

*Voluntary Challenge &
Registry*

Agrium

1999 Progress Report

January 31, 2000

EXECUTIVE SUMMARY

Canada was one of over 150 countries to sign the Framework Convention on Climate Change at the United Nations Conference on Environment and Development, held in Rio de Janeiro in June 1992. Under this agreement Canada established a national goal to stabilize net emissions of greenhouse gases at 1990 levels by the year 2000. The Kyoto Protocol, agreed to at the December 1997 Conference of Parties (C.O.P. 3), is the first agreement to deal with commitments beyond 2000. Under this legally binding Protocol, industrialized countries must reduce their collective emissions of greenhouse gases from 1990 levels by 5.2% by the period 2008-2012. Participating countries are expected to show significant progress by 2005. The Protocol will come into force when ratified by 55 signatories representing 55% of global greenhouse gas emissions. Canada has committed to emission levels 6% below 1990 levels; Canada signed the Protocol on April 29, 1998.

The National Climate Change Voluntary Challenge and Registry Program was established in 1995 as a key element in Canada's National Action Program on Climate Change and continues to be a part of Canada's current National Implementation Strategy; the program invites Canadian organizations to commit to developing action plans to limit or reduce net greenhouse gas emissions. The registry publicly documents the commitments, action plans, progress and achievements of all participants in the Voluntary Challenge.

This Progress Report does not lay out strict targets for Agrium beyond the year 2000 but presents the Company's progress to date and some plans by which future Agrium commitments may be made.

Agrium is a major North-American producer, marketer, and distributor of fertilizer products. Greenhouse gas emissions, which include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), arise from the consumption of natural gas for both energy use and process purposes at Agrium's Canadian fertilizer plants at Carseland, Joffre, Fort Saskatchewan and Redwater, Alberta; Vanscoy, Saskatchewan; and Kapuskasing, Ontario. Nitrous oxide emissions also arise from the process of nitric acid production at the Redwater facility.

The largest greenhouse gas component for Agrium is carbon dioxide, comprising 96% of the direct emissions from its Canadian production facilities. On a national basis, Agrium's 1990 contribution of 2,177 kt accounted for about 0.5% of Canada's total carbon dioxide emissions estimated at 464,000 kt. Agrium also accounted for about 0.3% of Canada's nitrous oxide emission totals. Agrium's methane contribution is significantly less.

Agrium's total estimated greenhouse gas emissions in the year 1998, on a carbon dioxide equivalent basis, were 24% higher than 1990 levels. Agrium's fertilizer production increased by over 37% during the same time frame. By 2003 emissions are expected to be 41% and production 52% higher than 1990 levels.

Agrium is currently completing a study of reduction and mitigation opportunities. Past studies have indicated that a combination of reduction opportunities such as energy efficiency improvements and third party carbon dioxide sales for enhanced oil recovery could impact Agrium's total direct CO₂E emissions. Other opportunities to mitigate Agrium's emissions, such as emissions trading and carbon sequestration in agricultural soils, will be dependent on the regulations established under Canada's implementation of the Kyoto protocol.

In light of these considerations, Agrium resolves to:

- continue to study major emission reduction opportunities that may potentially reduce carbon dioxide emission levels and implement those which are economically and technically feasible.
- continue development of improved fertilizer products, such as controlled release urea, which increase fertilizer uptake efficiency.
- maximize the utilization of carbon dioxide emissions from existing ammonia plants: through increased urea production and third party sales of carbon dioxide.
- continue to explore various other mitigation strategies, such as emission reduction credits, emissions trading, "clean development mechanisms", and carbon sequestration in soils.

Agrium is also committed to responsible product stewardship: advocating fertilizer use efficiency amongst customers through agronomic services and supporting research into agricultural greenhouse gas emissions from fertilizer use. Fertilizer production is an integral part of the overall agriculture cycle. Improved farming practices which include increasingly efficient use of fertilizer will reduce agriculture's environmental impacts by reducing losses of nitrogen to the environment, reducing the energy required to produce food and fiber and by maintaining and increasing soil organic matter by increasing plant yields and promoting the return of residual crop biomass to the soil.

COMPANY OVERVIEW

Agrium is the largest producer of nitrogen fertilizers in North America, and it is also a significant producer of potash and phosphate fertilizers. The Company produces, markets and distributes more than six million tonnes of fertilizer annually from nine operations that are among the most modern and efficient in North America. Four of these are nitrogen plants located in Western Canada, close to supplies of natural gas, the primary raw material used in the production of nitrogen fertilizers. Supporting these production facilities are more than 1.7 million tonnes of storage capacity as well as an extensive distribution network across Western Canada, the Pacific Northwest and Midwest of the United States.

With more than 225 retail farm centres, Agrium is the second largest independent retailer of fertilizers, seed and agricultural chemicals in North America and a major provider of agronomic services in the key agricultural markets of the United States.

Agrium has also established a presence in Argentina, where it is currently operating 18 retail farm centres and is an equal partner in the construction of a world-class nitrogen fertilizer facility. This facility, with annual production capacity of 1.1 million tonnes of urea is scheduled to commence production in mid-year 2000 and is located on a deep-water port to enable efficient export to other South American markets including Brazil, Paraguay and Uruguay.

INFORMATION RELEVANT TO AGRIMUM'S VOLUNTARY CHALLENGE

This report focuses on Agrium's Canadian production facilities. At its 4 Alberta operations, Agrium has 1 phosphate and 4 nitrogen nutrient production plants, 3 of which are amongst the 6 newest nitrogen plants in North America. Agrium also operates a Potash mine and mill in Saskatchewan and recently began operation of a Phosphate mine in Ontario.

Agrium, by the nature of its products, is strongly linked to the agricultural sector. The Company provides beneficial plant nutrient products which increase plant yield and thereby indirectly impact plant crop absorption of carbon dioxide and sequestration of carbon as bio-mass. Improved farming practices, which include the efficient application and use of fertilizers, have the potential to reduce agriculture's environmental impacts by reducing losses of nitrogen to the environment and by maintaining and increasing soil organic matter. In fact, the potential of Canadian agricultural soils to sequester large amounts of carbon is a major opportunity for Canada to meet its challenges in mitigating climate change. This opportunity, not yet an accepted part of the Kyoto Protocol, will be a part of the COP6 negotiations in November, 2000.

The vast majority of Agrium's greenhouse gas emissions are directly tied to the fixation of atmospheric nitrogen in a chemical form available to plant life; as such, emission levels have increased proportionately with nitrogen fertilizer production. From 1990-1998, market demand for the fertilizers needed to supply food for the world's increasing population resulted in a 37% production increase at Agrium's Canadian plants, including the retrofit and re-commissioning of a previously shutdown ammonia plant. Agrium's emissions from those plants increased 24%.

Energy efficiency is key to remaining competitive in the fertilizer industry; Agrium's Canadian nitrogen fertilizer plants are amongst the most energy efficient plants in North America, making significant improvements at these facilities difficult. While some improvement in energy efficiency may accompany significant expansions in production capacity, major reductions in energy use will require the development of new breakthrough technologies.

AGRIUM'S GREENHOUSE GAS EMISSIONS:

Table 1 - Emissions From Agrium's Canadian Production Facilities

Emission (kT)	1990	1996	1997	1998	1999*	2000*	2003*
CO ₂	2177	2683	2828	2771	2584	3054	3129
CH ₄ (as CO ₂ E)	7	11	11	11	11	12	12
N ₂ O (as CO ₂ E)	107	72	66	69	68	77	90
Total	2291	2766	2905	2851	2663	3143	3230

* estimates

Base Line And Projections

Significant improvements to the accuracy and validity of Agrium's baseline data were made over the past year. A detailed description of Agrium's emissions and inventory methodology can be found in Appendix A.

- Data includes stationary sources from Agrium's production facilities only; emissions related to mobile sources or the transport and distribution of products are not a part of this inventory
- Baseline data includes the Calgary ammonium nitrate facility which is no longer in operation (decommissioned in January, 1994);
- Baseline data excludes the Redwater Ammonia I plant; shutdown in 1987, it was retrofitted and restarted in December, 1994.
- Baseline data excludes Agrium's new Kapuskasing, Ontario phosphate mine; the mine was commissioned in mid-1999.
- 1999 projections include a 5 month market related production stoppage of the Redwater Ammonia I plant.
- 1999 projections also include an estimate of the new phosphate mine's emissions (assuming the equivalent of 5 months of operation at 60% of full design rates)
- Projections beyond 1999 are based on Agrium's 5 year business plans and assume:
 - No plant closures
 - Forecast increases in production
- *Nitrous oxide emissions resulting from nitric acid production are now included in both the baseline and projected data. This data was previously absent from the inventory.*

AGRIUM'S TARGETS & GOALS

Agrium remains committed to its target of sustaining 1990 emissions on a per tonne of product basis through 2000. As can be seen in Table 2, current projections show Agrium to be on course in meeting this goal (Note: 1999 data reflects the 5 month Redwater ammonia plant outage). Beyond the year 2000 no targets have been fixed. Agrium is currently evaluating the technical and economic feasibility of making emissions reductions at its facilities. Based on this study and ongoing developments surrounding offset opportunities such as carbon sequestration on agricultural lands, and flexibility mechanisms such as emissions trading, Agrium's future targets will be reevaluated on an annual basis.

Table 2 - Agrium GHG Emission Intensity

	1990	1996	1997	1998	1999	2000	2003
CO ₂ E per unit of finished product (t/t)	0.65	0.70	0.63	0.60	0.57	0.62	0.61

Agrium will continue to report the direct emissions of GHG gases from its production facilities and the results of its emission reduction efforts. Agrium also plans to continue its previous commitments to:

- develop improved fertilizer products, such as controlled release urea, which increase fertilizer uptake efficiency and plant yields;
- maximize urea production from existing plants (based on market requirements) which will decrease carbon dioxide emissions by utilizing carbon dioxide produced from ammonia production plants;
- investigate potential third party carbon dioxide sales in Canada for the production of other products and / or the tertiary recovery of hydrocarbons;
- pursue mutually beneficial partnerships for alternate uses of process carbon dioxide;
- continue studying major emission reduction / mitigation projects and energy efficiency opportunities and implement those initiatives which are economically viable and justifiable;
- look for reduction opportunities through the evaluation of product life cycles;
- pursue product exchange agreements and optimization of product warehousing to minimize transportation related fuel consumption;
- continue to refine and update our inventory of greenhouse gas emissions and support others, including Environment Canada, in their efforts to develop accurate and comprehensive inventories;
- play an active role in contributing to public understanding and sound public policy which addresses the threat and implications of climate change.
- supply technical training and advice to fertilizer retailers and growers on how to most efficiently use our fertilizer products

ACTIONS & RESULTS

Greenhouse Gas Inventories & Life Cycle Analysis of Fertilizer Production & Use

Accounting for greenhouse gas emissions from our production sites was improved this year, primarily by the inclusion of N₂O emitted from nitric acid production and the development of better inventory tools and emission factors.

Agrium, through the Canadian Fertilizer Institute (CFI), is participating in a 3 year research project into N₂O emissions related to fertilizer application and use as a part of farm management practices on the Canadian prairies. Agrium intends to use this work in developing a model of the

greenhouse gas impacts of fertilizer over its entire life cycle - from the production of fertilizer from feedstock materials through to a harvested crop.

In 1999 Agrium also helped fund, through the CFI, a literature review of current Canadian research done on carbon sequestration in agricultural soils.

Reduction Opportunity Inventory & Assessment

Agrium is currently conducting an inventory and assessment of greenhouse gas reduction opportunities at its plant sites. Under current plans an assessment of technically feasible reductions will be completed this winter; projects deemed to be both economically and technically feasible will be included in Agrium's business planning process.

Some of the major opportunity areas being explored are:

- energy efficiency improvements
- co-generation
- increased capture of high quality CO₂ for urea production or alternate uses
- increased urea production
- reduction of N₂O emissions from the Nitric Acid production process
- use of pipelines in high ammonia transportation corridors

A description of these reduction opportunities can be found in Appendix B.

Other General Reduction Opportunities Available to Agrium

- third party sales of CO₂
- alternate uses of CO₂, for instance as a feed stock for production of other chemicals
- off-site purchase of hydrogen to produce ammonia

In 1998 Agrium participated in an Alberta Chamber of Resources Study which examined some of these opportunities in Alberta. These are also described in Appendix B.

Several other areas by which Agrium can positively affect greenhouse gas emissions are not quantifiable at this time but are believed to have a positive impact. These include:

- increased product exchanges,
- transportation credits (rail vs. trucking),
- change of product specification for production efficiency gains.

Reduction Opportunities Implemented (1990 To Present)

Reductions in carbon dioxide emissions have been realized through initiatives such as:

- the realization of transportation and distribution synergies following the December 1996 merger of Agrium with Viridian, resulting in large savings in fuel consumption
- a mid-1996 change in the type of catalyst used in the Redwater nitric acid plant resulted in a significant reduction of its process emissions of N₂O

- a 1996 urea de-bottleneck project, completed at the Redwater Site. This project increased urea production resulting in about 75 kt/yr decrease in carbon dioxide emissions from the ammonia plant. The increased production was achieved by increasing the size and capacity of the existing equipment and by adding additional heat exchange equipment.
- increasing efficiency of the older plants using improved process control techniques.
- compacting of fines at the Vanscoy mine in Saskatchewan to reduce the load on crystalizers and hence reducing the amount of natural gas used as fuel.
- a 1995 connection to a hydrogen pipeline at the Fort Saskatchewan site; this hydrogen (H₂) displaces some of the H₂ normally generated on-site through the steam reforming of methane (which generates a lot of CO₂, cf. Appendix A) as well as allowing the second stage of the reforming process to be run more efficiently by using excess combustion air. The result is lower fuel consumption and lower process feed gas requirements: both corresponding to a reduction in carbon dioxide emissions.

Note : In the latter activity, there are some CO₂ emissions associated with the production and purification of the imported H₂. However, this H₂ is a waste stream from a methanol plant and if not used is burned for its energy value. As such, there is only a small transfer in CO₂ emissions from a direct to indirect source; the net reduction in emissions is the difference between the direct emissions avoided through Agrium's decreased natural gas consumption and the CO₂ emitted at the methanol plant from burning natural gas for energy instead of the recovered H₂.

Research and Development

There is ongoing research being conducted on producing controlled release fertilizers at Agrium. Use of controlled release fertilizers results in more efficient utilization of the fertilizer by crops by closely matching nutrient supply with the rate of nutrient uptake by the crop. This results in a decreased quantity of fertilizer required for crop growth, as well as lower nitrogen losses; the net result is lower agricultural greenhouse gas emissions, especially per unit of crop produced. Plant yields would also be expected to increase, resulting in increased carbon sequestration. See "Appendix C - Potential Offsets to Agrium's Emissions" for more detail.

In addition to the development of controlled release fertilizers, Agrium conducts significant field research on increasing fertilizer use efficiency by improving application techniques and technology. Agrium also provides annual funding to support external research being done on fertilizer use efficiency.

Education, Training, and Awareness

Agrium Production Sites

Energy efficiency is very important to competitiveness in the fertilizer industry and is a major focus at Agrium's production facilities. Natural gas usage is one of the primary performance indicators at most of these facilities and is integrated into the incentive programs in place at those sites.

The exercise of having each plant site develop inventories of their emissions and reduction opportunities has also promoted some awareness of climate change and greenhouse gases with plant site personnel. And while formal education or training on climate change is not in place in our production plants, a feature article on climate change and greenhouse gases is planned for an upcoming issue of *The Connection*, Agrium's internal magazine, as a start to the education process.

Fertilizer Dealers & Customers

Approximately 300 of Agrium's Retail staff receive training each year (through a variety of programs) focused on improving fertilizer utilization through the timing and method of application, proper product selection, and balancing nutrient blends to best meet specific crop and soil requirements.

In addition, Agrium's agronomists have contact with over 2000 growers each year through agronomic presentations. At these presentations Agrium's agronomists educate farmers on many topics including the efficient use of fertilizer products.

General Public / Outreach

Agrium is involved in several outreach activities through one of its industry associations: the Canadian Fertilizer Institute (CFI). The CFI is a participant in the Canadian Industry Program for Energy Conservation (CIPEC) and is involved in the Canadian National Implementation Strategy Issue Tables. Agrium is currently working with the CFI to improve the quality of fertilizer industry energy use data being used by Statistics Canada, CIPEC, and Canadian policy makers.

Through its involvement with the Canadian Fertilizer Institute in the Key Foundation, Agrium also provides approximately 50 science teachers each year with exposure to fertilizer production, information on fertilizer use and education on agronomy, including the environmental challenges associated with fertilizer use.

Agrium is a member of the Alliance for Responsible Environmental Alternatives (AREA), a coalition of industry, labor and municipalities across Canada and supports AREA's annual national climate change conference, as well as its efforts to promote information exchange on responsible climate change policy alternatives between members, government decision makers and the public.

In 1999 Agrium participated in the consultations which spawned Alberta's Climate Change Central, an entity designed as a public-private partnership expected to act as both catalyst and coordinator of future action on climate change in Alberta.

Agrium continues to share its progress in tackling climate change through its participation in the Voluntary Challenge and Registry, producing action plans and progress reports such as this publication.

2000 GREENHOUSE GAS REDUCTION PROGRAM

Agrium plans to continue its current course of action through to the end of 2000. The government's requirement of companies to meet Canada's obligation under the Kyoto Accord remains an unknown. In anticipation of possible finalization of the Kyoto Protocol in November 2000 and the development of Canada's Credit for Early Action program, Agrium's plans include:

1. Continued development of Agrium's historical inventory and 5 year emission forecasts;
2. Completion of Agrium's reduction opportunity inventory and assessment; an implementation strategy will be developed.
3. Continued exploration of potential flexibility mechanisms for mitigation such as; carbon in soil sequestration, increased CO₂ uptake through fertilizer application, products with increased fertilizer uptake efficiency, third party sales of CO₂, emissions trading, emissions reduction credits, and "clean development" mechanisms.
4. Continued development of controlled release urea fertilizer, including field research to gather information on the best applications for the technology
5. Continued support of external research projects monitoring the effects of various fertilization parameters (timing of application, placement method, form of fertilizer) on N₂O emissions. (including a major 3 year project conducted at both the University of Manitoba and Agriculture & Agri-Food Canada - Swift Current Research Station which extends through to first half of 2002)
6. Continued involvement in public policy through the Canadian Fertilizer Institute (CFI) on a federal level and through continued involvement in Alberta's Climate Change Central.

Agrium will reevaluate its climate change strategies as events develop over the course of 2000.

REFERENCES & FURTHER READING

1. Canada's Climate Change Voluntary Challenge & Registry Inc. "Registration Guide 1999"
2. Canada's Greenhouse Gas Emissions: Estimates for 1990 (1992, Environment Canada)
3. Trends in Canada's Greenhouse Gas Emissions 1990-1995 (1997, Environment Canada)
4. Agrium's Action Plan & Progress Reports as previously submitted to V.C.R. Inc. (available on the internet at www.vcr-mvr.ca)
5. Agrium Annual Report 1998
6. The Health of Our Air - Toward Sustainable Agriculture in Canada (1999, Agriculture and Agri-Food Canada)
7. Reducing Nitrous Oxide Emissions From Agri-Ecosystems - International Workshop held March 3-5,1999, Banff, Alberta, Canada
8. "Carbon Sequestration Potential in Saskatchewan's Agricultural Sector: Cost Effective Early Action Options to Help Meet Canada's Commitment to the Kyoto Protocol", N.T. Nesbitt and R.A. Hynd (1999)
9. Energy Consumption & Greenhouse Gas Emissions In Fertilizer Production G. Kongshuag (1998 presentation to EFMA seminar, Prague & IFA Technical Conference, Marrakesh)
10. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual
11. Canadian Fertilizer Institute Papers: Several published and unpublished CFI position and discussion papers were used in the writing of this report.

APPENDICES

- A. Basis for Reporting Agrium's Greenhouse Gas Emissions**
- B. Reduction Opportunities**
- C. Potential Offsets to Agrium's Emissions**

APPENDIX A -**BASIS FOR REPORTING AGRIMUM'S GREENHOUSE GAS EMISSIONS**

The vast majority of Agrium's greenhouse gas emissions result from its production of nitrogen fertilizers: predominantly from ammonia, which is also a feed-stock in the production of many other fertilizers (urea, ammonium nitrate, ammonium sulphate, ammonium phosphate). Ammonia is produced from natural gas, air, and water and in the process CO₂ is created as a byproduct. The process also requires a lot of energy which is supplied by burning natural gas.

CARBON DIOXIDE

The major sources of Agrium's CO₂ emissions are:

- Ammonia plant process feed gas
(natural gas converted to H₂ and CO₂ in the ammonia production process)
- Ammonia plant fuel gas
(natural gas burned in the 'reforming' furnace to furnish the heat of reaction and produce steam)
- Gas fired utility boilers
- Other gas fired equipment (such as heaters, and dryers)

Urea production consumes both ammonia and carbon dioxide and is usually tied to the ammonia plant process, whose CO₂ emissions are of high purity and easily captured. Although urea production consumes this CO₂, there are also greenhouse gas emissions associated with fertilizer use (cf. Appendix C).

Agrium's carbon dioxide emissions are calculated based on process feed and fuel gas compositions specific to each production facility and the gas flows metered into the plants:

- For ammonia process emissions, all carbon in the feed gas is assumed to be converted to CO₂ unless a significant amount of methane is purged from the process.
- For gas combustion, a combustion efficiency of 99.9% is assumed; all combusted fuel is assumed to be emitted as CO₂; all unconverted fuel is assumed to be emitted as methane.
- Ammonia process emissions are reduced by urea production, which consumes 0.733 tonnes of CO₂ per tonne of urea produced

Where data is not available, the emission factors listed in Section 5.0 of the VCR 1999 Registration Guide were used.

METHANE

The main sources of methane at Agrium's production facilities are:

- Unconverted ammonia process feed gas (most of which is recovered for use as fuel)
- Unconverted fuel (due to incomplete combustion)

Methane is also used to purge some vents at the Redwater plant site. This may be a future emission reduction opportunity, although a small one.

Methane emissions from incomplete combustion are calculated using the emission factors listed in Section 5.0 of the VCR 1999 Registration Guide.

NITROUS OXIDE

The major sources of N₂O at Agrium’s production sites are:

- Nitric acid production process emissions
- N₂O produced as a byproduct of fuel combustion

Nitric acid is produced as an intermediate product of the manufacture of ammonium nitrate. N₂O from nitric acid production results from the oxidation of ammonia in the production process and is exhausted from the plant’s stack. These stacks are normally equipped with NO_x emission abatement equipment; however, this equipment does not necessarily remove N₂O. One type of NO_x abatement technology, Non-Selective Catalytic Reduction, is believed to remove significant amounts of N₂O. As a result of the uncertainty, site specific stack testing is required to properly quantify these emissions.

In the absence of such testing, a factor of 1.05 kg N₂O / t nitric acid produced is used for plants equipped with NSCR and 9 kg N₂O / t for those unequipped, similar to what is outlined in the Environment Canada National Inventory and in proposed international (IPCC) guidelines (Note : these emission factors also assume the use of a 95-5 platinum-rhodium catalyst in the production process).

Combustion related N₂O emissions are calculated using the emission factors supplied in Section 5.0 of the VCR 1999 Registration Guide.

PROJECTED EMISSIONS (1999 - 2003)

Agrium’s emission projections were developed based on the Company’s 5 year business plans, as developed in September 1998, which include forecasts of production levels and fuel consumption. 1999 data from Agrium’s Redwater facility was updated in October 1999 to reflect the 5 month market related stoppage of their Ammonia I production plant.

GLOBAL WARMING POTENTIALS

To put Agrium’s emissions into proper perspective, it is best to express them as equivalents of CO₂. The following table offers the latest evaluation by the International Panel on Climate Change (IPCC) of the Global Warming Potential of the 3 key Kyoto Protocol Greenhouse Gases relative to CO₂ over 100 years (cf. ref. 10):

Gas	GWP
CO ₂	1
CH ₄	21
N ₂ O	310

APPENDIX B -**REDUCTION OPPORTUNITIES****1) Energy Efficiency Improvements**

Economic improvements in energy efficiency identified in the current study into emission reduction opportunities will be shared in future progress reports.

2) Third Party Sale of Carbon Dioxide

The sale of carbon dioxide for use in tertiary hydrocarbon recovery in the resource sector is a potential area to reduce carbon dioxide currently discharged to atmosphere. An estimate of the reduction potential from Canadian operations is not known at this time; however, enhanced oil recovery has definite potential as a market for CO₂ if oil prices increase.

3) Alternate Uses for Carbon Dioxide

In 1998 Agrium participated in a study for the development of carbon dioxide utilization action plan with the Alberta Chamber of Resources. Opportunities identified included enhanced oil recovery, coal bed methane displacement and other hydrocarbon production / upgrading related projects. It is believed that most will require tradeable CO₂ credits or other monetary incentives to be economical.

4) Co-generation

Co-generation involves generating two or more types of energy through the same process. The classic application involves burning natural gas to generate electricity and recovering the waste heat as steam. This design offers 2 avenues to reduce CO₂ emissions: through increased efficiency and fuel switching.

Rather than burn coal at a power station to generate electric power and natural gas in separate industrial boilers at the plant site to generate steam, a natural gas fired co-generation unit could supply both the steam and generate electric power. The co-generation unit would increase direct plant site emissions, but reduce global emissions by integrating heat & power generation and by displacing coal-derived power with natural gas-derived power. In Alberta, a 30MW coal power generator would emit approximately 250,000 tonnes CO₂, while a similar co-generation unit would emit approximately 150,000 tonnes CO₂¹.

Co-generation facilities are being considered at several of Agrium's Alberta plants. Depending on the assignment of the direct emissions - to the facility developer or to Agrium - Agrium may need to pursue some sort of credits recognizing the reduction in indirect emissions.

¹ Data taken from an internal memo: CO₂ Mitigation Opportunities at CNO (T.G. Sawchuk, June 2, 1999)

5) Off-site Purchase of Hydrogen

Other reduction opportunities which exist outside of the above mentioned categories include the possibility of purchasing ammonia feed stock components, specifically hydrogen and nitrogen from neighboring plants to produce ammonia. This would result in reduced energy costs associated with no longer requiring the primary reformer to produce hydrogen from natural gas (as mentioned in Appendix A, this process not only consumes large quantities of energy but also produces CO₂ as a process by-product). Agrium currently purchases hydrogen at its Joffre facility for ammonia production. As with co-generation, emissions savings here involve a partial “activity shift” (here there is a reduction in direct emissions, but an increase in indirect emissions - the opposite of the co-generation scenario) with the net CO₂ reduction dependent on the emissions avoided at the ammonia plant (credit) minus the emissions required to generate the hydrogen elsewhere (debit). The purchase and use of hydrogen at Agrium’s Fort Saskatchewan operation, as described elsewhere in this report, is an example where the “debit” is very small: there, the operation draws on a waste H₂ stream which would otherwise be burned to recover its energy value.

6) Increased Urea Production

Increased Urea production allows more ammonia process CO₂ to be captured within a product rather than be vented. At some plants this activity will require that the ammonia plant’s CO₂ recovery system be retrofitted to increase CO₂ capture for this use. Care must be taken when increased urea production is accompanied by increased ammonia production, as in most cases a net increase (tied to the increased ammonia production) rather than decrease in site CO₂ emissions will be observed.

7) Reduction in Nitrous Oxide (N₂O) Emissions from Nitric Acid Production

There may be potential opportunities to reduce N₂O emissions by way of operational changes or plant process modifications (ie. different catalysts and pollution abatement equipment). These opportunities will be explored in the coming years.

8) Ammonia Pipeline

In transportation corridors with high ammonia traffic, pipelines can be used to save some of the energy costs and emissions associated with transport. Agrium has over 30 years of experience with ammonia pipelines through the support and use of the Mapco pipeline in the U.S., a pipeline which stretches from northern Texas into Illinois.

APPENDIX C -**POTENTIAL OFFSETS TO AGRIMUM'S EMISSIONS****1) AGRICULTURAL SOILS AS A CARBON SINK**

Fertilizer as a part of modern farming practices can play a key role in the use of carbon sequestration to offset CO₂ emissions as carbon uptake by plants requires a corresponding uptake of nitrogen and other nutrients.

The carbon cycle of an agricultural ecosystem can be managed so that the CO₂ absorbed by crops is retained as soil organic matter.² Although not currently recognized as a sink by the Kyoto Protocol, Canadian agricultural soils have the potential to sequester enough CO₂ as soil organic matter to possibly meet 20% of Canada's Kyoto commitments.³ Globally, there is the opportunity to increase soil fertility while combating climate change.

Fertilizer use on its own may or may not lead to net CO₂ reductions from such sequestration. Some literature suggests that (as reported in Agrium's September 1997 progress report) any increase in C sequestered as crop bio-mass will be balanced by a corresponding increase in CO₂ emitted during the manufacture and distribution of the fertilizer used to produce that bio-mass. However, a holistic analysis of the net impacts of fertilizer production and use on atmospheric CO₂ and N₂O has not yet been done in a Canadian context. Agrium is currently engaged in activities which may allow such analysis in the future (cf. "Actions & Results").

In either case, there are real opportunities to sequester carbon in agricultural soils (and impact atmospheric CO₂) which will come from changing farming practices to make them less intensive: less tillage, less irrigation and more efficient use of fertilizer. There are companies currently entering into agreements with farmers to change their practices to those which sequester carbon, including efficient fertilizer use. The important role of fertilizer in carbon sequestration will be to maintain or increase plant yield, and thereby CO₂ absorption. The increased crop residues will decompose and build up soil organic matter.

Through the Canadian Fertilizer Institute, Agrium is supporting ongoing studies into the potential use of agricultural soils as a carbon sink (cf. Actions & Results).

An important caveat to the use of carbon sinks is that they are finite. Once exhausted they lose their capacity to absorb CO₂. Soils can only hold so much carbon; it is anticipated that following a change in farm management practices, a new equilibrium level of soil carbon would be established within 10-50 years.

Uncertainties surrounding the measurement of small changes in the soil's carbon content are also a concern, making verification of carbon sequestration a major challenge. Another danger is that carbon sinks can be transformed into net sources of CO₂: if trees were burned, or if farming practices returned to tilling, much of this stored carbon would be released once more to the atmosphere as CO₂.

² For an illustration of the carbon cycle refer to "The Health of Our Air" (ref. 4)

³ cf. C.F.I. Discussion paper on greenhouse gas emissions from fertilizer: "Better Science - Informed Decisions" (ref. 11)

Despite this, sinks could play the vital role of allowing the time necessary to develop and implement economically viable new technologies which will be less fossil fuel intensive than existing technologies. For agricultural soils to play this role, however, the Kyoto Protocol will need to recognize them as a legitimate sink and more science will need to be done on accurate measurement of soil carbon.

2) INDIRECT N₂O EMISSION REDUCTIONS ASSOCIATED WITH PRODUCT USE

There is significant opportunity for the Canadian fertilizer industry to impact agricultural greenhouse gas emissions by increasing the uptake efficiency of nutrients by plants.

According to “*The Health of Our Air*”, a publication recently released by Agriculture and Agri-Food Canada, nitrous oxide (N₂O) released by agriculture accounts for approximately 70% of world-wide anthropogenic N₂O emissions; furthermore, in Canada, 50% of agricultural N₂O emissions come from fertilizer / manure / crop residues applied to land as nutrients; another close to 25% come from losses of nitrogen when nitrate-nitrogen leaches and undergoes denitrification.

In Canada nitrous oxide makes up 5.4% of national greenhouse gas emissions (on a CO₂ Equivalent basis), although only 0.7% of Canadian CO₂E emissions are accounted to be from fertilizer application and use; the remainder, 4.7%, results from mobile fuel use (2.75%) and adipic acid production (1.76%). There is, however, significant uncertainty in these figures.⁴

Clearly, technologies which increase the efficiency of fertilizer use in agriculture and reduce N losses will have a part in meeting the challenge of mitigating climate change, particularly outside of Canada.

The easiest fashion in which to control N losses is to match plant nutrient demand and uptake rates with nutrient supply. Controlled release fertilizers and improvements in fertilizer application method and timing offer the ability to strike this balance. Other technologies such as precision agriculture and variable rate applications show promise.

Optimized nutrient uptake would also mean increased plant yield, and thereby increased CO₂ intake and C sequestration as described above under “Agricultural Soils as a Carbon Sink”.

3) WORKING WITH THE AGRICULTURAL COMMUNITY TO AFFECT CHANGE

Agrium’s position as a provider, both wholesale and retail, of agricultural inputs offers it a unique opportunity to partner with the agricultural community in tackling agricultural greenhouse gas emissions and harnessing Canada’s agricultural soils as a carbon sink.

Agrium has an existing relationship with its retail customers, through its products, field research and market testing as well as the training and advice it provides to dealers and farmers. The Company’s agronomic services include educating farmers on sustainable agriculture and influencing their farming practices.

⁴ The uncertainty in N₂O emission estimates could be +/-50%.cf. “Trends...1990-1995” (ref. 3)

Agrium could extend this opportunity even further by coming to an agreement with farmers to financially support them in changing their farming practices to those which will take advantage of Canada's agricultural soils as a carbon sink.

Some current barriers to the use of soil conservation practices are lack of experience, required purchase of new equipment, a resistance to change in philosophy, difficulty managing heavy residue loads in more moist areas. Further education and proper incentive could remove these barriers.