Green Plan Research Workshop

Summaries and Minutes of Meetings

Ramada Inn
LONDON, Ontario

March 22 - 23, 1994

FORWARD

This report is one of a series of **COESA** (Canada-Ontario Environmental Sustainability Accord) reports from the Research Sub-Program of the Canada-Ontario Green Plan. The **GREEN PLAN** agreement, signed Sept. 21, 1992, is an equally-shared Canada-Ontario program totalling $64.2 M, to be delivered over a five-year period starting April 1, 1992 and ending March 31, 1997. It is designed to encourage and assist farmers with the implementation of appropriate farm management practices within the framework of environmentally sustainable agriculture. The Federal component will be delivered by Agriculture and Agrifood Canada and the Ontario component will be delivered by the Ontario Ministry of Agriculture and Food and Rural Assistance.

From the 30 recommendations crafted at the Kempenfelt Stakeholders conference (Barrie, October 1991), the Agreement Management Committee (AMC) identified nine program areas for Green Plan activities of which the three comprising research activities are (with Team Leaders):

1. **Manure/Nutrient Management and Utilization of Biodegradable Organic Wastes** through land application, with emphasis on water quality implications
   A. Animal Manure Management (nutrients and bacteria)
   B. Biodegradable organic urban waste application on agricultural lands (closed loop recycling) (Dr. Bruce T. Bowman, London Research Centre, London, ONT)

2. **On-Farm Research**: Tillage and crop management in a sustainable agriculture system. (Dr. Al Hamill, Harrow Research Station, Harrow, ONT)

3. **Development of an integrated monitoring capability** to track and diagnose aspects of resource quality and sustainability. (Dr. Bruce MacDonald, Centre for Land and Biological Resource Research, Guelph, ONT)

The original level of funding for the research component was $9,700,000 through Mar. 31, 1997. Projects will be carried out by Agriculture and Agrifood Canada, universities, colleges or private sector agencies including farm groups.

This Research Sub-Program is being managed by the Pest Management Research Centre, Agriculture and Agrifood Canada, 1391 Sandford St., London, ONT. N5V 4T3.

Dr. Bruce T. Bowman
Scientific Authority

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PREFACE

Research Component of the Green Plan

The GREEN PLAN agreement, an equally-shared Canada-Ontario program, totalling $64.2 M, is designed to encourage and assist farmers with the implementation of appropriate farm management practices within the framework of environmentally sustainable agriculture. It is to be delivered over a five-year period starting April 1, 1992 and ending March 31, 1997. Under the agreement signed Sept. 21, 1992, the Federal component will be delivered by Agriculture Canada.

From the 30 recommendations crafted at the Stakeholder conference (Kempenfelt Centre, Barrie, October 1991), the Agreement Management Committee (AMC) have identified 10 program areas for Green Plan activities of which the three comprising research activities will be administered for Agriculture Canada by the London Research Centre. Projects will be carried out by Agriculture Canada, universities, colleges or private sector agencies including farm groups. The level of funding will total $7,760,000 through Mar. 31, 1997.

Sub-program Description

The research program areas are:

1. Manure/Nutrient Management and Utilization of biodegradable organic wastes through land application, with emphasis on water quality implications

    A. Animal manure management (nutrients and bacteria)

    B. Biodegradable organic urban waste application on agricultural lands (closed loop recycling)

2. On-farm research: Tillage and crop management in a sustainable agriculture system

3. Development of an integrated monitoring capability to track and diagnose aspects of resource quality and sustainability.

AGENDA
Green Plan Workshop
Ramada Inn
817 Exeter Road
London, ONT

Tuesday, March 22, 1994.

Noon -1:00 pm **Registration.**

1:00-1:10 pm **Welcome - Bruce Bowman**

1:15-2:15 pm **<u>Manure Handling & Closed Loop Recycling</u>**
Leader: Dr. Bruce Bowman

- **Literature Search on Manure/Nutrient Management**. Dr. Michael Goss, University of Guelph, Guelph, ONT
- **Nitrogen & Carbon Transformations in Conventionally-Handled Livestock Manures**. Dr. Gary Kachanoski, Environmental Soil Services, Guelph, ONT
- **Manure Composting Techniques: Understanding N and C Conservation** Mr. Richard St. Jean, Ecologistics Limited, Waterloo, ONT
- **Transformations in Soil: Crop Response to Nitrogen in Manures with Widely Different Characteristics**. Dr. E. G. Beauchamp et al, University of Guelph, Guelph, ONT
- **Impact of Manure Application Methods on Water Quality, Focusing on Nitrogen and Bacteria Transport in Soil**. Dr. Greg Wall, C.L.B.R.R., Guelph, ONT
- **Composted Biodegradable Organic Urban Waste Application on Agricultural Lands**. Ms. Valerie Alder, Ecological Services For Planning, Guelph, ONT
- **Soil Organisms as Bioindicators of Agronomic Practices.** Dr. Al Tomlin, London Research Centre, London, ONT

2:15-3:00 pm **<u>On Farm Research</u>**. Leader: Dr. Al Hamill

- **Literature Review of Methods Used to Conduct and Evaluate On-Farm Research**. Ms. Jane Sadler-Richards, Ecologistics Limited, Waterloo, ONT
- **Investigating Methods of Integrating Liquid Manures into a Cropping System and the Effect on Soil and Water Quality**. Mr. George Schell, Ecological Services For Planning, Guelph, ONT
- **Environmental Effects of Conservation and Conventional Cropping Systems**. Ms. Jane Sadler-Richards, Ecologistics Limited, Waterloo , ONT

- **Determining the Factors Responsible for, and Methods to Overcome the Limitations of Conservation Cropping Systems on Clay Soils**. Dr. Tony Vyn, University of Guelph, Guelph, ONT
- **To Obtain Information on Variable Rate Technology for Nitrogen Application and Determine the Feasibility of Implementing this Production Tool** Dr. Gary Kachanoski, University of Guelph, Guelph, ONT

3:00-3:15 pm Break

3:15-3:45 pm

- **Measuring the Effect of Crop Residue or Live Cover Crops in Conservation Tillage Systems on Soil and Water Quality**, Dr. Ian Van Wesenbeeck, Harrow Research Station, Harrow, ONT
- **Crop Rotations and Cover Crop Effects on Tomato Yields and Soil Properties in Southwestern Ontario**, Mr. R. W. Johnston, Horticultural Soil Management, Ridgetown, ONT

3:50- 5:30 pm **Development of an Integrated Monitoring Capability**. Leader: Dr. Bruce MacDonald

Development of Standard Methodologies:

- **Resident Biomass and Organic Carbon** (current measures as an indicator of agro-ecological fitness) Mr. David Charlton, Ecological Services For Planning, Guelph, ONT
- **Resident Biomass and Organic Carbon** (including 75 landscapes from Tillage-2000 plots) Dr. Gary Kachanoski, Environmental Soil Services, Guelph, ONT
- **Bio-indicators and Methodologies to Quantify Soil Quality.** Dr. C. M. Monréal, CLBRR, Ottawa, ONT

State of Resources:

- **A proposal to Assess the State of Agricultural resources: Improving the Land Resource Database** (Regions of Waterloo and York (Whitchurch-Stouffville)) Mr. D. Cressman, Ecologistics Limited, Waterloo, ONT
- **Proposal for the Upgrade of Soil Survey Information in Oxford County**. Mr. D. Charlton, Ecological Services For Planning, Guelph, ONT
- **Development and Application of Standardized Methodology for Sampling Soil Landscape Polygons**. Mr. J. Hagarty, Ecological Services For Planning, Guelph, ONT
- **Development and Testing of "State of Agricultural Resources", A Reporting and Monitoring Methodology for Ontario**. Harold Moore, Gregory Geoscience Limited, Kanata, ONT

- **Monitoring Soil Loss and Redistribution Using ^{137}Cs**. Dr. Gary Kachanoski, Environmental Soil Services, Guelph, ONT

Partitioning of Solutes:

- **Partitioning of Solutes from Agricultural Fields within the Hydrologic System at Two Sites in Southern Ontario and the Subsequent Impact on Adjacent Aquatic Ecosystems**, Dr. David Rudolph, University of Waterloo, Waterloo, ONT

- **Development and Application of a Computerized System to Manage, Use and Distribute Data Collected by Green Plan Monitoring Research Projects**. Mr. Ken Denholm, **Guelph**, ONT

5:30-6:30 pm - Social Hour

6:30 pm - Banquet Speaker: Dr. Doug. Hoffman

Wednesday, March 23, 1994.

8:30 - 10:15 am **Individual Group Discussions - Breakout Rooms.**

- **Manure Handling & Closed Loop Recycling** - Leader: Dr. Bruce Bowman

- **On Farm Research.** - Leader: Dr. Al Hamill

- Development of an Integrated Monitoring Capability. - Leader: Dr. Bruce MacDonald

10:15 - 10:30 am Break

10:30 - Noon **Group Discussions (resume)**

Noon **- Adjournment.**

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1.0 Manure/Nutrient Management & Closed Loop Recycling

1.1 Title: Literature Search on Manure/Nutrient Management

Contractor: Dr. Michael Goss, Department of Land Resource Science, University of Guelph, Guelph, ONT, N1G 2W1

ABSTRACT:

This report has been prepared to determine the current state of the art of manure management in Ontario in relation to concerns in the farm community and amongst the general public. It is intended to serve as a guide for coordination of the research, extension and implementation programs need to overcome current problems in manure management. Following an introductory chapter, a detailed assessment of current knowledge is presented using a framework that follows manure from the point of excretion to the point of utilization in crops. The third chapter presents areas of actual or recently completed research in Canada. The fourth chapter is a review of three manure systems workshops held in Woodstock, Port Perry and Kemptville. The workshops were intended to gather information on the views of the agricultural community on the perceived problems associated with manure management, and to solicit solutions. The current knowledge base, together with the on-going research projects and the input from the agricultural community, provides the basis for identifying priority needs for research and extension. A priorized assessment of these needs in presented in Chapter five. Twelve key objectives were identified for research and extension needs on manure management in Ontario over the next five years:

1. Develop extension packages to assist farmers in making more effective use of nutrients in manure.
2. Establish a research programme involving engineers, animal scientists, agronomists, soil scientists and economists to develop a comprehensive framework by which alternative manure management systems can be compared.
3. Establish the relation between environmentally safe and most profitable rates of manure application to cropland, taking account of the method and time of applications. This also requires the development of more acceptable manure application methods in conservation tillage systems.
4. Develop the means of predicting the composition of the major types of poultry, pig and cattle manures, based on feeding regimes.
5. Improve nitrogen application recommendations for different crops based on a soil N test, taking into consideration the losses of NH_3 with different times and methods of manure application.
6. Develop practical cost-effective methods for managing manure odours from farm systems. This should include seeking means by which the hazard to human or animal health from toxic gases, such as H_2S, can be relieved in different manure systems, and developing better engineered and economic manure management systems that minimize gaseous losses from manure.
7. Investigate the transformations of manure N following addition to soil to provide more accurate estimates of the denitrification (NO_x gas losses), mineralization and immobilization processes that are agronomically and environmentally important.
8. Investigate and develop the ability to predict the transformations of manure N during storage and/or composting to characterize the impact on availability of N to crops, the potential for nitrate leaching, and gaseous losses of NH_3 and NO_x, together with CO_2 and CH_4.
9. Examine the potential for reducing the nutrient content of manures using improved feeding programmes, including use of feed additives.
10. Assess on-farm economics of different manure management systems in direct association with research on storage, application and utilization of manure.
11. There is a need to assess off-farm costs due to environmental impacts, but this should not be developed solely with respect to manure management. However, the information on environmental degradation associated with alternative manure management systems must be quantified to allow the costs to be determined.
12. Develop the means by which the deterioration of livestock facility structures by gasses produced from manure can be minimized.

1.2 Title: Nitrogen & Carbon Transformations in Conventionally-Handled Livestock Manures.

Contractor: Dr. Gary Kachanoski, Environmental Soil Services, 361 Southgate Drive, Guelph, ONT. N1G 3M5

ABSTRACT:

Annual Report for 1993/94. c/o Gary Kachanoski, Dean Barry

One requirement for improving predictions of available N in manure is a better understanding of how manure storage and handling practices affect manure composition. Objectives of the current project are to document current knowledge on N and C transformations during handling and storage of manure, investigate the effects of selected manure systems on manure quality, identify manure storage and handling practices that promote efficient nutrient use, and provide an economic assessment of the manure systems investigated. A survey of literature indicated that interactions between manure composition and N availability are not well understood. Manure handling and storage systems have been documented for four farm sites (semi-solid dairy manure, solid poultry manure, liquid swine manure, solid dairy manure) and the dairy and beef cattle research centres at the Elora Research Station. Manure samples have been collected from various stages of the manure handling systems at each site and used to develop methodology for analyses of various C and N compounds that are likely to control the quality of manure in relation to crop growth. Analyses of manure samples included the standard procedures used when a farmer submits a manure sample. Methodology for feed analysis was adapted for manure to determine lignin, cellulose, and hemicellulose. Rates of CO_2 and N_20 evolution under aerobic and anaerobic conditions were determined for selected manure samples in the laboratory. Concentrations of volatile fatty acids (acetic, butyric, isobutyric, and propionic acid) in liquid manure and in K_2SO_4 extracts of solid manure were determined by gas chromatography. Incubation of sand-manure mixtures for up to 32 days was conducted to characterize mineralizable C and N in the manures. Rates of CO_2 evolution during incubation were used to calculate total mineralizable C in manure by a first order rate equation. A freeze-thaw manure treatment suggested that use of fresh samples is preferable to use of previously frozen samples both for general analyses and incubation studies. Changes to the incubation methodology, including periodic leaching with a nutrient solution, are suggested. Future work involves selecting 2 manure handling systems per year (3 years) and measuring the C and N transformations as the manure passes through the handling system. A complete inventory will be done of equipment, time, labour and other information required for an economic analysis of each handling system.

1.3 Title: Manure Composting Techniques: Understanding N and C Conservation

Contractor: Mr. Richard St. Jean, Ecologistics Limited, 490 Dutton Drive, Suite A1, Waterloo, ONT, N2L 6H7

ABSTRACT:

This project involves the monitoring of 16 manure composting processes with respect to nitrogen and carbon conservation . Each of the processes will be conducted at farm scale and replicated three times. Manures from beef, dairy, and poultry operations will be used for the monitored processes.

The experimental program has been set up to examine nitrogen, carbon, and other nutrient transformations and losses as affected by composting technology, air exchange rate, moisture level, bedding type, ration, and nutrient addition from barnyard runoff.

On line monitoring of carbon dioxide, and ammonia in the compost off gas, and oxygen content, moisture content and temperature of the composting manures will be carried out for all 16 trials. The raw manures and finished composts will be sampled and analyzed for dry matter, volatile solids, ash, organic carbon, total carbon, total nitrogen, ammoniacal nitrogen, nitrate nitrogen, nitrite nitrogen, phosphorus, potassium, pH, and in limited cases bacterial biomass carbon and nitrogen. The manure samples and finished composts will also be subjected to leaching tests, using distilled water as the leaching agent. Leachates will be analyzed for total nitrogen, ammoniacal nitrogen, nitrate nitrogen, nitrite nitrogen, phosphorus, and potassium. The relative leaching potential of the raw manures and compost will be compared based on the leaching tests.

Composting trials will be carried out using passive aeration technology for 6 trials, static pile forced aeration technology for 2 trials, mechanically mixed forced aeration technology for 4 trials and turned pile methods for 4 trials. Three of the turned pile methods are variations used on "ecologically operated farms".

All of the passive aeration and static pile forced aeration processes will be conducted on weigh scale platforms to monitor weight changes due to moisture and carbon dioxide losses during the composting process. The monitored weight changes will also provide an accurate means of preparing mass balances for the analyzed parameters. Mass balances for all analyzed parameters will be prepared based on conservation of ash principles and where appropriate compared to balances established based on actual total weight changes.

The use of composted manure as a bedding material for beef cattle and the effect on subsequent manure and composting processes will be investigated as part of the project. The use of barnyard runoff as a moisture source for composting manure will also be investigated. These two aspects will affect the integration of composting into farm manure management and nutrient recycling.

1.4 Title: Transformations in Soil: Crop Response to Nitrogen in Manures with Widely Different Characteristics

Contractor: Dr. E. G. Beauchamp, J. Buchanan-Smith and M. Goss, Department of Land Resource Science, University of Guelph, Guelph, ONT, N1G 2W1

ABSTRACT:

The objective in this work is to develop an understanding how the N in manures with different characteristics applied to soil in the field is immobilized or mineralized and released in synchrony with crop N requirement. Soil factors include time of application, soil texture and soil acidity. Manure characteristics include the effects of the protein levels in the dairy rations.

Expected Outputs: Phase 1 - Development of a yield response curve for corn with fertilizer, and comparison with manure N rates; Phase 2 - Comparison of the mineralization/ immobilization and availabilities of N from five different manures following fall and spring applications on one site; Phase 3 - A laboratory study on the influence of soil texture involving four soils ranging from loamy sand to clay loam; Phase 4 - A laboratory study involving four soils ranging in soil acidity in which ammonium and NO^{-}_{3} contents are monitored during incubation; Phase 5 - using feeding trials and characterization of the manure to develop one or more models for predicting manure N content of manures from animals given different feedstuffs.

Taken from the Project Titles Document. Project just in startup phase at time of 1993-94 workshop.

1.5 Title: Impact of Manure Application Methods on Water Quality, Focusing on Nitrogen and Bacteria Transport in Soil.

Contractor: Dr. Greg J. Wall, Land Resource Unit, Centre for Land and Biological Resources Research, Agriculture Canada, 70 Fountain St., Guelph, ONT, N1H 3N6

Research Partners: Upper Thames River Conservation Authority, London, ONT; Ontario Ministry of Agriculture and Food, Woodstock, ONT; Ontario Ministry of the Environment, London, ONT

ABSTRACT:

Research is proposed to study the agronomic and environmental problems associated with the land application of liquid manures in no-till corn cropping systems in Ontario. An on-farm field scale monitoring and evaluation proposal has been developed with the following objectives:

Conduct field scale studies of liquid manure application technologies for different soils/climate conditions,

Evaluate application technologies in no-till corn cropping systems in terms of sustainable crop productivity and subsurface water quality (nitrogen, bacteria),

Identify pathways and processes of nutrient and bacteria transport to tile drains and groundwater with special consideration to preferential flow,

Validate water quality models (GLEAMS, DRAINMOD) with field scale data and use models to identify scenarios in which water quality standards are likely exceeded,

Develop liquid manure application recommendations for environmentally sustainable crop production.

Manure will be applied to a corn crop on a no-till field that has been systematically tile drained, at a rate which will provide the total N requirements of the crop. The manure, to which a combination of chemical and bacterial tracers have been added, will be injected into the soil using 3 different methods of application. Tile water quality will be monitored for 24 hours after application. An irrigation system will be activated to bring the field soil moisture level to near saturation while tile drainage monitoring continues. Test and control treatments will be replicated 3 times for statistical analyses. Soil, crop, and groundwater monitoring will be conducted throughout the study. Data will be analyzed and used to calibrate a tile drainage model. Recommendations on liquid manure management in no-till corn cropping systems will be made.

1.6 Title: Closed Loop Recycling - Composted Biodegradable Organic Urban Waste Application on Agricultural Lands

Contractor: Ms. Valerie Alder, Ecological Services For Planning, 361 Southgate Drive, Guelph, ONT, N1G 3M5

ABSTRACT:

The application of composted organic waste to agricultural lands has the potential to benefit agriculture in terms of improving soil quality, but information on the environmental and agronomic aspects of the use of compost is needed to allow farmers to assess the risks and benefits of its use. The purpose of this study is to evaluate the impact of composted organic waste applications to farmland on soil quality, crop growth and yield, and water quality in addition to assessing the economics of its application.

Sites for the field trials have been established on farms in Halton and Hamilton-Wentworth Regions. The sites are mapped as a Guelph loam and Chinguacousy clay loam and the farmer cooperators use reduced tillage systems.

The treatments involve a comparison of two compost sources and a zero application. While the total amount of tillage in each trial will be constant, the timing of the tillage, with respect to compost application, will differ such that the compost will be incorporated by the tillage operation or left unincorporated. In successive years of the study comparisons will be provided for cumulative applications of compost in addition to first-time applications.

Evaluation includes the effect of composts and their management on early season soil moisture, corn emergence and stand, and final yield. Soil samples and soil solution samples will be used to examine the migration of carbon, nitrogen and any metals which may be of concern, in the soil profile. Soil microbial biomass measurements will be used as an indicator of changes in the soil environment as a result of compost applications. In later years of the study, rainfall simulation will be used to evaluate the composition and amount of rainfall runoff from the plots, and soil sampling will allow the evaluation of longer term (3 years) changes in soil properties including water holding capacity and aggregate stability.

Lab studies are ongoing in order to evaluate application rates and to assist us in the selection of compost materials to be used. In these studies we have been comparing a leaf compost (City of Guelph), vegetable waste compost (Scotts Composting Farm), vinegar sludge/cherry juice/wood chip/vegetable waste compost (Loam Crafters), and corn/bean seed cleaning/wood chip compost (Village of Hensall). Densities of these materials range from 0.264 to 0.438 g/cm^3. Preliminary results of a study in which we measured emergence of corn through various depths of compost left on the soil surface, suggest that at rates equivalent to 2.5 inches (6.4 cm) of material, corn development is impeded by the compost. For the four compost materials, rates of application for a 2.5 inch depth of application were 159 to 264 dry T/ha. At the lowest rates of 0.5 and 1.0 inch, rates of application were between 39 and 104 dry T/ha.

The study is being conducted in cooperation with the University of Guelph, who advise on technical aspects of the study, and the Ontario Ministry of Agriculture and Food. Under OMAF's Land Amendment Demonstration Studies, 'LADS', the ministry is attempting to demonstrate the beneficial effects of urban waste material applications in field scale trials. Our cooperation involves the sharing of information concerning compost trials.

1.7 Title: Soil Organisms as Bioindicators of Agronomic Practices.

Contractor: Dr. Al Tomlin, Pest Management Research Centre, Agriculture Canada, 1391 Sandford St., London, ONT, N5V 4T3

ABSTRACT: by Drs. A. Tomlin, R. Protz, C. Tu, J. Traquair, & D. Reynolds

Several species of soil organisms respond to agronomic practices such as crop selection, tillage practice, and pesticide treatments in a predictable manner, and could be used to detect whether soil quality is being aggraded or degraded.

We propose to: (1) estimate the state of the biological content of agricultural soils by developing a suite of selected bioindicators, and measuring their response to imposed agronomic practices (2) make correlations amongst selected bioindicators and soil physico-chemical characterizations (especially infiltrometry). Using bioindicators, we will attempt to determine whether selected southern Ontario agricultural soils are being sustained, aggraded or degraded. Traditionally, measuring the state of health of soil has been the province of soil chemists and physicists, but there is good recent evidence that soil biota should be included in assessing soil quality because many chemical and physical processes and features of the topsoil are driven or modulated by biological processes. The relationships between proposed bioindicators such as earthworms can be correlated with chemical and physical data, particularly those related to labile organic matter, nutrients and pollutants, and dynamically modeled to determine their movement and exchange through soil ecosystem compartments for predictive purposes.

Simultaneously, we will measure soil macropore characteristics (macropores are one of the most obvious manifestations of biotic activity in soil) as indicators of soil health using the tension infiltrometer technique. There are very strong parallels between soil faunal activity and the size distribution and numbers of hydraulically active macropores that should be exploited as indicator tools. Successful completion of these phases of the work will allow development of best management practices (BMP's) that can be incorporated into land stewardship programs.

We can now measure soil biota-soil structure interactions using resin-impregnated soil blocks, followed by computerized digital image analysis techniques to quantify faunal contributions to soil structure, and physical characteristics such as porosity and aggregate structure (which will be correlated with infiltrometry data). The resin-impregnated preparations are robust, and can be archived under minimal storage conditions for temporal comparisons of soil microfabric and structure. The resin preparations can be submitted to fluorescence microscopy, and subjected to energetic beams (eg. PIXE, SIMS) for backscatter analysis to quantify and spatially map elements in the soil microfabric affected by biological activity. Analyses of resin preparations are particularly useful for measuring environmental impacts of agronomic practices on the soil (eg. tillage, compaction, pollutants, fertilizing, manuring). The resin preparations have considerable value as "bioindicators" in their own right, because the "frozen" microfabric reflects biological activity at microscopic scale (roughly analogous to histological preparations of tissues on microscopic slides).

Green Plan Workshop
Ramada Inn
Wednesday March 23,1994
Manure Handling and Closed Loop Recycling Discussion

Attendees

Leader: Dr. Bruce Bowman (B.B.)

Ms. Valerie Alder (V.A.)
Mr. Dean Barry (D.B.)
Mr. Harvey Brown (H.B.)
Mr. Richard Brunke (R.B.)
Mr. Pierre Gasser (P.G.)
Ms. Brenda Grant (B.G.)
Mr. Don King (D.K.)
Mr. John Miller (J.M.)
Dr. Richard Protz (R.P.)
Mr. Tom Sawyer (T.S.)
Dr. Bob Sheard (B.S.)
Mr. Richard St. Jean (R.S.)
Dr. Alan Tomlin (A.T.)

Secretary: Mr. Richard Brunke

Literature Review Summary "**Prioritised listing of research and extension needs on manure management in Ontario over the next five years**." Table #2, was handed out.

Dry manure spreaders?
- manure application rate should be around 5-10 T/ac.
- most spreaders applied approximate minimum of 30 T/ac.
- using pan collectors during manure spreading demonstrated that an application rate of 40 t/ac was classified by the farmer as an light cover.
- Bruce: most farmers classify application rate as light, medium or heavy and not by t/ac.
- assist farm machinery company in design in dry manure spreaders that can apply at rates of 5- 10 t/ac.

R.B.: It may be easier to interpret the application in volume per acre or travel distance per full spreader rather than t/ac. These unit is easier to visualized.

B.B.: **Innovative Farmers Conference (1994) Breakout Session**
- a substantial amount of information was presented on manure handling and spreading but none on a compost application/utilization, in part due to the lack of knowledge on composting.
- perhaps opportunities for No-Till livestock farmers to apply composted manure directly to No-Till land without having to incorporate it. Composts tend to be stable soil amendments, in which nutrients are not so susceptible to losses (leaching, volatilization)

B.B.: Historically it appears that the same manure handling and utilization problems have been looked at over and over through the decades.

Question:

How does composted manure differ from other composted materials?

- Discussion on the Hensal compost operation
- By-product nitrogen presently equal to manure nitrogen; (bean by-product) up to 50% nitrogen lost.
- But this by-product is not completely composted, the system not on line as of yet.

Manure Compost:

R.S.: clarified what is happening on farm with their composting studies. All but one farm has the compost piles covered. No additives are added to material being composted.

Germany and Switzerland -

- compost manure operations - it appears that they have a very organized setup.
- they add 10% clay and/or rock dust as additives to sequester nutrients and perhaps to add nutrient to the compost for better balance.
- use covers if compost piles are outside to minimize leaching/volatility losses - mechanized means for removing and replacing cover when turning piles.

Compost

- if composing practice is too complex it will be difficult to adopt/implement on farms; Presently farmers believe high nitrogen losses occur during composting.

How much nitrogen is currently lost when spreading solid manure?

- Compared to solid manure spreading; how much nitrogen is lost when spreading on field through volatilization?????

Water reduction in manure: reduce transport cost

- Anaerobic digesters - reduce water content and are high in nutrient (esp. nitrogen) conservation. Don't know what water quality implications are for spreading in fields, relative to liquid or solid manure practices

What physical effects does heavy manure spreading equipment have on the soil during application?

R.S.: Quoted from a report that in 1987, 83% of manure was handled as solids. Believes that approx. 50/50 dry & liquid manure handling presently.

Trend: Last 3- 4 yrs farmers are going back to solid manure handling.

Biotic Effects:

A.T.: manure application can stimulate large increases in soil biota.

- population stimulation depends on the source/type of manure; often, immediately following manure application, there may be a short term suppression, but after a period of there is an overall increase in the population.

B.B.: also observed a noticeable difference in earth worm population between No-Till and Conventional Till (CT) in Great Lakes Water Quality Field Studies. After 4 years of No-Till, earthworm populations were 2X, and earthworm biomass were 3X those in adjacent conventionally-tilled soils (all soils in CT until 1990). (no manure applications on either tillage practice).

A.T.: Earth worms are very active: they pull leaves and plant material into the ground. They do show some preference for different materials. They sometimes will pull green leaf material into the ground and allow it to decompose prior to eating it.

By adjusting manure application one can adjust earthworm population.

R. P.: Why not change time of application and the design of the spreaders to accommodate time change such that manure can be applied to the plants when the nutrients are required?

D.K.: Concerns of transport through macropores during the drier summer times.

In Quebec, they are trying liquid manure surface application between corn rows with some success. The liquid manure is kept away from the corn leaves, thereby minimizing leaf burning problems. The corn canopy minimizes drift and odour problems. Also, they are testing fine chopped solid manure application and finding only small amount of leaf burning is occurring.

O.M.A.F. is putting a expert system together for manure handling and spreading (utilization?).

Historically: 20 yrs ago side dressing was tested.

Results:

- application rate too low
- problem with rain
- manure nitrogen unpredictable whereas commercial nitrogen was predictable

Farmers require 60-80 days to apply manure between May-June. This could be increase if the farmers could applied manure during the growing season.

Started reviewing Priority list:

- present information list to farmers

Question to D.K.& B.G.: **What will be your product delivery from your Manure Application research?**

- Method, rates and time to apply manure to no-till
- also they will try to develop or modify a model.
- Ted Taylor (O.M.A.F.) - interested in looking at results for BMP publications

B.G.: cooperating with Husky in testing a new liquid manure applicator.

T.S.: observed this year that a large number of farmers are **not** spreading manure this winter - improvement in attitudes
The researcher must express their results of manure application rates in yield terms. (yield represents dollars to the farmer)

Problem: Farmers still tend to view their manure as a waste product rather than as a resource

What do farmers want to know about manure?

1. Environmental - best time of application
2. Yield results
3. Interaction with M.O.E.(regulatory)
4. When, why, and because (manure application)

R.P.:

- weather is known and therefore can farmer apply within the 60 days. (Application of manure around rain events)

Response:

- Large number of farmers hire commercial applicators and therefore, it is difficult the vary the time of application
- It is always suggested manure should be applied to corn fields.
- To handle the volume it could be applied to hay fields after cuts, recognizing there is a loss of nitrogen.
- Farmers are adaptable and will adapt.

Interest in seeing the report on application of paper waste to soil by Dr. Doug Hoffman.

- can paper wastes be added to liquid manure? Will this help in reducing the liquid fraction?

B.B.: has seen problems with similar test sites of paper waste applied to soil surface.

Compost:

The farmers will be getting more composted material in the future and will need help with application rate, times etc...

V.A.: presently the compost material she is working (E.S.P. Green Plan project) with is not being applied to farm land. They are evaluating the nutrient value of the compost and trying to get a handle on application rates.

There is no guide lines for compost application to farmland.

There are guide lines for sewage sludge application By M.O.E.

City of Guelph is building a large compost site to compost 50% of the organic matter from the city. If they cannot find a place to put it, it will be put in the municipal dump. It will be treated as waste volume reducing method rather than a carbon source.

This type of compost should be put on farmland as long as there is no negative impact.

Municipality and M.O.E. should be involved with this group to discuss compost application.

Agric. Canada: safety of compost material health wise

Presently it does not appear to be a problem with pilot plants but when in full operation it could potentially be a problem.

R.B.: has seen sewage sludge plants that were not operating at proper processing temperatures such that not all bacteria would be killed.

How Will farmers deal with disposal of the manure and city compost?

T.S.: farmers will require tight guidelines for compost material application. Farmers see manure as a waste product

- Research required to show the "dollar value benefit" when using manure and compost.
- Best Management Booklet- available to farmers.

T.S.: believes that important information has not been given to the farmers.

A.T.: Priority list should be delivered to the farmers.

T.S.: Sewage sludge handler required a 2 day course. Halton has a good system working with the sludge handlers.

B.B.: Farmers do not know their rights in the sewage application contracts, e.g. farmers have right to determine when to apply the sludge, not the applicators.

Though it is regulated sludge is still being applied during the spring and winter months.

Manure storage required is 220 days

Farmers knowledge of compost material is minimum and therefore they will require assistance in application rates and procedures.

Composting allows one to work with variable carbon products.

Break:

D.K.: **How will the information be distributed?**

Expert system activity:

- Manure Management expert system under development by O.M.A.F.
- Decision management information tree for manure application for farmers to use
- qualitative and quantitative parts of expert systems
- **all research will be recorded and available to the public and other researchers.**

Will the leaders of the talks (yesterday) be available to meet with the press?

B.B.: Wants to be sure that the team is organized in a format before meeting the press.

Have to be careful of how the information gets out to the press

Also thinking of preparing a pamphlet for the public, outlining the different research projects.

A.T.: Critical to deliver the information to the public and press.

Standardizing Data across projects

- measurement and reporting of parameters

Is there anyway for the coordinator to coordinate these samples?

B.B.: Is there any standard sample procedure for manure samples and analysis?
R.S.: No real method- mainly sampler experience
D.B.: Their looking into it.
B.B.: Contracters are encouraged to call each other for information and exchange ideas.

Liquid manure:

P.G.: Eastern Ontario, would like to know if anyone is using the nitrogen meter to monitor liquid manure nitrogen and if they would be interested in comparing their results? (calibration tables)

Literature Review (prepared by the Univ. of Guelph):

Will be distributed to all research groups upon request; also to libraries.
A digital copy may be available.

Next Year Report Workshop

The number of people will be increase (more field extension people, farmers will be invited).

B.B.: With more data to be presented next year do you think this year's format would acceptable?

A.T.: Suggested next year workshop include a poster session.

After workshop data report should be prepared for the media.

It was also suggested to have some seating arrangements including tables for easy note recording.

2.0 On-Farm Research

2.1 Title: Literature Review of Methods Used to Conduct and Evaluate On-Farm Research

Contractor: Ms. Jane Sadler-Richards, Ecologistics Limited, 490 Dutton Drive, Suite 1A, Waterloo, ONT, N2L 6H7

ABSTRACT:

Three study types or categories (small plot, large plot and observational) were identified during this review. Where appropriate, sub-categories were also identified. The level of farmer cooperation in the study was rarely mentioned in the literature and as a result was not included in the category definitions.

A summary of definition including strengths and weaknesses follows. Examples from the literature and additional references are presented in the Appendices.

It should be noted that the fundamental principles of experimental design are just as important in designing on-farm experiments as for research station or laboratory research (Cochran and Cox). Proper replication and randomization are necessary to ensure validity of the conclusions. Blocking and judicious choice of covariates can dramatically increase the precision with which the experiment compares treatments. Focused study objectives are crucial in guiding the choice of the experimental design and subsequent statistical analysis.

Study Type:	Small Plot
Definition:	Where all treatments are applied and replicated at each field site using research plot scale equipment and techniques (i.e. non-commercial scale equipment and/or treatment application techniques).
Purpose:	To determine the effect(s) of specific individual variables or combinations thereof on one or more parameters of interest; often used to determine optimum crop production practices.
Strengths:	- variables can be controlled to a greater degree; - the effects of variations to one or a few factors can be determined; - on-farm setting can take advantage of field conditions established over several years; - a larger number of treatments and more complex treatment arrangements (e.g. factorials) can be accommodated
Weaknesses:	- treatment management may not reflect field scale management conditions; - results may not extrapolate directly to field scale results; - results may not be credible to producers; - more effort per hectare under experiment and thus less likely to be replicated over several locations and/or years

Study Type:	Large Plot
Definition:	Where treatments are applied using commercial scale equipment and/or treatment application techniques are representative of field scale practices. i) Whole field/Farm/watershed - where treatments are applied on the basis of a whole unit area and treatment boundaries coincide with other accepted boundaries. One whole unit are represents one treatment, applied one time. ii) Field Strips - where the length of the treated area equals the length of the field to facilitate field management practices but the width of the treated area is set to facilitate the needs of the study. Each treatment is applied at least once in each field.
Purpose:	To determine the effect(s) of specific individual variables or combinations thereof on one or more parameters of interest; complex combinations of variables may be identified as crop production systems which in turn are compared against either components or other combinations; often used to determine optimum crop production practices to achieve either economic or environmental goals or both.
Strengths:	- on-farm setting can take advantage of field conditions established over several years; - treatment management may better reflect field scale management conditions; - results may extrapolate directly to field scale results; - results may be more credible to producers; - since these studies are often replicated across a large region, their conclusions have broader applicability. For example herbicide trials run by an agricultural chemical firm may be replicated at 50 sites across all of western Canada.
Weaknesses:	- treatment application and some methods of data collection are generally less accurate and precise than that obtained using hand-held or small scale equipment; this may result in a greater variation in results and require the inclusion of more years and/or locations to establish trends; - a limited number of treatments (generally 2-12) can be evaluated at one time; - the size and complexity of whole field/farm/watershed studies often limits the number of whole plot replications such that the results often amount to case studies where statistical evaluations of selected parameters are performed; - treatment effects may be more likely to be confounded by other factors

Study Type:	Observational Plot
Definition:	Where a condition and effect relationship is examined within the boundaries of an ongoing farm enterprise. While site selection criteria may be stringent, no manipulation of the condition to suit the needs of the study is involved.
Strengths:	- farm setting can take advantage of field conditions established over several years; - site management reflects actual field scale management conditions to producers; - results may be used as direct indicators of field scale expectations; - results are generally more credible to producers; - site selection criteria can be used to determine comparable conditions with the resulting data; - this approach is an alternative to designed studies which may be prohibitively expensive, unethical, too time consuming or simply impossible (e.g. one cannot replicate a study of the environmental impact of a nuclear power plant)
Weaknesses:	- the stringency of site selection criteria; this may result in a greater variation in results and require the inclusion of more years and/or locations to establish trends; - a limited number of treatments (generally 2-12) can be evaluated at one time; - the size and complexity of whole field/farm/watershed studies often limits the number of whole plot replications such that the results often amount to case studies where statistical evaluations of selected parameters are performed; - control of concomitant variation. Many other factors, other than those the investigator is interested in, are likely to vary among sampling units. Controlling these variables or properly adjusting for them is a major problem.

2.2 Title: Investigating Methods of Integrating Liquid Manures into a Cropping System and the Effect on Soil and Water Quality.

Contractor: George Schell, Ecological Services For Planning, 361 Southgate Drive, Guelph, ONT, N1G 3M5

ABSTRACT:

This integrated liquid manure project consists of a series of field length plots at farm sites in Southwestern and Eastern Ontario. E.S.P. are managing the project along with two research partners, REAP-Canada and Ag-Knowledge. The 1994 field season will be the first of three field seasons for this project. In preparation for this field season, REAP-Canada and Ag-Knowledge have worked with the farmer cooperators to develop experiments that are compatible with the farm management system at each site. In some cases, the farmers have recently purchased equipment that will allow them to conduct the experiments, while at other sites, rental arrangements have been made with equipment manufacturers.

The project consists of 3 experiments, with the following objectives:

Experiment A: To examine and evaluate different manure application rates and methods (shallow injection or surface broadcast) with the goal of maintaining optimum crop production compared to inorganic nitrogen fertilizers.

Experiment B-1: To evaluate the effects of liquid manure applications to a standing corn crop as compared to applying inorganic nitrogen fertilizer.

Experiment B-2: To measure the influence of manure application timing and technique on crop growth, soil quality, soil nutrient content and, to a limited degree, on water quality.

A total of 6 farm sites have been selected for the experiments, 4 in Southwestern Ontario (REAP-Canada), and two in eastern Ontario (Ag-Knowledge). The conservation management systems practiced at the 6 farms include no-till (2 sites), minimum tillage (using the Aerway), chisel tillage (2 sites) and ridge tillage on strips. In Southwestern Ontario, Experiment A will be conducted at the dairy farm of Gary Chipps (near Delhi) and the hog farm of John VanDorp (near Woodstock). Experiments B-l and B-2 will take place at the hog farms of Andre Soetemans (near Forest) and Richard Yantze (near Tavistock). In Eastern Ontario, Experiments A and B-l will be conducted at the Menard dairy farm (near Embrun). The Grenier poultry farm (near St. Isidore de Prescott), will host Experiments A, B-l and B-2 and contains both clay and sandy soils (separate experiments will be conducted on the fields with the two different soil textures).

Each experiment will include treatments where manure will be applied at a rate corresponding to a predetermined proportion of the N requirement of the crop. In order to establish the manure loading rates as accurately as possible, we will take composite samples of the manure 2 wk before the applications, using a 12 ft long sampler designed for this purpose. The electrical conductivity of the samples will be measured using a conductivity pen, before sending the samples for lab analysis. Manure loading rates will be established in advance of the experiments on the basis of the analytical results. We will measure the electrical conductivity of the agitated manure just before application and adjust the rates if the conductivity of the agitated manure sample differs from that of the earlier composite sample.

Once the manure has been applied, the focus of the data collection for Experiments A and B-l will be to identify agronomic effects of the different manure and inorganic N treatments. The nutrient status of the soil will be evaluated through soil fertility tests and soil N tests. Data collection for Experiment B-2 will also include the sampling for nitrate analysis of soil cores and pore water samples following the manure applications. Open well piezometer will be installed to a depth of 2 metres to permit periodic sampling and observation of the water table depth. Meteorological stations will be set up at each of the farm sites to record hourly precipitation and temperature, along with wind speed and direction. Examination of the climatic data may help to explain some of the variations in the experimental results between the different sites and from one year to the next.

2.3 Title: A Comparison of theEnvironmental Effects of Conservation and Conventional Cropping Systems.

Contractor: Ms. Jane Sadler-Richards, Ecologistics Limited, 490 Dutton Drive, Suite 1A, Waterloo, ONT, N2L 6H7

ABSTRACT:

This three year research study is designed to compare the environmental effects of conservation and conventional cropping systems. The current project is funded by Agriculture Canada through the Green Plan program.

It has become evident that conventional cropping systems produce some serious off target environmental concerns such as soil erosion (Hausenbuiller, 1985) and contamination of ground and surface waters by agricultural chemicals (Hallberg, 1981: McDowell et al,, 1984; Hubbard et al., 1982; Baker et al, 1982; Baker and Johnson, 1979)

Since the early 1980's, there has been a significant increase in the use of conservation tillage by producers. While the move towards conservation cropping systems has been a positive trend, there is some concern about the full environmental impact of the newly adopted systems. Several studies have indicated that conservation tillage systems, particularly no-till systems, can have elevated nutrient and pesticide losses (Barisas et al., 1978; Baker and Johnson, 1979; McDowell and McGregor, 1980),

Such studies lead to the question: Are we solving one problem (i.e. soil erosion), but creating another (nutrient and pesticide leaching)?

In the main study, fields have been selected from farms which represent viable production systems where respective conservation or conventional production systems have been in place for a minimum of four years. The compared production systems include a no-till system and a conventional (mouldboard plough) system which have a corn/soybean/winter wheat rotation. Eight paired fields (16 fields total) have been selected based on their similar soil type, drainage, slope, geographic area, cropping rotations, cropping inputs and cooperator willingness to participate.

Selected soil and water quality parameters will be monitored beginning in spring 1994, with a focus on pesticide and nutrient movement, Monitoring will occur on a seasonal and rainfall event basis four times per year for three cropping years. Economic data on the two productions systems will allow for an economic analysis. An additional large and independent study on Soil Organisms as Bioindicators of Agronomic Practices" will also occur at these sites.

In addition to the above it is interesting to note at this lime that the availability of suitable no till sites has been the driving force in site selection. To date 12 cooperator agreements have been signed with 4 more agreements pending. While project site selection criteria have been met some have been relaxed somewhat to aid in project implementation e.g. in the first year of the study the need for winter wheal at one site was relaxed to include any cereal crop.

2.4 Title: Determining the Factors Responsible for, and Methods to Overcome the Limitations of Conservation Cropping Systems on Clay Soils

Contractor: Drs. Tony Vyn & Clarence Swanton, Crop Science Department, University of Guelph, Guelph, ONT, N1G 2W1

ABSTRACT:

Field experiments to address the following four objectives will be conducted for the 1994, 1995 and 1996 growing seasons.

Objective A
To establish essential seedbed characteristics for good crop emergence and growth on clay soils and to define appropriate tillage systems to meet these criteria in a soybean/corn rotation system.

Experiments were established on farms in Elgin and Lambton counties to investigate corn and soybean response to the seedbed conditions resulting from 7 to 8 tillage systems ranging from fall mouldboard plowing to no-till (slot). A particular focus was on fall strip-till, fall mulch-till and spring zone-till as intermediate options that might result in superior aggregate size, temperature, mechanical impedance and soil moisture conditions for crop growth. These investigations are the primary responsibility of Dave Hooker who has been hired as a Ph.D. student.

Objective B
To determine the conservation tillage systems which will result in good growth response of corn and soybeans following winter wheat and clay soils.

Experiments were established in Huron and Lambton counties for seven tillage/straw management treatments for corn and soybeans, adjacent blocks following winter wheat. Tillage systems ranged from no-till to fall mouldboard plow, while wheat straw levels ranged from none to full in the no-till system.<The focus of the measurements will be on residue biomass levels, rate of soil drying in spring, and crop emergence and yield response. Most of the sampling will be coordinated by a Ph.D. student (George Opoku) who is here on a Commonwealth Scholarship.

Objective C
To determine the effects of tillage on weed seedbanks and emergence patterns on clay soil.

Selected sub-plots within field experiments for *Objective* A are to be used for the vertical seed distributions and weed seedbank measurements in *Objective C.* Soil moisture and temperature data will be used to test models predicting weed seedling emergence. Eri Roman, a Ph.D. student from Brazil will be primarily involved with these and other investigations of weed emergence on clay soils.

Objective D
To evaluate the impacts of a cereal cover crop and reduced tillage systems on weed management on clay soils.

Two clay soil sites were selected (in Lambton and Elgin counties) for an investigation of the merits of rye cover crop inclusion after soybeans in a soybean-soybean-corn rotation on the effectiveness of integrated weed management systems ranging from wide-row soybeans with burndown, preemergence herbicide plus interrow cultivation to narrow-row soybeans with only a burndown application. In total, 18 treatments are to be included on these no-till sites. Weed density and biomass determinations will be conducted to assess the effect of management systems on weed pressure and crop yield.

2.5 Title: To Obtain Information on Variable Rate Technology for Nitrogen Application and Determine the Feasibility of Implementing this Production Tool

Contractor: Dr. Gary Kachanoski, Department of Land Resource Science, University of Guelph, Guelph, ONT, N1G 2W1

ABSTRACT:

Recent studies have indicated significant within field variability of fertilizer N requirements. Technology has also been developed for variably applying fertilizer within fields. However, procedures for obtaining the map which determines how the fertilizer should be varied are not defined and or have not been evaluated. The overall objective of the study is to determine the feasibility of using variable rate technology for N fertilizer application, to maximize economic crop response while minimizing environmental impacts on water quality. Specific objectives include(l) To assess different methods of obtaining the field map for variable application N of fertilizer, (2) Determine the economic benefits of variable application of N fertilizers, and (3) Determine the change in potential nitrate loading to the groundwater from variably applying N fertilizer within a field compared to constant application.

Two main sites (Sl,S2) and 2 auxiliary sites were established in the spring of 1993. the 2 main sites are in Huron Co. near Londesboro, Ontario on the farm of Bruce Shillinglaw. Each site consisted of 4 adjacent blocks of no-till planted com. Each block consisted of 2 treatments;(1) Fertilizer added (F) ~160 kg N/ha, and (2) No fertilizer N added (NF). Each treatment was 8 rows of com with 75 cm row spacing and a length of approximately 325 m. Spatial patterns of yield with fertilizer added and yield with no fertilizer were obtained from detailed hand harvesting (approx. 250 m hand yield samples per field). Yield patterns were also obtained using a commercial on-the-go yield sensor attached to a combine. Soil cores were taken in a dense grid from each field to obtain the spatial pattern of the soil N test. Extensive soil sampling to a 90 cm depth was also carried out in the fall period to obtain the spatial patterns of residual mineral soil N, and the subsequent loss of N by leaching. soil water solution samplers were also installed at selected landscape positions in the fertilized and non-fertilized treatments to monitor the quality of leaching water. All of the instrumentation and sampling was referenced to a detailed elevation map of the site obtained from a laser theodolite survey of each site.

First year results indicate significant within field variability of soil N test (ie Coeff. Variation=52%), yield with fertilizer applied, and the crop response to applied fertilizer (ie. yield with fertilizer minus yield with no fertilizer). Increases in yield from applied fertilizer N varied from essentially zero to over 3500 Kg grain/ha. Fertilizer N requirements within the field varied from 0 to 170 kg N/ha. The variability was not random and was significantly correlated to topography. A single map of yield with fertilizer added would not be enough information for fertilizer recommendations. The yield gain from adding fertilizer N is required. Areas within the field with the highest yields were also the areas that did not require any fertilizer N. The measurements are being used to obtain the map for varying fertilizer requirements this coming growing season.

The yield measurements with the on-the-go yield sensor were highly correlated (r=0.92) to hand sampled yields. The sensor did an excellent job in mapping out yield variations. The only problem encountered with the sensor was a minimum yield requirement of approximately 1.8 t/ha for the sensor to work. The yield measurements from the sensor were accurate enough to detect the yield decreases every 10 m from the hand sampling locations. In 1994 fertilizer N will be applied variably and evenly to compare the economic and environmental benefits of this technology.

2.6 Title: Measuring the Effect of Crop Residue or Live Cover Crops in Conservation Tillage Systems on Soil and Water Quality

Contractor: Dr. Ian van Wesenbeeck, Harrow Research Station, Agriculture Canada, Harrow, ONT, N0R 1G0

ABSTRACT:

A crop rotation production system in association with reduced tillage has been suggested as one of the best management practices for sustainable agriculture. Corn, soybeans and wheat constitute 90% of the planted acreage in Essex county. The focus of this study therefore, is on the use of a red clover cover crop in the wheat/corn/soybean rotation, with specific emphasis on the wheat into corn part of the rotation.

The objectives of this study are: 1. To measure the effect of the red clover cover crop on the long term changes in soil structure, hydraulic properties, and the influence on soil biomass, and N-cycling, in a wheat-corn-soybean rotation. 2. To determine the contribution of the red clover cover crop on the availability of N to the subsequent corn crop. 3. To evaluate vegetation management strategies and determine factors limiting no-till corn planting into wheat and red clover residue. 4. To evaluate the impact of the red clover cover crop on weed management during corn production in a clay soil.

The study will be conducted at the Woodslee research station where 9 m x 20 m plots with a wheat-corn-soybean rotation are already in place. The experimental design is a completely randomized block with four replications of five treatments in the part of the rotation where corn follows wheat:

1. Conventional tillage - red clover plowed down in the fall
2. Conventional tillage - no red clover
3. No-till - winter wheat stubble/red clover sprayed overall
4. No-till - winter wheat stubble/red clover band sprayed over next years corn rows
5. No-till - winter wheat stubble/no red clover

The effect of the cover crop and residue on soil drying and seedbed temperature in the spring will be monitored using time domain reflectometry (TDR) probes, and thermocouples respectively. Soil test nitrogen in corn will be made at 0-30 and 30-60 cm depths at the time of planting and at regular intervals throughout the growing season to monitor the breakdown and release of N from the cover crop. In addition soil microbial biomass measurements will be made to determine biomass C and N in the soil. Measurements of soil physical properties will include aggregate stability, bulk density, porosity and pore size distribution, and hydraulic conductivity. Plant analysis will include grain yield, tissue N, plant emergence, plant height, and residue measurements. Weed counts and biomass by species will be made in each of the treatments after planting to determine threshold levels. Late season weed ratings and biomass measurements will also be taken. Although the bulk of the effort in the first year of the program was dedicated to equipment construction, a crop was planted and some baseline soil property measurements were made in the 1993 field season.

2.7 Title: Crop Rotations and Cover Crop Effects on Erosion Control, Tomato Yields and Soil Properties in Southwestern Ontario (a program begun in 1989 under the Land Stewardship I Program, OMAF)

Contractor: Mr. R. W. Johnston, Soil Science and Horticultural Soil Management, Ridgetown College of Agricultural Technology, Ridgetown, ONT, N0P 2C0

ABSTRACT:

Vegetable production in Southwestern Ontario is a high value industry (tomatoes alone are valued at more than 80 M dollars) that is primarily based on coarse textured soils under very intensive cultural conditions. There is no other area in Canada with the unique combination of climate, soils and expertise necessary to support warm season vegetable production. The soils in this region have been intensively farmed over the years resulting in degradation (loss of soil organic matter and structure) through limited crop rotation and increasing mechanization. In the Leamington area much of the soil suffers from slow internal drainage, low soil organic matter and is open to wind and water erosion. Kent County is marginally better due to a more recent history of forage crop rotations. However, as tomato acreage shifts somewhat to Kent, its soil quality is in jeopardy also.

This project was initiated in 1989 at the request of vegetable farmers, extension personnel, research personnel and was one of the research priorities of the Ontario Soil Management Research and Services Committee (1980-1989). The current additional 3-year cycle, encompassing the 1994-96 growing seasons is supported by Green Plan funding.

The objective remains to obtain better information on the effects of rotations on soil structure, drainage differences, moisture holding capacity, and improvements in tomato yields which will provide more reliable recommendations for farmers on proper rotation and cover crop management.

Rotation plots were established at Leamington and Dresden to assess the effects of 9 and 8 crop rotations, respectively. Nine different crops are grown. Crops are planted as main plots with 4 split plots for rates of nitrogen (0,45, 90, 135 kg/ha N) applied to the tomato crop. All crops are planted each year to increase number of rotation cycles. There are four replications at each location

The cover crop research is conducted in a rotation experiment. . Three rotations are utilized at each location; continuous tomatoes; winter wheat, tomatoes; and green beans, sweet corn, tomatoes (Dresden has green beans, peas and tomatoes). Five cover crops are planted after each crop: rye, annual ryegrass, hairyvetch, oil seed radish and Austrian winter peas.

The previous 4 years of research has shown that rotation of crops compared to monoculture increased tomato production by as much as 130% and improved tomato quality (color, soluble solids and total solids). Water ponding was reduced and earthworm activity increased, as was soil organic matter content slightly, after 3 years. The most dramatic effect was increased tomato yields.

Green Plan Workshop
Ramada Inn
Wednesday March 23, 1994
On Farm Research Group Discussion

Leader: Al Hamill (AH)

Doug Aspinall (DA)
Sylvie Bertrand (SB)
Ken Boyd (KB)
Harvey Brown (HB)
Wally Findlay (WF)
Pierre Gasser (PG)
R.W. Johnston (RJ)
Gary Kachanoski (GK)
John Miller (JM)
Jeff Quinn (JQ)
Jane Sadler Richards (JSR)
George Schell (SCH)
Clarence Swanton (CS)
Ian Van Wesenbeeck (IVW)

Secretary: Joe Fonseca

Discussion began at app. 8:35 with an introduction by AH.

AH defined purpose of the 'breakout session' as an opportunity for Primary researchers/contractors to: expand on projects presented the previous day of the workshop, and get help from colleagues. Also researchers are gathered to see how well the requests from the original GP workshop are being followed up on. Also to be kept in mind are if any gaps in research are of a concern to those present, these may be filled if funds are available. This is meant to be an open discussion and people are to speak out.

A question was put forward regarding the Crop Rotation and Cover Crop Effects on Tomato Yields and Soil Properties study as a GP project. Russell Johnston answered that this project was a continuation with some changes. The objective of the project is to recognize changes in soil especially with respect to changes in infiltration rates and water holding capacity. The study will also take aggregate stability readings, taking more samples in moister conditions to assess differences in how aggregates come about. Some of the sandy loam soils the project is studying are of very poor condition, some with about 1/2 % organic matter. The project is interested in Nitrogen status, there is a very low carryover of N over the winter especially at the Leamington site. So it would be useful to follow N pathways to see where it's going. Also the study is interested in irrigation, that is, how water storage is altered with slow infiltration. There is a slope at the sites so there is water runoff, if soils are improved this may change.

GK: Are the sites tiled? RJ: Yes.

CS: Is there any insect/disease monitoring?
RJ: There was an attempt. Monitoring would be useful. Plants are greener after soil conditions are improved. There was a uniform application of BRAVO. Plants after alfalfa stay green and don't look like they will mature, the fruit do get more colour.

Q: Why the difference (in plant response)?
RJ: This difference may be due to an increased tolerance, source of tolerance may be increased soil N, legume cover, or aggregates.

SB: Were there any post-harvest differences?

RJ: Post harvest differences showed up in the first 2 to 3 yrs of the experiment especially, due to weather conditions in yr 4. After alfalfa crop, the fruit had higher solids and better colour.

SB: There is anecdotal evidence that organically grown strawberries have a longer shelf life.

AH: This would not apply to these tomatoes, however, since they are for processing.

SB: But higher sugar content - lower evaporation.

CS: In Sweden, Nestle has developed an environmental label on products. This is not an organic label but an IP label (Integrated Production) for 'segregated process products'. These products differ in production methods and are the same price as regular products. Down the road this may be a useful idea.

JQ: How does alfalfa cause it's effect. Could it make Calcium more active? Could it add a growth factor to the soil?

RJ: This hasn't been looked at.

GK: Had a question over the amount of N additions.

RJ: Plants responded with additions of 45 kg N/ha to 90 kg N/ha. Even with alfalfa. Always got an increase in N after alfalfa.

GK: Expressed concerns with cover crops releasing N in fall and spring when water is going through. Cover crops ploughed under and N added to groundwater. Cover crops when ploughed are an organic source of N - not to plant - to ground water.

JQ: N will contribute to increase in soil organic matter.

GK: N peak occurs in 3rd to 4th weak of June

JQ: When is N applied? RJ: Preplant.

GK: It's irrelevant JQ: You can time the killing of the alfalfa.

GK: An increase of 1% in organic matter will add 20 T of Carbon/ha. Problem - good quality soil - get increase in organic matter. Have a N release in spring and fall. This must be addressed.

RJ: There is a long way to go to create quality soils with high organic matter.

GK: Were yields increased with no legume?

RJ: Can't really answer - used cover as hay. Red clover increased nematodes. Still have increase in yield of tomatoes. Rye cover crop, not annual rye grass, is used in a standard rotation. Good except continuous tomato rotation - get a decreased yield.

CS: Is there variation in yields? Yield on own doesn't mean much. Variation and efficiency of production - the cost over the years - is important. Charting against weather. The best rotation should have the lowest variation.

RJ: looked at average yield. CS: Not enough - have to show variation.

RJ: That would be worthwhile. Also worthwhile to look at efficiency of N use. Poor structure of soils- poor efficiency. With recommended 90 kg N/ha not enough yield effect. Some farmers in area probably putting 200 kg/ha and up to keep yield up. The rate of N added to soil the only difference (from study site) in producers around the study area - they won't admit it though. Must have groundwater effect.

JQ: So increase in organic matter - increase in efficiency of N utilization.

GK: Bottom line - what get with no N vs. N. JQ: Get away with less N if increase soil quality.

GK: Yes but N from alfalfa. JQ: Credit for soil N.

GK: Decrease fertilizer rate - check yield. If no fertilizer really low yield. With no cover - yield?

RJ: 4-8 t/acre With alfalfa - ~40 T. With fertilizer - varies. With fertilizer on alfalfa - ~45 T get 5 t increase.

GK: So 5 T increase. No cover + fertilizer? RJ: 25 to 35 T.

GK: So take 30 T average. 25 T increase. Can't say N use efficiency greater in cover crop system.

RJ: Maybe increase high N application rate to see effect on yield. GK: Then check the N concentration in water.

RJ: Study applications way below what farmers using.

CS: How far from use is the variable N applicator?

RJ: Different varieties vary in N uptake. Non-determinate varieties vs. determinate varieties which now - can increase N and not worry about plant staying vegetative.

JSR: Change the subject?

CS: Must be difference in soil biology.

RJ: To see AL TOMLIN Re: changes in earthworm populations.
AH: **ACTION - SEE AL TOMLIN RE: EARTHWORMS**. What about solution samplers?

RJ: Problem - decreased activity below 60 cm. Don't know where tile is for samplers.

AH: Topic for discussion - ANALYSIS. Is everyone using similar system. For data to be sent to Bruce MacDonald for the database, the numbers must mean the same thing - i.e. use similar analytical techniques. Any suggestions/comments?

JSR: People have already decided on methods. So is there time to adjust? For year 2 - could catalogue methodologies, to see if in sync or not. A little to late this year.

GK: Which analyses are of concern? AH: P and N.

JSR: Eg. pesticide concentrations - immunoassay technique. For soils work - 2 methods available. Preference for one - do others feel the same way?

AH: Differences for labs? GK: Not for N - nitrate and ammonia N same - standardized. Soil P - difference. Total N - Kjeldahl vs. digest.

WF: Recently received request to participate in round-robin for water sampling methods. Sponsored by some Federal agency. So there are efforts out there to standardize samples in the lab.

JSR: Can take more samples than needed - store as backups or analyze later. Are others doing this? - taking extra samples? If not to much extra cost to store. If more sites are needed for other workers. Develop a sample bank? Sample store is valuable - open for discussion or just keep in mind.

Q: Are samples frozen? JSR: Depends on samples. Food storage lockers/freezers can be rented for ~$10/mo.

AH: Do these freezers have recorders? JSR: Probably varies with facility.

AH: Need to know if go down. JSR: Probably have alarms, but problem if need temperature record.

<u>Administrative business</u>

WF: End of fiscal year is nearing - Mar. 31. So get claims in. At least get estimates in so money can be protected. For invoicing purposes, services must be for this fiscal year.

AH: Especially equipment - purchase must be in by Mar 31. Invoice can be later.

SB: Legal concerns over stored samples. Contract with GP now - later used for work sponsored by other.

JSR: Samples taken with Ag Canada funds, so Ag Canada's samples?

GK: So at end of study offer to Ag Canada, if they don't want them keep them.

SB: Will farmer be surprised if samples used in 10 yrs? Just concerns to be looked at.

GK: Requests sites. If anyone has a site and want Cs reading to check erosion at ~$25. To benchmark - into database - can come back later.

CS: Want composite sample or 1 spot? GK: Depends on what you want. Use tube type sampler.

JSR: Has had problems getting tubes into ground. Ball type samplers easier to lose but easier to sample with.

GK: Can find them with a metal detector but need idea of where they are. CS: GTS would help.

GK: Yes. Mark sites if getting a sample so could be a benchmark site.

JSR: Want list of things needed to categorize. GK: **(Action)** Get a hold of him [WHO?] Where it is in field. Categories.

IVW to GK: Is there a site near Dresden/North of Wheatly where Cs has been counted. N release from cover crop suggestions.

AH: **(action)** RJ meet with IVW and (Craig Drury). Where climates are similar. As long as analysis/technique similar.

JSR: **Methodology discussion of her project. Environmental Effects of Conservation and Conventional Cropping Systems.**

Soil sampling for pesticides and soil nutrients - N and P. What is best/most realistic approach? Study involves 8 paired sites, so 16 fields. 2 No-till fields are located at one farm. 8 no-till fields/ 8 conventional i.e. mold-board ploughed. Will sample nutrients and pesticides in soil profile. Tube sampler consists of acetate/plastic tube in sampler which pulls out column. Column to freezer - sliced to specific sampling level. E.g. 0-2 cm depth etc. Choose level to analyze. In normal dissipation study look at bare soil. i.e. worst case. Each sample date will take 4 cores. Question 1 to group - Should crops be in place or not? Standard methods - not. Question 2 to group - Where in cropped area to sample? In-row, between rows, offset? Problems with banding or knifing in of fertilizer. Where to sample to decrease bias in results? Crops: Corn - soy - wheat

IVW: Technique of bare soil sampling? JSR: Crop is pulled out where sampled.

Q: But banding would still be there. JSR: That's part of treatment or application.

Q: Still biases results. JSR: Different for nutrient/pesticide. Crop intercepts what's applied..

IVW: All depends on objectives of experiment.

JSR: Objective to look at 2 cropping systems. So lean to crop present. Also would like to work out where to sample.

CS: If not standard method some will criticize according to international rules.

AH: For real situation. Look at with crops in place. Breakdown patterns already worked on for regulatory work. For sampling: problem was wrestled with on Great Lakes Water Quality Study. Suggestion there was : take 3 rows in plot areas and establish sample pattern. Take 7 samples in row to 21 samples in total. On next sampling date move to other side of plant or move a standard distance - then composite the samples. This removes variation from sprayer application. This maintains variation and you still sample the whole area.

CS: Can increase sample size even though you composite the samples. Can increase sample area.

AH: The sample area varies. CS: 21 subsamples added together. Variation an issue.

AH: By moving the sampling each time, variation the same. JSR: What about In-Row vs. between?

CS: It's a function of crop growth. Move with leading edge of root system through growing season?

AH: Lots of feeder roots In-Row. CS: Feeder roots probably structural only.

GK: Water draw down higher In-Row so lots of uptake and activity In-Row.

AH: John Gaynor study sampling moved out from plant. But not quite sure on methods. Didn't follow edge - circled the plant.

GK: If your doing environmental monitoring - sample In-Row. Can use shifting grid but include In-Row.

JSR: How many In-Row areas to sample? 3 rows IR then where else? How rigorous? Can only take so many than composite. Use a transect?

AH: Should tire compaction be avoided? JSR: Yes.

CS: Why add variation with crops. If crop takes up only 0.01% of pesticide. This is a low portion compared to the soil - a non-issue.

JSR: Interested in - if there's a lag time between application and when picked up by soil, i.e. what is influence of crop?

AH: Microbes associated with crops differ may effect breakdown.

GK: Comes back to what objectives of study are. If interested in pesticide persistence in cropping system, monitoring experiment with crops in. If interested in changes in soil conditions - dissipation, standard method with bare soil. The 2 objectives are different. What's effect on soil structure? Crop should not be present. If interested in leaching out of pesticide after addition, crop should be present.

AH: Also for farmers benefit crop should be present.

CS: For sampling 1 In-Row, 1 in centre, and move on grid?

JSR: 3rd piece of advice needed. Column. Surface water and tile water samples will be taken. So there's a suggestion to take readings from 1st 6 in. skip 6 in. then sample last 6 in.

IVW: Best to read whole column. Might miss a whole peak/plume. Split it in 2 and you know whole profile.

JM: Any crops have manure? JSR: No, would be confounding factor.

JM & CS - short discussion on problems with compaction due to manure application at JM's farm.

CS: How is data to be put together? What is there in regards to pulling info. together in GP projects. Possibly a BMP booklet? Workshops for farmers? How can info be given out to minimize lag between research.

JSR: There is a requirement for GP projects to publish 1 paper in the Scientific literature plus a provision for publication in the popular press. This is a requirement, never been done before.

CS: There should be an opportunity to get farmers and researchers together.

SB: There are provisions for symposia near the end of the program.

CS: (to KB) Is there a possibility to use OMAF bulletins to get info out at end of program? Good to get key info. people together to develop a plan to get info out there.

CS: There's a lot of work on Nitrogen. Lots of models on movement of N in the environment. A lot of data on N is being gathered. Researchers could use this data for models. Is data applicable to worldwide models.

Discussion over collection of data for modelling. AH expressed concerns that this may be a gap in database being put together.

Concerns over format of data, locating sites, parameters to measure for modelling were expressed.

ACTION: a standardized data sheet for researchers listing parameters to measure plus the format needed, should be sent to researchers. Crop measures should also be included. *(See end of minutes)*. Important parameters to include were discussed: temperature (min & max.), rainfall, soil moisture, radiation.

SCH: Some parameters - radiation can be taken at 1 point as variation low across areas.

CS: Problem with OMAF reporting station data not being given in useable format.

GK: (to JSR) Slope variation - how is it being made up for. N - in low lying areas don't need as much, but needed on hills. Variation in amount of N needed.

JSR: Hope to take samples along slope. Labour demand a question.

GK: Is runoff being tested? JSR: No.

GK: If doing paired t-tests not enough reps. Due to high variation if slopes kept in , should take out. What is tile depth? Small differences in depth can have huge differences in flow.

JSR: Can't control for this. Tiles are established. Sch: How could N to groundwater in sandy soiled be measured?

GK: Multilayer sampler best but high cost. JSR: Will collect Input/Output info. but no plans as yet for it.

SB: Economics is a gap in program development, more emphasis should be placed on it.

SCH: (to GK) Re: spring N test. Is it valid in manure soils especially before planting.

GK: N test just total Nitrate in top 2 ft of soil. If applied manure 5 days before sample no N picked up. Next spring yes.

SCH: What about 5 days before applying?

GK: Test supposed to be tied to planting - with the warming of soil N is mineralized. So N at time of planting an index of N mineralization, i.e. in situ incubation and time that take sample is important. Manure has huge ammonia component but not enough time to mineralize, so can't be picked up by test.

SCH: **Equipment needs** Will need datalogger for measuring soil temperature for models. If there's a spare.

CS: If weather station OMAF/airport nearby - don't need. AH: soil temperature more important than air speed/direction.

GK: Probably need voltage input for temperature. Pulse input for windspeed. Can get 2 channel datalogger for about $400.

AH: For $2-300 can get temperature logger for small amounts of data. **ACTION** AH will send information on datalogger to SCH.

JM: Is there any work in Eastern Ontario.

AH: Only PG working there but expertise from CLBRR involved in many projects.

REVIEW of workshop.

AH concerns: Is timing (scheduling), scenario, agenda, 10 min. for project summaries OK. Comments or criticisms for future workshops requested.

GK: Posters of design/procedures/objectives to summarize projects. Don't need everyone to make presentations. As long as there is room for posters, can spend more time with area of interest. Can group posters by project.

PG: 10 min's insufficient for summaries in future.
.

CS: May need more than 1 yr to get enough data

JSR: Suggested adoption of SWEEP non-confrontational committees with 'all here to help' attitude. Able to bring problems with methodologies to colleagues.

Discussion re: date of workshop/meetings. **RESOLVED** that **early March** best as most sampling is done by mid January and annual reports are due about the same time.

RESOLVED next workshop should have **POSTER SESSION**, projects ending will have a **PRESENTATION**, general **QUESTION AND ANSWER SESSION** in smaller groups - similar to present 'break-out session'. Will get together **YEARLY**.

ACTIONS:
PARAMETERS for model information from CS and IVW will get out to researchers. Requirements for **Bruce MacDonald's** site characterization **DATABASE** will be included.

MINUTES of session will be given out.

Adjourned 10:40 am.

3.0 Integrated Monitoring Capability

3.1 Title: Development of Standard Methodologies: Resident Biomass and Organic Carbon Variability (as a function of landscape position and management).

Contractor: Mr. David Charlton, Ecological Services For Planning, 361 Southgate Drive, Guelph, ONT, N1G 3M5

ABSTRACT:
This project is building on a foundation laid by the National Soil Conservation Program Soil Quality Evaluation Study. The present Green Plan study allows for continued monitoring of benchmark site 14-ON in Southern Ontario enhanced by detailed soil carbon and resident biomass analyses. This research represents an important opportunity to evaluate soil carbon and biomass activity under forested land conservation tillage and conventional tillage systems. The experiment is structured such that infield invariability due to topographic position can on be controlled and evaluated. Along with the carbon analysis, detailed physical soil properties are being collected at each sample location in order to further illuminate the infield variability of carbon in response to microscale soil variation.

The major objectives of this project are to characterize the forms and the spatial and temporal variation of soil biomass and carbon, and to relate soil biomass and carbon components to the physical and chemical and biological properties of soil thereby relating these properties to soil fitness, crop performance and yield.

The research is specifically designed to test the following hypothesis:
! increasing soil disturbance (conventional tillage as opposed to conservation tillage) will decrease soil carbon amounts;
! soil erosion processes will redistribute organic matter and topsoil from upper slope positions to lower slope positions thereby increasing soil biomass and carbon in lower slope positions relative to the more highly eroded upper slope positions; and
! there will be interaction between management and slope position which will intensity the effects resulting in the lowest soil carbon levels under conservation tillage at eroded positions in the field and the highest soil carbon levels under conservation tillage in the depositional or less eroded field locations

Mid-growing season (period of peak biomass production) and post-growing season (period of low biomass production) samples have been collected from the 14-ON site. Analysis for carbon is continuing on these samples. Preliminary results indicate that carbon and biomass levels are related to landscape position and management practices. Interactions between landscape position and management also appear to be statistically significant based on the analysis to date. Detailed physical characterization of the sample sites reflects the same trends although statistical analysis of these data are not yet complete.

The most immediate task on this project is to find a suitable second site where a second year of data can be collected. Considerable effort was put into finding a site which allowed the comparison of management and slope position, however, no suitable sites which had a reasonable history of contrasting management regimes were located. Alternative site selection criteria must be developed and a second site chosen in time for pre-crop growth sampling in May of 1994. A second site can then be sampled at the peak of crop growth in the summer of 1994 with data analysis and project reporting to be completed in the fall of 1994.

Data analysis to date suggests that the correlation between management system and carbon and biomass levels is strong. Therefore, it is recommended that the second site focus on a single management regime and further testing of the within field variability of carbon and biomass in response to macroscale properties.

A second site will be selected and physical characterization will be completed prior to crop growth in the spring.

3.2 Title: Development of Standard Methodologies: Resident Biomass and Organic Carbon

Contractor: Dr. Gary Kachanoski, Environmental Soil Services, 361 Southgate Drive, Guelph, ONT, N1G 3M5.

ABSTRACT:

The objectives of this project are, (1) to develop and test methodologies to measure resident biomass and organic soil C, (2) to characterize forms and spatial and temporal variations of soil C sufficient to distinguish a 20% change over and above seasonal and random variations, and (3) to relate the soil C measurements to other soil properties.

The study has two parts; (1) method development and (2) field characterization including spatial and temporal variations. Both parts of the study make use of extensive information already collected as part of the Provincial Tillage-2000 project. A total of 150 Ap horizon soil samples were selected from the Tillage-2000 benchmark monitoring locations. The samples represent 75 soil landscape positions each split into a conservation and conventional tillage system (ie. 75 soil landscapes x 2 tillage systems = 150 samples). The samples cover a wide range in soil texture/type (Brookston Clay-loam to Fox sand)and have detailed back-up information already available. Analysis carried out on these samples as part of this project include; Light Fraction C and N (150 samples), Macroorganic C and N (150 samples), total C and N (150 samples), potentially mineralizable C (100 samples), total mineral N (150 samples), $CaCl_2$ extractable C and N (75 samples). In addition, a subset of 20 Ap horizon soil samples were selected which cover a range in soil textures(sand to clay-loam), landscape position (severely eroded, depositional), and total organic C. These samples were used for detailed chemical analysis using ^{13}C-NMR and GC-MS. These detailed analyses are being completed by Dr. E. Gregorich, CLBRR, Agric. Canada (Ottawa), and Dr. M. Goss (Univ. of Guelph).

Detailed statistical analysis of the relationships between the different indices of soil C and N are currently being carried out. The purpose is to determine which measurements are necessary to characterize the current state of the soil, so that future monitoring can be carried out. Significant correlation is present between some of the different measurements indicating they may be measuring the same thing. Soil texture (%sand, silt, clay) is highly correlated to many of the measurements, as expected. The relationships between variables are currently being assessed for different tillage systems, slope classes, and erosion classes.

Similar measurements will be used to characterize and quantify the resident biomass and organic C status of field sites.. Two sites covering three textural groups have been chosen for detailed field sampling in the next 2 years, to quantify the status of soil C. The sites are in Southern and Western Ontario and are the Lobb farm (Huron Co.), which has a sand to sandy loam textured catena sequence and a silty clay-loam to clay-loam catena sequence, and the Pottruff farm (Brant Co.), which has a loam catena sequence. Each catena sequence will have three benchmark monitoring locations; upper (eroded), middle (transitional), lower (depositional).

3.3 Title: Development of Standard Methodologies: Bio-indicators and Methodologies to Quantify Soil Quality.

Contractor: Dr. C. M. Monréal, Centre for Land and Biological Resources Research Agriculture Canada, Central Experimental Farm, Ottawa, ONT, K1A 0C3

ABSTRACT:

The objectives of this study are to develop, test and adapt methodologies to examine the use of soil enzymes, lipids and light fraction of soil organic matter (SOM) as indicators of soil fitness, current agro-ecological status and to inform the public on the impacts of management on soil resources; to characterize and separate the temporal and spatial variabilities of soil enzymes, lipids and the light fraction from normal and random variation with a view to establishing quantitative relationships between soil enzyme properties, lipids and light fraction with other soil attributes that relate to quality in soil agro-ecosystems.

A comprehensive database of kinetic parameters (Michaelis constant, maximum velocity and inhibition constants) on soil enzymes (dehydrogenase, glucosidase, glutaminase, urease, sulfatase, phosphatase) lipids and light fraction obtained in spatially and temporally variable situations in the A and B horizons of native and cultivated soils at seven locations in Ontario. The soil properties are expected to be those associated with long term cultivation, the use of manure vs NH_3 as sources of N, conventional and conservation tillage, and physical soil properties. The testing of statistical models used in quality control systems will be carried out in an effort to quantitatively assess the potential relations of soil biochemical and chemical properties with soil fitness and quality under aggrading, sustaining and degrading soil conditions.

Taken from the Project Titles Document.

3.4 Title: State of Resources: Improving the Land Resource Database . Assessing the state of the agricultural resources -Wilmot Township and the town of Whitchurch-Stouffville

Contractor: Mr. D. Cressman, Ecologistics Limited, 490 Dutton Drive, Waterloo, ONT, N2L 6H7

ABSTRACT:

The purpose of this project was to develop and apply methodologies in Wilmot Township and the Town of Whitchurch-Stouffville for upgrading existing soil survey information and integrating it with other resource information in a GIS environment to support assessments of the state of agricultural land resources.

In Wilmot Township the first step was to convert a very detailed soil map (1:20 000) on an uncontrolled photomosaic base to a scale and level of detail that is more commonly used in land use and resource management planning (1:50000). The map was then registered to the Ontario Base Mapping (OBM) in a GIS.

Three alternate methods were tested in three test areas in the Township for grouping soil map units (polygons). The methods were based on soil associations, soil drainage classes and soil material types. The soil association method of grouping was selected for application to the Township based on the degree of clarity, accuracy, information content and time required to produce the final product. A Digital Terrain Model (DTM) was used to map slopes in excess of 10 percent. New soil polygons were then complied in a digital format and a data base structure developed for the polygon attribute data in the GIS.

Upon completion of the generalized soil map, a variety of soil interpretations were completed. For the Township as a whole, soil capability ratings were prepared together with a generalized capability map at a scale of 1:100,000. Ratings were also prepared using the criteria of "Land Suitability Rating System for Spring Seeded Small Grains", Working Document from the Research Branch of Agriculture Canada, (1992). The soil map was also interpreted to produce a map of erosion potentials and a transmissivity map which rates the potential for movement of solutes through the soil profile.

Within a portion of the Township, the Bamberg Creek sub-watershed, several assessments were undertaken which required an integration of information from the new soil map with information about agricultural land use practices. Maps of soil erosion potentials, priority management areas, fertilizer N and pesticide loadings, and risk of contamination of groundwater were produced from this information. A comparison of 1983 and 1993 agricultural land use system maps was completed .

In the Town of Whitchurch-Stouffville, OBM data in digital form were obtained and incorporated into a GIS data base then interpreted in a Digital Terrain Model (DTM) to produce a slope map. The slope map units were field checked, merged with soil map units on the York County soil map and digitized into the GIS data base. For each polygon a CLI capability rating and a rating for spring seeded small grains was established. From these interpretations a 1:50,000 CLI soil capability map was produced.

For an assessment of the state of agricultural land resources in the Town, information on proposed land use developments was obtained and digitized. An overlay analysis was performed in the GIS data base to determine the capability classes of land proposed to be converted to non-agricultural uses.

3.5 Title: State of Resources: Proposal for the Upgrade of Soil Survey Information in Oxford County

Contractor: Mr. D. Charlton, Ecological Services For Planning, 361 Southgate Drive, Guelph, ONT, N1G 3M5

ABSTRACT:

1**. Introduction**

Environmental concerns have become a major issue for the agricultural industry in the 1990's. In particular, southwestern Ontario has been a focus of concern as a result of agreements under IJC to reduce phosphorus delivery from the Lake Erie Basin. The area is also one of the most intensively farmed areas in Ontario with major specialty crop, cash crop and livestock industries.

An upgraded provincial soil data base is available for much of the area. This information is essential for the protection and designation of agricultural lands in Official Plans and also forms the basis for delivery of programs dealing with environmental impact assessments and sustainable agriculture. A major gap in the data base for this area is Oxford County. We will upgrade the existing soil map for Oxford County so that it is compatible with adjacent county/regional municipality information. The upgrade will be undertaken according to present standards outlined by OCLRE. The study will focus on slope, soil reliability and development of information and maps in electronic format.

A DTM based on 5 m contour interval data and spot elevations from digital OBM's has been produced for two test areas in northern Oxford County. Slope information generated from the DTM has been field verified and based on this analysis the DTM method will be used to complete the remainder of the County. A stratified, random transect method will be used for field verification purposes. This sampling procedure will be used to verify slope mapping, provide an estimate of soil reliability for soil polygons, and where necessary, reclassify polygons using a standard legend developed for the area. The information will be compiled and an upgrade 1:50,000 map produced in electronic format along with all other available agricultural resource and planning information.

2. **Tasks Completed to Date**

Two test areas have been evaluated using the DTM. One of the test areas is in rolling topography north of the Village of Bright, while the other test area is north of the Village of Embro with fairly level topography in the central and northwestern portions and fairly steep topography along Mud Creek in the southeastern portion.

The digitally generated slope map was checked in both test areas: 80 slope checks in the Bright area and 60 slope checks in the Embro area. The data generated was very promising. There was a problem however distinguishing between the A (0-0.5%) and the B (0.5-2%) slopes. This was due to the lack of topographic resolution at the lower slope ranges. However, since the main use of the slope data will be for CLI interpretations, no distinction is made between A and B slopes. In the final product, these two slope classes will be combined.

3. **Tasks Remaining**

The digital OBM's for the entire County have been ordered and slope maps will be generated for the entire county. When this is completed, transects will be sampled through soil polygon as defined in the existing soil map. The sampling will include both soil and slope verification. The soil legends of the surrounding counties will be reviewed and a standard soil legend will be developed for Oxford County. The purpose of the sampling program is to give an estimate of the reliability of various soil polygons. No soil polygon boundaries will be changed, however some soil polygons may be subdivided according to slope class differences. Finally, a state of resources report from an agricultural perspective will be produced for Oxford County.

3.6 Title: State of Resources: Development and Application of Standardized Methodology for Sampling Soil Landscape Polygons

Contractor: Mr. J. Hagarty, Ecological Services For Planning, 361 Southgate Drive, Guelph, ONT, N1G 3M5

ABSTRACT:

The Soil landscape of Canada (SLC) mapping for Southern Ontario (scale 1:1,000,000) is associated with a database of soil properties which have been derived from existing soil surveys. Much of the information in the SLC database is outdated due to the age of the soil surveys and changes in the approach to soil survey and soil descriptions. As an example, the carbon content of much of the soil of Southern Ontario has been overestimated due to the past practice of collecting soil samples from fence rows and road cuts where the impacts of many years of agricultural practices would not be properly reflected. This situation could result in misleading information on the current state of Ontario's agricultural soil resources. This is potentially a serious problem as the 1:1,000,000 soil landscape map is a large-scale planning tool which is increasingly being used to make decisions at a provincial and even national scale regarding the state of the soil and susceptibility to degradation.

This study will directly assess these current inadequacies in the soil database associated with the SLC mapping. Agricultural field will be sampled in a systematic manner, independent of land use history, which will result in soil samples and soil attributes which are representative of the majority of agricultural soils within each of the SLC polygons.

The proposed work has two main phases. In Phase 1 the sampling method will be developed, tested and refined. In this phase a relatively intensive sampling program will be conducted in four of the soil polygons identified on the SLC map. This work will be conducted in the Regional Municipalities of Niagara and Haldimand- Norfolk which have recently been surveyed and for which there is good, recent soil attribute data available. These data are contained in Detailed Soil Map (DSM) files. By correlating the results of the proposed sampling method with the results of the detailed samples from recent soil surveys, the method can be refined quickly and efficiently.

The second phase of this study will take the method developed in Phase 1 and apply it to the Regional Municipalities of Niagara and Haldimand-Norfolk and the counties of Brant, Oxford and Middlesex. This represents approximately 67% of OMAF's Region of Southern Ontario.

Based an the work In Phase 1 a rationale for selecting a single sampling Site in each of the dominant and subdominant soils within a soil landscape polygon will have been developed. This will allow a cost effective collection of a large number of soil samples throughout a wide area of province.

3.7 Title: State of Resources: Development and Testing of "State of Agricultural Resources", A Reporting and Monitoring Methodology for Ontario.

Contractor: Mr. Harold Moore, Gregory Geoscience Limited, Kanata Square, Suite 504, 260 Hearst Way, Kanata, ONT, K2L 3H1

ABSTRACT:

This research project is centered around the development and testing of a method to monitor the state of the agricultural resources in Ontario. It consists of four main components:

Define the information requirement of a monitoring methodology
Define and collect the data needed to supply the required information and define the resource modelling procedures required.
Test the methodology in two different parts of the province
Define the implementation of the methodology for Ontario.

An agricultural resource has been broadly defined as any quantitative economic, environmental or social feature of agriculture. Any group or person that has a direct or indirect concern in any resource has been defined a stakeholder. A niche for text data such as qualitative reports are presently being researched.

Numerical and spatial data lending insight into the nature of the resource is being collected to chart the trends in the use/availability of the resources. Numerical data are such data as number of farmers in an age group. Spatial data is data such as number of dairy cattle per acre in a given region. Both data types are compatible with a Geographic Information System used to perform spatial analysis. To simplify the expression of these quantitative trends, these data are being summarized and standardized into agricultural indicators similar to economic indicators presently being used to predict economic growth.

To address the diverse interests of the wide array of identifiable stakeholders, indicators are being grouped into simple and composite indicators. Simple indicators are standardized units reflecting only one aspect of a resource. Composite indicators are a further compression of several indicators into one, giving a more general trend in a resource or sector of agriculture.

Several reporting methods are presently being investigated. To date it would appear that a brief one-page review may be the most efficient mode of data transfer to stakeholders. It may be necessary to produce more than one type of report to address the various levels of interest of the stakeholders. Electronic information services are also being investigated as well although it is important for such a service to be able to carry cartographic images.

3.8 Title: State of Resources: Monitoring Soil Loss and Redistribution Using ^{137}Cs

Contractor: Gary Kachanoski and P. von Bertoldi, Environmental Soil Services, 361 Southgate Drive, Guelph, ONT, N1G 3M5.

ABSTRACT:

At a number of spatial scales (plot, field, farm, watershed, region) the amount of past soil loss is an important parameter in estimating the current state of the soil resource. However, even though soil erosion has been identified as the single most significant factor resulting in the degradation of the land base, there have been few actual measurements of the amount of erosion occurring. Soil loss values are not available because of the difficulty and expense in obtaining measurements. However, in recent years there has been increased interest and use of fallout ^{137}Cs from atmospheric testing of thermonuclear devices in the early 1950's and 1960's. The current level of ^{137}Cs in soil relative to the baseline level that would be present if no soil loss had occurred is a good indication of the cumulative soil loss at a site. Thus, it would be possible to easily benchmark all current and future study sites by measuring ^{137}Cs. However, reliable estimates of baseline amounts of ^{l37}Cs (if no soil loss had occurred) are needed. Baseline values of ^{137}Cs can vary significantly, but have been correlated to local precipitation pattems.

The two major objectives of this project are (1) Construct a map of base-line ^{137}Cs (total deposition, Bq m^{-2}) values for south-westem Ontario, and (2) Determine the redistribution of ^{137}Cs/soil since 1965 within a watershed typical of Ontario conditions, including deposition within the watershed, export out of the watershed, and loss from the uplands.Construct a map of the redistribution with geographic positioning so that the watershed can be used as a long-term monitoring site for similar studies in the future.

A total of 39 sites were selected on the basis of availability of long-term precipitahon records and geographic position. At each site an undisturbed, uneroded area was located. Two composite soil samples were obtained from within each of the undisturbed areas. Each soil sample was composited from 9 soil cores taken to a depth below the top of the B horizon. The soil samples were dried and analysed for fallout ^{137}Cs using high resolution gamma-spectroscopy. The analyses were combined with the soil weight and depth measurents to obtain ^{137}Cs deposition values on an area basis (Bq m^{-2}). The data indicate that 82% of the variability of the ^{137}Cs values was accounted for by differences between sampling locations, and only 18% of the variability was attributed to within site variability. The ^{137}Cs values ranged from 1861 to 3015 Bq m^{-2}. Significant spatial trends were observed in the data. Preliminary correlation analysis indicates a significant relationshig between precipition during the major years of fallout and measured ^{137}Cs values. Measured values from other studies are being added to the database, and additional statistical analysis will be completed before constructing a baseline ^{137}Cs fallout map for south-westem Ontario.

Work this coming year will focus on the Kintore monitoring watersheds in cooperation with the University of Waterloo's hillslope water partitioning study. A detailed topographic map will be obtained from laser theodolite measurements of one of the watersheds. A total of approximately 400 benchmark locations within the watershed will be sampled and ^{137}Cs measured to obtain a surface soil/sediment balance for the watershed from 1965 to present. Pattems of soil loss and deposition within the watershed will also be mapped.

3.9 Title: Development and Application of a Computerized System to Manage, Use and Distribute Data Collected by Green Plan Monitoring Research Projects

Contractor: Mr. Ken Denholm, Ontario Land Resource Unit, Centre of Land and Biological Resources Research, 70 Fountain Street, Guelph, ONT, N1H 3N6

ABSTRACT:

Background

In contrast to many past studies, the current monitoring projects will deliver to Agriculture Canada both a written report providing analysis sand interpretation and also a substantial volume of data (both raw and processed) in digital formats. This project develops the capabilities required to review and verify the quality of digital data delivered and also to store and manage the information for further analysis and future comparisons.

Briefly, the specific objectives of this project are: 1) to develop a data management and analysis system with the capability to correlate, interpret and document linkages between the data collected through Green Plan monitoring research projects (both site specific and area or map data) and other land resource information for Ontario; 2) to carry out data and spatial analysis to verify the quality and content of data delivered through Green Plan monitoring contracts and agreements and where possible to standardize and extend the area of the data analyses; 3) to provide standardized, documented copies of data for assessment and use by other projects and agencies and for comparison with future measurements to determine the direction and magnitude of change in land characteristics.

Progress in 1993-94

The principal activities for the 1993-94 year have been: i) to upgrade the data management capability currently available in the Ontario Land Resource Unit (OLRU) to the level required to handle the Green Plan monitoring research data; and ii) to incorporate data from land resource inventories, census of agriculture and remote sensing into the data management system to provide a framework and background for data from the Green Plan monitoring research projects. A review of the hardware options was carried out with the recommendation to consolidate the current systems into a more powerful unit which had the capacity to meet existing and Green Plan needs. The consolidated system which replaces the current systems retain the ARC/Info software. This option allows all GIS data management activities to be carried out on a single modern machine with a single set of software with the associated improvements in performance, savings in communications time and consolidation of the personnel skills required.

Planning for next year:
For research projects which involve major data collection or assembly, such as the current Green Plan Monitoring Research projects, the data stored in generally accessible data bases become a component of the project equal in importance to the interpretive reports.

Over the next year, this project will receive data, verify the formats and quality and incorporate it into the data management system. The major activities which will deliver digital data include: Maps and Data from:

- SLC polygon characterization - ESP
- State of resources assessment of Oxford - ESP
- Upgrade of Wilmot and Whitchurch-Stoufville - Ecologistics
- 137-Cs Baseline assessment - Environmental Soil Science
- Ramsay Township - Gregory Science

3.10 Title: Partitioning of Solutes from Agricultural Fields within the Hydrologic System at Two Sites in Southern Ontario and the Subsequent Impact on Adjacent Aquatic Ecosystems

Contractor: Dr. David L. Rudolph, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, ONT N2L 3G1

ABSTRACT:

A major objective of this project is to construct an adequate data base representative of the annual variations in water and contaminant fluxes at two contrasting sites in Ontario. Thus, an important requirement for initiating this study was choosing appropriate sites. The Agriculture Canada experimental farm at Woodslee was chosen as one site. For the second site, the Kettle Creek and Kintore Creek watersheds were chosen as possible sites. After visiting the two potential sites, the research team opted for the Kintore Creek watershed as the second site. The two sites (Woodslee and Kintore) have been chosen to make optimal use of ie extensive data bases and information available from previous studies. Selection of this site has also led to an excellent working relationship with the Upper Thames Conservation Authority and has provided us with access to an exceptional data set.

At each site groundwater monitoring wells along with tile and stream gauging stations are being installed to monitor water movement in the local hydrologic systems. A meterological station will be deployed at each site and vadose zone monitoring will be conducted. This monitoring network is designed to collect data over several annual cycles to observe ie partitioning of water through the various hydrologic components.

Water samples will also be collected on a rigorous schedule to monitor nitrate levels primarily. Analysis for some common pesticides will also be undertaken on a less frequent basis. The annual variation in nitrate concentrations will provide evidence of how these types of solutes associated with the agricultural operation are distributed within ie hydrologic systems.

The aquatic ecosystem in the adjacent stream is also being assessed by a team of biologists to evaluate the annual impact of the agricultural operation on the health of the stream ecosystem.

Green Plan Workshop
Ramada Inn
Wednesday March 23, 1994
"Integrated Monitoring Capability" Group Discussion

Discussion Leader: Bruce MacDonald

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C. Monréal
E. Mozuraitis
R. Protz
D. Rudolph
R. Thomas
A. Ward
M. Webber

Secretary: Ken Denholm

The Green Plan research program was briefly reviewed: origins in Kempenfeldt Conference leading to 30 recommendations. The objectives refined to about 10 and grouped into areas of activity. Research Program objectives were identified to include three project areas (i) Manure and closed-loop recycling, (ii) On-farm research and (iii) Monitoring. Bruce Bowman was designated to lead the research program and Bowman, Hamill and MacDonald were responsible for individual research objectives. A research committee was formed and each project area formed an advisory committee to refine and develop the program. Five members of the Monitoring project committee were represented in this discussion group.

The general criteria for the research program were reviewed; projects must have deliverables applicable at the farm level by the end of the program.

Question to the group "What is missing from the current Green Plan monitoring program?"

Discussion:

1. Possible imbalance in program. There is too much emphasis on land based activities and not enough on surrounding or affected waters.

   What is impact on receiving waters?

   Water Quality - Sediment and solute
   - Land Intercept

   Can we tap into OMEE river monitoring? - Can we incorporate the information into GIS?

2. For the entire research program there is a need to coordinate and standardize (or at least cross-correlate) measurements of similar parameters. Ideally this would involve cooperation between different groups looking at the same nutrient to standardize methodologies and analytical procedures. It would also include ongoing quality control checking to ensure comparability of measurements.

Difficulty between agencies - sharing or accessing data

Data Quality - Quality Assurance/Quality Control (QA/QC)
- physical and chemical data quality
- spatial integrity of data

We require information on
- history of data
- consistent quality

Various commercial laboratories may be able to provide some reference standardization e.g. Great Lakes or Soil Testing.

3. Interpolating/Extrapolating this area is difficult but must be addressed. Some effort should be devoted to relating landuse to chemical loadings. The question was raised about funding for verification and field checking i.e. **$$$$ for accuracy????**

4. Need principles for additions to land of materials such as:
- sludge
- waste

- Definition of these materials
- understanding of their soil conditioning value
- characterization of the quality of compost - heavy metals
- heavy metals less mobile - focus on nutrients
- spatial relationships: rural - urban fringe
- Current activity by U. of Waterloo, studying sub-watersheds of the Grand River (funded by a tricouncil grant)

The deliverables of the monitoring program should contribute to our ability to monitor the status and changes in our land resource base

<u>Discussion:</u>

Environmental Indicators:

- are they adequate?
- can we measure change?

** Need time frame longer than the Green Plan to have effective indicators ***

Can't measure change in 5 years!!

Targeting:
- Site specific to Broad areas
- Targeting Environmental Indicators - use strategy "on the ground" to develop indicators.

- Use funding - Now
  - beyond 1997
- Don't let money lapse - stay open to new projects

Dataset critical for targeting - requires a minimum level of detail

Stay focused on nutrients

Need to progress from Chemical/Physical to Biological - impacts as opposed to indicators

What about the requirement for tangible farm level deliverables by 1997?

Discussion:

- have environmental farm plans ready to go
- to the extent possible, characterize specifics
  - field scale
  - cropping systems

- must work and communicate to establish public confidence
- must be sensitive to the zone of urban influence in agriculture

Considerations for farm level use of the information:

Discussion:

Monitoring Techniques for farmers
what is the starting point?
should be a simple test to implement
how does producer know when reasonable level of soil tilth?
what information and tools do farmers need to assess soil base?

- Identify components
- methods to measure - simplify methodologies for use on the farm
- understand processes
- make sure the practices promote sustainability

How do we take next step? - synthesis of a wide range of 'single-factor' experimental results is right brain function.

What is the farmer willing to accept?
Farmer is Steward of the Land but has economic as well as environmental obligations.

How to show progress (change)?
1) Provide tools
2) Education - OSCIA
- Innovative farmers

Considerations for the Program:

Discussion:

Program Evaluation - will the information collected meet the Ag Can requirements to assess the Green Plan Research activity?

- only three crop years
-database will be incomplete but will be coordinated for some groups of studies e.g. contaminant flux measured on the same watershed as Cs^{137} data estimating erosion. There is substantial work required to correlate data from unrelated programs.

Broad level objective:

Sustainable land management which includes concepts like:
- live on interest not capital
- operating on renewable portion of resource base
- maintenance of natural flora and fauna

Future directions and considerations for the remainder of the program:

Discussion:
- Consider a policy of preserving representative samples
- Map with all sites and related activities
- Compile a Mini-Atlas which documents green plan activities such as:
- Conservation Club demonstrations
- Research
- Woodlands, Wildlife and Wetlands activities.

Communications:

Discussion:

Next Year - What level of information?
- time too short
- suggest presentations in form of posters with overview from principal investigator
- Oral presentations at appropriate times
- Progress reports

External Communications
- have information available at public meetings
- OSCIA, Innovative Farmers, etc.
- Land Stewardship Centre

Keep in mind - social pressures on farmer
- decline in farm infrastructure
- farmer as a resource
- **Rural is NOT synonymous with Agriculture**