

Greenhouse Gas Mitigation Program for Canadian Agriculture

Ontario Demonstration and Awareness Activities

Final Report January 2003 - April 2006

to

Soil Conservation Council of Canada



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

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Greenhouse Gas Mitigation Program for Canadian Agriculture Ontario Program Final Report 2003 to March 2006

1. Introduction

The Ontario Greenhouse Gas Mitigation Program (GHGMP) committee (Taking Charge Team) chose to put more emphasis on nutrient activities than on soil related activities. The reason for this approach was based on research and coefficient numbers for Ontario which indicated that the potential for carbon sequestration was much less than for Prairie soils. The committee also wanted to encourage demonstrations of Beneficial Management practices that were practical and could provide economic and as well as environmental benefits. The following outlines the key objectives of the program.

a) Nutrient Component

Nitrogen was the main focus of the nutrient component of the program as nitrous oxide has a high Global Warming Potential. The other reason for the nitrogen focus was the large acreage of crops which require significant nitrogen inputs. The objectives of the nutrient component were as follows:

- Profile Best Management Practices (BMPs) that reduce nitrous oxide emissions an important gas in the agricultural portion of Canada's commitment under the Kyoto Protocol.
- Establish regional hub demonstration farms (larger demonstrations) across the province with satellite farms (incorporating complementary management practices) around them demonstrating:
 - nitrogen rates and timing in winter and spring wheat
 - improved nitrogen use in livestock operations
 - improved nitrogen rates and timing on clay soils
 - nitrogen management in a strip tillage system
 - nitrogen management with cover crops in field and horticultural cropping systems
 - fine tuning of nitrogen rates in horticultural crops
 - fine tuning of fertigation in horticultural crops
- Where possible, establish links with greenhouse gas research
- Where possible, research (funded from other sources) may be conducted on demonstration farms.

b) Soils Component

The soils component of the Ontario program focused on carbon dioxide reductions and removals through reduced tillage practices and the use of cover crops.

- Profile Best Management Practices (BMPs) that sequester carbon, reduce carbon dioxide emissions and reduce methane under field conditions, important greenhouse gases in the agricultural portion of Canada's commitment under the Kyoto Protocol.

c) Economics

Beneficial Management Practices (BMPs) for greenhouse gas mitigation may be able to generate some income through offset credits. However a trading system is not currently in place, so farm managers have to make adoption decisions on the economic and other benefits of the practice

being considered. The Ontario program attempted to analyze and communicate the economic impacts of adopting a number of the BMPs that were demonstrated.

d) Evaluating Best Management Practices and their potential in Reducing Greenhouse Gas Emissions (nitrous oxide) from Soils

Nitrous oxide makes up a significant portion of Canadian agriculture's share of greenhouse gas emissions from the soil. A number of BMPs have been identified as having potential to reduce nitrous oxide emissions but for many it is difficult to know how effective the practices are. This portion of the program intended to develop a database of pertinent soil and crop information that can be used in a model to predict N₂O emissions. It also calculated an International Panel on Climate Change (IPCC) estimate of N₂O emissions on selected sites.

e) Communication and Awareness Activities

The communication and awareness of climate change and greenhouse gas (GHG) mitigation beneficial management practices was a key component of the national program. It was also a key component of the Ontario program. A broad range of activities were used to increase awareness of climate change and the BMPs for GHG mitigation. Presentations at farm meetings and conferences, and articles in newsletters and in the wider farm media were combined with tours and field days to show the rural community what can be done on the farm. Where possible links were made to other programs such as the Environmental Farm Plan, Nutrient Management Planning, Greencover Canada and the Agricultural Policy Framework.

The administration of the Ontario GHGMP was handled by the Ontario Soil and Crop Improvement Association. A staff person from the organization acted as the program coordinator. The actual in-field plot establishment of demonstrations and organization of tours and field days was carried out by the project leads.

2. Management and Planning Activities

The information regarding the Greenhouse Gas Mitigation Program for Canadian Agriculture became available from the Soil Conservation Council in the summer of 2002. Some members of the existing Taking Charge Team (TCT) along with representatives from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), the University of Guelph, Agriculture, Agri-Food Canada and agricultural businesses formed a committee to decide how to implement the program in Ontario. The committee met several times in the fall and winter to formulate budgets, which greenhouse gas beneficial management practices to demonstrate and the best methods to communicate program messages. A request for proposals for projects to be completed under the program was put out late in the winter. A number of proposals were received and the committee decided which projects to fund.

The committee also invited the GHGMP coordinator from the Canadian Pork Council and Ontario representatives from the Cattlemens Association and Dairy. They attended a few meetings but the only partnership that was formed was with the pork group.

In March 2003 several members of the Taking Charge team were involved in a series of meetings held across the province titled "Getting Ready for Spring: A Soil and Nitrogen Management Tune-up". The workshops focused on soil and nitrogen management with a focus

on the bottom line. Participants were also introduced to the Kyoto Protocol, greenhouse gas emissions and mitigation practices. A French version of the workshop was held March 2004 in eastern Ontario.

Members of the TCT attended a number of meetings, workshops and tours over the life of the program. The TCT members participated in some of the events and had an opportunity to learn more about greenhouse gas emissions and observe how the program was progressing.

Each year an annual meeting was held to present the results of the program to government and university staff for their information as well as to obtain feedback on the program. Following the annual meetings the TCT met to evaluate the past year and plan for the year to come. In the last month of the program a cooperator meeting was held for those involved in the field crop projects. The horticulture cooperators were invited to the “Advances in Soil and Nitrogen Management: Brightening the Bottom Line and Reducing Greenhouse Gas on the Farm” workshops to hear some of the results of the projects presented. Horticulture and field crop project cooperators who were unable to attend the meetings were contacted about the results of the project they were involved in.

The Ontario Soil and Crop Improvement Association (OSCIA) program coordinator acted as a liaison between the Soil Conservation Council of Canada (SCCC) project manager and the Ontario program. The program coordinator assisted the committee with development of the program and worked with the project leads to get the program up and running. They also managed the financial activities of the program. This included working with the committee and project leads to develop the budget, track finances and request funds from SCCC. OSCIA also assisted with a number of communication activities. Quarterly reports were prepared on demonstration and communication efforts and submitted to the SCCC project manager. These reports were prepared with input from the project leads. The program coordinator attended meetings to report on Ontario program results and to network with other program staff for opportunities to improve the Ontario program. They also attended training sessions and occasionally took other TCT members with them.

The local and regional Soil and Crop Improvement Associations played a key role in the demonstrations and providing a venue to get the message out. Several regional associations were linked to the demonstration projects, supplied cooperators and discussed how the projects were progressing. Many of the local organizations organized tours and meetings to show the BMPs and to discuss management options for reducing GHG emissions.

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) crop specialists played a significant role in the success of the Ontario GHGMP program. Staff participated as part of the advisory committee and assisted with the development of the Ontario program. They worked closely with the Program Coordinator to ensure the program met its objectives. OMAFRA staff were instrumental in bringing the University of Guelph researchers together with the OSCIA regional associations to develop the demonstration projects. In many cases they acted as project leads, coordinating the establishment of the demonstrations on cooperator’s farms. OMAFRA specialists worked closely with the program coordinator to provide information for reports and assisted with communication efforts. The specialists are involved in technology transfer in their

jobs so were able to use their expertise to assist with the communication component of the program. They spoke at numerous meetings, wrote articles, planned field days and developed displays to increase awareness of the BMPs.

The University of Guelph was a strong partner in the success of the program. Researchers at the Guelph, Kemptville and Ridgeway campuses worked with OMAFRA and the OSCIA to develop and implement the demonstrations. They also helped with the analysis of the data at the end of each season. In some cases they were able to make linkages between their research and our projects. Operationally there was assistance with staff and access to equipment for the projects.

The Ontario Program Committee (Taking Charge Team) consisted of the following:

Stephen Broad, Soil Conservation Council of Canada, Chair

Harold Rudy, Ontario Soil and Crop Improvement Association

Kevin Ferguson, Ontario Soil and Crop Improvement Association

Alan Kruszal, Ontario Soil and Crop Improvement Association (replaced Kevin Ferguson March 2006)

Barry Newcombe, Innovative Farmers Association of Ontario

Bob Bedgood, Christian Farmers Federation of Ontario

Ron Bayeart, Agriculture and Agri-Food Canada

Claudia Wagner-Riddle, University of Guelph

Dale Cowan, Agri-Food Laboratories

John Finlay, Ontario Ministry of Agriculture, Food and Rural Affairs

Anne Verhallen, Ontario Ministry of Agriculture, Food and Rural Affairs

Adam Hayes, Ontario Ministry of Agriculture, Food and Rural Affairs

Deanna Deaville, Ontario Soil and Crop Improvement Association, Program Coordinator

Cedric McLeod, Canadian Pork Council

3. Communications

A significant communications effort was achieved over the life of the GHGMP. The program kicked off with a series of Soil and Nitrogen workshops held across the province and concluded with a similar set of workshops. A number of methods of communication were used including the various forms of the agriculture media, workshops, participation in conferences, displays and infosheets. See table 1 for a summary of communication activities. Appendix 1 has a detailed listing of communication activities.

The Nutrient Management Act had increased awareness of the nutrients in manure as the GHGMP began. Increasing nitrogen prices and a new summary of Ontario nitrogen research was increasing interest in the farm community in better nitrogen management. The communication effort of the GHGMP built on these issues and was able to communicate to farmers that nitrogen management could improve their bottom line and reduce nitrous oxide emissions.

Table 1. Event and Communication totals for Ontario Greenhouse Gas Mitigation Project 2003-March 2006

2005-2006 Ontario GHG Mitigation Program

Quarter	Demos Established	Field Days (Ag and Hort)	attendance	Mtgs & Wkshps (Ag & Hort)	attendance	Communications (Ag and Hort)
1	64	2	65	3	90	3 news articles
2	6	16	6630	4	110	4 new posters, 3 articles
3	0	0	0	20	1025	4 articles
4		0	0	19	3590	2 articles, 1 radio broadcast
Total	70	18	6695	46	4815	

2004-2005 Ontario GHG Mitigation Program

Quarter	Demos Established	Field Days (Ag and Hort)	attendance	Mtgs & Wkshps (Ag & Hort)	attendance	Communications (Ag and Hort)
1	61	0	0	3	145	
2	6	25	6065	3	180	4 articles
3	0	0	0	6	305	3 articles
4	0	0	0	15	1765	
Total	67	25	6065	27	2395	

2003-2004 Ontario GHG Mitigation Program

Quarter	Demos Established	Field Days (Ag and Hort)	attendance	Mtgs & Wkshps (Ag & Hort)	attendance	Communications (Ag and Hort)
1	54	0	0	0	0	
2	6	7	2405	0	0	
3	0	0	0	7	355	
4	0	0	0	31	3930	
Total	60	7	2405	38	4285	

Ontario GHG Mitigation Program Event and Communication Activity Totals 2003-2006

2003-2006	Demos Established	Field Days (Ag and Hort)	attendance	Mtgs & Wkshps (Ag & Hort)	attendance	Communications (Ag and Hort)
Total	197	50	15165	114	11500	19 articles, 4 posters, 1 radio broadcast

a) Meetings and Workshops

There are three large agricultural conferences held during the winter months; the Southwest Agricultural Conference, FarmSmart and the Eastern Crops Conference with a yearly attendance of 1800, 500 and 250 respectively. The Corn, Soybean and Wheat Annual Conference attracts 350 delegates. Several presentations were given at these conferences on soil and nutrient management information relating to the demonstration projects from the previous year.

Soils topics discussed:

- warming up soils for no-till
- planter clinics
- pasture management
- managing buffer strips
- soil compaction workshops
- creating and managing natural areas on the farm
- soil quality workshop
- soil management
- corn and soybean tillage workshop
- soil life
- timing and application of manure

GHG Topics:

- greenhouse gas emissions and agriculture
- greenhouse gas mitigation on the farm

- GHG on-farm projects update

Nutrient topics discussed:

- sidedressing liquid manure
- manure incorporation tools
- nitrogen rate and application workshops
- new nitrogen recommendations
- nitrogen management on livestock farms
- strip tillage and nitrogen management
- land application of biosolids
- fertility management zones
- nutrient management with cover crops

The Innovative Farmers Association of Ontario also holds an annual conference at which they featured speakers on the GHGMP and related topics over the three years.

The horticultural industry covers a wide variety of crops and production methods. There are a number of horticultural conferences and meetings held each year with attendance ranging from 20 - 2000. These include:

- Ontario Berry Growers Conference
- Ontario Processing Vegetable Industry Conference
- Fruit and Vegetable Growers Convention
- Great Lakes Vegetable Workers Meeting
- Integrated Pest Management Update
- IPM Scout Training Days
- Various individual commodity meetings such as Blueberry, Potato School, Grape Growers meetings etc.

The following is a selection of topics presented on GHGMP activities at the above conferences and meetings which relate to the horticultural industry.

Soils topics:

- Soil health
- The physical soil
- Managing soil as a habitat
- Building organic matter in both annual and perennial production systems
- Reducing Tillage – Lessons from Field Corn – Sweet Corn
- Crop Rotation pays

Nutrient topics:

- Managing your soil fertility
- 3 year Grower Nitrogen trials – Sweet Corn
- Cover Crops – Cucumber session
- Predicting Availability of Nutrients from Manure
- Cover Crop Update
- Nutrient Scavenging and Soil Building with Cover Crops

Water and Energy Efficiency Topics:

- Trickle Irrigation – Tomatoes, Cucumbers
- Irrigation and Fertigation
- Trickle Irrigation
- Irrigation Scheduling - Tomatoes

The Ontario Soil and Crop Improvement Association's annual meeting attracts about 130 delegates. Each of the three years of the program the GHGMP activities were highlighted. The OSCIA has 54 local associations that hold annual meetings and workshops in the fall and winter. The GHG BMPs were discussed at many of the local meetings.

Getting Ready for Spring: A Soil and Nitrogen Management Tune-up

In March of 2003 the first significant communication event for the program was held. It consisted of a series of workshops titled "Getting Ready for Spring: A Soil and Nitrogen Management Tune-up". Ontario Ministry of Agriculture, Food and Rural Affairs specialists and University of Guelph researchers prepared presentations on soil and nitrogen management issues. Taking charge team members were involved in preparing an introductory presentation and a TCT member delivered a presentation over lunch on "Kyoto: What's in it for the Farmer?" In the morning the presentations covered how to maintain and build organic matter, the carbon cycle and the potential for carbon sequestration in Ontario. In the afternoon the focus was on the nitrogen cycle including when nitrous oxide emissions occur, fine tuning nitrogen rates and maximizing manure efficiency. The workshops were held at five locations across the province with a total attendance of 235. The evaluations suggested participants were very happy with the material presented and were interested in attending future workshops on related topics. A French version of the workshop was held in March of 2004 with 16 participants.

The program concluded with a similar series of workshops titled “Advances in Soil and Nitrogen Management: Brightening the Bottom Line and Reducing Greenhouse Gas on the Farm” in March 2006. Six meetings were held in some of the same locations as in 2003 and in new locations. The nitrogen topics were similar but were updated with new information and some of the information from the GHGMP projects. The soil management topics covered: carbon sequestration, on farm benefits of soil quality and how to build carbon. 200 people attended the sessions. The evaluations indicated that participants gained a better understanding: of the impact of farm practices on GHG emissions, soil management to build/maintain soil carbon and how to fine tune nitrogen use.

b) Articles, News Media and Infosheets

July/August 2004 - Corn Producer Article - 22,000 circulation

“Green House Gas Mitigation (A.K.A. improving N Use Efficiency)” written by Greg Stewart.

Fall 2004 – Golden Horseshoe Soil and Crop Improvement Association Newsletter - 550 circulation, “Using Fall Strip Till Systems for Corn Production on Heavy Clay Soils” written by Ian McDonald.

Fall 2004 - Ontario Soil and Crop Improvement Association Newsletter - 5000 circulation
OSCIA News Article – “Spring Application of Nitrogen on Wheat: Does it Contribute to Nitrous Oxide Emissions?” written by John Shepherd.

CropTalk - OMAF News Article – 5000 circulation– “Fertilizer Application – Fall of Spring?” by Keith Reid

Spring 2005 Ontario Soil and Crop Improvement Association Newsletter – “Still Looking for a Way to Make Cover Crops Pay” – 4000 reader circulation

Spring Edition Ontario Corn Producer Magazine – “More Payback from Cover Crops” - 21000 reader circulation

Sept 2005 – Ontario Corn Producer Article - 22,000 circulation
“Simple, but on time” Reduced tillage written by Greg Stewart.

Fall 2004 - Ontario Soil and Crop Improvement Association Newsletter - 5000 circulation –
Highlights from Ancaster Cropping Information Systems Day
“Oats are a good cover crop to use” County Grower Publication for Vegetable Growers,

Cover Crops Article – Hort Matters Publication sent to Agri-business and Hort Growers across Ontario.

Hort Irrigation Scheduling – Hort Matters Publication sent to Agribusiness and Hort Growers across Ontario.

- Reduce energy use

- Reduce potential for N₂O release from soil.

Cover Crop Article for SCCC e-newsletter, nationally distributed.

Radio Report – CFCO radio with listening area of five counties.

November, 2005. Corn Producers Magazine. Manure Injection – Putting Manure in it’s place. 23,000 circulation.

November, 2005. OSCIA Newsletter OMAFRA Crop Talk articles. Considered yet how to Fertilize the 2007 corn Crop? (N use Efficiency), What does \$500 Nitrogen Mean for Spring Wheat?, Available Nutrients for Manure from Various Livestock Types. 3500 circulation.

January 2006. Eastern Top Crop Manager. Practices reducing GHG’s evaluated. 12,000 circulation.

Associated Growers newspaper. Essex/Kent County. Cover crop article. *Rye is the winner for late fall cover!*

4. Demonstration Field Days and Tours

The demonstration of Best Management Practices (BMPs) was achieved through several major projects. Each project established a number of demonstration sites; combined up to 70 demonstration sites were established each year which were part of tours or were signed for those passing by. The following is a list of the projects:

- Building soil structure and managing nitrogen with strip tillage corn systems in heavy textured soils
- Advancing nitrogen use efficiency on livestock farms
- Cover crops for carbon sequestration and nitrogen management in field crops
- Demonstrating the impact of both application date and rate of nitrogen on N₂O emissions in wheat production
- Precision toolbars for tillage and nitrogen application
- Nitrogen use efficiency in horticulture crops

The final project “Evaluating Best Management Practices and their Potential in Reducing Greenhouse Gas Emissions from Soils – Estimates of N₂O Emissions and Agronomic Data Base” was not a demonstration project but was intended to work with the projects above to calculate nitrous oxide emissions of the various BMPs for use in communication efforts.

The following is a summary of the projects.

a) Building soil structure and managing nitrogen with strip tillage corn systems in heavy textured soils

This project was initiated to demonstrate strip till, a form of reduced tillage, in an area where corn is planted mainly with conventional tillage. The BMP is reduced tillage which would reduce CO₂ losses from the soil and possibly sequester carbon in the soil. The second part of the project was to demonstrate that nitrogen could be applied sidedress rather than preplant as was the norm

and that nitrogen rates could possibly be fine tuned. This would demonstrate a nitrogen management BMP which could reduce nitrous oxide emissions.

Objectives:

1. Compare strip tillage systems to conventional and/or no-till systems for suitability of corn production on clay soils for providing an opportunity to increase acreage and reduce the present practice of continuous soybean production which is experiencing reduced crop yields and lower overall productivity.
 - Planting timeliness was also examined:
 - Early plant (as early as soil fit in each individual tillage treatment)
 - Late plant (plant all types when the last one is planter ready)
2. Evaluating nitrogen application timing and rates in strip till systems on clay soils to increase nitrogen use efficiency and reduce potential N₂O emissions. This is primarily attempting to prove the suitability of post planting nitrogen application systems and remove the presence of residual nitrogen levels in heavy textured saturated soils in the early spring.
 - Preplant (early May) Urea was compared to Urea Ammonium Nitrate (UAN) preplant and sidedress UAN
 - Nitrogen rates (0, 0.5, 1.0 and 1.5 of the normal N rate) applied preplant in conventional tillage and sidedress in the fall strip till treatment

	2004	2005
Number of sites – soil and nutrient component demonstrations	5	6

Equipment

The strip tiller is essentially a primary tillage implement that only tills a defined portion of the entire field. The unit consists of trash whippers at the front to move residue to the side, followed by a cutting blade to cut residue. Behind that is a mole knife to shatter, lift and loosen the soil and at the back are forming coulters to create a berm. Usually a berm of 10 to 15 cm (4 to 6 inches) high by 20 to 30 cm wide (8-12 inches) wide is created spaced according to the corn row width. The goal is to achieve a berm that will “settle down” to be slightly elevated compared to the surrounding untilled ground by spring.

Results

The planting timeliness part of the project showed no significant difference between the conventional and strip tillage systems at each planting date. The strip tillage system produced yields equivalent to conventional tillage. The strip till system appeared to have some advantages over the conventional system as it was less prone to crusting, used less fuel (required fewer tillage passes before planting) and caused less soil disturbance reducing the loss of organic matter from the soil. The bottom line would be the same or better.

In conventional tillage systems over the two years, there was no negative impact to adopting side dress nitrogen application compared to traditional at planting or preplant nitrogen application. In both seasons where the spring conditions were difficult, plenty of opportunity existed to side dress nitrogen in either the conventional or strip tillage systems. This would suggest that

producer’s fears of waiting to apply nitrogen because of the chance of being prevented from entering wet fields is likely unfounded.

Nitrogen rates required to produce the most profitable crops given the cost of nitrogen and revenue potential from the sale of crop suggest that the nitrogen rates needed to grow corn on these sites could be easily reduced 20-40 lbsN/ac if not more over what rates are traditionally being used, especially where side dress application timing was used.

The complete report can be found in appendix 2.

b) Advancing nitrogen use efficiency on livestock farms

Accurate estimation of corn fertilizer N (nitrogen) requirements is essential in maintaining profitable yields while minimizing the amount of soil N not utilized by the corn crop. Unutilized N is subject to environmental losses; including the possibility for conversion to nitrous oxide. Unfortunately, accurate prediction of plant available N from manure is difficult because of variability (or uncertainty) associated with manure application rates, uniformity of application, N analysis of the manure, N losses due to leaching or volatilization and conversion rates of the organic N fraction to plant available forms. Other factors such as soil type, incorporation timing and method and soil type differences also impact our ability to accurately determine fertilizer N recommendations required following the application of manure or from the historical use of manure.

A series of on-farm demonstration sites were established to assess overall N use efficiency on livestock farms and to evaluate technologies such as the soil nitrate-N test, as tools to advance this nitrogen use efficiency and to accurately predict corn fertilizer N requirements on fields where manure had been recently applied.

Objectives

- Demonstrate best management practices to maximize nitrogen use efficiency on farms with historical livestock manure use.
- Field test and demonstrate the benefit of the Pre-side-dress Soil Nitrate Nitrogen Test (PSNT) for determining corn nitrogen requirements the spring following fall applied manure and assess the accuracy of the Ontario Ministry of Agriculture, Food and Rural Affairs general nitrogen recommendations for corn following manure application on a field basis.
- Increase awareness of opportunities to reduce GHG emissions and environmental risks associated with the application and use of livestock manure.
- Test the effectiveness of these practices by providing input data for Claudia Wagner-Riddle’s GHG calculator

	2003	2004	2005
Number of sites – nutrient component demonstrations	9	10	10

Project Description

- Manure types – liquid cattle, liquid hog and solid poultry

- Timing of manure application – majority were broadcast applied late summer or fall of the previous year, four sites where at least one crop had been grown since the manure application and one applied in the spring prior to planting
- Four rates of fertilizer N (0, 56(50), 112(100), and 168(150) kg-N/ha(lbs-N/ac)) were established by sidedressing the appropriate rate of U.A.N (28%) sometime during the latter part of June

Results

On the 15 sites that received liquid cattle manure sometime over the previous 2 years, OMAFRA General Recommendations and the PSNT provided recommendations which averaged close to those actually required. The PSNT provided a slightly more profitable recommendation, primarily because of the accurate prediction of sites that did not require fertilizer N to produce the most economic yield. Nitrogen recommendations provided by both OMAFRA General Recommendations and the PSNT both severely under predicted N requirements on the seven sites that received liquid hog manure over the past 2 years. The PSNT generally provided the lowest recommendations and as a result incurred unacceptably high economic losses because of less than adequate fertilizer N recommendations. On the six sites that received solid poultry manure, both OMAFRA General Recommendations and PSNT under predicted requirements, but the financial liability associated with the recommendations was not as severe as for the hog sites.

The cooperating farmers generally applied fertilizer N rates that exceeded 110 kg-N/ha, even when manure was applied the previous fall. On the liquid cattle sites, over application reduced profitability, by an average of \$20/ha compared to if OMAFRA General Recommendations or the PSNT rates were used.

The end of season fall residual soil nitrate N concentrations clearly demonstrated that applying fertilizer N to corn in excess of the maximum economic rate of nitrogen, elevates soil mineral concentrations in the fall. This unutilized (residual) soil mineral N is subject to environmental loss, including possibly conversion to nitrous oxide and/or leaching.

The complete report can be found in appendix 3.

c) **Cover crops for carbon sequestration and nitrogen management in field crops**

Manure application to cereal residue following harvest is a common practice. It is a good time to apply manure from a soils perspective but not so good from an environmental point of view as the nitrogen in the manure can leach or be lost as nitrous oxide. Cover crops planted following manure application provide an opportunity to tie up that nitrogen for release hopefully at a time when the following crop can utilize it helping to reduce nitrogen losses. The roots and other residues from the cover crops can help protect the soil from erosion, improve soil structure and add organic matter to the soil (carbon sequestration).

Objectives

- Demonstrate and evaluate the growth potential of a wide range of cover crops, all with and without manure nutrients for carbon sequestration

- Evaluate the potential uptake of soil residual nitrogen and fall applied manure nitrogen with cover crops. Demonstrate the impact of cover crops on timing of nitrogen release, soil nitrate levels and subsequent reduction in fertilizer nitrogen rates to succeeding crops all of which may be important in preventing releases of nitrous oxide from agricultural soils
- Collect data that can be included in the nitrous oxide calculator developed by Claudia Wagner-Riddle

	2003	2004	2005
Number of sites – soil and nutrient component demonstrations	6	6	6

Project Description

- Manure (type and application varied) was applied to winter wheat stubble in the middle of August and the cover crop species were established within one week of the application
- The cover crop species evaluated were: Annual Ryegrass, Buckwheat, Oats, Oilseed Radish, Peas, and Red Clover
- The cover crop was drilled using a conventional or no-till drill

Results

Application of manure which contained relatively high rates of ammonium N (over 50 kg-N/ha) often resulted in the doubling of non-legume cover crop growth (i.e. oats, oilseed radish and annual ryegrass). The quantity of N in cover crop biomass was often doubled when manure with high rates of ammonium N was applied. Oats and oilseed radish were the most effective non-legume cover crop species with respect to growth and N sequestration with biomass N quantities often exceeding 80 kg-N/ha where manure with a relatively high rate of ammonium N was applied. There is little benefit to planting non-legume Cover crops when manure associated with low ammonium N rates was applied but could be beneficial in non-manure situations where soil N levels are high.

Field peas were successfully established at many of the sites. Peas often contained more N than did an oat cover crop, especially when manure was not applied. This is not surprising since peas are a legume and have the capacity to fix atmospheric N when soil N is not available. Peas may be a good cover crop choice when soil and/or manure N availability is not high. Peas also demonstrated an ability to sequester soil mineral N, but often did not reduce soil mineral N levels as low as oat or oilseed radish.

Oat, Oilseed Radish and Pea Cover crops rarely reduced apparent fertilizer N requirement by more than 30 kg-N/ha where manure was applied the previous fall. The size of the apparent cover crop credit was usually comparable to values predicted by Ontario's Nutrient Management assumptions regarding the increase in manure N availability when cover crops are planted following late summer applications of manure.

Potential economic returns for corn, determined by corn yield minus the costs of cover crop establishment and required fertilizer N, was rarely increased by use of a cover crop. This suggests that at these sites, the increase in corn yield and/or reduction of fertilizer N requirements associated with use of cover crops was not large enough to offset the added cost

of establishing a cover crop. There may be other indirect economic benefits, such as reduced erosion risk, but on these sites it appears that the use of cover crops could not be economically justified when only taking into consideration corn yield response and reduction in fertilizer N requirements.

Cover crops demonstrated an ability to sequester large amount of manure and/or residual soil N when manure was applied in wheat stubble fields in August. Unfortunately, a relatively low amount of this cover crop N appeared to be transferred to the next corn crop. There is a need for research to determine the fate of apparent cover crop N that is not available to the next crop and the impact of this unutilized free cover crop N on production of Greenhouse Gases and potentials for leaching.

The complete report can be found in appendix 4.

d) Demonstrating the impact of both application date and rate of nitrogen on N₂O emissions in wheat production

In the past number of years there has been considerable progress in the introduction of new wheat cultivars in both red and white wheats. These products are being introduced to meet specific end user needs. There was some question as to whether the current nitrogen fertilization recommendations were sufficient to meet the needs of these new cultivars? This project intended to demonstrate the impact of nitrogen rate and application timing on the uptake characteristics of the new wheat cultivars to ensure that rates and timings maximize crop uptake to minimize excess nitrogen left in the field following physiological maturity.

Additionally the impact of application timing in terms of overall nitrogen efficiency was examined. Does the application timing impact the overall uptake of applied nitrogen and therefore influence the amount of nitrogen that is potentially lost to volatilization etc.

The project also demonstrated, to Ontario farmers, the impact of common management systems in wheat production on the relative volume of NO₂ emissions. Other agronomic factors such as yield, protein and economics will be highlighted.

Objectives

Through field strip trials in Halton, Middlesex and Ottawa regions raise awareness of greenhouse gas emissions from wheat production. Data will be collected for Claudia Wagner-Riddle’s nitrous oxide calculator.

		2003	2004	2005
Number of sites – nutrient component demonstrations	Winter wheat	16	16	16
	Spring wheat	3	4	4

Project Description

- The Halton and Middlesex regions hub sites were planted to winter wheat in the fall, and the Ottawa region hub site was planted to spring wheat in the spring, satellite sites were established around the Middlesex and Ottawa sites
- Nitrogen application timings were targeted for March 31, April 25 and May 10 for the winter wheat, timings were later for the spring wheat but similar for crop stage

- Five nitrogen rates (0, 30, 60, 90, 125 lbs N/ac) and one split application were applied

Results

Wheat yields of zero-N and N-rich fertilized plots were highly variable from field-to-field. Yield response to N fertilizer was also highly variable. N remaining in the soil increased with higher N rates, at all locations. The proportion of fertilizer N recovered in the grain and straw decreased with higher rates of N application. Lower recovery means more potential for N leaching, denitrification and loss as nitrous oxide, a greenhouse gas.

Application of N in mid- to late-April tended to result in the highest yields (similar to current recommendations), while more losses were associated with early or late applications. The practice of split rate applications between early-mid April and early-mid May was not beneficial.

The complete report can be found in appendix 5.

e) Optimizing Environmental Efficiencies With Precision Toolbars

The majority of the corn in Ontario is produced using conventional full width tillage (moldboard plow, heavy disc, soil saver, etc.). Reduced tillage systems can reduce the loss of organic matter as CO₂ and reduce fuel consumption which contributes to greenhouse gas emissions. The corn crop is one of the highest nitrogen input crops grown. Improving the nitrogen use efficiency of the crop will reduce the amount of nitrogen required to grow the crop and the amount left in the soil at the end of the season. Reducing soil nitrate in the fall, winter and spring period will reduce the possibility of loss through leaching or as nitrous oxide gas.

Objectives

- Confirm by on-farm demonstrations that in-row strip tillage combined with precision nitrogen applications provides significant opportunities to reduce fuel consumption, reduce soil disturbance, increase fertilizer nitrogen use efficiency, and harmonize equipment needs.
- That measurement of corn seedling N status using a SPAD meter can predict corn fertilizer N requirements.
- To demonstrate the potential GHG emission reductions and the carbon sequestration potential of this system.

	2003	2004	2005
Number of sites – soil and nutrient component demonstrations	6	6	6

Results

Producers on medium textured soils can use no-till or zone-till systems with no significant yield losses relative to full width (conventional) tillage systems. Use of these tillage systems would not only enhance returns associated with corn production, but also help reduce CO₂ levels through conservation of soil organic matter and(or) reduced diesel fuel consumption associated with tillage operations.

Applying in the range of 35 to 45 kg-N/ha of fertilizer N at planting increased corn yield and N use efficiencies. Provided that appropriate fertilizer N rates are applied, the higher N use efficiencies associated with row zone applications of fertilizer N should reduce fall residual soil N levels and reduce the risk of nitrous oxide greenhouse gas emissions from Ontario's agricultural soils through the late fall to early spring period.

Zone-till tool bars can be effectively used as both pre-plant tillage implements and N applicators. In fact, at some sites it was demonstrated that all fertilizer N requirements could be safely applied using a spring zone-till operation. This eliminates the need for a separate field operation to apply sidedress N, which not only minimizes production costs but eliminates diesel fuel use and emissions associated with sidedress operations.

Use of a SPAD meter to measure corn chlorophyll concentration did not result in a suitable technique for identifying optimum N rates for corn. Future research should consider using more sophisticated radiometers to evaluate corn N status and derive, if possible, relationships between early season corn seedling N status and fertilizer N requirements.

The complete report can be found in appendix 6.

f) Nitrogen use efficiency in horticulture crops

i. Nitrogen Rate Trials

The advent of the Nutrient Management Act, higher nitrogen prices and some of the on farm projects under this program have helped to increase grower awareness and interest in the need for nitrogen rate trials. The larger acreage crops like potatoes and tomatoes have had some small plot research trials in the past. The high soil variability found in many vegetable crop areas and the variety specific response of some vegetables means that on farm strip trials are necessary for many of the horticultural crops grown in Ontario.

Objectives

- Demonstrate the potential of reduced fertilizer nitrogen rates in a variety of common horticultural crops through on-farm reduced rate strip trials
- Evaluate the potential for soil nitrate testing and a variety of quick test methods to be used as a means to adjust crop nitrogen fertilizer recommendations within season

	2003	2004	2005
Number of sites – nutrient component demonstrations	9	9	10

Project Description

- Small plot or field length strips with different nitrogen rates were laid out
- In some cases a small area with 0 nitrogen was used instead of a larger strip to reduce crop loss

Results

- Nitrogen rates in select horticultural crops bear further review and study as some projects have indicated the potential to significantly reduce rates

ii. Fertigation and In Season Monitoring

Applying fertilizer through drip irrigation systems promises the opportunity to apply nitrogen “just in time”, in response to plant needs and weather conditions. This offers a tremendous opportunity to enhance nitrogen use efficiency and increase yields. In season monitoring with quick test techniques is needed to ensure that nitrogen applications are accurately applied and adequate for plant needs.

Objectives

- Demonstrate the potential of reduced fertilizer nitrogen rates in a variety of common horticultural crops through on-farm reduced rate strip trials
- Evaluate the potential for soil nitrate testing and a variety of quick test methods to be used as a means to adjust crop nitrogen fertilizer recommendations within season
- Demonstrate the calibration of a fertigation system to evaluate delivery efficiency of water and fertilizer

	2003	2004	2005
Number of sites – nutrient component demonstrations	3	3	4

Project Description

- Two fertigation programs were compared
- Quick N tests for soil and plant nitrate levels were evaluated

Results

- Quick test methods for in season nitrogen monitoring require immediate testing and analysis and very consistent lab techniques so are only for the very dedicated grower

iii. Evaluation of Irrigation Efficiencies

Drier mid summer weather in recent years and the need for consistent, predictable, high yields has lead to the rapid expansion of irrigation in vegetable growing areas. Drip irrigation promises high water use efficiency with small amounts of water applied at any time. Low pressure boom irrigation also has higher water use efficiency than the high pressure traveling guns and a degree of flexibility of use that drip does not have.

Objectives

- Demonstrate and evaluate the relative efficiencies of drip versus boom irrigation techniques
- Demonstrate and evaluate the worth of a variety of soil moisture monitoring devices for better timing and use of irrigation/fertigation

	2003	2004	2005
Number of sites – water /energy efficiency	2	2	1

Project Description

- Different methods of irrigation were compared – no irrigation, drip irrigation, traveling boom depending on the site
- Soil moisture monitoring equipment was installed

Results

- Soil moisture monitoring tools can track soil moisture levels and indicate the need for irrigation

iv. Evaluation of Cover Crops for Biomass and Nitrogen Cycling

Cover crops are commonly used for erosion control on many vegetable farms. There is increased interest in the nitrogen cycling value of cover crops to subsequent crops. There are a number of crops like peas, snap beans and cucumbers that are harvested in early to mid summer, allowing a large window for cover crops to be established and put on significant growth. This project looked at the potential for nitrogen scavenging, biomass production and nitrogen release.

Objectives

- Demonstrate and evaluate the growth potential of various cover crops after early harvested horticultural crops
- Evaluate the potential uptake of nitrogen from soil residual nitrogen and where possible fall applied manure nitrogen
- Demonstrate and evaluate timing of nitrogen release, and subsequent reduction required in nitrogen applications to succeeding crops

	2003	2004	2005
Number of sites – soil and nutrient component demonstrations	6	6	7

Project Description

- Cover crops were established after early harvested crops such as processing cucumbers, snap beans and early cauliflower
- Field scale strips of various cover crops were established soon after harvest

Results

- Cover crops require timely planting, some soil moisture and residual N to return significant amounts of biomass. The cover crop motto after horticultural crop harvest should be “Plant early, plant often”
- Cover crop nitrogen scavenging and release may not be economic by itself but adds to the suite of benefits accrued by cover crops (organic matter additions, soil erosion protection etc)
- Cover crops do reduce soil moisture levels in the fall. Cover crops do hold a significant amount of residual nitrogen, but only a small portion is actually available for crop uptake in the spring

The complete report can be found in appendix 7.

g) Evaluating Best Management Practices and their Potential in Reducing Greenhouse Gas Emissions from Soils – Estimates of N₂O Emissions and Agronomic Data Base

Project Description

- Development of a framework for greenhouse gas emission calculation at the farm level
- Data collection for greenhouse gas emission estimates
- Development of a database using agronomic and management data supplied from the GHGMP demonstration farms plus incorporating scientific data supplied as in-kind from research projects.

Results

The results for this project indicated that the potential for N₂O-N loss from soils cultivated with wheat is higher with increasing rates of fertilizer application. Indirect evidence from apparent fertilizer N recovery (AFNR) and N balance showed increasing N loss with increasing rates of N application. Application of fertilizer N exceeding 101 kg N/ha did not contribute to significant improvement in grain yield while greatly increased the potential for N losses to the environment.

Estimates of N₂O emissions for livestock sites – estimated emissions due to manure N ranged from 1.34 to 5.59 kg N₂O-N/ha per year. Estimated N₂O emissions increased linearly with increasing fertilizer N rate for corn. At the highest fertilizer N rate applied, estimated N₂O emissions due to fertilizer ranged from 2.86 to 3.78 kg N₂O-N/ha. Due to the low AFNR at these sites an option for reducing potential N₂O emissions from these sites would be maximizing the utilization of manure N for corn production while minimizing the use of fertilizer N. On average the N₂O emissions were 52% lower for the maximum economic rate of nitrogen compared to the full rate of nitrogen.

The data was used as input parameters for the GHG Farm calculator to generate estimates of N₂O emissions.

The complete report can be found in appendix 8.

Field Days And Tours

Field days and tours were held at numerous locations across the province during the program. Many demonstration activities were part of smaller tours held by local Soil and Crop Improvement Associations while others were part of larger events such as Canada's Outdoor Farm Show, the show itself attracts about 20,000 visitors each year.

Soil Quality/Management Workshops
Southwest Crop Diagnostic Day, Ridgetown
Eastern Crop Diagnostic Day, Winchester
FarmSmart Farming Systems Expo, Elora
Manure Technology Open House
Michigan Vegetable Team Tour
Ohio Vegetable Team Tour
Simcoe Research Station Open House

Ontario Berry Growers Association Meeting
Outdoor Farm Show
Ontario Soil and Crop Improvement Association - the demonstration plots were featured in a number of local association tours
Manure Injection/Sidedress Demonstration Day
Cropping Innovation Review
Pioneer Grower Days

5. Lessons Learned

The partnership that was formed between OSCIA, OMAFRA, and U. of G. was key to the success of the program. The OSCIA administration and strong local organizations were important in the reporting and financial tracking. The local organization link with OMAFRA extension staff provided a significant forum for getting the GHG mitigation message out and helped to keep the project focused on the needs of the farmer. The partnership between OMAFRA and U. of G. was instrumental in the establishment and success of the demonstrations. Together they were able to address needs from the ground up and each was able to complement the other to develop and implement a strong program.

The magnitude of the program was a challenge to implement. The short lead time before the funding was received made it difficult to do a lot of planning before the demonstrations had to be established the first year. The flexibility of the program did allow us to make changes as we went and as we saw ways to better deliver the program.

There was a lot of monitoring that we would have liked to have done which would have enhanced the message. The way the program was designed led us to believe some monitoring would be done but that did not happen. As we were not to do it as part of the program is restricted what we could say about some of the practices we were demonstrating. For future programs it would be nice to have research into GHG BMPs for Ontario occurring at the same time either separate from or to provide more information about the practices.

A tremendous amount was learned from the demonstration projects themselves and that is reflected in section 4 above and in more detail in the reports in the appendices.

The meetings and tours brought the program staff into contact with a lot of people. It was amazing how much interest there was in what was being talked about. Some were very informed about climate change and greenhouse gas emissions while others were keen to learn. Everyone wanted to know if offset credits would ever provide real income to the farm.