could happen in each scenario.

The report suggests that further development is needed to improve the structure of the model, to incorporate better scientific data on soil and crop characteristics, and to calibrate the model on a small number of farms.

Comments: This appears to be a good start towards developing a model which could be used to illustrate to farmers the effect of their current or proposed farm management system on farm income, soil loss, organic matter content and crop yield for a period of 50 years. At this stage it is a long way from wide spread use as an extension tool.

Associated SWEEP/LSP Research:

SWEEP Report # 38 - Management of Farm Field Variability, I. Quantification of Soil Loss In Complex Topography, II. Soil Erosion Processes On Shoulder Slope Landscape Positions.
SWEEP Report # 45 - Management of Farm Field Variability, III. Effect of Tillage Systems on Soil and Phosphorus Loss
SWEEP Report # 46 - Management of Farm Field Variability, IV. Crop Yield, Tillage System and Soil Landform Relationships
SWEEP Report #49B- Land Reshaping of Lowland Clay Soils II: Modelling Report

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(C) Further develop the model for use as an extension tool as the report outlines.

Report # 34

Report Name: Survey of Moisture Distribution Between Tile Drainage Laterals and It's Relationship to Compaction and Rooting Depth in Flat Clay Soils

Researcher: C. Mirza, M. Percy, Strata Engineering Corporation, Don Mills, Ont.

Date: December, 1990

Key Words: drainage tiles, soil compaction, moisture content, Brookston clay soil, soil cracking, yields

Summary: Three tile drained farms on flat, poorly drained Brookston clay soil in northern Essex County were studied with respect to soil moisture distribution between drainage laterals and its relationship to compaction, root growth, crop development and yields. Since this survey type study was carried out under uncontrolled conditions with a small number of farms no firm conclusions could be drawn.

Information from this study suggests that a soil moisture content of 20%± represents optimum conditions for soil compaction on Brookston clay. Field operations should be avoided at or near this moisture content.

Soil cracking was observed on all farms during the summer months promoting quick downward movement of rain water to the tile drain level. This may limit adequate wetting of the root zone and result in the loss of agricultural chemicals.

Comments: Due to a lack of controls and replications and the variability between the farms chosen (soil texture, crop history, management, etc.) no conclusions could be drawn from this study although some of the observations are of interest.

Associated SWEEP/LSP Research:

SWEEP Report # 4 - Assessment of Soil Compaction and Structural Degradation in the Lowland Clay Soils
SWEEP Report #16 - Effects of Subsoiling on Corn Yields and Soil Conditions in Southwestern Ontario
SWEEP Report #24 - Investigation of Soil and Crop Response to Fall Subsoiling in Southwestern Ontario
LSP Research - Management of Fine Textured Poorly Drained Soil for Intensive Agriculture
LSP Research - Management of Fine Textured Poorly Drained Soils for Intensive Agriculture: Characterization of a Forage Factor -Parts I and II
LSP Research - Improving The Degraded Structure Of Fine Textured Soils With Deep Tillage And Grass And Legume Crops

LSP Research - Improving The Degraded Structure Of A Clay Loam Soil With Deep Tillage & Grass & Legume Crops
LSP Research - Crop Production With A No-Traffic Tillage System
LSP Research - The Effects Of Soil Compaction On The Production Of Processing Vegetables and Field Crops - A Review

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(A) Influence of soil cracking on transmittal of water and agricultural chemicals beyond the root zone. Options such as periodic irrigation or blocking the tile drains during the summer months could be investigated.

Report # 35

Report Name: Nutrient Distribution and Stratification Resulting From Conservation Farming

Researcher: D. Cressman, Ecologistics Limited, Waterloo, Ont.

Date: December, 1990

Key Words: reduced tillage, conventional tillage, no-till, nutrient stratification, bulk density, phosphorus, potassium

Summary: The study examined the effect of various field management systems on the distribution patterns of P, K, Mg, and Ca at various soil sampling depths.

The tillage system used affected the vertical distribution of nutrients in the soil sampling layer. Severe vertical stratification was found in no-till systems and to lesser degrees in reduced tillage and conventional tillage systems in the 0 to 10 cm depths. At greater depths the amount of stratification in the no-till system decreased but increased in the reduced tillage and conventional tillage systems, due to mixing of the soil. The longer a field had been under no-till the greater the severity of nutrient stratification in the sampling layers.

The following factors were found to affect the development of vertical nutrient layers:

- soil mixing
- soil texture
- soil physical properties
- soil fertility prior to fertilizer application
- soil organic matter content

Clayey soils in the study tended to have more stratification than sandy soils. The higher infiltration rates associated with sandy soils enhanced the leaching of nutrients from the upper layers therefore decreasing the potential for vertical stratification. Clay particles fix or retain P and K, therefore there is little movement from the point of application.

Horizontal stratification of nutrients is associated mainly with banding of fertilizers under no-till systems. Generally horizontal stratification did not vary greatly with soil depth except for P which varied significantly with sampling depth.

Comments: Consistency in crops, and row widths were difficult to obtain. Extensive field histories were also difficult to obtain. Climatic conditions varied from location to location. It is difficult to make a direct and valid comparison between locations under such conditions.

No comment was made as to the possible effect of the rushed data collection or the incomplete questionnaires on the results of the survey. The agronomic effects of nutrient stratification or the effects on plant growth or yield were not discussed.

Associated SWEEP/LSP Research:

SWEEP Report #44 - Comparison of Planters and Fertilizer Applications Systems for No-till Corn

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(C) The impact of vertical stratification with respect to nutrient loss due to soil erosion needs further study. Horizontal stratification on fields with known histories and similar cropping patterns should be examined. The impact of vertical nutrient stratification on plant growth and yield needs further study. There should be further study on the effects of specific management practices under controlled conditions.

Report # 36

Report Name: Red Clover Cover Crop Studies 1987 - 1990

Researcher: J. Sadler Richards, Conservation Management Systems - A Division of Ecologistics Ltd., Lucan, Ont.

Date: January, 1992

Key Words: cover crop, red clover, erosion control, conservation cropping, residue cover, chemical kill, mechanical kill, corn, chisel plow, no-till

Summary: This three year study evaluated the effects on residue levels and corn performance of various chemical and mechanical kill methods and times of kill, of a red clover cover crop.

Treatments consisted of chemical kill, mechanical kill with moldboard plow, and mechanical kill with chisel plow in either fall or spring. The chemical kill treatments were no-till planted. Measurements taken were soil residue cover, red clover above ground dry matter, corn plant emergence, corn plant height, 50 % silking date, corn yield and associated factors.

At all sites, chemical kill plots had significantly more residue remaining (33 - 84 %) after planting than the mechanical kill plots (3 - 26 %). The level of residue on the moldboard plots was not high enough to provide sufficient erosion control. Spring chemical kill treatments resulted in more residue than fall kill. For each treatment, the amount of red clover dry matter was related to the date of kill (later kill, more dry matter). Chemical kill plots had significantly less soil loss than mechanical kill treatments.

Corn emergence was low at 14 days after planting (DAP) for chemical kill in May, while fall moldboard and fall chemical kill had higher emergence. Differences were less significant at 21 DAP, but in general fall kill treatments had more plants emerged. At most sites, moldboard treatments had taller plants at the 2 -3 and 6-7 leaf stage and also reached 50% silking sooner.

Corn yields were considerably lower on chemical kill treatments than on mechanical kill treatments. Yields also tended to be higher and grain moistures lower for earlier killed treatments.

The study's authors believe that there may be some allelopathic effects of the previous year's cereal stubble or the red clover residue on the corn. Insects and slugs were also more of a problem in the no-till treatments. These factors may have contributed to the lower yields in the chemical kill treatments.

A red clover cover crop killed in the fall by chemical means or by chisel plowing is effective in reducing soil erosion and only reduces corn grain yields by a small amount, if at all.

Comments: The study was done on seven different sites, with up to four different planters, up to four different corn hybrids, four different previous crops and there was no check without red clover for the chemical kill treatments. These variables could have had a significant effect on the results of the study. The yield data shows an 11% reduction was experienced after winter wheat (chemical kill) but after oats, barley or red clover hay the chemical kill yields ranged from a 1% reduction to a 9% advantage. The straw was removed from the spring cereal crops and left on the winter wheat fields. There is a stronger case for the authors conclusions applied to winter cereals than spring cereals. The hand harvest yields were done using the 10 average cob method which is not as accurate as shelling all the cobs. There may not be a need for a cover crop, if corn is no-tilled into wheat stubble, as the ground is well protected to begin with. Why complicate matters by planting red clover?

Associated SWEEP/LSP Research:

SWEEP Report # 12 -	Choice and Management of Cover Crop Species and Varieties for Use in Row Crop Dominant Rotations
SWEEP Report # 27 -	Cereal Cover Crop Study
SWEEP Report # 29 -	The Effect of Organic Mulches on Soil Moisture and Crop Growth
SWEEP Report # 32 -	Optimal Herbicide Use in Conservation Tillage Systems
SWEEP Report # 43 -	The Use of Cover Crops for Nutrient Conservation
SWEEP Report # 52 -	Field Scale Tests of Cover Crops I and II
SWEEP Report #57A-	Field Testing of Cover Crop Systems for Corn and Soybean Production
LSP Research -	Crop Rotations & Cover Crop Effects On Erosion Control, Tomato Yields & Soil Properties In Southwestern Ontario
LSP Research -	A Cover Cropping Strategy For First Early Potato Production

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) The authors recommend further research, including monitoring the amount of nitrate nitrogen being contributed to the corn crop from the red clover and initiating field scale studies on the fall kill treatments.

Report # 37

Report Name: Effects of Tillage on the Quality and Quantity of Surface and Subsurface Drainage Water : Uplands

Researcher: Dr R.G. Kachanoski, University of Guelph

Date: January, 1992

Key Words: water quality, tillage, surface drainage, subsurface drainage, surface runoff, tile drainage, no-till, moldboard plow, nitrate nitrogen, phosphorus, macropore transport, leaching

Summary: The study was conducted to determine the effects of tillage systems on the quantity and quality of surface runoff and tile drainage water. The plots were located in Huron County on a long term no-till - moldboard plough comparison. Tile lines in each of the tillage systems were monitored for flow quantity, and the concentration of nitrate nitrogen and phosphorus. Multi-level groundwater samplers were installed to track the movement of soluble chemicals. Surface runoff was monitored through the use of runoff collection flumes and rainfall simulation studies were undertaken to characterize the hydraulic soil properties.

The results of the 2 year study showed that tile flow was no different between the 2 tillage systems. No-till had significantly higher average concentrations of nitrate nitrogen in the early spring and fall compared to the moldboard but the reverse was true in the late fall (both systems had concentrations that exceeded drinking water standards). More N leaching occurred in the no-till than moldboard plough treatment. The increased N leaching in the no-till was attributed to a higher N soil test in the no-till system and a requirement for less N fertilizer than the moldboard system (both systems received the same amount of fertilizer). The amount of N lost by leaching was correlated to the difference between the fertilizer N applied and the fertilizer amount required according to the N soil test.

More macropore transport was evident in the moldboard system than the no-till. However the average solute transport velocity was faster in the no-till (may be due to the increased occurrence of blocked pores).

Surface runoff was negligible for both treatments (sand-loam soil). Out of 121 cm of rainfall that fell between Oct. /89 and Oct. /90, 19 cm left the site as tile flow and an estimated 49 cm moved below the tile lines (in both tillage systems). Rainfall simulation trials indicated that increased water runoff would be expected in the no-till system for very large rainfall events. However, total phosphorus loss would be 2-4 times lower than the moldboard system. Runoff simulation on a clay-loam part of the plot indicated ortho-phosphorus in the runoff was higher in the no-till compared to the moldboard. With an increased runoff volume from the no-till, this may be a problem in heavier textured soils.

Comments: An excellent study that contains a lot of good information about water quality and tillage systems for a sandy-loam soil. The higher runoff in the no-till treatment found in this study contrasts with other American studies, particularly at Coshocton, and with the results of SWEEP Report #30 (P. Neave).

Associated SWEEP/LSP Research:

SWEEP Report # 17 - Effect of Ammonia on Soil Properties and Relevance to Soil and Water Quality
SWEEP Report # 18 - Effects of Management on Soil Hydraulic Properties
SWEEP Report # 23 - Processes Involved in Mobilization of Phosphorus in Different Farming Systems in Southwestern Ontario: Nutrient Levels in Plant Tissues and Soils
SWEEP Report # 30 - The Response of Soil Microflora and Fauna to Spring Plowing of Zero-till and Pasture Soils
SWEEP Report #37A- Appendix I-X of SWEEP Report 37
SWEEP Report # 51 - Loss of Nitrogen by Microbial Denitrification, Nitrification, Surface and Tile Runoff: In Relation to Tillage Methods
SWEEP Report # 60 - The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters
SWEEP Report # 45 - Management of Farm Field Variability, III. Effect of Tillage Systems on Soil and Phosphorus Loss

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) More work needs to be done on a variety of soils in order to understand the infiltration/runoff behaviour under different tillage systems.

Report # 38

Report Name: Management of Farm Field Variability:
I. Quantification of Soil Loss in Complex Topography
II. Soil Erosion Processes on Shoulder Slope Landscape Positions

Researcher: Dr. R.G. Kachanoski, Dr. M.H. Miller, Dr. R.D. Protz and D.A. Lobb, Land Resource Science, University of Guelph and Dr. E.G. Gregorich, Agriculture Canada, Ottawa

Date: January, 1992

Key Words: soil erosion, soil loss, topography, shoulder slope, slope position, soil management, Cesium 137

Summary: The intent of the study was to examine the relationships between soil loss, landscape configuration and slope position on Ontario croplands. Of question to the investigators was the tenet that most soil loss on complex landscapes in Ontario was caused by soil erosion by water and that the process was directly linked to surface water contamination.

The study was divided into two parts : I. to quantify in situ losses of soil from complex landscapes and II. to examine the process of soil loss from these areas.

In the first study, Cesium 137 was used as a radioactive isotope tracer to correlate with soil loss following calibration procedures. The field site was first sampled on a grid pattern in 1971 for detailed soil and landscape features. The soil material was stored and subsequently analyzed for Cesium 137 in 1986. The procedure was repeated in 1986. Changes in the surface content of Cesium 137 were compared to the 1971 data. On the silty soils found in the field site, marked drops in Cs 137 content on crest and shoulder slope positions were observed. Considerable increases were observed in lower slope positions and depressional areas. Using calibration procedures and mathematical models the rate of soil loss and gain was estimated. The rates were up to 100 t/ha/yr from convex slope positions. This far exceeds predictions from other models such as the Universal Soil Loss Equation (USLE).

The process of soil erosion on complex topographies with erodible materials was examined in the second study. First, the processes of soil erosion were explained and evaluated for the likelihood of explaining the relationships observed in the first experiment. From the literature, this study and previous work in Ontario, tillage erosion was identified as having a potential causal relationship with extremely high erosion rates on complex topography. The planing and displacement effects of tillage implements were examined. Cs 137 was sampled before and after a variety of tillage passes on metre-wide strips along the contours of slope positions. Up and downslope operations were examined. If,on average, an operator plows up and down slope the same number of times over any landscape position , the net loss could be up to the equivalent of 67 t/ha/yr. on shoulder slope positions.

The investigators concluded that wind and water erosion processes could not explain soil losses of these extremes (USLE predictions would be 10 to 30 t/ha/yr.) The investigators concluded that excessive tillage is directly related to the loss of soil and its productive capacity.

Comments: A combination of research vision, understanding of geomorphological processes and mathematical modelling make this study among the most comprehensive and controversial studies conducted with the TAP sub-program of SWEEP. This information could be particularly useful for the research community as a hypotheses-generating document for further work. It could also shed light on program planning and extension work in tillage and cropping systems on upland soil-landscape conditions in Ontario. For programming, perhaps water quality and soil erosion are not necessarily linked - soil quality and productivity are also valid rationales for financial and technical assistance.

For extension work, excessive tillage is directly and not just indirectly related to soil productivity and financial losses. Conservation tillage and no-till may be appropriate technologies for yet another reason.

However, it should be clear that this is a well done case study. It is difficult to extrapolate to all upland or complex topographies without a more comprehensive process study.

Associated SWEEP/LSP Research:

SWEEP Report # 45 - Management of Farm Field Variability, III. Effect of Tillage Systems on Soil and Phosphorous Loss

SWEEP Report # 46 - Management of Farm Field Variability, IV. Crop Yield, Tillage System and Soil Landform Relationships

SWEEP Report #49A- Land Reshaping of Lowland Clay Soils, I: Field Study

SWEEP Report # 55 - Soil Loss by Tillage Erosion: The Effects of Tillage Implement, Slope Gradient, and Tillage Direction on Soil Translocation By Tillage

SWEEP Report # 60 - The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters, A. - Soil Erosion, Phosphorus Loss and Corn Yield, B. - Herbicide Losses

SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) An integrated research program is needed to examine erosion and other degradation processes and the impact of current and remedial practices on soil quality on Ontario cropland. From this, knowledge could be gained about the relative impact of tillage, water and wind erosion on a variety of representative soil and landscape conditions .

(A) Further, the impact of tillage and cropping practices could be examined. And finally, changes to farming systems as well as rehabilitative work could be tested to determine the effectiveness of conservation measures. This study could complete the much needed work left undone by the successful T-2000 program.

Report # 39

Report Name: Report on "Tye-Drill" Modifications for Sowing Soybeans on Commercial Farms Under No-till Conditions

Researcher: J. Rigby et al., Southwestern Ontario Agricultural Research Corporation (SWOARC), Harrow, Ont.

Date: January, 1992

Key Words: no-till, Tye drill modifications, coulters, press wheels, no-till planter, soybeans, no-till drill, yield

Summary: In 1988 a two year study was conducted to determine if more aggressive and better matched coulter/press wheel combinations would improve the performance of the Tye drill for narrow row planting of soybeans in a no-till system. Side by side comparisons of crop performance were made for fields planted with the Tye drill and the farmer's planter. Five farmer cooperators from Kent county participated in the study. Year 2 of the study had an additional objective to determine if single or double V presswheels, in combination with a rake, could effectively level the seedbed and/or part the corn residue to improve coverage of the drill row.

The results of the first year were inconclusive due in part to the drought. In 1989 no significant differences showed in the results and no conclusions can be drawn. The report has shown the significance of seed placement and the need for minor adjustments to the coulters. Better seed placement and coverage could be achieved by a combination of improved balance between the front and rear of the Tye drill and/or more pressure up front, achieved by either spring action or weight. The farmers felt the no-till drill did not perform to their expectations.

Comments: Although no conclusions can be drawn from this study some good management tips were given for set-up of the Tye drill. The report suggested that the study be repeated on a commercial field scale using a standard bean combine and weigh wagon to better emulate farm practices.

Associated SWEEP/LSP Research:

SWEEP Report # 20 - Conservation Tillage Equipment: Availability, Utilization and Needs
SWEEP Report #N/A- Conservation Tillage Handbook - Equipment Modifications and Practical Tips for Use

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(C) As suggested in the report the study could be conducted at a field scale level using traditional harvesting equipment to parallel true farming practices.

(C) Research could be conducted comparing various drills and planter set-ups for the no-till system under various cropping and soil conditions.

Report # 40

Report Name: Management of Mulch Tillage Systems on Clay Soils

Researcher: G.A. Stewart and Dr. T.J. Vyn, Crop Science Department, University of Guelph, Guelph, Ontario

Date: March, 1992

Key Words: clay loam, silt loam, mulch tillage, corn, soybeans, yield, crop rotation, soil properties, residue cover, chisel plow, moldboard plow, offset disc, yield

Summary: The aim of this study was to provide specific recommendations in regards to: 1) the effect of soil moisture content at the time of fall primary mulch tillage, 2) the timing of spring secondary tillage within a mulch system and 3) the interaction of the two previously mentioned factors with various tillage implements and depths of operation.

The study was conducted on silt loam and clay loam soils. The fall tillage treatments included no tillage, moldboard plow, offset disc, chisel plow (equipped with sweeps or twisted shovels). All tillage treatments were done under wet and dry conditions (relatively speaking). The twisted shovels were operated at 12 and 15 cm. depths and with or without a levelling harrow. Spring secondary tillage was done with a cultivator.

The tillage implements performed equally well in the wetter conditions. Harrowing or levelling operations in the fall following chisel plowing and performing secondary tillage earlier in the spring may reduce soil drying rates. However, this may only make a difference to the seedbed conditions during an early dry spring.

The mulch tillage systems tested performed better when corn was planted into soybean rather than corn residue. However, the amount of residue left after mulch tilling soybean residue was not sufficient to provide adequate erosion protection. The authors recommend that no fall tillage operations be performed following soybeans and to limit tillage in the spring to a minimum.

Following corn, most mulch tillage operations provided adequate soil residue cover but, produced coarser seedbeds than did moldboard plowing. Generally this did not result in lower corn yields on the silt loam soil, but on the clay loam soil, mulch systems tended to result in corn yields lower than those obtained when moldboard tillage was used.

Comments: This study set out to answer many of the questions farmers have been asking about mulch tillage. The information gathered after one season seems to suggest that mulch tillage on a clay loam soil may produce lower corn yields. The same system on silt loam soils may not reduce corn yields. Unfortunately this study was only conducted for one growing season making it impossible to draw definite conclusions. Three years of information would have provided more answers to the questions. It does provide some support for the idea that soybean residue requires little tillage to prepare a seedbed. The results bring forth the questions: Is it wise to break the soil to increase the rate of drying and/or to save soil moisture? Does a smooth soil surface dry more uniformly than a rough surface?

Associated SWEEP/LSP Research:

LSP Research -	Management of Fine Textured Poorly Drained Soils for Intensive Agriculture
LSP Research -	Management of Fine Textured Poorly Drained Soils for Intensive Agriculture: Characterization of a Forage Factor - Parts I and II
LSP Research -	Improving the Degraded Structure of Fine Textured Soils with Deep Tillage and Grass and Legume Crops
LSP Research -	Improving the Degraded Structure of a Clay Loam Soil with Deep Tillage and Grass and Legume Crops
LSP Research -	Crop Production With a No-Traffic Tillage System
LSP Research -	The Effect of Soil Compaction in the Production of Processing Vegetable and Field Crops - A Review

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) Further research is needed in this area in order to overcome some of the reluctance to switching from fall plowing.

Report # 41

Report Name: Evaluation of Row Crop Planter Modifications for Corn Production within Conservation Tillage Systems

Researcher: G.A. Stewart, Dr. T.J. Vyn, Crop Science Department, University of Guelph, Guelph, Ontario

Date: March, 1992

Key Words: no-till, corn, residue cover, silt loam, loam, planter, coulters, soil moisture, bulk density, residue clearing devices, moldboard plow, yield, crop growth

Summary: The objective of this study was to evaluate row crop planter modifications in terms of their effect on seedbed conditions and corn growth and yield in order to assist producers in selecting planter attachments for conservation tillage systems.

The study was conducted over two growing seasons on silt loam and loam soils. The previous crops on the sites were grain corn and winter wheat which had been underseeded to red clover. The treatments included moldboard plow, hand planted, slot, disc furrowers (one or two sets per row), wire brushes, spoked wheels, 2 fluted coulters (1" or 2"), 3 fluted coulters, coulters + V sweep, coulters + wire brushes, coulters + spoked wheels and coulters + disc furrowers.

Winter wheat + red clover residue was removed from the row more effectively with row clearing devices (ie. disc furrowers, spoked wheels, etc.) than with coulters alone. Following grain corn, however, fluted coulters alone were efficient in removing residue from the row area.

In the seedbed (depth: 2.5 - 7.5 cm) fluted coulters resulted in penetrometer resistances, macroporosities and bulk densities that were generally not different from those obtained by moldboard tillage. The use of residue clearing devices alone resulted in greater penetrometer resistances and bulk densities than fluted coulter measurements. Although not significant the use of residue clearing devices did tend to result in more uniform seed placement in winter wheat + red clover residue.

Corn yields were only significantly different in one of the six site/years. The difference there showed a yield advantage where fluted coulters were used in wheat + red clover residue. In general none of the treatments used resulted in yield differences. This may have been due to the generally above average growing conditions. Results therefore should be interpreted with some caution.

Comments: The study was well done but required more time for a thorough investigation of the different modifications. Specific recommendations could not be made about the different methods examined as they all resulted in similar yields. These results are contrary to earlier work done by this researcher where slot planting did not perform well.

Associated SWEEP/LSP Research:

SWEEP Report # 21 - Efficiency of Residue Management for Providing Optimal Corn Growing Conditions in Non-Tilled Sandy Loam Soil

SWEEP Report # 39 - Report On "Tye-Drill" Modifications For Sowing Soybeans on Commercial Farms Under No-till Conditions

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) This study should be continued on a wider variety of soil types over several years.

Report # 42

Report Name: Report on Development and Operation of the Cross-Slot Planter

Researcher: J. Rigby, Rondeau Agricultural Conservation Corporation, Blenheim, Ontario

Date: March, 1992

Key Words: planter, no-till, cross-slot, seed placement

Summary: The study evaluated the cross-slot unit, a new type of seed opener which was developed in New Zealand in 1969. The report details how the unit was attached to an air planter to seed corn and soybeans. The planter was used in the field one year and early results were promising.

The benefits of this opener include:

1. - suitable placement of the seed in no-till conditions without the use of additional coulters or trash whippers
2. - elimination of hair pinning of residue in the seed slot
3. - crusting around the seed is eliminated
4. - smearing of moist soil is reduced
5. - less disturbance of the seed zone

Comments: The colour plates and diagrams help the reader visualize what is being discussed. This opener could be a major breakthrough for conservation tillage if and when it becomes commercially available. The development work was well done. It would have been nice to have had more field data on the performance of the planter.

Associated SWEEP/LSP Research:

SWEEP Report # 44 - Comparison of Planters and Fertilizer Applications Systems for No-till Corn

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) Further testing of the cross-slot opener should be done to fine tune it for field conditions.

Report # 43

Report Name: The Use of Cover Crops for Nutrient Conservation

Researcher: Dr. M. H. Miller, Dr. E. G. Beauchamp, Department of Land Resource Science, Dr. T. J. Vyn, G. A. Stewart, Crop Science Department, J. D. Lauzon, Department of Land Resource Science, Dr. R. Rudra, Engineering Department, University of Guelph.

Date: March, 1992

Key Words: cover crops, red clover, oilseed radish, ryegrass, corn, winter wheat, barley, nitrogen, phosphorous, nitrate leaching, crop response.

Summary: This study was conducted on a sandy loam soil at Ayr and a loam soil at Woodstock to assess the effectiveness of cover crops in preventing nutrient loss and providing nutrients to subsequent crops. Red clover, oilseed radish and annual ryegrass were established in or following crops of winter wheat and barley. The researchers were largely unable to establish cover crops in corn. Each of the main crops received 1/2, 1 and 2x the recommended amount of nitrogen fertilizer.

Biomass production and nutrient content of the cover crops were measured in September and November. There was no response in cover crop biomass or nitrogen content to the nitrogen rate on the main crop, except for oilseed radish following wheat at Ayr. Red clover produced the greatest amount of biomass and had the highest N content, while ryegrass had the least. Oilseed radish had considerably greater P concentration and biomass P content than either ryegrass or red clover.

All of the cover crops reduced the amount of mineral N (NO_3 + NH_4) in the top 45 cm of soil compared to the check (no cover crop) in September. In plots where significant leaching occurred, nitrate N concentrations in soil water at 75 cm depth were reduced below 10 mg/l under ryegrass and oilseed radish, but were between 30 - 50 mg/l under red clover or no cover crop.

Soil nitrate contents in April and May were higher under oilseed radish than under the other cover crops or the control. This suggests that N is being mineralized from this crop earlier than from ryegrass or red clover. By June, the red clover treatment had the highest soil nitrate levels, while oilseed radish was only slightly above the check and ryegrass was below the check.

Corn was grown on these plots with no additional nitrogen fertilizer, to assess the nitrogen availability from the cover crops. Corn nitrogen content, and final yield, were highest on the red clover plots and least following ryegrass. This suggests that the oilseed radish releases nitrogen earlier than it is able to be used by a corn crop, while ryegrass immobilizes nitrogen so less is available than when no cover crop is grown.

A laboratory study was also conducted to compare the ease with which nutrients were leached from cover crop top growth. A greater proportion of N and P were leached from oilseed radish than from

ryegrass or red clover, suggesting a greater potential for contamination of surface waters with this cover crop.

Comments: The results of this study must be used cautiously because they are based on only one year of data. None of the cover crops studied is ideal from the standpoint of "nutrient relay" to a subsequent crop of corn, because they either do not take up enough nitrate in the fall, or they do not release enough (or enough at the right time) for the subsequent crop. It would be interesting to see how the winter and spring cereals would compare as a cover crop.

Associated SWEEP/LSP Research:

SWEEP Report # 12 - Choice and Management of Cover Crop Species & Varieties for Use in Row Crop Dominant Rotations
SWEEP Report # 27 - Cereal Cover Crop Study
SWEEP Report # 36 - Red Clover Cover Crop Studies 1987 - 1990
SWEEP Report # 52 - Field Scale Tests of Cover Crops I and II
SWEEP Report #57A- Field Testing of Cover Crop Systems for Corn and Soybean Production
SWEEP Report #57B- Effect of Winter Rye Mulches and Fertilizer Amendments on Nutrient and Weed Dynamics in No-till Soybeans

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) As a minimum, this data must be confirmed by a second years results. Much more information is required on the uptake and release of nutrients from different cover crops, and the influence of other factors on this process such as weather and soil type.

Report # 44

Report Name: Comparison of Planters and Fertilizer Application Systems for No-Till Corn

Researcher: Dr. M.H. Miller, Department of Land Resource Science, University of Guelph

Date: March, 1992

Key Words: no-till, fertilizer placement, cross-slot planters, coulter-strip, three-strip band, strip band, phosphorus, corn, yield.

Summary: This project was a response to difficulties being encountered with conventional fertilizer placement systems on no-till planters. Three planting/fertilizer placement systems were evaluated:

1. A cross-slot planting system developed in New Zealand which results in less soil disturbance than other no-till planters and places fertilizer closer to the seed row than a conventional side-band (5 cm to side and 5 cm below)

2. A strip-band fertilizer application system developed at Guelph which places fertilizer in two strips, one on either side of the row and about 2 cm below.

3. A coulter-strip fertilizer application in which the fertilizer is deposited on the soil surface in front of a fluted coulter.

The specific objectives of the study were:

a) To compare the effectiveness of planting and fertilizer application using the cross-slot, three strip-band and coulter-strip application systems.

b) To compare the cross-slot planter with a conventional planter under varying soil conditions.

Results:

It is concluded that the strip-band is marginally superior to the side-band but the difference is not sufficient to justify the planter modifications required. Yield increases of a similar magnitude can be obtained by applying a small amount of fertilizer with the seed.

The coulter-strip fertilizer application system did not result in significant differences in early shoot growth or nutrient concentration, compared to the side-band using the same planter for both placements. Similarly, there was no difference in grain yield. The location and distribution of P determined in 1990 did indicate that the fertilizer was mixed only with the upper 2-3 cm of soil.

The cross-slot planter resulted in yields comparable to the strip-band fertilizer application system developed at Guelph. Set up of the cross-slot planter could have been improved. Increasing the weight on the planting units may be necessary to achieve proper penetration under some conditions.

Comments:

The title of this report is misleading. The report result focuses on the fertilizer placement in a no-till system. Data collected on P values indicates that current soil test recommendations are adequate. Fertilizer placed in a multistrip-band is marginally superior to the single side-band, however, the difference is not sufficient to justify the modifications required.

Associated SWEEP/LSP Research:

SWEEP Report # 25 - The Development and Testing of a Dry Fertilizer Placement Machine
SWEEP Report # 35 - Nutrient Distribution and Stratification Resulting From Conservation Farming
SWEEP Report # 42 - Report on Development and Operation of the Cross-Slot Planter

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) The potential of the cross-slot system requires further refinement, in fine-tuning both the fertilizer and seed placement.

Report # 45

Report Name: Management of Farm Field Variability III. Effect of Tillage Systems on Soil and Phosphorous Loss

Researcher: Dr. R.G. Kachanoski and Dr. M.H. Miller, Department of Land Resource Science, Centre for Soil and Water Conservation, University of Guelph, Guelph, Ontario

J.D. Aspinall, Resources Management Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario.

A.P. von Bertoldi, Department of Land Resource Science, University of Guelph, Guelph, Ontario.

Date: January, 1992

Key Words: soil erosion, ^{137} Cesium, tillage erosion, moldboard plow, minimum tillage, no-till, shoulder slope, crest slope, Tillage 2000

Summary: The objective of the study was to determine the rates of soil erosion and phosphorus delivery on various soil landscapes, under different tillage systems. The benchmark locations were selected from the Tillage 2000 locations with a total of 400 different benchmarks being selected.

At each benchmark the amount of ^{137}Cs was measured in the fall of 1987 and again in 1990. Cesium was used because it is bound to the soil and will not move unless the soil it is bound to moves as well. Tillage translocation of soil was found to be a dominant process for soil movement on complex site positions of upland soils in Ontario. The researchers conclude that the estimated soil and phosphorous loss estimates given in the report could have significant error.

Generally, the soils under the moldboard system had the highest cesium loss over the three year period. Minimum till systems were next with no-till systems having negligible cesium loss. The level of cesium loss was assumed to be directly related to the amount of soil and phosphorous lost. Also of note was that soil movement tended to be down slope but not off farm and therefore was not a factor in phosphorus loading to surface water.

Comments: The study verifies the position that erosion increases with degree and intensity of tillage action. It also substantiates the position that tillage translocation increases when annual tillage action runs perpendicular to major slopes. Of significant interest to policy makers and programmers is that within field soil redistribution, as caused by tillage translocation, is not linked with phosphorous delivery to surface water.

Associated SWEEP/LSP Research:

SWEEP Report # 38 - Management of Farm Field Variability, I. Quantification of Soil Loss In Complex Topography, II. Soil Erosion Processes on Shoulder Slope Landscape Positions

SWEEP Report # 46 - Management of Farm Field Variability: IV. Crop Yield, Tillage System and Soil Landform Relationships

SWEEP Report #49A- Land Reshaping of Lowland Clay Soils, I: Field Study

SWEEP Report # 55 - Soil Loss by Tillage Erosion: The Effects of Tillage Implement, Slope Gradient, and Tillage Direction on Soil Translocation By Tillage

SWEEP Report # 60 - The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters, A. - Soil Erosion, Phosphorus Loss and Corn Yield, B. - Herbicide Losses

SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) More work is needed to determine if the three dimensional mass balance of cesium gives a more accurate estimate of soil and phosphorous movement within field boundaries than the two dimensional. There is a need to determine what processes cause phosphorous loading to surface water, if the majority of the soil that does move remains in the field.

(A) A long-term, comprehensive research and monitoring program is needed to examine the process, practice and the remedial action of conservation management systems on a representative range of soil and landscape conditions across Ontario.

Report # 46

Report Name: Management of Farm Field Variability, IV. Crop Yield, Tillage System, and Soil Landform Relationships

Researcher: Dr. Kachanoski and Dr. Miller, Department of Land Resource Science, Centre for Soil and Water Conservation, University of Guelph, Guelph, Ontario

J.D. Aspinall, Resources Management Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario.

A.P. von Bertoldi, Department of Land Resource Science, University of Guelph, Guelph, Ontario.

Date: May, 1992

Key Words: conventional tillage, conservation tillage, moldboard plow, minimum tillage, no-till, corn, soybeans, small grains, yield, soil texture, landscape position, Tillage 2000

Summary: The study was carried out in conjunction with Tillage 2000. The objective was to: determine crop yield response to different tillage systems and different landscape positions, and relate variations in crop yield response to soil and landscape properties. In total there were 40 farm sites, on a field scale, 3 or 4 landscape units at each site. A basic soil survey was done at every site. Corn, soybeans, and small grains were studied. The tillage systems were classed into conventional and conservation. The tillage classes were further broken down into moldboard, minimum, and no-till.

The study compared the various tillage types in relation to yield response. Moldboard plow showed a slight yield advantage when compared to minimum tillage. No significant yield difference was evident between the moldboard system and no-till. The no-till system showed a slight yield advantage over the minimum till system. The study indicated that over all and in the paired comparisons the conservation systems did relatively better in the year of drought stress than did the conventional system. This suggests a buffering action of conservation tillage systems during times of water stress.

There was little difference overall in tillage systems on crop yield across all farm sites. The reason given was the interaction of tillage and texture. There was significant interaction of soil texture class and soil loss on relative crop yield losses.

Comments: The effectiveness of tillage systems on soil conditions over time can be verified by yield comparisons. Of note, is that a no-till system, when done properly, can produce yields above conventional systems on certain soil types.

Associated SWEEP/LSP Research:

SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from Adoption of Conservation Tillage Practices in Crop Production in Southwestern Ontario
SWEEP Report # 20 - Conservation Tillage Equipment: Availability, Utilization and Needs
SWEEP Report # 29 - The Effect Of Organic Mulches On Soil Moisture and Crop Growth
SWEEP Report # 38 - Management of Farm Field Variability, I. Quantification of Soil Loss in Complex Topography, II. Soil Erosion Processes on Shoulder Slope Landscape Positions
SWEEP Report # 45 - Management of Farm Field Variability, III. Effect of Tillage Systems on Soil and Phosphorous Loss
SWEEP Report # 56 - Yield Reduction Effects of Crop Residues in Conservation Tillage
SWEEP Report # 60 - The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters, A. - Soil Erosion, Phosphorus, and Corn Yield, B. - Herbicide Losses
SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

See SWEEP Reports # 38 & # 45

Report # 47

Report Name: Effect of Woodlot Borders and Crop Residue on the Distribution of Invertebrates in Agroecosystems

Researcher: P. Neave (with Dr. V. Thomas) Department of Zoology, University of Guelph

Date: May, 1992

Key Words: soil life, insects, cryptozoic fauna, arthropods, earthworms, crop residue, invertebrates, richness, abundance, occurrence, evenness, woodlot

Summary: The objectives of this report were to examine the effect of distance from a woodlot and crop residue cover on invertebrate abundance and diversity in agricultural fields. There were 2 crop residue (over winter) treatments at each of 2 sites: (1) Mount Forest - silage corn (no residue) and barley with the straw left (residue cover) and (2) Fergus - chisel plowed soybean stubble (no residue) and unplowed soybean residue (residue). Three groups of invertebrates were sampled in 4-5 transects/residue treatment at intervals up to 50 m into the field from the woodlots. The three groups were the cryptozoic invertebrates (live on the soil surface such as spiders, sow bugs, millipedes and slugs), foliage arthropods (found on crop and weed plants such as syrphid flies and ladybird beetles) and earthworms. The roles played by these organisms in agroecosystems include residue decomposition, pest control and nutrient cycling. Invertebrates were sampled using pitfall traps for cryptozoic invertebrates, plastic bags and intercept traps for foliage invertebrates and formalin/hand sorting for earthworms.

Richness (number of taxa in a sample), occurrence (number of taxa found in all samples), abundance (total number of individuals found) and evenness (equatability of distribution of abundance among the taxa) were used to determine the influence of the treatments on the invertebrate populations. The abundance and richness of cryptozoic invertebrates declined significantly with increasing distance into the fields. The decline in abundance was dependent on date with the greatest decline occurring with increasing distance into the fields in late fall. Crop residue on the field over winter significantly increased cryptozoic abundance and richness at all distances from the woodlot in some fields, suggesting the crop residue promoted invertebrate persistence in these fields.

The numbers and richness of Carabidae (carabid beetles) increased significantly with increasing distance into the fields in late July and August, particularly in the corn cropping systems. The crop residue appeared to have little effect on carabid distribution.

Evenness of the cryptozoic community increased significantly with increasing distance into the fields. Species dominance, therefore appears to be greater in the woodlot than in the field. Crop residue cover on some fields significantly decreased evenness at all distances from the woodlot.

Earthworm number and mass increased significantly with increasing distance into the fields, possibly because of increased competition from other macro-decomposers which were more abundant near the woodlot.

This study appears to suggest that large fields may have taxa poor centres, with several dominant taxa being present in relatively large numbers for part of the year. This is not the ideal situation, as it probably interferes with the natural predator control of pests and with decomposition and nutrient cycling.

Comments: Interpretation of some of the data was speculative. The results would be more meaningful if there had been more replications of each treatment, particularly since there were different crop residues at each site and different tillage conditions in the no residue treatments as well as different past histories for the sites.

Associated SWEEP/LSP Research:

SWEEP Report # 30 - The Response of Soil Microflora and Fauna to Spring Plowing of Zero-till and Pasture Soils

LSP Research - Response of the Soil MicroFlora and Fauna to Spring Plowing of Zero-till and Pasture Soils

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) There is a lack of information available on soil fauna in agroecosystems. We need to develop sampling protocols and to develop a database of information on soil life as indicators of soil quality.

Report # 48

Report Name: The Feasibility of Band Spray Application in Conjunction with Inter-Row Cultivation in No-till Corn

Researcher: J. Rigby, Blenheim, J.E. Shaw, Ridgetown College of Agricultural Technology, Ridgetown, Southwestern Ontario Agricultural Research Corporation (SWOARC), Harrow, Ontario

Date: May, 1992

Key Words: no-till, weed control, corn, band-spray, inter-row cultivation

Summary: This study evaluated the efficacy of using band-spraying and inter-row cultivation for weed control in no-till corn. Preemergent and postemergent herbicides were evaluated for their suitability within this integrated weed management system.

The results indicate that shallow inter-row cultivation and the low recommended rate of herbicide (banded or broadcast overall) produced weed control and yields equivalent to the higher recommended rate of herbicide. Most preemergent and postemergent herbicide treatments performed very well.

Under a large scale field trial of inter-row cultivation, yield was virtually unaffected, a high level of weed control was maintained, soil disturbance was minimal, crop residue remained on the surface, the shallow layer of disturbed soil did not erode, and the technology was easily adapted. Applying this technology to the general farming operation reduced herbicide usage by 60% and weed management costs by 40%.

Observations made by the researcher included:

1) the burndown should not be applied too early, let the first flush of weeds be killed by the burndown
2) care must be taken when banding post-emergent herbicides with the cultivator as dust can affect their performance
3) good weed control was achieved in the experiments because the plots were weed free before the herbicide treatments were applied (due to the burndown)
4) cultivation did a better job of controlling the larger weeds, therefore it may be better to delay cultivation until the weeds are larger.

Comments: The study showed that this system performed well and has the following advantages:

1) Reduced rates of herbicides
2) Reduced weed control costs
3) All the erosion control benefits of no-till

The comments made by the farmer indicate that there are a few drawbacks to the system, they include:

1) Dependence upon weather for timely cultivation
2) The combine may tend to slide out of the undisturbed areas on side hills if conditions are damp

The system certainly has its benefits but it is unknown what effects cultivation has on the soil macro pores and on drainage.

Associated SWEEP/LSP Research:

SWEEP Report # 19 - Studies on the Control of Problem Weed Species in Conservation Tillage Systems SWEEP Report #19A- Weeds of Corn, Soybean and Winter Wheat Fields Under Conventional, Conservation and No-Till Management Systems In 1988 and 1989
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems
SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 49A

Report Name: Land Reshaping Of Lowland Clay Soils I: Field Study

Researcher: L. Leskiw, A. Laycock, Can-Ag Enterprises, Guelph, Ontario

Date: May, 1992

Key Words: surface drainage, sediment transport, phosphorus, clay soils, land planing, monitoring, soil quality, hydrology

Summary: Ponding on flat clay soils is a significant management problem. Land planing using laser assistance to conduct cut and fill operations facilitates surface water drainage and operability of low-relief clay soils. Land planing is popular in Kent and Essex counties. This is a high risk area for surface water contamination by phosphorus and sediment. For this reason, research regarding the effect of planing on soil quality, water quality and farm/ crop management was initiated in the SWEEP area.

The goals for the study were to: develop a method for estimating phosphorus movement on fields with different management; to locate and monitor sites for three years (1989-91) in the study area; and, to compare the resource quality and profitability of planing to conventional practices subject to several management systems. Fields for study and monitoring stations were established on four farms. Each farm was surveyed in detail to determine micro-watershed boundaries and pre-treatment soil and water quality conditions. Monitoring stations were established in natural run-off areas to measure sediment and nutrient run-off during storm events. Climate and farm management data collection was assisted by farmers.

The results suggest that there were no net negative impacts upon soil quality. Surface run-off volumes were greater from the planed fields but not significantly. Management practices between the two areas did not have significant influence on run-off volumes and content. There were observable differences, however, between those fields with existing depressions and those found adjacent to watercourses. If fields had several depression areas and were adjacent to the stream, the redirection of surface flow caused by planing resulted in more run-off during some storm events. High concentrations of phosphorus were found in samples taken from tile outlets, particularly after manure applications. Economic analyses suggests that planing makes the timing of operations more convenient but not necessarily more profitable. Several recommendations are made. The most notable recommendation of which to farmers include considering other surface drainage options such as tiled drop inlets and the need for precision in the operation and timing of land planing practices.

Comments:

This was a well designed and executed study on a rather controversial subject.

However, there are several concerns :

1) Not much can be concluded from the study.
2) The lack of winter data due to the water sampling technology may raise further questions about the conclusions of the project stating "no noticeable differences".
3) The long-term effect of planing on soil quality cannot be addressed by a three-year study. Topsoil made shallow by planing operations will mix with subsoil in conventional tillage systems. This will accelerate the degradation of the soil and may increase run-off rates.

In short, from the results of this survey it is not possible to judge the environmental impact of land reshaping of clay soils.

Associated SWEEP/LSP Research:

SWEEP Report # 4 - Assessment of Soil Compaction and Soil Degradation in Lowland Clay Soils
SWEEP Report # 14 - The Effect of Terraces on Phosphorus Movement
SWEEP Report #49B- Land Reshaping of Lowland Clay Soils II: Modelling Report

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

Further research is required in the following areas :

1) (C) modelling of surface run-off from agricultural lands
2) (A) monitoring of soil and water resource quality in agricultural lands, and
3) (A) development of reliable water and run-off monitoring technologies for use during the range of climatic conditions experienced in Ontario

Report # 49B

Report Name: Land Reshaping of Lowland Clay Soils II: Modelling Report

Researcher: Andrew H. Marshall in association with CAN-AG Enterprises, Guelph, Ontario

Date: May, 1992

Key Words: clay soils, model, phosphorus, land planning

Summary: The modelling was done using data from sites monitored in the SWEEP Project Land Reshaping of Lowland Clay Soils. A modified version of the field scale model for Chemicals, Runoff, and Erosion from Agricultural Management Systems (CREAMS) was used. The objective of the study was to develop a method of estimating the empirical values for the field parameters used by the model and evaluate its ability to predict occurrences of surface runoff and subsurface drainage flows.

The analysis was completed on field data for surface runoff events only. The Land Reshaping project did not measure tile flow; therefore, that component could not be incorporated into the model. The success of the model was based on its ability to predict an event occurrence. The analysis did not evaluate the model's ability to quantify runoff volume of each event. An adaptation was incorporated in the model to allow for a seasonal variation in the hydraulic conductivity parameter.

The model successfully predicted the occurrence of 116 out of 130 observed events of overland flow. The model did not find any difference in the event occurrence between planed and unplaned fields. From the measured data of overland run-off for a five month period, the unplaned fields showed a lower amount of run-off than planed fields.

Comments: The project successfully completed its main objective of predicting overland flow events. This report would be of little interest to anyone who does not understand modelling.

Associated SWEEP/LSP Research:

SWEEP Report #49A - Land Reshaping of Lowland Clay Soils I: Field Study

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(C) The model should be further evaluated quantitatively making use of the parameter selection technique developed. At the same time, the phosphorous loss component of the model should be evaluated using this modified technique.

Report # 50

Report Name: Evaluation of O.B.A.T.A. Approach to Low Input Farming

Researcher: L. Leskiw, A. Laycock, Can-Ag Enterprises, Guelph, Ontario

Date: May, 1992

Key Words: low input farming, kelp, molasses, O.B.A.T.A., aeration tillage, Aerway, erosion control, cover crops, fertilizer, no-till, corn, soybeans, winter wheat, yield, subsoiling, crop rotation, mulch tillage, soil compaction, residue cover, microbial biomass

Summary: The goal of this project was to evaluate the Ontario Biological Aeration Tillage Association (O.B.A.T.A.) approach to low input farming methods on their farms. The O.B.A.T.A. approach includes the use of: a subsoiler for pre-emergence or post-emergence soil aeration; kelp, sugar (molasses) and fertilizer along with cover crops; crop rotation and reduced tillage. Rates of herbicides and fertilizers are reduced in the O.B.A.T.A. approach.

The study includes a literature review of several cover crops, allelopathy, biological soil life, seaweed: plant growth, soil erosion, nitrate leaching and tillage and conventional versus organic farming. Seven farms in Oxford, Elgin, Haldimand-Norfolk and Waterloo counties were involved in the three year study. All sites were monitored for soil characteristics, field operations, economics and crop yields.

The results are as follows:

1) No significant differences were found to exist between standard and O.B.A.T.A. management treatments in terms of levels of P, K, Mg, Ca, or pH in the three years.
2) No significant differences in percent organic matter.
3) No measurable differences between treatments for compaction at any soil depth.
4) No visible trends in microbial biomass development could be observed.
5) Corn, soybean and winter wheat yields were not significantly different from standard yields.
6) The use of cover crops and aeration tillage systems were effective in reducing water run-off, soil or sediment and phosphorus losses.

Comments: The data in this report must be interpreted very carefully as the author's biases show where he speaks favourably of O.B.A.T.A. when the result may not necessarily support the conclusions. The author mentioned that the microbial biomass measurement was not as useful as he had hoped. The potential for cover crops to aid in weed control is mentioned several times but the report makes no mention of weed control after cover crops. Herbicide rates used were the same for both treatments. Only one of the participants used the complete O.B.A.T.A. system.

There is some question about how the economics were derived. Gross returns are stated for the final year of corn only. Two passes of aeration tillage and one with a subsoiler likely will not cost much less than the moldboard plow and two cultivations. The cost of the residue spray, foliar spray, seed treatment and cover crop seed plus the cost of application would appear to more than offset any fertilizer savings. It would appear that conservation tillage can provide many of the same benefits as the O.B.A.T.A. system with fewer passes over the field.

Associated SWEEP/LSP Research:

SWEEP Report # 26 -	The Use of Kelp and Molasses in Aeration Tillage Systems
SWEEP Report # 66 -	Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program
LSP Research -	Crop Rotation Effects on Crop Yields and Soil Properties in Southwestern Ontario

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 51

Report Name: Loss of Nitrogen by Microbial Denitrification, Nitrification, Surface and Tile Runoff: Relation to Tillage Method

Researcher: D.J. McKenney, Department of Chemistry and Biochemistry, University of Windsor and C.F. Drury, Research Station, Agriculture Canada, Harrow.

Date: May, 1992

Key Words: ridge tillage, no-till, moldboard plow, surface run-off, tile run-off, nitrate, nitrite, nitric oxide, nitrous oxide, nitrogen, corn, yield, Kentucky bluegrass

Summary: The report covered three separate experiments all related to the occurrence of nitrogen losses from soil under a variety of tillage systems.

The first experiment compared the affected volume, concentration, and total amount of NO^-_3 lost from surface and tile run-off, under ridge till, no-till, and moldboard plow systems planted to corn, compared to a Kentucky bluegrass treatment. As the amount of nitrogen utilized by plants will reduce the nitrogen available to be leached, grain corn yields and nitrogen uptake of the three tillage plots were compared.

The plots were centred above tile placed at a depth of 0.6 m. Both surface and tile water were collected from natural rainfall events. Rainfall for 1989 was below average, for 1990 above average and in 1991 there were drought conditions. The results of the study showed that the greatest movement of water for all of the corn tillage systems was through the tile rather than surface run-off. The corn tillage system that had the greatest volume of tile flow was the moldboard plow system.

Grain corn yield and tissue nitrogen under the ridge till and the no-till plots was higher than the moldboard plow system. The higher nitrogen uptake in the conservation plots over the moldboard plow plots was similar to the reduction in the amount of NO_3^- lost by leaching. While the concentration of NO_3^- from the tile was less under the conservation tillage it was still above drinking water standards. Bluegrass sod was the only treatment that consistently had both surface and tile run-off waters within drinking water standards.

The objective of the second experiment was to identify the effects of various tillage methods on the denitrification process with depth. The treatments consisted of bluegrass, and continuous corn under ridge tillage, no-till and moldboard plow as in the first experiment. Soil cores were taken in October 1989 and July 1990 and background levels of nitric oxide and nitrous oxide were determined by using the continuous flow technique. Potential denitrification estimates were determined by using the acetylene inhibition technique.

Background denitrification rates were about the same level in 1989 and 1990 and decreased with depth under all tillage systems. No relationship between tillage systems and production rates was demonstrated between the two years. Large variations in rates persisted within and among sampling sites. Both background levels and potential denitrification decreased with depth.

The objective of the third experiment was to study the physical effects of water on NO and N_2O production under conditions favouring denitrification. The combined effect of O_2 and soil water content on NO production was also studied.

Comments: At times it was difficult to determine if the information provided in the report was the results of the study or part of a literature review. The differences in weather conditions that occurred between the three years provides some interesting information. However, further trials should be conducted to determine if the results obtained for each of the three years is an accurate indication of surface and tile run-off as well as corn yield for each system. No explanation was given as to why in 1989 there was a greater loss of NO_3^- per event than 1990.

Study 2 only looked at potential denitrification rates under laboratory conditions rather than actual rates under field conditions. This was a lab study not a field study and further examination is needed to determine if the results are transferable to field conditions. The length of the study should have been longer than 2 years before making estimates on the potential for denitrification.

Continuous corn is known to degrade both surface and subsurface soil structure over time, which could affect the results. Monoculture corn is not used as extensively as it once was on Ontario farms. Mulch tillage, the most popular conservation tillage system for lowland clayey soils was not included in this study. The no-till system used in the study, the planter shoe tillage, is not common in Ontario. With this in mind another system of no-till, one more representative of what is used in Ontario, should have been studied.

Nail-like spikes extending above each statistical box are not explained. It could be assumed that these refer to the Standard Deviation of Error, however it would be preferable if this were explained.

Carbon levels affect denitrification, however the organic matter levels in the various zones within the profile are not reported.

Associated SWEEP/LSP Research:

SWEEP Report # 17 - Effects of Ammonia on Soil Properties and Relevance to Soil and Water Quality
SWEEP Report # 28 - The Effect of Split Applications of Nitrogen On Corn Yield Under Ridge and No-Till Conditions
SWEEP Report # 35 - Nutrient Distribution and Stratification Resulting From Conservation Farming
SWEEP Report # 37 - Effects of Tillage on the Quality and Quantity of Surface and Subsurface Drainage Water: Uplands
LSP Research - Cropping and Soil Management Effects of the Dynamics of Crop Residue Derived-N in the Coarse Textured Soils in Southern Ontario
LSP Research - Nitrogen Research with Corn Using Conservation Tillage
LSP Research - Nitrogen Conserving Farm Systems

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) Research on the nitrogen cycle is needed but not in field studies.

Report # 52

Report Name: Field Scale Tests of Cover Crops I and II

Researcher: J. Sadler Richards, Conservation Management Systems, A Division of Ecologistics Limited, Lucan, Ontario

Date: May, 1992

Key Words: cover crop, barley, annual ryegrass, oats, corn, soybeans, winter wheat, hairy vetch, no-till

Summary: The objectives of the cover crop study were:

- to determine the effect of species, planting date and method of application, on current and subsequent crop growth and yield
- to determine the effect of species, date and planting method on residue cover
- to document costs associated with specific cover crop systems
- to prepare general recommendations for cover crop system management for species, date and planting method
- to evaluate the response of cooperating producers and extension workers to the systems demonstrated

The evaluation of the success of the systems was based on the following:

- establishment of the cover crop
- provision of ground cover
- weed control
- effects on the current crop in the establishment year and the following year.

Experiment number one field studied barley and oats seeded at 10% leaf drop in soybeans and seed broadcast at soybean harvest. Due to inclement weather six row barley species were used instead. Corn was planted in the spring of the following year.

Experiment 2 studied spring barley and annual ryegrass which were seeded into separate standing corn crops, early July.

Experiment 3 studied hairy vetch no-till drilled into winter wheat stubble in August, to compare the effect of timing of kill on growth and yield of no-till corn the following year. However, due to wet conditions the seed rotted and there was no germination or growth of hairy vetch. As a result the study was discontinued.

Experiment 4 studied various application rates of barley, oats, and annual ryegrass. The barley and oats were broadcast into soybeans at 10% leaf drop. Annual ryegrass was applied into corn at the second interrow cultivation.

Comments: The study set out to examine cover crop system effects on current and future crops. The two years allowed for the study is not long enough. Due to adverse weather conditions and other circumstances many of the studies ran only for one year.

The management varied from site to site as the farm management varied. This makes it difficult to draw conclusions and compare cover crops. The seeding rate was extremely variable and frequently was not the rate that was to be studied, making comparisons more difficult.

The report is difficult to read, as sites not treatments are compared. The results do not show any clear advantage to using intercrops in corn or soybeans where sufficient residue exists and is left on the soil surface.

Associated SWEEP/LSP Research:

SWEEP Report # 12 - Choice and Management of Cover Crop Species and Varieties for Use in Row Crop Dominant Rotations
SWEEP Report # 27 - Cereal Cover Crop Study
SWEEP Report # 36 - Red Clover Cover Crop Studies 1987-1990
SWEEP Report # 43 - The Use of Cover Crops for Nutrient Conservation
SWEEP Report #57A- Field Testing of Cover Crop Systems for Corn and Soybean Production
LSP Research - Crop Rotations and Cover Crop Effects of Erosion Control, Tomato Yields and Soil Properties in Southwestern Ontario
LSP Research - A Cover Cropping Strategy for First Early Potato Production

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

None required.

Report # 53

Report Name: Phosphorus Movement in Soil As a Function of Phosphorus Solubility and Reactivity

Researcher: Dr. L.J. Evans, University of Guelph

Date: May, 1992

Key Words: phosphorus, crop residue, organic acids, conservation tillage

Summary: The rationale behind the research was that organic acids released during decomposition of crop residues on the soil surface of conservation tillage treatments would result in an increase in the amount of soluble phosphorus in the soil solution early in the growing season (when phosphorus nutrition is important) due to competition between phosphate ions and organic acid ions for soil adsorption sites (hence more available P). To investigate this hypothesis, a series of three experiments were performed. In the first, an acidic soil (Welland Series) of pH 5.3 from Niagara Region of southern Ontario was limed to pH's of 6.4 and 7.5. Corn residues were either added directly to the soil surface or were incorporated into the soil. The experiment consisted of nine treatments -three residue treatments - control, surface applied residue and incorporated residue and three pH values - 5.3, 6.4 and 7.5. Barley was grown in the various soils in a greenhouse. The plants were harvested at two different growth periods, corresponding to Feeke's stages 3 and 6 (approximately 20 and 40 days growth respectively). Both plant and soil analyses were performed.

There were differences in the yield of barley between the control soil and the two residue treatments but they were not significant at the first harvesting period. Final yields at the later harvesting were significantly lower in the control than in the two residue treatments at the two lower pH values but the effect of the residue treatments on final barley yields disappeared in the soil limed to a pH of 7.5.

The increased plant yields were more related to increased tissue potassium at the earlier harvesting stage and increased N tissue content at the later harvesting stage than to tissue phosphorus. The increased yields also corresponded to increased soluble carbon contents in the extracted soil solutions and therefore it is possible that the degradation of the corn residues either at the soil surface or directly incorporated into the soil released soluble nitrogen and potassium, in addition to soluble phosphorus. Although there was some evidence for increased soluble phosphorus contents in the extracted soil solutions these increases were not significant.

In a second experiment, the soils with the three different pH values were incubated with incorporated corn or alfalfa residue over a period of forty-eight days. At various time intervals the soil solutions were extracted and analyzed for soluble organic carbon and phosphorus.

Incubation with either corn or alfalfa residues led to an increase in soluble organic carbon, soluble total phosphorus and ortho-phosphate. The maximum amounts of each of the constituents occurred at after two to three weeks, with contents of the constituents being released over a longer time period for alfalfa than for corn. Because of uncertainties in the exact nature of total phosphorus measured by the ICP-AES technique, it is not clear whether the increase in P content is due to the release of mineral-bound phosphorus or due to an increase in organic phosphorus. An automated procedure for determining both inorganic and organic forms of soluble phosphorus was developed in the latter stages of this work - (see Appendix I.)

In the third experiment, the soils were shaken with phosphate in the presence and absence of different naturally occurring organic acids. It was shown that retention of phosphorus was less in the presence of these acids and that those organic acids that form strong bonds with the surfaces of soil particles were the most effective in reducing specific adsorption of phosphate.

This study has shown that there is an increase in crop yield if soils at three different pH's are amended with crop residues either applied at the soil surface or incorporated into the soil. Incubation of the soils with either corn or alfalfa residues increased the amount of soluble phosphorus in the soil solution after about two to three weeks of incubation. With increased time however the content of soluble phosphorus decreases. This increase in soluble phosphorus is probably due in part to release of inorganically and organically bound phosphorus from the crop residues and as the final part of the study has shown to release of soil bound phosphorus by the increased concentration of released organic acids.

Comments:

The literature review contains a good overview of phosphorus forms and reactions in the soil.

Associated SWEEP/LSP Research:

SWEEP Report # 23 - Processes Involved in Mobilization of Phosphorus in Different Farming Systems in Southwestern Ontario: Nutrient Levels in Plant Tissues and Soils
SWEEP Report # 35 - Nutrient Distribution and Stratification Resulting from Conservation Farming
SWEEP Report # 56 - Yield Reduction Effects of Crop Residues in Conservation Tillage.

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(B) We need to develop an understanding of the cycling of carbon, phosphorous and nitrogen in cropping systems, particularly with a view to understanding the "allelopathic effect" observed by many no-till farmers.

Report # 54

Report Name: Rainfall Simulation to Evaluate Erosion Control on TED Research Sites

Researcher: G. Schell, Ecological Services for Planning Ltd., Guelph, Ontario

Date: July, 1992

Key Words: erosion, erosion control, conservation technology, rainfall simulation, Universal Soil Loss Equation, cover crops, conservation tillage, phosphorous, run-off, no-till, conventional, reduced tillage, manure, aeration tillage, residue cover, slope.

Summary: The purpose of this study was to use rainfall simulation to evaluate the relative effectiveness of the different conservation and erosion control technologies tested in the TED program of SWEEP.

Rainfall simulation was conducted during the summers of 1989-91 on fourteen farms. On-farm research on these areas was initiated, previous to this study, to evaluate the effectiveness of one of the following : conservation tillage, residue management, nutrient management and cover crops. Sample design followed the replications and comparisons established in the TED projects. Rainfall simulation methods established by the Ontario Institute of Pedology were adopted for the study. Benchmark soil conditions were sampled for soil particle size, moisture content, organic matter content and initial concentrations of available phosphorus. One metre square run-off plots were placed, to collect run-off, and was sampled for water volumes, sediment loads, sediment P and soluble phosphorous concentrations.

Mean values of each treatment for before and after rainfall conditions were analyzed using the Duncan Multiple range test. The results of the rainfall simulation were found to be highly variable and definite conclusions regarding the effectiveness of specific conservation treatments was difficult to ascertain. However, certain trends in the data were observed. For example, as expected, conservation tillage systems yielded less run-off and soil loss. The higher the residue level - the lower the run-off. The investigators found that cover crops with fibrous rooting (e.g. hairy vetch) were more effective at erosion control.

Variability in the data was attributed to variation in the slope and soil conditions between plots on each farm.

Comments: The identification of the need to test the relative efficiency of several conservation technologies at controlling soil loss and run-off was a positive step: any on-farm conservation agronomy research should be subjected to standardized objective evaluation.

There are several problems relating to the use of rainfall simulation:

1) topographic position and soil type were not used rigorously as criteria for the establishment of the on-going TED study sites. This does not only make the design of original studies suspect but raises serious questions about the design of this study. If observations across treatments were not made on similar site (soil and slope position) conditions, the subsequent flow of logic from observations to conclusions and recommendations is likely flawed.

2) the Universal Soil Loss Equation (USLE) was referred to in the treatment of the literature but was not used as a model to help verify the appropriateness of specific sites chosen for the simulation work. If this had been done it would have indicated the relative potential influence of the variation of LS and K factor-values on predicting soil loss for the TED study areas.

3) it is not readily apparent that spatial influences on run-off were considered in the design. The potential for aggregation of detachment, sheet and inter-row erosion was not accounted for with one metre squared plots within treatments. Further, the influence of micro-topography over a larger area was not addressed. In addition, the effectiveness of cover crops in early spring would have been more appropriately tested in March or April.

It is difficult place confidence in those results, where physical conditions were not similar between treatments.

Associated SWEEP/LSP Research:

SWEEP Report # 12 - Choice and Management of Cover Crop Species
SWEEP Report # 27 - Cereal Cover Crop Study
SWEEP Report # 38 - Management of Farm Field Variability, I. Quantification of Soil Loss in Complex Topography, II. Soil Erosion Process on Shoulder Slope Landscape Positions
SWEEP Report # 58 - Manure Management for Conservation Farming

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) Better standards, with particular emphasis on design and field variability, for evaluating conservation technologies with rainfall simulation should be developed. Research toward this end should be supported.

Report # 55

Report Name: Soil Loss by Tillage Erosion: The Effects of Tillage Implement, Slope Gradient, and Tillage Direction on Soil Translocation by Tillage.

Researcher: Dr. R.G. Kachanoski, Dr. M.H. Miller, D.A. Lobb, University of Guelph

Date: June, 1992

Key Words: tillage erosion, tillage implements, slope gradient, tillage direction, tillage depth, tillage ground speed, chisel plow, moldboard plow, disc, cultivator

Summary: The objective of this study was to determine the effect of tillage implement type on the magnitude of soil translocation and net downslope soil translocation by tillage under a range of slope gradients within a typical upland landscape. The effect of other factors such as soil conditions, tillage depth, and tillage ground speed were also examined. Two tillage treatments were conducted for each of four tillage implements - chisel plow, moldboard plow, tandem disc, and C-tine cultivator. Measurements were taken for both upslope and downslope tillage translocation over the range of slope gradients.

The results indicate that the chisel plow, moldboard plow, tandem disc, and cultivator all caused tillage erosion which resulted in soil loss. Less soil is translocated upslope than downslope by each tillage implement. There are relationships between slope gradient, tillage depth and tillage ground speed. however, these relationships are not always strong, nor are they consistent between tillage implements, or within tillage treatments of tillage implements. There was some indication that soil translocation increased as slope gradient, tillage ground speed. and tillage depth increased. There was also some indication that ground speed increased as slope gradient increased, that ground speed decreased as tillage depth increased, and that tillage depth increased as slope gradient increased. The inconsistency on these relationships may suggest that there are other factors involved in the translocation of soil by tillage other than slope gradient, tillage depth and tillage ground speed.

Implications arising from this study include: 1) other factors involved in tillage erosion may include tillage tool shape and arrangement, tractor-implement matching and tillage operator responsiveness, 2) the relationships observed between the many variables are specific to the tractor, tillage implement and operator.

Comments: An excellent report that discusses some of the factors involved in tillage erosion but also raises questions about some other factors that may be involved.

Associated SWEEP/LSP Research:

SWEEP Report # 38 - Management of Farm Field Variability, I. Quantification of Soil Loss, II. Soil Erosion Processes on Shoulder Slope Landscape

SWEEP Report # 45 - Management of Farm Field Variability, III. Effect of Tillage Systems on Soil and Phosphorous Loss

SWEEP Report # 46 - Management of Farm Field Variability, IV, Crop Yield, Tillage System and Landform Relationships

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) 1) Develop a practical and accurate method of measuring tillage depth for both primary and secondary tillage operations

2) Conduct more rigorous studies of the effects of slope gradient and curvature, tillage depth, tillage ground speed, and tillage implement on soil translocation

3) Examine the role of tillage tool shape and arrangement in the volume and extent of soil translocation

4) Examine the role of the tillage operator in the interaction between slope gradient, tillage depth and ground speed

5) Examine tillage erosion on a broad range of soil types to determine the effects of soil texture and soil moisture content on soil translocation

Report # 56

Report Name: Yield Reduction Effects of Crop Residues in Conservation Tillage

Researcher: Dr. R.P. Voroney, B.J. Farquharson, K.J. Janovicek, Dr. E.G. Beauchamp and T.J. Vyn, University of Guelph, Guelph and Dr. M.C. Fortin, Agriculture Canada, Ottawa

Date: July, 1992

Key Words: crop residues, conservation tillage, canola, corn, red clover, rye, soybeans, winter wheat, crop rotation, soil moisture, soil temperature, residue cover, phenolic acids, volatile fatty acids, phytotoxin, calcium nitrate, zero-till, yield

Summary: The aim of this study was 1) to evaluate surface placement of coarsely-chopped overwintered corn and fresh rye plant residues for phytotoxin production using corn as the test crop, 2) to evaluate the effects of various crop residues and residue placement options on zero-till corn performance, 3) to evaluate calcium nitrate amendments to seed row using corn as the test crop 4) to determine the soil environmental factors controlling the production and accumulation of phytotoxins, 5) to compare the production of volatile fatty acids and phenolic compounds from weathered versus fresh manure residues under saturated conditions and 15^{o}C, 6) to determine the effects of volatile fatty acids and phenolic acids on early corn radicle growth, 7) to determine the effects of volatile fatty acids and phenolic acids on winter wheat bioassays.

The study concluded that the presence of crop residues on the soil surface in conservation tillage systems affected soil water content and temperature, and plant growth, however measurements of the soil moisture and temperature could not totally explain the reduction in corn plant development particularly under residues from red clover and canola.

The phenolic acids (PCs) and volatile fatty acids (VFAs) were not found in concentrations considered phytotoxic in field soil samples, however they were detected in some plots after certain June rain events.

Calcium nitrate reduced accumulation of VFAs when added to soil in the laboratory study, however when added with the seed under field conditions the yield reduction effect of rye residue was not overcome.

In the laboratory VFA production was found to be greatest under green readily decomposable residue such as legumes, under high soil temperatures (15-25^{o}C), and soil water potential above field capacity. The potential for VFA production decreases as the plant materials matured to harvest stage and underwent weathering. Phytotoxic concentrations could be produced within 48 hours of incubation, and increased to a maximum at about 14 days.

From the corn bioassay it was determined that some VFAs and PCs had a phytotoxic affect, although not all hybrids were affected equally.

From the winter wheat bioassay it was determined that the VFAs were more phytotoxic than the PCs.

Comments: This study set out to answer some of the questions farmers have been asking about phytotoxicity of crop residues. While the acids were found at toxic levels in the laboratory, they were not detected in the field.

Associated SWEEP/LSP Research:

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(B) This study considered certain VFAs and PCs, whereas other compounds such as the volatile C_6 through C_9 organic compounds could be examined. Future research should consider the dynamics of both the production and utilization of phytotoxin compounds during decomposition of crop residues.

Report # 57A

Report Name: Field Scale Testing of Cover Crop Systems for Corn and Soybean Production

Researcher: Roger Samson, Allison Arkinstall and Jeff Quinn, Resource Efficient Agricultural Production (REAP) Canada, Ste. Anne de Bellevue, Quebec.

Date: July, 1992

Key Words: catch crop, cover crop, rye, oilseed radish, corn, soybeans, red clover, hairy vetch, no-till

Summary: The study was divided into a number of sections dealing with various aspects of catch crop and cover crop management.

Experiment 1.1 was divided into 3 parts, each comparing some aspect of the use of rye in a soybean production system. No significant difference in soybean yield was observed. The rye harvested for a forage system gave the only positive economic return.

Experiment 1.1a studied the use of winter rye as a double crop forage before soybeans. The treatments were winter rye spring plowed (control) and rye harvested as a forage (test). The harvested rye produced hay with low crude protein and low digestibility. Soybean yield was low due to weed pressure.

Experiment 1.1b compared rye killed with herbicide to mow killed for use as a mulch for soybean production. The rye in the mowed plot regrew and crabgrass was affected very little by the mowing. The entire plot area was sprayed with herbicide and inter-row cultivated. The mowed treatment appeared weedy even with the grass treatment.

Experiment 1.1c compared no-till soybeans and no cover crop with no-till soybeans into winter rye which was killed with a herbicide. Both treatments received a comprehensive herbicide program. It was observed that the soybeans with the rye had better weed control.

Experiment 1.2 compared red clover frost seeded into winter wheat to hairy vetch drill seeded into winter wheat in early May and the effect of both treatments on corn the following year. No significant difference in biomass production of the interseeded legumes was observed. However, because of weather conditions, the red clover produced more biomass than anticipated. No significant difference in corn yield was observed between treatments in the year following the legume interseeding.

Experiment 1.3 compared solid and liquid manure as a nutrient source with oilseed radish catch crop for corn. The treatments were manure incorporated with and without the oilseed radish catch crop. No significant difference between corn yield occurred between liquid swine manure with and without the oilseed radish. However the control treatment received 60 kg. N/ha side dressed. A significant difference in yield occurred between the solid manure treatments. The treatment with the oilseed radish yielded more than the control. However since the soil N and the ear leaf N were similar the difference in yield was attributed to decreased weed pressure in the test plot.

Experiment 2.1 evaluated the nitrogen contribution of cover crops. The cropping system studied was corn following red clover and hairy vetch cover crops. The treatments were frost seeded red clover (control) and May drill seeded hairy vetch (test), with 0, 40, and 80 kg N/ha. Two depths were sampled at the prescribed corn height to determine if movement of nitrogen had occurred in the hairy vetch plot. No significant difference between nitrogen levels at the lower depth (30 - 60 cm) was found. At the shallow depth (0 - 30 cm) the level of NO_3 was higher under the red clover plot.

Experiment 2.2 evaluated the nitrogen contribution of oilseed radish as a catch crop with manure fertilized corn. The treatments were a control and oilseed radish, with 0, 40, 80 kg N/ha on two separate farms. All of the sampling dates on the first farm resulted in the oilseed radish plots having higher levels of NO_3 than the control. The level of NO_3 increased from 8 ppm to 23.1 ppm in the 36 days between the first and last soil sampling. The control plots showed a significant response to fertilizer while the oilseed plots did not. The oilseed radish plots on the second farm were similar to the control plots in the amount of NH_4 and NO_3 in the soil tests. The level of NO_3 increased in both treatments between the first and last soil samples. Both treatments responded significantly to the addition of fertilizer. It was indicated that the oilseed radish yield was less than the first farm and this was given as the reason for the response to fertilizer in the oilseed radish plots.

Comments:

The studies were conducted for only one year and the sample size was extremely small. For that reason the studies can not be considered to indicate trends but are only observations of what happened in that year.

In Experiment 1.1a it was observed that the weed pressure was less in the harvested plots. The explanation given for the lower weed growth was the removal of nitrogen from the system with the harvested rye. However the rye forage was reported to be low in crude protein and would not be a very large source of nitrogen. The reduced weed pressure could be likely due to the removal of weeds through the harvesting of the rye.

The report indicates that oilseed radish increases soil nitrogen levels. Oilseed radish is not a legume and therefore can not increase soil nitrogen levels. However, it may conserve N which otherwise could be lost.

Associated SWEEP/LSP Research:

SWEEP Report # 12 - Choice and Management of Cover Crop Species & Varieties for Use in Row Crop Dominant Rotations
SWEEP Report # 19 - Studies on the Control of Problem Weed Species in Conservation Tillage Systems
SWEEP Report #19A-Weeds of Corn, Soybeans, and Winter Wheat Fields Under Conventional, Conservation and No-till Management Systems In 1988 and 1989
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems
SWEEP Report # 36 - Red Clover Cover Crop Studies 1987-1990
SWEEP Report # 43 - The Use of Cover Crops for Nutrient Conservation
LSP Research - Crop Rotations and Cover Crop Effects of Erosion Control, Tomato Yields and Soil Properties in Southwestern Ontario
LSP Research - A Cover Cropping Strategy for First Early Potato Production

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

None required. Future research of this type is not justified unless a much stricter scientific method is followed.

Report # 57B

Report Name: Effect of Winter Rye Mulches and Fertilizer Amendments on Nutrient and Weed Dynamics in No-till Soybeans

Researcher: R.Samson and J. Omielan, Resource Efficient Agricultural Production (REAP) Canada, Ste. Anne de Bellevue, Quebec and C. Drury, Agriculture Canada, Harrow, Ontario

Date: June, 1992

Key Words: no-till, soybeans, rye, cover crop, mulch, weed control, allelopathy, nutrient effects, physical effects

Summary: The purpose of the project was to study the effect of no-till rye mulches on nutrient and weed dynamics. It was thought that the growth of rye depleted the soil nitrates therefore reducing the amount available for weed growth. The high C:N ratio is thought to create enough nutrient immobilization to have effected weed growth.

The experiment consisted of 5 treatments:

1 rye grown and left (physical, chemical and soil nutrient effects of the mulch)
2 rye removed (soil nutrient effects of the mulch)
3 rye moved in place (physical and chemical effects of the mulch)
4 poplar wood mulch moved in place (physical effect of the mulch)
5 control (bare plot, no mulch)

The nutritional and physical effect of rye mulch on weeds appeared to be additive. The physical effect of a mulch either rye or poplar added, reduced weed biomass by about 36%. Allelopathy was reported as not being a significant factor in weed suppression as there was no apparent additional weed suppression by rye moved in place over poplar mulch moved in place. The soil nutrient effect with rye grown and removed reduced weed pressure by 36%. The combined effect of rye mulch grown and left reduced weed biomass by about 80%.

The nutrient effect of the rye mulch was also apparent in the lower soybean biomass and N content. The addition of 75 kg. of N/ha in the fertility experiment quadrupled the weed biomass in the mulch plots but this was only half of what was observed in the bare plot fertilized with 75 kg. N/ha.

Comments: This is one of the very few studies attempting to sort out the causes of weed suppression by cover crops. It is unfortunate that there is only one year's data. The main areas of concern are the use of 2,4-D in the burndown herbicide treatment, which could have affected the beans detrimentally, and the fact that the rye grew to the heading stage. Current recommendations are to kill the rye at 30 - 60 cm. height, so the nutrient effects may not be as evident.

Associated SWEEP/LSP Research:

SWEEP Report # 19 -	Studies on the Control of Problem Weed Species in Conservation Tillage Systems.
SWEEP Report #19A-	Weeds of Corn, Soybean and Winter Wheat Fields Under Conventional, Conservation and No-till Management Systems in 1988 and 1989.
SWEEP Report # 27 -	Cereal Cover Crop Study.
SWEEP Report # 29 -	The Effect of Organic Mulches on Soil Moisture and Crop Growth.
SWEEP Report # 43 -	The Use of Cover Crops for Nutrient Conservation.
SWEEP Report # 52 -	Field Scale Tests of Cover Crops I and II.

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(B) As the report indicated, further study is needed to better understand soil nutrient dynamics under rye mulch. There is a need to determine if early season deprivation of nitrogen by the rye cover crop affects final soybean yield.

Report # 58

Report Name: Manure Management in Conservation Farming

Researcher: Roger Samson, Dr. Anne Weill, Allison Arkinstall, and Jeff Quinn, Resource Efficient Agricultural Production (REAP) Canada, Ste. Anne de Bellevue, Quebec.

Date: July, 1992

Key Words: liquid manure, oilseed radish, rye cover crop, no-till, soybeans, winter wheat, manure compost, solid manure

Summary: In Experiment 1, the efficiency of nutrient availability of late summer liquid swine manure application was compared with spring applied manure. The treatments consisted of summer applied manure with an oilseed radish cover crop, summer applied manure, and spring applied manure. The tillage treatments were: fall moldboard plowing, fall chisel plowing, spring Aerway, and zero-till. The subplot treatments were O kg N 50 kg N added. The tillage systems in combination with manure management were evaluated as to the most efficient management approach for nutrient conservation, pollution control and corn performance. A randomized, complete block design with split plot was used (12 plots, 2 subplots, 3 replication).

In Experiment 2, the effect of manure and rye cover crops on no-till soybean production was evaluated. The treatments included: rye seeded in August and September, manure application with rye seeded in August and September, manure alone and a control. Sub treatment plots consisted of weed control either chemical or hand pulled or no weed control.

Experiment 3 was conducted to determine the potential of various manure sources and rates for no-till winter wheat production. Various N rates were evaluated to determine the N requirements of no-till winter wheat seeding systems following soybeans. The treatments included: aerial seeding at leaf yellowing in soybeans, no-till drilled (after soybean harvest), conventional (one cultivation after soybean harvest). Subtreatment plots included the use of chemical fertilizer, liquid swine manure, mature swine and beef compost. The swine and beef compost was used one year and replaced with immature dairy compost the following year.

Experiment 4 was conducted to determine the effect of low rates of summer applied solid manure and compost on forage yield and composition. It was believed that compost would reduce manure clumping which smothers alfalfa plants and the risk of manure being present in the hay at time of harvest. The treatments were solid beef manure, mature beef compost, fertilizer (0-30-135) and no fertilizer or manure.

Comments:

The researchers took a systems approach when conducting the study. However, when evaluating the effect of the different parameters, it is difficult to determine which parameter is causing the observed result. Generally, it is questionable whether two years is long enough to draw some of the conclusions that appear in this report. However, rather interesting observations have been noted. A number of issues were not commented on in the report.

In Experiment 1, no comment was made on the release of nutrients from the cover crop once it had died. It is not known if these nutrients were released and whether timing was appropriate for crop growth.

The study commented on the increased infiltration rate created by a no-till system. The potential for groundwater contamination by nitrates and bacteria was not explored.

The rotation used was winter wheat/corn with swine manure. Because of the tendency of fusarium in corn, with a winter wheat/corn rotation, swine farmers are tending to move away from this rotation. Therefore, this type of rotation may not be appropriate for a liquid hog manure management system.

Appendix to Experiment 1, which involved looking at the effect of manure application, tillage and fall cover crops on erosion, was located on a separate site; this eliminated the opportunity for direct comparison.

In Experiment 2, variability occurred within the trial when the source of manure was changed from beef manure to dairy manure and the application rate was increased by 50t/ha. The reason for the change was given as the diary manure was believed to be richer. Test results to prove this belief are not provided in the report or no mention that any analysis was conducted. Straw from the applied manure was counted in the residue measurements of the plots and therefore the manured plots had a higher residue count. Results of the study indicated that the timing of rye planting early versus late had a greater effect on rye biomass than did manure application. This is widely known. The longer a plant has to grow before killing should be able to produce greater amounts of biomass than a plant seeded later and killed at the same time.

In Experiment 3 there seemed to be little consistency from year to year within the same trial. After the first year the mature compost was changed to immature compost. Also the compost application rate was increased over that of the first year. Biodynamic compost was used in the second year of the trial. The maturity and C:N ratio of the compost are not stated. The significant increase of the winter wheat was attributed to the biodynamic compost. No credit was attributed to the compost from the previous year. The speculation that a superior compost (one with more nitrogen) could produce yields comparable to those obtained from the soluble N, chemical fertilizer plots is suspect.

At the end of Experiment 4, the researchers recommended incorporating high rates of manure before forage establishment to ensure medium to high soil nutrient levels. They neglected to determine or establish several items: the desirable nutrient levels for forage establishment, the fate of nutrients before establishment, and the impact on water quality.

Associated SWEEP/LSP Research:

SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) A comprehensive research program is required to determine the fate of nutrients from several sources (commercial manure, urban) in various tillage and cropping systems over time. Site-specific recommendations for rates, combinations of materials, timing of operations and cultural practices then could be developed to ensure cost-effective production with minimal environmental impact.

Report # 59

Report Name: Evaluation of 58 Commercial Corn Hybrids (2850 to 3450 C.H.U.) in Two Conservation Tillage Systems Compared to Conventional Tillage in Kent County, Southwestern Ontario

Researcher: G. Scheifele, Ridgetown College of Agricultural Technology, Ridgetown, J. Rigby, Blenheim and D. Smith, Thamesville (Farmer Cooperators) and Dr. H. Hope, Plant Research Centre, Agriculture Canada, Ottawa, Ontario

Date: June, 1992

Key Words: corn hybrids, tillage, conservation tillage, no-till, residue, soil moisture, soil temperature, time to coleoptile emergence, yield, cold tolerance, ridge till, crop growth

Summary: This study presents one years data from a study that is to continue for another 2 years. Fifty-eight corn hybrids from 18 seed companies were selected from the Ontario Corn Committee performance list and grown in side-by-side no-till/ridge till versus conventional till plots. Seed from each seed lot tested was made available to Dr. H. Hope for cold tolerance predictor determination studies. Variables measured in this study included: % residue, soil moisture, soil temperature, air temperature, time to coleoptile emergence, time to development of V-1 to V-5 leaves, percent emergence at V-3, percent final stand at harvest, days to 50% pollen shed and silk emergence, percent broken stalks, harvest grain moisture and yield.

The 1991 data is summarized in this report but because of the hot, dry growing conditions the required conditions needed to evaluate cold tolerance for emergence and early growth did not occur making it difficult to draw any conclusions. Two more years of data will be needed before drawing any conclusions or making recommendations.

Comments: This research has potential to be very useful but as mentioned in the report more data is needed to make any recommendations. Correlation of the field trials to the lab tests are very important because hybrids could be removed from the recommended list before a field test could be completed.

Associated SWEEP/LSP Research:

SWEEP Report # 22 - Field Emergence Predictors For Grain Corn Under No-till Management
SWEEP Report # 56 - Yield Reduction Effects of Crop Residues in Conservation Tillage

Future Research: ( ) indicates reviewers suggestion for priority, A - high, C - low.

(A) Continue this study for another 2 years and correlate it to Dr. H. Hope's laboratory work to develop recommendations for corn hybrid selection for no-till growing conditions.

Report # 60

Report Name: The Effect of Conservation Tillage Practices on the Losses of Phosphorus and Herbicides in Surface and Subsurface Drainage Waters

Researcher: Dr. J. Gaynor and D. Bissonnette, Southwestern Ontario Agricultural Research Corporation (SWOARC), Harrow, Ontario

Date: May, 1992

Key Words: conservation tillage, phosphorus, herbicides losses, surface water, subsurface water, soil erosion, no-till, ridge tillage, phosphorus transport, poorly drained, Brookston Clay Loam soil, zero-till, atrazine, metolachlor

Summary: **Part A:** A three year study to identify sediment and phosphorus transport from a poorly drained, Brookston clay loam soil, cropped to corn under three tillage practices: conventional, no-till and ridge tillage. Water quality and corn yields were measured for all plots and compared. Rainfall was measured and surface and subsurface runoff was quantified for each rainfall event. Water samples were taken and analyzed for sediment and orthophosphate.

The results indicated that conservation tillage had a variable effect on sediment transport. In 2 of the 3 years, sediment transport was reduced by the conservation tillage treatments compared to that from conventional tillage. Zero-tillage was more effective at reducing erosion than ridge tillage over the three years. A greater proportion of sediment transport occurred in surface runoff from the conservation tillage treatments whereas subsurface transport accounted for a greater proportion of sediment loss from conventional tillage.

Dissolved phosphorus transport was higher from zero tillage than from ridge or conventional tillage. In 2 out of 3 years, subsurface drainage accounted for greater than half and 74% of the orthophosphate loss from conservation tillage and conventional tillage treatments respectively. Sediment phosphorus loss was similar between ridge and conventional tillage but higher from zero till. Ridge reforming in ridge tillage may incorporate some of the crop residue with soil allowing for greater residue decomposition which could account for the greater release of soluble P from ridge compared to zero tillage.

Transport of soluble P was higher in no-till and ridge till than conventional tillage. This work concludes that for a poorly drained, Brookston clay loam soil, conservation tillage effectively reduced soil erosion but not phosphorus transport.

Part B: A three year study conducted on a poorly drained, low slope Brookston clay loam soil to investigate the effect of conventional tillage, zero tillage and ridge tillage on surface and subsurface transport of atrazine and metolachlor applied preemergence to corn. Each runoff producing event was monitored to calculate the proportion of rainfall that left as runoff (which was collected to determine herbicide concentration).

The proportion of rainfall that ran off the plots was independent of tillage but dependent upon rainfall intensity, duration and soil moisture content. Subsurface runoff exceeded surface runoff in all treatments. A greater proportion of the runoff occurred from the surface of the conservation tillage treatments compared to conventional tillage. The greater proportion of runoff from the surface of the conservation tillage treatments could impact on water quality since herbicide concentrations are higher in surface than subsurface runoff water.

Runoff producing events which occurred soon after herbicide application, transported the largest amount of herbicide. Herbicide concentration was higher in the surface runoff water compared to subsurface runoff and mean concentrations were higher from conservation tillage than from conventional tillage treatments. Tillage had no effect on transport quantities of atrazine or metolachlor. Atrazine and metolachlor on crop residue were readily leached into soil by rainfall received soon after application. Herbicides showed greater persistence on ridge tops than in the valleys in ridge tillage. Soil persistence of the herbicides was longer in conventional than zero tillage.

Tillage and crop residue did not influence herbicide transport in surface and subsurface runoff on poorly drained soil.

Comments:

This is an excellent study that has raised some questions about phosphorus movement in conservation tillage systems on a poorly drained soil. The study showed that the herbicide movement of atrazine and metolachlor were not affected by tillage systems and crop residue.

Associated SWEEP/LSP Research:

SWEEP Report # 14 - The Effect of Terraces on Phosphorus Movement
SWEEP Report # 18 - Effects of Management on Soil Hydraulic Properties
SWEEP Report # 23 - Processes Involved in Mobilization of Phosphorus in Different Farming Systems in Southwestern Ontario: Nutrient Levels in Plant Tissues and Soils
SWEEP Report # 37 - Effects of Tillage on the Quality and Quantity of Surface and Subsurface Drainage Water: Uplands
SWEEP Report # 55 - Soil Loss by Tillage Erosion: The Effects of Tillage Implement, Slope Gradient, and Tillage Direction on Soil Translocation by Tillage
SWEEP Report # 53 - Phosphorus Movement in Soil as a Function of Phosphorus Solubility and Reactivity
SWEEP Report # 45 - Management of Farm Field Variability III: Effect of Tillage Systems on Soil and Phosphorus Loss

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) There is a need to determine the source of soluble phosphorous in the conservation tillage systems (crop residue, surface soil) and further study the effect on total phosphorus losses in poorly drained soils. This study should be extended to include different soil types and topographic profiles to see how they affect phosphorus and herbicide movement. Another study hsould be initiated to see how different tillage systems affect hydrologic response of watersheds and how this will impact herbicide transport and loss.

Report # 62

Report Name: An Economic Evaluation of Soil Conservation Technologies - Summary Report (Volume I)

Researcher: Deloitte and Touche Management Consultants, Guelph, Ontario

Date: October, 1992

Key Words: Tillage 2000, Pilot Watershed Study, economics, field, watershed, macro-economic, model, conventional tillage, reduced tillage, no-till, crop rotation, corn, soybeans, wheat, net returns, opportunity cost, return to labour, risk analysis, GAMESP, soil loading, phosphate loading, soil loss, environmental impact, equipment dealers, policy, adoption

Summary: The overall purpose of this study was to provide an economic evaluation of soil conservation technologies (mainly conservation tillage) tested within the SWEEP program. A second objective was to assess the economic implications of adopting soil conserving technologies based on the results of both the Pilot Watershed Study (PWS) and Tillage 2000 programs. The economic evaluation was to provide an assessment of the economic impact on participating farmers (at both a field and watershed level) and to assess the downstream macro-economic impact associated with reduced soil loss.

The three pilot watersheds are located in southwestern Ontario: Kettle Creek, between St. Thomas and London; Pittock, north of Woodstock; and Essex, just east of the town of Essex. Each watershed was divided into two areas. In one area the cooperators were encouraged to adopt soil and water conserving technologies while in the other area the cooperators were encouraged to maintain conventional cropping practices. Field input and output data were monitored for each of the paired watersheds covering three cropping years, 1989 to 1991. In addition, results of OMAF's Tillage 2000 program were incorporated into the field level economic analysis.

The methodology for assessing the economics of soil and water quality conservation technologies used was as follows. The PWS and Tillage 2000 data was combined with expert consultation to develop eleven representative cropping scenarios. The information was then run through a financial simulation to determine the field level impact associated with alternative tillage practices. Following that a financial optimization was run for the watershed level analysis. This was a two step process utilizing the GAMESP model (for simulation of soil and phosphorus loading and soil loss) and running a 3-period profit maximizing linear program (to maximize the 3-year profits subject to environmental constraints).

1. Field Level Economic Analysis

The various types of tillage were classified under one of the following three general practices: conventional tillage, reduced tillage or no-tillage.

The net returns per hectare from either reduced or no-tillage systems are roughly equivalent to the returns from conventional tillage practices for a corn following corn rotation. However, when considering the net returns to labour, both reduced and no-tillage practices exceeded conventional practices, by between $20 to $80 per hectare in the Kettle and Pittock watersheds. Continuous corn rotations are not common in the Essex watershed.

No-tillage practices generated marginally higher net returns per hectare relative to either reduced or conventional practices, by between $20 and $40 per hectare for corn following other crops. When considering the net returns to labour, both reduced and no-tillage practices were higher compared to conventional tillage practices by a wide margin ranging from $20 to $110 per hectare, across all three watersheds.

Conventional tillage practices generated the highest net returns per hectare for soybeans following corn. Net returns, however, are only a small margin higher in both the Pittock and Essex watersheds, where soybean production is more predominant. When considering the net returns to labour, all three tillage practices are roughly equivalent across all three watersheds, which makes the use of soil conserving technologies very competitive in this rotation.

For wheat following soybeans, the net returns per hectare are highest under reduced tillage practices, by between $20 to $40, and are roughly equivalent with no-tillage. However, if considering the net returns to labour, both reduced and no-tillage practices significantly exceed the benefits of conventional tillage practices by up to $60 per hour.

The financial risk (i.e. variability in crop yield response) associated with soil conservation is equivalent to conventional tillage practices, based on a detailed analysis of corn production.

2. Watershed Level Economic Analysis

The results of the watershed economic analyses indicate that in the Kettle and Pittock watersheds the optimum solution is to select conservation tillage practices in growing continuous corn. In the Essex watershed, the optimum solution is to select conventional tillage in growing a soybean-corn-soybean rotation. Despite these two different starting points, if there is a general desire to reduce the levels of soil loss, soil loading and/or phosphorous loading, then the optimum solution is to utilize conservation tillage practices. In addition to this it would be optimal in the Essex watershed to alter the crop rotation.

It is important to note that the exclusive use of conservation tillage practices in the Kettle and Pittock watersheds could reduce soil loss by as much as 45%, relative to conventional tillage, without having to set aside land or lose profits. If further soil loss restrictions are required in these two watersheds, the opportunity cost to farmers is lower using conservation tillage systems. This means that in this situation it would be more profitable to use conservation tillage systems than conventional tillage systems.

The same impact is true in the Essex watershed. By imposing limits on soil loss in the Essex watershed, farmers will have lower costs using a combination of conservation tillage and alternative crop rotations.

3. Macro-Economic Analysis

The study found that there is likely very little impact that will accrue to farm input suppliers and processors as a consequence of greater adoption of soil conserving practices.

The macro-economic analysis indicates that the economic benefits obtained from a 10% reduction in soil erosion are around $2.89 per hectare. A 40% overall reduction in soil erosion would increase the estimated downstream benefits to $11.84/ha. These benefits are likely somewhat understated since a part of the impact was not quantifiable. For example, evaluations of the financial cost of soil erosion to wildlife, habitat regeneration, and natural aesthetics are unavailable, so the benefits of reduced sedimentation were not calculated.

4. Policy Implications

The study reviews the current state of conservation adoption and reviews an adoption process model and the factors affecting adoption. Potential policies and programs for increasing adoption of conservation tillage systems are also examined. Programs and policies examined are as follows:

1. Pricing programs
   - -lower cost crop insurance
   - -adjustment assistance programs such as interest free loans, tax credits, rebates on conservation equipment and/or bonus payments
   - - equipment trade-in program

2. Information programs
   - -make conservation equipment available for trial use
   - -increase extension efforts

3. Regulatory programs

5. Strategies to Enhance Conservation Practices

The report examines the impact of programming on the adoption process, the impact of programming on factors constraining adoption, and offers a suggested program mix strategy.

Comments: The report examines soil conservation technologies (primarily conservation tillage) from the field, evaluating the on-farm profitability of conservation tillage; to the watershed level, reduction of soil loss, phosphorus and soil loading; to societal benefits and policy implications. The findings in the report would have been strengthened by reliable economic information from the Pilot Watershed Study and if there had been more years of data from the monitoring stations for use in verifying the GAMESP model predictions.

When examining the field level economic analysis, including Tillage 2000 information, one should keep in mind that the majority of the farmers had less than three years experience with the conservation tillage systems. Therefore, in wheat and especially soybeans, economic returns from conservation tillage systems may be greater than the analysis in this report indicates.

The study does offer some ideas to policy makers and to those promoting the adoption of soil conservation. More information is needed to fully understand the adoption process.

Volumes II to VII of this report provide more detailed information on the various sections of this report. Volume V contains an economic assessment of some of the Technology Evaluation and Development projects.

Associated SWEEP/LSP Research:

SWEEP Report # 3 - An Economic Assessment of the Distribution of Benefits Arising from Adoption of Conservation Tillage Practices in Crop Production in Southwestern Ontario
SWEEP Report # 10 - An Economic Evaluation of Tillage 2000 Plot Data (1986 - 1988)
SWEEP Report # 11 - An Economic Evaluation of Tillage 2000 Plot Data (1986 - 1989)
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems
SWEEP Report # 63 - Volume II - Collection and Analysis of Field Data From Pilot Watershed Studies
SWEEP Report # 64 - Volume III - Field Level Economic Analysis of Changing Tillage Practices in Southwestern Ontario
SWEEP Report # 65 - Volume IV - An Economic Evaluation of the Tillage 2000 Program in Ontario
SWEEP Report # 66 - Volume V - Economic Assessment of the Technology Evaluation and Development (TED) Program
SWEEP Report # 67 - Volume VI - Watershed Level Economic Analysis of Changing Tillage Practices in Southwestern Ontario
SWEEP Report # 68 - Volume VII - Macro-Economic Impact Assessment of Soil Conserving Technologies (SWEEP)
OMAF - Tillage 2000 Progress Reports
OMAF - Tillage 2000, 1985 - 1990

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) The analysis should be done again with the five years of Tillage 2000 data, better economic information, and soil and phosphorus loading data from a watershed study.

Report # 77

Report Name: Pilot Watershed Study: Executive Summary - Volume 9

Researcher: Robert R. Walker and Robert W. Tossell, Beak Consultants Limited, Guelph, J. Sadler Richards, Conservation Management Systems, A Division of Ecologistics Limited, Lucan, Ontario

Date: February, 1993

Key Words: agricultural watersheds, water quality, erosion, phosphorus, conservation tillage, watershed modelling, soil quality, hydrology, residue management, rainfall simulation, cooperator attitudes, program implementation

Summary: The Pilot Watershed Study (PWS) was designed to evaluate the environmental benefits as well as the agronomic and socio-economic implications of conservation farming systems when applied over whole agricultural watersheds. The study design and evaluation program was based upon the use of paired test and control watersheds. The control watershed cooperators were encouraged to continue with conventional farming practices while the test watershed cooperators were encouraged to adopt conservation farming systems during the course of the study.
Over 75 cooperating farms were involved in the study over a four year period. Three pairs of watersheds (test vs. control) were selected to be representative of three different, yet common farming environments in terms of crop rotations, soils and topography within the Lake Erie Watershed. The study areas were selected at the earliest stage of the PWS and are located in Essex County, (east of the town of Essex) an area representing primarily cash cropping with row crops/grain rotations on flat poorly drained clay soils; in the headwaters of Kettle Creek, (north of St. Thomas) representing rolling landscapes with mixed farming involving row crops/grain rotations and swine production on silty loam soils; and in the headwaters of the Gordon Pittock Reservoir (north of Woodstock) where row crop/grain rotations are maintained along with swine and dairy operations on an undulating landscape.

Implementation of Conservation Systems
As a proactive and targeted program the PWS identified specific geographic areas where soil degradation/water quality problems were of interest and where adoption of soil conservation measures by local cooperators would have the greatest impact on soil erosion control and sediment delivery to water courses. Within the PWS an incentive package was required to promote change (i.e. the adoption of conservation practices) and general cooperation within the time frame of the study so that objectives could be realized. The incentives were formulated on the basis of access to information, experience, specialized equipment and financial grants. Cooperators signed agreements with the PWS that outlined the responsibilities of each party. The agreements were amended annually and included changes to conservation farm plans by test cooperators or confirmed the maintenance of records by control watershed cooperators. During the project approximately 89% of eligible landowners/managers participated in the program (e.g. 65 out of a possible 73 in the final year).

To meet the objectives of the PWS conservation farm plans were developed with the test cooperators which identified the management techniques that would be used to maintain soil productivity and

improve water quality in the associated test watersheds. The approach involved the integration of watershed computer modelling used to predict the impacts of current watershed management practices with farm and field level conservation planning. This integration effectively made the watershed modelling tool into a planning tool that could be used to estimate the potential combined effects of individual farm plans on the watershed before any work was done on the ground. With this information a unique opportunity to adjust plans in order to meet watershed soil erosion and sediment delivery targets was available. A two level approach was used that involved first, a background analysis step and second, a field discussion step.

Indicators of Adoption and Cooperator Attitude Changes

The incidence of conservation practices in the test watersheds increased positively during the study. The study time frame represented the early adoption phase which is often characterized by a relatively steep participant learning curve. Within the first three years of the study approximately 81% of identified conservation crop and tillage actions and 52% of conservation structures were completed by the test cooperators. The shift in acreage that was moldboard ploughed versus no tilled was also dramatic.

Documented changes in cooperator attitudes toward soil and water conservation resulted in several conclusions including the following:

1. Implementation of erosion control measures resulted in test cooperators perceiving less erosion occurring on their farms in 1992 relative to 1988. Conversely, control cooperators saw the same amount or slightly more erosion happening on their farms over the same time period. Control cooperators likely became sensitized to erosion problems as a result of the PWS, but did not receive encouragement to implement measures within the watershed boundaries to alleviate the problem.

2. Test cooperators were generally neutral or slightly positive about practice effects on crop yields. They were almost always more positive with respect to effects on profitability. This bodes well for future adoption as cooperators appeared to be acknowledging the net financial benefits of implementation of even the less familiar practices.

3. In general, cooperators agreed that five to ten years was a realistic time frame for achieving a satisfactory comfort level with conservation planting equipment. This took into consideration extremes in weather, shifting weed populations, fine-tuning equipment to variable soil textures and moisture conditions, and the application of conservation planting to all crops in the rotation. Some suggested a three-year time frame may be adequate for developing confidence in no-till wheat production.

4. When asked about their post PWS conservation intentions, a strong majority of farmers in both the test and control watersheds intended to increase or maintain the same acreage under conservation practices. The primary exception to this was the adjusted or modified moldboard plow which many said they would either discontinue or didn't know whether they would continue. Seventy-four percent of the test cooperators and 38% of control cooperators said they would maintain or increase their acreage under no-till.

Monitoring

Watersheds were fully instrumented and monitored from late 1988 until June 1992. Residue management in the test watershed resulted in generally higher cover levels in test watersheds over the course of the study. In the latter stages of the study, test watershed cover exceeded control watershed cover by an average of 17%.

Climate

During the study monitoring period (1989-1992) the precipitation deviated significantly from normal trends. While above average or average precipitation was desired in order to rigorously test the conservation systems implemented, well below normal precipitation was experienced in 1989, 1991 and the first six months of 1992. Winter precipitation and snowfall were well below normal resulting in minimal snow cover and modest spring melt events. Severe storms were rare during the study period. Precipitation was near normal in 1990 on the whole and exceeded the normal precipitation during the later summer months.

Test and control watershed pairs experienced very similar weather throughout the study although total event precipitation did differ significantly on occasion.

Hydrology

Streamflow was measured continuously by the Water Survey of Canada at the watershed mouths. Surface run-off was monitored at field scale monitoring sites from most of the significant precipitation events. Total run-off generated from 1 metre square plots during simulation storms was measured and recorded. Watershed scale, field scale and plot scale run-off behaviour was examined and compared between corresponding test and control sites. Run-off was also related to conservation system effects using cover (live and dead) as the primary independent variable to determine whether run-off increases or decreases under conservation tillage.

In Essex, watershed and field scale run-off increased under conservation systems while plot scale studies indicated a general reduction in run-off. In Kettle Creek, watershed scale evaluations indicated a reduction in run-off with increased cover while plot scale evaluations indicated the reverse. The field scale evaluations in Kettle Creek were inconclusive.

In Pittock, the watershed scale and field scale studies were inconclusive, partly due to a lack of data. Pittock was generally drier, producing fewer significant run-off events. Plot scale studies in Pittock indicated a positive relationship between cover and run-off.

Plot scale studies in Essex also indicated that, in general for pre-plant periods, total run-off was highest from control plots with less plant residue and run-off from the control plots exceeded run-off from other times. In Kettle Creek test plot run-off generally exceeded control plot run-off during pre-plant and post tillage periods when test plot residues were highest. No differences were observed for post harvest times when cover was similar in both set of plots.

In Pittock, test run-off exceeded control run-off during post tillage periods when residues differed significantly.

Pre-plant period run-off was generally highest for all areas combined. Post tillage run-off from control plots was generally the lowest due to high surface detention storage and surface roughness.

Overall, test plot run-off exceeded control plot run-off in this aspect of the study.

Water Quality Loadings
A continuous record of water quality loadings was generated for each watershed, for events at the field scale, and for each rainfall simulation measurement.

In Essex, the watershed scale total suspended solids (TSS) and total phosphorus (TP) data indicated that a trend to improvement in the test watershed may have started in 1991 and continued through the first half of 1992. However, this observation was not statistically significant as test and control unit area loadings have been very similar throughout the study. At the field scale a definite inverse relationship between cover (live and dead) and TSS and TP loadings has been identified. The relationship shows that as event run-off increases the improvement in run-off water quality in the test watershed over the control increased. That is, the benefit afforded by cover becomes most evident during more extreme precipitation events. At the plot scale, control plot run-off of TSS and TP is significantly higher than the test plot run-off in the pre-plant and post tillage periods.

Run-off loadings during the post harvest period, when cover levels are similar, is not significantly different between test and control plots. Rainfall simulation measurements also indicated that run-off loadings are highest during the pre-plant period for both test and control plots.

In Kettle Creek, at the watershed scale, a similar trend, as observed in Essex, may be in effect. The 1991 and 1992 test watershed loadings tended to decrease relative to the control loadings especially for TSS. While these results are not statistically significant, the trend is positive. The field scale studies show a marked improvement in run-off loadings for TSS and TP from test fields when compared to control fields at high run-off flow rates. In Kettle Creek, the positive benefit is shown to occur only for high flow events.

The plot scale studies for Kettle Creek are similar to those for Essex. Control run-off loadings for TSS and TP are significantly higher than test plots during the post harvest and pre-plant periods. Post tillage run-off loadings are low and not significantly different. While improvements in test run-off loadings are significant they are not as pronounced as in Essex. Pre-plant and post-tillage periods generated the most run-off loadings of TSS and TP in both test and control plots.

At the watershed scale, Pittock test loadings of TSS and TP were lower than control in 1990 when the test watershed achieved the highest cover values, exceeding overall cover in the control watersheds. Test watershed cover decreased in 1991 and 1992 reflecting a lower level of cooperator enthusiasm in Pittock. A comparison of watershed loadings between test and control after 1990 was not statistically significant. The Pittock area received less precipitation and much fewer field scale surface run-off events. Only one of four microbasins had sufficient data to evaluate the effect of cover on run-off loadings of TSS and TP. That field scale site indicated that TSS and TP loadings were inversely related to cover, as hoped. At the plot scale the overall loadings of TSS and TP were highest from the control plots. This was due to high control plot loadings during the pre-plant period. Run-off loadings of TSS and TP for the post-harvest and post tillage periods were significantly higher from test plots although overall loads were low during these periods.

Generally, cover was shown to reduce run-off loadings of TSS and TP from watersheds, fields and plots. Results at the plot and field scale are statistically significant. At the watershed scale, general improvements in test watersheds over control watersheds may be in effect over the last 12 to 18 months of the study. These trends are not statistically significant. These observed trends coincide with the management of higher crop residue levels in test watersheds. These results are highly positive in light of the fact that these evaluations have been conducted for a transition period and more dramatic improvements in test watershed loadings relative to control watersheds is likely as soil quality and farmer confidence and familiarity are improved.

Comments:

It is unfortunate that this study was conducted over a relatively short period of time. Some trends were beginning to emerge but the limited amount of data made it difficult to draw any definite conclusions regarding effectiveness at the watershed scale. Smaller scale research areas identified positive environmental benefits. Ideally the study could have monitored the watersheds for three years years while conservation tillage was being implemented and then for three to five years after implementation. In this study the entire monitoring period was an adoption-transition phase in terms of soil structure and social factors such as farmer education and farm management. The study did not run long enough to allow for collection of data from the watersheds during a post-transition period.

The two years of abnormal weather (generally low precipitation amounts for the period) made it difficult to build a large base of information for use in evaluation of the conservation tillage system. The watersheds generally did not experience extreme precipitation events which are necessary to test the systems in place.

Associated SWEEP/LSP Research:

SWEEP Report # 69 - Basin Selection, Study Area and Climate (Volume I)
SWEEP Report # 70 - Implementation of Conservation Technology (Volume II)
SWEEP Report # 71 - Evaluation of Conservation Systems: Social Factors (Volume III)
SWEEP Report # 72 - Evaluation of Conservation Systems: Soil Quality and Crop Parameters (Volume IV)
SWEEP Report # 73 - Evaluation of Conservation Systems: Basin Hydrology (Volume V)
SWEEP Report # 74 - Evaluation of Conservation Systems: Water Quality (Volume VI)
SWEEP Report # 75 - Evaluation of Conservation Systems: Modelling (Volume VII)
SWEEP Report # 76 - Program Recommendations and Conclusions (Volume VIII)
SWEEP Report # 62 - Volume I - An Economic Evaluation of Soil Conservation Technologies, Summary Report
SWEEP Report # 63 - Volume II - Collection and Analysis of Field Data From Pilot Watershed Studies
SWEEP Report # 64 - Volume III - Field Level Economic Analysis of Changing Tillage Practices in Southwestern Ontario
SWEEP Report # 67 - Volume VI - Watershed Level Economic Analysis of Changing Tillage Practices in Southwestern Ontario

Future Research: **( ) indicates suggestion for priority, A - high, C - low.**

(A) The watershed studies should be continued for three to five more years to evaluate the test following the adoption period. This is consistent with the time frames for agricultural watershed scale studies conducted else where in North America.

Report # N/A

Report Name: Tillage 2000, 1985 - 1990

Researcher: J.D. Aspinall, Resource Management Specialist, Ontario Ministry of Agriculture and Food, Guelph, Dr. R.G. Kachanoski, Associate Professor, Department of Land Resource Science, University of Guelph, Guelph, Ontario

Date: December, 1992

Key Words: corn, soybeans, winter wheat, small grains, yield (machine and hand), no-till, conventional tillage, ridge till, Tillage 2000, conservation tillage, soil landscape units, benchmark, soil properties, topographic properties, crop growth characteristics, minimum tillage, percent residue cover, soil texture, eroded soils, economics, net returns

Summary: The objectives of this project are:

1. to determine the variations in crop yield response to soil landscape variability under different tillage systems;
2. to relate variations in crop yield response to intrinsic soil properties;
3. to determine the relative rates of soil erosion and phosphorus delivery in various landscape positions under the different tillage systems;
4. to provide a basis for designing subsequent experiments dealing with strategies to manage farm field variability under different soil conditions and farm systems so as to enhance productivity while minimizing soil erosion and phosphorus delivery; and
5. to investigate the causes and extent of severe shoulder slope erosion.

This project was a cooperative effort by the Ontario Ministry of Agriculture and Food (OMAF), the Department of Land Resource Science, University of Guelph, and the Ontario Soil and Crop Improvement Association (OSCIA). The project began in 1985 with the identification of 23 farm cooperators and up to 40 farmers per year participated over the life of the project.

A paired sampling design was established on each of the field scale study sites because of the interaction between tillage and soil landscape on measured crop yield. A number of permanent paired benchmark plots (6m x 6m) were established for collection of data from each tillage system. For each treatment, information regarding field history and major aspects of field work operations were recorded. A detailed characterization of soil and topographic properties was undertaken in 1986. In addition to these measurements, crop data was collected every year from each benchmark.

Average surface residue cover after planting was 10%, 29%, and 55% for the moldboard, minimum and no-till tillage systems respectively.

Soil texture (Ap horizon) class and tillage x texture class interactions were significant (0.001 probability) in explaining the variations in yield of all crop types. A regression of the ratio of no-till yield/conventional tillage yield against %sand content of the Ap horizon was significant. For sand contents greater than

36% the no-till yield would on average be higher than the conventional tillage system. The no-till yield for finer textured soils would on average be lower than conventional tillage systems. The interaction of tillage and texture is suggested as the reason for little overall differences in tillage system on crop yield, across all farm sites.

Across all years, conservation corn yields averaged one percent less than the conventional yields. Soybean and small grain conservation yields were, on average, 3% less than the conventional yields. None of the observed differences were statistically significant. Grain corn conservation tillage machine yields exceeded the conventional yields 3 out of 5 years. Although the lowest yields were harvested in 1988 the average conservation yield exceeded the conventional corn yields.

For all crops minimum tillage yields were 3 and 2 percent less than moldboard yields for the machine and benchmark harvests respectively. Minimum tillage yields never exceeded moldboard yields for any of the individual crops. The machine yields show that on average no-till grain corn yields were as good as the moldboard and the minimum till yields. No-till soybean yields when compared to the moldboard yields were equal. The hand yields indicate that no-till was successful for grain corn and small grains when compared to minimum tillage.

There was a significant interaction between soil texture and the success of conservation tillage systems. For sandy textured soils, the 5 year average machine yield was 7% higher for the conservation versus conventional systems. Machine yields in clay and to some extent in clay loam soils were lower (6%) in the conservation systems. Yields were similar in other soil textures.

Minimum tillage relative to moldboard plowing was the most successful on the silt loam soils and less successful on the other textures, especially the clay soils.

The data indicated a variable success for the no-till versus moldboard in the medium texture classes (loam, silt loam, clay loam). No-till had much higher yields (15%) than the moldboard in the sandy soils and much lower yields in the clay soils.

The data indicated a trend of decreasing no-till yields relative to minimum till yields with increasing clay content (decreasing sand). Similar yields were obtained for loam and silt loam texture classes. Sandy soils had significantly higher yields in no-till; clay loam and clay soils had significantly lower yields in no-till. This was similar to the moldboard versus no-till data.

Comparisons of the differences in the final corn populations (5 year average) between tillage pairs revealed that the conservation tillage system's populations were significantly less than the conventional populations.

For all conservation treatments averaged over 5 years the average grain corn leaf count, was approximately one-half to one leaf less than the conventional treatments. Similarly, the height of corn plants for the conservation systems were found to be about 4 to 9% less than the conventional systems.

Soybean conservation populations were not statistically significantly different from the conventional populations. The minimum tillage populations were slightly above the moldboard stands. No-till populations were essentially equal to the minimum and moldboard populations. Plant heights were significantly reduced by as much as 18% for both the minimum and no-till soybeans when compared to the moldboard system.

The small grain population of the minimum tillage when compared to the moldboard tillage system was 2% less. No-till populations were 12% lower than the moldboard and the minimum tillage systems. This was statistically significant for the moldboard versus no-till comparison. Differences in leaf counts were not observed for any of the tillage comparisons.

A paired benchmark analysis on crop response on stress (low yielding) and non-stress (high yielding) benchmarks, in stress and non-stress growing conditions was carried out. It indicated that conservation tillage systems may be more buffered against adverse climatic growing conditions than conventional tillage systems. The field yield data also indicated that the ratio of conservation yield/ conventional yield was highest in 1988 the drought stress year.

There was a significant interaction of soil texture class and soil loss, on relative crop yield losses. Severely eroded soils with a % sand content greater than 70% had an average predicted yield loss of 37% of the field average yield. Severely eroded soils with 50-70% and <20% sand content had an average predicted yield loss of 8% of the field average yield. The benchmarks in the medium textured classes had much less predicted yield loss from soil loss, than the benchmarks with lighter or finer soil textures. This is consistent with the higher available water holding capabilities of medium textured soil compared to other textures.

Comparing only yields from tillage systems may not be appropriate when certain tillage systems have significantly lower pre-harvest production costs.

The data in the Tillage 2000 project indicate that it should be possible to implement a conservation tillage system with no loss in yield productivity or economic return, in all but the heavier textured soils. This is especially true for sandy textured soils were increases in yield are likely under conservation tillage.

The net returns per labour hour were, on average, always higher for the minimum and no-till tillage systems for all crops except for minimum tillage soybeans when compared to the moldboard. The highest returns per labour hour were observed for no-till corn. See SWEEP Report # 11 "An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1989) for more information.

Comments: This is an excellent report. All of the objectives were met either in this report or in the parts of the project which were funded by the Technology Evaluation and Development section of SWEEP. This project is the only one of its kind to successfully conduct research on field scale plots on farms in Ontario.

The direct involvement of the farmer (planting, harvesting, etc. with his own equipment) and extension staff (OMAF and others) provided the following benefits:

- the farmers and extension staff involved gained experience with conservation tillage systems
- the extension staff involved were able to provide expertise to the farmers involved
- the extension staff and the farmers involved were able to communicate the results of the project to the farm community as they became available

- tillage plots were established in several communities across the province giving other farmers the opportunity to see conservation tillage systems first hand
- farmers put more faith in machine harvested yields from field size plots
- it demonstrated that a field scale research design would work and it gained farmer and researcher credibility
- it provided the first field scale research data for conservation **systems** in Ontario

Associated SWEEP/LSP Research:

SWEEP Report # 1 - Tillage 2000 and Its Effect on Awareness of Conservation Tillage
SWEEP Report # 10 - An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1988)
SWEEP Report # 11 - An Economic Evaluation of Tillage 2000 Demonstration Plot Data (1986-1989)
SWEEP Report # 32 - Optimal Herbicide Use in Conservation Tillage Systems
SWEEP Report # 38 - Management of Farm Field Variability, I. Quantification of Soil Loss In Complex Topography, II. Soil Erosion Process On Shoulder Slope Landscape Positions.
SWEEP Report # 40 - Management of Mulch Tillage Systems on Clay Soils
SWEEP Report # 41 - Evaluation of Row Crop Planter Modifications for Corn Production within Conservation Tillage Systems
SWEEP Report # 45 - Management of Farm Field Variability, III. Effect of Tillage Systems on Soil and Phosphorus Loss
SWEEP Report # 46 - Management of Farm Field Variability, IV. Crop Yield, Tillage System and Soil Landform Relationships
OMAF - Tillage 2000 Progress Reports

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(A) More research needs to be done to improve conservation tillage yields on the clay and clay loam soils.

Report # N/A

Report Name: Conservation Tillage Handbook - Equipment Modifications and Practical Tips for Use

Researcher: J. Sadler Richards, Ecologistics Ltd, Waterloo, Ontario and Ontario Ministry of Agriculture and Food

Date: October, 1989

Key Words: conservation tillage, equipment modifications, no-till, minimum tillage, mulch tillage, ridge tillage, moldboard plow, chisel plow, seed drills, row crop planters, disc

Summary: The handbook takes a pictorial look at conservation tillage equipment such as: modified moldboards, chisel plows, minimum till equipment, conservation seed drills, conservation row crop planters, and ridge till equipment. It highlights modifications to the various pieces of equipment and gives some practical tips on how to use the equipment in the field.

Comments: The handbook is an excellent approach to showing farmers some of the conservation equipment available, modifications to make the equipment more useful and some practical tips for use. It is ideal for a beginning farmer to review and get some general information on equipment.

New technology has developed since this book was written which dates this publication. The handbook only looks at equipment which is a small part of a conservation system. Other factors must be considered to make the system work.

Associated SWEEP/LSP Research:

SWEEP Report # 13 - The Effect of Moldboard Shape on the Residue Management Potential of the Moldboard Plow
SWEEP Report # 20 - Conservation Tillage Equipment: Availability, Utilization and Needs
SWEEP Report # 31 - Field Scale Tests of Modified Moldboard Plow
SWEEP Report # 40 - Management of Mulch Tillage Systems on Clay Soils
SWEEP Report # 41 - Evaluation of Row Crop Planter Modifications for Corn Production within Conservation Tillage Systems
SWEEP Report # 42 - Report on Development and Operation of the Cross-Slot Planter

Future Research: **( ) indicates reviewers suggestion for priority, A - high, C - low.**

(C) Update the handbook to include new equipment/modification ideas as technology evolves.

APPENDIX I

LAND STEWARDSHIP PROGRAM

The Land Stewardship Program was a three-year program, September 1, 1987, to August 31, 1990, to provide grants for the adoption of conservation farming practices on Ontario farmland - practices that would enhance and sustain agricultural production and improve and protect our soil and water resources. The Ontario Ministry of Agriculture and Food program provided assistance that encouraged farmers to adopt practical, cost-effective conservation farming systems and promoted the development of a long term commitment towards a stewardship ethic. The intent was to improve soil resources and water management by reducing soil erosion and compaction, restoring soil organic matter and tilth, and reduced the potential for environmental contamination arising from agricultural practices.

The Land Stewardship Research Program was intended to assist in achieving the goals of the overall program by adding to the current base of knowledge, by providing extension staff with recommendations and assisting farmers in the adoption of conservation practices. Total funds available over the three year period were $2.25 million. This program was not part of SWEEP.

LAND STEWARDSHIP PROGRAM RESEARCH

Project Title	Researcher & Institution
Agroforestry Research & Development	Dr. A. Gordon, Dept. of Environmental Biology, U. of Guelph, Guelph N1G 2W1
Management Of Fine Textured Poorly Drained Soils For Intensive Agriculture	Dr. J. Stone, Agriculture Canada Research Branch, Harrow NOR 1GO
Agroforestry Research In Ontario	C. Nanni, Ridgetown College of Agricultural Technology, Ridgetown, NOP 2CO
Soil Stewardship Cropping Systems For Corn & Soybean Production In Ontario	Dr. B.D. Kay, Dept. of Land Resource Science, U. of Guelph, Guelph N1G 2W1
Crop Rotations & Cover Crop Effects On Erosion Control, Tomato Yields & Soil Properties In Southwestern Ontario	R. Johnston, Ridgetown College of Agricultural Technology, Ridgetown, NOP 2CO
Management Of Fine Textured Poorly Drained Soils For Intensive Agriculture: Characterization Of A Forage Factor - Part I	Dr. A. Oaks, Biology Dept., McMaster University, Hamilton L8S 4K1
Management Of Fine Textured Poorly Drained Soils For Intensive Agriculture: Characterization Of A Forage Factor - Part II	Dr. J. Stone, Agriculture Canada Research Branch, Harrow NOR 1GO
Differences In Soil Conservation Between Operator-Owned and Rented Land	Dr. W. Van Vuuren, Agricultural Economics & Business, U. of Guelph, Guelph N1G 2W1

A Cover Cropping Strategy For First Early Potato Production	Dr. A.W. McKeown, Horticultural Experiment Station, Box 587, Simcoe N3Y 4N5
To Investigate The Establishment, Subsequent Growth And Erosion Control Potential Of Certain Tree & Shrub Species On Gully And Stream	A. Skepasts, New Liskeard College of Agricultural Technology, New Liskeard POJ 1PO
Crop Rotation Effects On Crop Yields And Soil Properties In Southwestern Ontario	C.K. Stevenson, Ridgetown College of Agricultural Technology, Ridgetown NOP 2CO
Improving The Degraded Structure Of Fine Textured Soils With Deep Tillage & Grass & Legume Crops	C. Wiel, Alfred College of Agriculture and Food Technology, Alfred POJ 1PO
Improving The Degraded Structure Of A Clay Loam Soil With Deep Tillage & Grass & Legume Crops	W. Curnoe, Kemptville College of Agricultural Technology, Kemptville KOG 1JO
Farm Shelterbelt Design & Demonstration	Dr. V. Chanasyk, School of Landscape Architecture, U. of Guelph, Guelph N1G 2W1
Crop Production With A No-Traffic Tillage System	D.S. Young, Ridgetown College of Agricultural Technology, Ridgetown NOP 2CO
Response Of The Soil Microflora & Fauna To Spring Plowing Of Zerotill & Pasture Soils	Dr. V.G. Thomas, Dept. of Zoology, U. Of Guelph, Guelph N1G 2W1
Cropping & Soil Management Effects On The Dynamics Of Crop Residue Derived-N On the Coarse Textured Soils In Southern Ontario	R.P. Voroney, Dept. of Land Resource Science, U. of Guelph, Guelph N1G 2W1
Nitrogen Research With Corn Using Conservation Tillage	C.K. Stevenson, Ridgetown College of Agricultural Technology, Ridgetown NOP 2CO
The Effects Of Soil Compaction On The Production of Processing Vegetables And Field Crops - A Review	C.K. Stevenson, Ridgetown College of Agricultural Technology, Ridgetown NOP 2CO
Nitrogen Conserving Farm Systems	G. Kachanoski, Dept. of Land Resource Science, U of Guelph, Guelph N1G 2W1

APPENDIX II

Other SWEEP Reports (Not Included in the Summaries)

SWEEP Report # 61 - Final Report of the Technology Evaluation and Development (TED) Sub-Program of the Soil and Water Environmental Enhancement Program (SWEEP), October 1992.

SWEEP Report # 78 - Changes in Cropping, Tillage and Land Management Practices in Southwestern Ontario for 1986 and 1991, April 1993.

KEY WORD INDEX

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