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L'Association Québécoise de Spécialistes en Sciences du Sol se veut d'abord un lieu de rencontre et de prise de position sur toutes les questions relatives à la science, à l'utilisation, à l'aménagement et à la conservation des sols. Elle a pour objectifs de diffuser l'information scientifique et technique relative au sol et de prendre position sur tout sujet d'intérêt public concernant l'utilisation, l'aménagement et la conservation des sols. Tout diplômé universitaire oeuvrant en sciences du sol au Québec peut devenir membre de l'association à condition d'en faire la demande, d'être admis par le comité d'admission et de payer la cotisation annuelle fixée par l'assemblée générale.

Le bulletin de l'AQSSS est une publication bisannuelle éditée en juin et décembre. Toute contribution au bulletin est bienvenue. Faire parvenir vos textes, photos et idées à l'éditeur.

Mot du président

Chers(es) collègues passionnés des sols, il semble que les années se suivent et se ressemblent, me revoici président de notre association. Je tiens à remercier ceux qui ont pensé à me redonner cette tâche agréable pour une autre année. Je tiens à rendre hommage au professeur Léon-Étienne Parent pour avoir mené la barque pendant les deux dernières années en dépit d'un horaire très chargé. L'an dernier a été une année très fébrile pour notre association avec l'organisation du congrès conjoint de l'AQSSS avec la Société Canadienne de la Science du Sol. Ce congrès a été un vif succès avec plus de 200 participants et la qualité des présentations de nos membres est à souligner. Je me dois de faire un clin d'oeil à Isabelle Royer pour le prix Bentley et Pierre Tardif pour le prix de la meilleure affiche; leurs performances vont convier leur collègues plus âgés à exceller dans le futur.

Le congrès a débuté par un Symposium sur la contribution des activités agricoles et forestières sur les émissions de CO_2, N_2O et CH_4. Ce symposium était le premier à traiter en même temps de ces trois gaz et a permis aux experts de faire le point. La contribution de Lucien Bordeleau, Claude Bernard, Thi Sen Tran et Adrien N'dayegamiyié pour la mise sur pied du programme est à souligner. Le congrès comme tel a été un vif succès. Il a été intéressant pour nos amis des autres provinces de constater la richesse de la Science du Sol du Québec. Par exemple les résultats des essais à long-terme du Service des Sols du MAPAQ à Saint-Lambert ont intéressé beaucoup les gens. Le succès d'un congrès réside souvent dans l'implication des membres de l'association. Un gros merci à Denis Angers, Jean Caron, Rock Ouimet, Léon Parent, Éric Van Bochove, Pierre Lafrance, Alain Pesant, France Pelletier, Claude Bernard, Jean Zizka, Michel Nolin et tous les autres que j'oublie pour leur contribution. De même, je tiens à remercier David Paré d'avoir accepté de remplacer Claude Camiré à pied levé (sous les menaces de R. Ouimet de lui faire le même sort). Ce congrès n'aurait pas été possible sans l'apport de notre hôte, l'Université Laval, et je remercie le Doyen M. André Gosselin pour avoir mis à notre disposition les locaux nécessaires. Nos collègues Albertains se souviendront longtemps du banquet à la Ferme de Saint-Lambert; ils ont apprécié les leçons de russe de Léon D. Parent et la joie de vivre de notre groupe. Cette occasion a permis de rendre hommage à un des fondateurs de notre association le Dr. Marton Tabi qui a reçu le Prix Auguste-Scott. La contribution du Dr. Tabi, à la fois comme chercheur en fertilité des sols, comme éditeur en chef de la revue Agrosol et comme administrateur de recherche, a marqué de façon indélébile l'avancement des connaissances en Sciences du Sol.

Le congrès de cette année a pour thème "De Nouveaux Défis en Science du Sol" et se tiendra du 16 au 18 octobre 1996 à Saint-Hyacinthe. Des conférenciers invités vous entretiendront de biodiversité et changement climatique, de contamination des sols, de valorisation des résidus exogènes en agriculture et foresterie, d'enseignement de la Science du Sol et de vulgarisation des connaissances. Réservez ces dates à votre agenda, le comité organisateur vous attend en grand nombre. Je crois que l'année 1996 sera fertile en trouvailles dans notre domaine et le congès est l'occasion idéale de les partager. Je termine en vous transmettant mes meilleurs voeux pour la prochaine année.

Régis R. Simard, président.

"Comentaire reçu d'un invité, albertain, au banquet de l'AQSSS":

...

P.S. Another memory that will stay with me is the Annual Meeting of the Quebec Soils Society ... the Canadian banquet was definitely boring compared to that!

N.D.L.R.

VERSION 3
du Système canadien de classification des sols
(S.C.C.S.)

Madame, Monsieur,

Lors d'une réunion tenue à Ottawa, en novembre 1995, entre les différents chefs d'Équipe pédologique fédérale du Canada, il a été convenu de mettre en branle un processus de révision de la dernière édition du S.C.C.S. datant de 1987. Un Groupe de travail national sur la classification des sols a donc été formé dont M. Bernie Stonehouse de l'Équipe pédologique de la Saskatchewan a été nommé président.

L'objectif visé par ce groupe est une nouvelle édition du S.C.C.S. pour la fin de 1996 ou le début de 1997. Celle-ci devrait comprendre, en autre, l'ajout d'un nouvel ordre de sols, les vertisols et certains changements et additions à l'ordre des cryosols.

Ayant été désigné comme responsable pour le Québec de la révision d'une section de cette prochaine édition, j'aimerais solliciter votre participation et collaboration en tant que spécialistes en sols. Ce que j'aimerais, c'est que vous me fassiez part de vos commentaires et surtout des corrections que vous souhaiteriez voir apportées à la future édition du S.C.C.S..

Ces remarques peuvent être de plusieurs ordres, soit :

1- Des erreurs d'édition ou d'orthographes que vous auriez notées dans la version 1987 du S.C.C.S..
(À noter que cette révision se fait à la fois sur les versions française et anglaise du S.C.C.S.).

2- Une terminologie ou des classes que vous aimeriez, voir mieux définies ou plus clairement décrites.

3- Ou toute autre remarque qui améliorerait, soit la présentation ou le contenu de ce document.

Enfin, il est possible de proposer des sujets où les besoins de recherche devraient être plus poussés afin d'améliorer la classification du système.

Comme il est rappelé dans la préface de l'édition 1987, le S.C.C.S. est un système ouvert à l'amélioration. Chaque édition doit être considérée comme une nouvelle étape dans l'évolution du système taxonomique. Celui-ci s'améliore au fur et à mesure des connaissances acquises sur les sols et amène une meilleure organisation de cette connaissance. En tant que spécialistes en sols, vous devez assumer une part de responsabilité dans son évolution et son amélioration.

Je vous encourage donc à me faire parvenir vos remarques et commentaires que je me chargerai de faire suivre aux personnes concernées.

Merci de votre précieuse collaboration,

Luc Lamontagne
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Résumés des conférences présentées au 9e congrès conjoint AQSSS-SCSS, 21-28 juillet 1995, Université Laval, Québec

Symposium sur les gaz à effet de serre - communications orales

Les temps de résidence du carbone et le potentiel de stockage de carbone dans les sols cultivés français. The residence times of C in French cultivated soils, and their potential for C storage. Jérôme Balesdent, INRA, Station de Science du Sol, F-78026 Versailles cedex.

Pour prévoir la capacité des sols à séquestrer du carbone, en réponse aux changements climatiques ou aux changements d'utilisation, il est nécessaire de connaître la distribution des temps de résidence du carbone dans les sols. Nous avons utilisé les abondances naturelles en isotopes ^{13}C et ^{14}C pour mesurer cette distribution dans des expérimentations agricoles en maïs de longue durée en France. Les trois quarts du carbone du sol y ont un temps moyen de résidence de 40 ans. Les fractions granulométriques grossières contiennent la majeure partie du carbone à durée de vie plus courte. La datation au carbone 14 des matière organiques permet d'introduire un compartiment de carbone stable, minoritaire en surface. Aucune des séparations chimiques testées n'a permis de concentrer du carbone labile ou du carbone stable. Les restitutions souterraines stockent autant de carbone que les restitutions aériennes. Ces données, synthétisées dans un modèle simple et complétées par des données de thermodépendance de la minéralisation du carbone, permettent de prévoir le stockage de carbone par ces sols dans le cadre de scénarios de changements globaux. Le mode d'occupation du sol aura une influence sur la séquestration de carbone plus importante que celle des changements atmosphériques.

In order to predict the potential of soils to store carbon in response to land use or climate changes, there is a need to know the distribution of residence times of C in soils. We used the natural abundances in ^{13}C and ^{14}C to measure this distribution in long-term experiments of maize cultivation in France. 75% of the topsoil carbon had a mean residence time of 40 years. Coarse particle-size fractions contained most of the younger carbon. A compartment of stable C was estimated using radiocarbon dates. No chemical separation allowed us to concentrate either stable or labile C. Underground plant material injection stored as much C as aboveground restitutions. We summarized these data in a simple model, completed with thermal dependence of C mineralization, to run scenarios of climatic change. Land use changes will have more influence than atmospheric changes on C storage in these soils.

Nitrous Oxide Emissions from Agricultural Soils. E.G. Beauchamp, Land Resource Science, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

The concentration of nitrous oxide (N_2O) in the atmosphere is increasing at a rate of 0.2-0.3 percent per year. The lifetime of N_2O molecules in the atmosphere is estimated to be approximately 130 years. With respect to global warming, N_2O molecules are considered to be 230 times more effective than the same quantity of carbon dioxide molecules. Nitrous oxide is also associated with stratospheric ozone depletion. The contribution of N_2O from agricultural practices is highly uncertain but has been estimated to comprise as much as one-half of the total from anthropogenic sources. The major sources of N_2O are from microbiological processes, especially nitrification and denitrification with a minor contribution from chemodenitrification. The increase in annual production of N_2O coincides in part with increases in use of mineral N fertilizers, manures, leguminous crops and soil tillage. Forest clearing, savanna and sugar cane field fires, and burning of agricultural wastes and wood also contribute to N_2O production. The general objective is to measure as well as determine the factors that are mainly responsible for N_2O production and then develop methods or practices to regulate it. In recent years major emphasis has been to develop satisfactory methods to measure N_2O production and flux from agricultural soils. This has turned out to be very difficult because of spatial and temporal variability in soils. Associated with the development of suitable methodology is the scale of measurement ranging from the soil microbe or microcosm to regional ecosystems. Many soil variables are involved including oxygen supply, mineral N levels, precipitation, temperature, drainage, and texture. It appears that repression of N_2O production and flux is of utmost importance. Although difficulties in measurement methodology exist, a clearer picture of the contributions of various agronomic practices is emerging. Means for controlling or regulating N_2O production and flux from agricultural soils are also becoming more clear. We need not wait for precise N_2O flux measurements on all kinds of landscapes to begin adjusting various agricultural practices to minimize or regulate N_2O production.

Storage of carbon in soils of eastern Canada. M.R. Carter[1*], D.A. Angers[2], E.G. Gregorich[3], and M. Bolinder[2], [1]AAFC, Research Centre, Charlottetown, Prince Edward Island, Canada C1A 7M8, [2]AAC, Soils and Crops Research and Development Centre, Sainte-Foy, Québec, Canada, G1V 2J3; and [3]AAFC, Centre for Land and Biological Resources Research, Ottawa, Ontario, Canada K1A 0C6.

Studies were conducted on 15 sites in eastern Canada to assess agricultural management effects on soil C storage, under cool humid climates, and to identify agricultural practices or systems that favour C storage. Results indicate that agricultural soils contain (within a 0-60 cm depth) a mean value of 8.2 kg C m^{-2}, with a range of 3.2 to 13.1 kg C m^{-2}. The distribution of C with depth, as a proportion of total C, was approximately 61% in the 0-20 cm layer, 26% in the 20-40 cm layer, and 13% for the 40-60 cm layer. Proportions of soil organic C, over the 0-60 cm depth, ranged from 0.8-2.4% in the microbial biomass and 7.6-41.2% in the macroorganic matter. Such organic C fractions were greatly modified by agricultural management practices. Cropping practice, type of vegetation, and organic amendments had a major effect on soil C storage capacity. For example, in a 4 yr study on a Normandin silty clay, soil organic C storage (0-60 cm soil depth) was 6.7 kg C m^{-2} under monoculture barley and 7.9 kg C m^{-2} under a barley-red clover rotation. In contrast, manure applied at 50 m^3 ha^{-1} to the above rotations resulted in an organic C store of 7.7 kg m^{-2}, compared to a level of 6.9 kg C m^{-2} with fertilizer. Several comparisons of mouldboard ploughing and direct-drilling generally showed a tendency for an increased organic C storage (0-60 cm soil depth) for the ploughed system, even under conditions of similar crop biomass production.

Denitrification kinetics, nitrate stability and evolution of gases from soil system. C.M. Cho[*], Department of Soil Science, University of Manitoba, Winnipeg, MB.

Competitive Michaelis-Menten type kinetics among electron acceptors, O_2, NO_3, NO_2, and N_2O, were developed and applied to describe the transport of these electron acceptors within soil profile in order to estimate the aerobic-anaerobic interface depth, stability of NO_3 and emanation of gases, N_2O and N_2, from soil surface under non-uniform soil moisture conditions. Soil moisture content and biological activity distribution of the soil affected the depth of aerobic-anacrobic interface. All of the oxides of N were found to be stable in the acrobic layer while competitive reduction of the oxides took place in the anaerobic zone. Nitrous oxide stability in the anaerobic zone is governed by the presence of either NO_3 or NO_2 which competed for electron with N_2O making it stable. If the concentration of NO_3 is low, N_2O became a source of electron acceptor and was reduced to N_2 gas. Because of the solubility of N_2O gas in soil solution, the mobility of N_2O was retarded during the transport thus making it more prone to reduction. In many instances, if the soil moisture content is low, the depth of oxidized zone extends so deep that NO_3 is practically stable making it a probable cause of groundwater pollution.

Long-term (35 years) effects of fertilization and rotation on denitrification and soil respiration. C.F. Drury[*], T.O. Oloya, D.J. McKenney and C.L. vanLuyk, Harry Research Centre, Agriculture & Agri-Food Canada, Harrow, Ontario and University of Windsor, Windsor, Ontario.

A long-term study was initiated in 1959 to determine the effects of fertilization and crop rotation on soil and water quality. Treatments included fertilized and unfertilized plots of continuous corn, continuous bluegrass, and rotation corn. In addition, soils from an adjacent mixed deciduous forest were sampled. These treatments dramatically altered crop yields, the amount of crop residue returned to the soil and the resulting C reserves in a Brookston clay loam (Humic Gleysol). The objective of this study was to determine the long-term effects of these fertilization and crop rotation practices on denitrification and soil respiration. Denitrification was estimated using the acetylene inhibition method from KNO_3 amended soil samples incubated anaerobically. The fertilized bluegrass treatment resulted in the greatest N_2O production (16.8 mg N kg^{-1}), over 14 times greater than the unfertilized continuous corn treatment which had the lowest denitrification rate and 6 times greater than the fertilized continuous corn treatment. The fertilized and unfertilized rotation corn treatments produced 2.8 to 3.5 times as much N_2O than the corresponding continuous corn treatments. Soils from the woodlot had the second highest denitrification rate. In the 0-10 cm depth, the fertilized treatments always had greater denitrification rates than the corresponding unfertilized treatments. Both cropping and fertilizer treatments affected the soil respiration rates especially in the top 10 cm. In a second experiment using both KNO_3 and glucose amendments, denitrification was increased on average by 15 fold compared to the KNO_3 only treatments and differences between the long-term cropping and fertilizer treatments were reduced reflecting C limiting conditions.

Carbon dioxide emissions from southern Alberta soils under contrasting management practices. B.H. Ellert[*] and H.H. Janzen, Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.

The exchange of carbon between soils and the atmosphere has a major influence on global and regional carbon cycles, because the pool of soil C is larger and more changeable than most other C pools. The quantities of C sequestered in soils depend on the balance between inputs from photosynthesis of plant C and outputs from decomposition of plant residues and soil organic matter. Recept measurements of soil respiration in southern Alberta are revealing the temporal dynamics of CO_2 fluxes, and providing insights into the influence of

environmental variables and management practices on CO_2 emissions. Soil respiration in various experimental plots was monitored *in situ*. using closed chambers (volume ≈ 1 to 3 L) and portable gas analyzers or alkali traps to determine the CO_2. Emissions were highly variable in time and space. Temporal variability was associated with fluctuations in soil moisture and temperature, and with changes in contributions from plant respiration and decomposition of recent plant residues. Similar factors also contributed to spatial variability, but the influence of environmental variables and management practices predominated in most plots. Fluxes of CO_2 from soils under contrasting management regimes will be presented, and impacts of the major environmental driving variables will be discussed. Estimates of CO_2 emissions must be compared with estimates of photosynthesis to assess whether soils are a net source or sink of atmospheric CO_2. Relationships between net photosynthesis and soil respiration will be explored. The relative merits of CO_2 fluxes as indicators of biological activity and of soil C sequestration also will be addressed.

Carbon balance of the Breton Classical Plots over fifty five years. R.C. Izaurralde*, W.B. McGill, J.A. Robertson, N.G. Juma, and J.T. Thurston. Department of Renewable Resources. University of Alberta. Edmonton, Alberta T6G 2E3.

Several land management practices have potential for sequestering carbon dioxide into soil organic C. At a regional level, however, there is uncertainty on how management influences the amount and proportion of the carbon sequestered. Our objective was to explain the changes in soil organic carbon measured during 55 years on the Breton Classical Plots (established in 1930 on a Gray Luvisol at Breton, Alberta) by using historical records of yield and management. The treatments selected were a factorial combination of two crop rotations (Wheat-Fallow [WF] and Wheat-Oat-Barley-Hay-Hay [WOBHH] and three fertility levels (Control [C], NPKS fertilizers [F], and cattle manure [M]. Calculated or estimated data used in the analyses were: total shoot biomass, root mass, root/shoot ratios, shoot C, soot C, manure C, and soil organic C. Two of the six systems did not sequester any C: WF-C and WF-F. Regardless of the fertility level, the WOFHH systems sequestered more C per unit C added (0.37-0.56 Mg Mg^{-1}) than the WF-F system (0.24 Mg Mg^{-1}). These values suggest an underestimation of root C inputs. The annual rate of C sequestration varied from 0.23 to 0.56 Mg ha^{-1} y^{-1}. Manure C decreased by half (from 110 to 56 y) the turnover time of soil organic C.

Nitrous oxide and carbon dioxide emissions as affected by lime and tillage. C. Lapierre* , R. Simard, D. A. Angers and D. Prévost, Agriculture et Agroalimentaire Canada, Ste-Foy, Qc.

The production and consumption of N_2O and CO_2 in soils and the exchange rate of both gases with the atmosphere, are not only dependant on natural conditions but are also influenced by cropping practices. The objective of the study was to evaluate N_2O and CO_2 fluxes at the soil surface, when acidic pastures are taken into cereals using different tillage intensities and lime additions. The experiment was laid out according to a split plot design with tillage intensity: rototiller (MT), chisel (RT) and moldboard plow (CT) as the main factor and liming (0, 6, 12 Mg $CaCO_3$ ha^{-1}) as the subfactor, in four replicates. Gases were sampled *in situ* using closed chambers. Between March and November 1994 N_2O and CO_2 emissions ranged from 0.12 to 67.6 μg m^{-2} min^{-1} and from 1.1 to 11.8 mg m^{-2} min^{-1} respectively. Positively correlated with soil temperature ($r= 0.91^{**}$), CO_2 fluxes increased progressively from March 29 to July 25 and gradually decreased later in the season as soil temperature cooled down. The emission of N_2O had a much more episodic character. Fluxes stayed below 5 μg m^{-2} min^{-1} throughout the sampling season except for a period of 15 days following fertilization where it peaked to values around 50 μg m^{-2} min^{-1}. High fluxes of N_2O were associated with elevated level of water-soluble NO_3 and NH_4. During peak emission period, fluxes of N_2O were higher in CT and RT compared to MT. Aggressive soil disturbance promoted gas emissions from poorly drained pastures.

Nitrous oxide emission and denitrification as affected by tillage, corn-soybean-alfalfa rotations, and nitrogen fertilization. A.F. MacKenzie*, M.X. Fan, F. Cadrin, and M. Abbott. Macdonald Campus of McGill University, Ste Anne de Bellevue. Quebec.

Nitrous oxide (N_2O) produced from agricultural activities must be determined if management procedures to reduce emissions are to be established. In 1994, N_2O emissions and denitrification were studies with a closed chamber method on a Ste.Rosalie clay (Humic Gleysol) and an Ormstown silty clay loam (Humic Gleysol). Nitrous oxide emission rates were determined on tillage treatments (no tillage and conventional tillage), seven rotations (monocultural corn (CCCC) and soybean (SSSS); corn-soybean two years rotation (CSCS, SCSC); soybean-corn-alfalfa four years rotation (SACS, CSAC and ACSA), with N rates of 0,90, and 180 kg N ha^{-1} for corn and 0, 20, and 40 kg N ha^{-1} for SSSS. Rates of N_2O emission and denitrification, varied throughout the season. In early May, N_2O emissions of 0.5 o 0.7 g N ha^{-1} h^{-1} and denitrification of 0.70 to 1.1 g ha^{-1} h^{-1} were observed. After N fertilization in early June, maximum N_2O flux and denitrification rates reached 3.6 to 8.2 and 7.5 to 13.8 g N ha^{-1} h^{-1} for the Ormstown soil; 1.2 to 2.5 and 1.8 to 3.8 g N ha^{-1} h^{-1} for Ste.Rosalie soil. Rates varied with tillage, N rate and crop rotations treatments. Four to five weeks after fertilization, rates decreased to as low as 0.1 to 0.2 g N ha^{-1} h^{-1} level. Most N_2O and denitrification rates were higher with no-till, corn, and

increased N rates. The N_2O emission rates were related to soil water content, NO_3 concentration and fertilizer N rates.

Denitrification losses and N_2O emissions from Alberta soils. M. Nyborg*, J.W. Laidlaw, S.S. Malhi, and E.D. Solberg. Univ. of Alberta, Edmonton; Agric. and Agri-Food Canada, Lacombe; and Alberta Agric. Food & Rural Developm. Edmonton.

Cultivated soils of central and northern Alberta mineralize N from soil organic matter during the winter despite being frozen. Nitrification also occurs in frozen soils although its rate is slow. For example, winter rates of mineral-N accumulation of eight frozen or partially frozen Black Chernozems ranged from 0.26 to 0.43 kg ha^{-1} d^{-1}. Much of accumulated mineral-N, however, was lost when the soils became thawed and saturated during late March. Mass balance of ^{15}N-labelled nitrate-N indicated that the mineral N lost in the spring occurred primarily via denitrification. In the field, the N_2O+N_2 emissions. In the laboratory, however, N_2O emissions represented a small percentage of the total emission. In all, mineralization and nitrification of soil N in winter coupled with N_2O emission from thawing soils may have been overlooked in the understanding of emissions of N_2O from soils.

Methane, Nitrous Oxide and Carbon Dioxide Emissions From Dairy Manure. E. Pattey*, P. Rochette, R. Desjardins and M. Edwards. Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada, Ottawa, ON.

Fluxes of CH_4, N_2O from manure with bedding stored under three conditions 1) composting by the passive aeration method, 2) stockpiled aerobically and 3) as slurry were measured from mid-May to mid-August 1993. The manure was placed in 2.6-m^3 bins. The treatments were replicated three times and the volume of the manure was 1.4 to 2.0 m^3. The greenhouse gas (GHG) fluxes were measured twice a week with a dynamic closed system developed in-house. The concentration of CO_2 was measured in real-time with an infrared gas analyzer (LI-6251), while two series of five air samples were collected with 10-mL syringes for gas chromatograph analysis of methane and nitrous oxide. As expected the manure stored as slurry had the highest methane emissions, but N_2O fluxes were small. Stockpiled manure showed a high initial CH_4 emission peak over 20 days. Composting the manure reduced at least four-fold the initial peak of CH_4 emission compared to stockpiled dairy cow manure. However, slightly higher N_2O fluxes were found in composting manure. CO_2 fluxes were in the same range except for the first week, when higher fluxes were measured from stockpiled manure. Compared to total GHG production (CH_4, CO_2, N_2O), the direct contribution of methane to the radiative forcing (34:1 CH_4:CO_2) was about 68% for slurry, 31% for stockpiled manure and less than 7% for compost. Slurry and stockpiled manure emitted about 33% more GHG (expressed in CO_2-equivalent mass) than the compost, showing that reducing methane emission through aerobic storage is a valuable approach of reducing GHG buildup.

Nitrous Oxide Emissions From Dairy Cattle Manure-Amended Soil in the Fraser Valley of British Columbia. J.W. Paul,* B.J. Zebarth and C.G. Kowalenko. Agriculture and Agri-Food Canada, Pacific Agriculture Research Centre.

Nitrous oxide emissions were measured on a silt loam soil and a clay loam soil cropped to silage corn during the growing season of 1994. Dairy cattle slurry or separated dairy manure liquids were applied at rates of 75 and 150 kg NH_4^+-N ha^{-1} in mid-March and in mid-April. Nitrous oxide emission was measured using a chamber technique twice per week until June, then weekly until the end of September. Losses of nitrous oxide peaked at 5-10 g N ha^{-1} hr^{-1} approximately 3 weeks following manure application and coincided with the period of most rapid nitrification. Nitrous oxide emissions were at maximum rates in early May and decreased in the order: dairy cattle slurry > separated manure liquids > inorganic N fertilizer (100 kg N ha^{-1}) > control. Emissions were higher from the clay loam soil than from the silt loam soil. Corn yields were higher on the clay loam soil than on the silt loam soil but there was no effect of manure rate, manure type or time of manure application.

Denitrification under sub-optimal temperature in a Québec agricultural soil subject to freezing periods. F. Pelletier*, D. Prévost and É. van Bochove, Agriculture and Agri-Food Canada, Sainte-Foy, Québec.

Formulation of predictive models for N_2O emissions from agricultural ecosystem requires specific knowledge of the temperature coefficient for denitrification. The objectives of the present study were: (1) to examine if low temperature adaptation of denitrifiers populations occur during cold periods; (2) to obtain quantitative information regarding the temporal variability of denitrification in response to temperature and (3), to investigate interactions between denitrifiers temperature response and the availability of organic matter. Denitrifying enzyme activity (DEA) at nine temperatures (2 to 35°C), denitrifier populations (most-probable-number [MPN] counts) and water-soluble organic C (WSOC) were determined 15 fold over a 2-year period (1993 to 1995) in a silty loam soil. The Ratkowsky model was employed to linearly relate DEA to temperature and to define a temperature coefficient. Denitrification activity was detected at 2°C at each sampling time and a sharp increase was observed at 7°C in spring and autumn 1994. Temperature coefficients varied from 0.023 to 0.052 throughout the experiment and were related to specific agricultural and environmental factors in the following order: late fall

and/or tillage>thawing>summer>frozen-soil. Denitrifier populations decreased during freezing period but MPN and WSOC were not significantly correlated with temperature coefficients. Q_{10} values ranged between 0.7 to 9.4 and varied with sampling time and temperature range.

Impact of Agriculture and Forestry on Landscape-scale Soil Organic Carbon Storage in Saskatchewan. D.J. Pennock* and C. Van Kessel. Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan.

The development of sound management approaches to reduce soil organic carbon (SOC) losses from soils presuppose that we thoroughly understand the sources of these losses. We use a landscape-scale research design to estimate carbon losses by comparing SOC storage in undisturbed landscapes with comparable clear-cut sites in the Mixedwood/Gray Luvisolic zone of central Saskatchewan and long-term agricultural sites in the Black soil zone. A drop in median levels of soil organic carbon storage in the upper 45 cm of the soil (from 56.8 Mg ha^{-1} in mature mixedwood sties to 49.7 Mg ha^{-1} in clear-cut landscapes) occurs due to clear-cutting. The dominant soil type in these landscapes, Gray Luvisolic soils, experience no significant change in SOC storage; however significant losses occur from Brunisolic (29 % loss) and Gleysolic (32 % loss) inclusions in these landscapes. Changes in SOC from Black soil zone landscapes are strongly related to texture: sandy glacio-fluvial landscapes experience slight gains of SOC (from 54.1 to 60.1 Mg ha^{-1}); silt and clay glacio-lacustrine landscapes experience a 15.3% decrease in SOC (from 145.2 to 122.9 Mg ha^{-1}); and loamy glacial till landscapes undergo a major decrease in SOC storage (from 119.6 to 75.2 Mg ha^{-1}). Our results indicate that attempts to mitigate SOC losses in Saskatchewan should concentrate on agricultural activities, especially in glacial till landscapes.

Utilization of Portable CO_2Analyzers for the Measurement of Soil Respiration. P. Rochette*[1], E.G. Gregorich[1], B. Ellert[2], E. Pattey[1], R.L. Desjardins[1] and R. Lessard[1]. CLBRR, AAFC, [1]Ottawa and [2]Lethbridge.

Soil respiration is the rate at which the carbon dioxide produced by the metabolic activity of soil microorganisms and plant roots is emitted at the soil surface. It is an important component of the net carbon dioxide exchange between agricultural ecosystems and the atmosphere, and reliable estimates of soil respiration are required in carbon balance studies.

Field measurements of soil respiration can be made using several methods. The various chamber techniques (open chamber, static and dynamic closed chambers) and of the micrometeorological techniques (eddy correlation, aerodynamic gradient and Bowen ratio) will be described. A dynamic closed chamber system using a portable CO_2 analyzer will also be presented and the recommendations for its use will be discussed. Several intercomparisons between the various techniques were made. Early reports by several authors indicated that the static closed chambers underestimated soil respiration compared to dynamic open and closed chambers. However, in more recent experiments made in Ottawa and Lethbridge, static and dynamic closed chambers showed an excellent agreement on all but two comparisons. Analysis of the soil temperature and CO_2 concentration under the static chambers failed to explain why the static chambers occasionally underestimated the fluxes. Soil respiration measured with a dynamic closed chamber were also compared to eddy-correlation measurements. The relationship between simultaneous estimates by both techniques had a slope of 0.87 (±0.04) and a coefficient of determination of 0.34. The relatively large dispersion is likely the result of the difference between the areas measured by the two techniques.

Soils as Sources and Sinks for Atmospheric Methane. Edward Topp, Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada, Research Branch, K.W. Neatby Building, Central Experimental Farm, Ottawa, Ontario, K1A 0C6

The concentration of methane in the atmosphere is increasing at a rate of about 1% per year. On a mole per mole basis, the climate forcing by methane is estimated to be 26 times that of carbon dioxide. Methane is produced in soils as the end product of the anaerobic decomposition of organic matter. In the absence of oxygen methane is very stable, but under aerobic conditions is mineralyzed to carbon dioxide by methanotrophic bacteria. Soil methane emissions, primarily from natural wetlands, landfills and rice paddies, are estimated to represent about half of the annual global methane production. Oxidation of atmospheric methane by well-drained soils accounts for about 10% of the global methane sink. Whether a soil is a net source or sink for methane depends on the relative rates of methanogenic and methanotrophic activity. A number of factors including pH, Eh, temperature and moisture content influence methane transforming bacterial populations and soil fluxes. Flux estimation and scaling up is complicated by spacial and temporal variability. Soil management can impact methane transformations. For example, landfilling of organic matter can result in significant methane emissions, whereas some cultural practices inhibit methane oxidation by agricultural soils.

The dynamics of N_2O and CO_2 concentrations in frozen soil and over-lying snow cover. E. van Bochove*[1], H.G. Jones[2], F. Pelletier[1] et D. Prévost[1], [1]Agriculture and Agri-Food Canada, Research Centre, Sainte-Foy, Québec and [2]Institut national de la recherche scientifique (INRS-eau), Sainte-Foy, Québec.

Significant emissions of N_2O and CO_2 have been measured in climates where soils are subject to freeze-thaw cycles and in natural ecosystems covered by snow. In cold climate of Eastern Canada a large proportion of annual precipitation falls as snow and accumulates on soils during 4 to 5 months. Multilevel gas probes were installed prior to the onset of snow cover to sample the atmosphere of soil (< 0.7 m) and snow profiles (0-1 m) of a sandy loam in agricultural and forest ecosystems. We present evidence that N_2O and CO_2 are produced deep (B, C horizons) in the agricultural soil throughout the winter/spring-melt periods and that concentrations in the soil profile (N_2O ~5000 ppbv) decreases strongly in the snow cover (N_2O < 1000 ppbv) above the frozen soil surface layer. In contrast N_2O concentrations in the forest profiles were very low (~350 ppbv). The highest N_2O concentrations (~12000 ppbv) beneath the frozen agricultural soil surface were observed during the initial melt period. Nitrous oxide concentrations in soils decreased to very low levels (< 2000 ppbv) during the main melt period and the disrupting of the frozen layer . The concentration of N_2O in soil profiles continued to decrease to the end of the melting. The observations on concentration gradients within the soil show that soil respiration is approximately equivalent in both ecosystems but that the concentrations of N_2O in the agricultural soil are the result of agricultural practice and the release of melt waters. Fluxes were calculated by determining the concentration gradients in snow and applying Fick's first law of diffusion using an effective diffusion coefficient based on snow density measurements.

Long-term Emissions of Nitrous Oxide from Agricultural Fields. C. Wagner-Riddle, G.W. Thurtell, G.E. Kidd, E.B. Beauchamp and R. Sweetman.

Increases in concentration of greenhouse gases in the atmosphere are expected to bring about global climate change. In this study, we report nitrous oxide emissions measured using micrometeorological techniques and a tunable diode laser trace gas analyzer. Since 1992, several fields have been monitored including two fallow plots, blue grass, alfalfa, barley, canola, soybeans and corn plots. Over two years, spring thaw emissions from non-vegetated (ploughed or covered with crop residue) plots were very high. Between 45 and 60% of the total annual emission from the these plots occurred in March and April. Therefore, spring thaw on non-vegetated plots was the single most important event contributing to the total nitrous oxide emissions. Similar effects were not observed on the vegetated (alfalfa and grass) plots.

The lowest total annual N_2O emissions were measured for the fields in which a crop was present over the winter and spring thaw, that is alfalfa and blue grass. All other fields had crop residue on the soil surface, or had been ploughed. The annual emissions measured with the TGA were larger than the emission estimated from fertilizer use.

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Agriculture management effects on soil carbon storage in eastern Canada: Project outline and preliminary results. D.A. Angers[1], M.A. Bolinder[1*], E.G. Gregorich[2], M.R. Carter[3], R.G. Donald[6], R.P. Voroney[7], C.F. Drury[4], B.C. Liang[2], R.R. Simard[1], R.P. Beyaert[5] and D. Côté[8]. AAFC [1]Ste-Foy, [2]Ottawa, [3]Charlottetown, [4]Harrow, [5]Delhi, [6]Landmark Resource Consultants Ltd., Halifax; [7]University of Guelph, Guelph; [8]MAPAQ, Ste-Foy.

A large amount of C is stored in soil organic matter (SOM), over most of the earth's land surface, the quantity of C in SOM exceeds that stored in living vegetation by a factor of two or three. The project described is part of the AAFC Greenhouse Gases Initiative, and contributes to the achievement of the main objectives of this research program under the soil and climatic conditions of eastern Canada (Maritimes, Québec, Ontario). The project is a four-year study (1993-1997) with the following three objectives: 1) determine the soil C balance for selected local farming systems; 2) isolate the SOM fractions responsive to management effects, and 3) modify or validate existing SOM simulation models in order to identify farming systems which favour C sequestration. In the first phase of the project, fifteen existing replicated experimental sites were sampled with a uniform sampling strategy. Preliminary results indicate that the total soil C storage (0-60 cm) in eastern Canadian agricultural soils varied from 3.2 kg C m^{-2} in a sandy soil in southern Ontario to 13.1 kg C m^{-2} in a poorly drained soil in the northern Maritimes, with an overall average value of 8.2 kg C m^{-2}. The distribution of C with depth was similar at all the sites, suggesting that the total soil C storage can be estimated from surface measurements.

Livestock sector masterplan to reduce greenhouse gases production. Development of an expert system: Phase I, concepts and Phase II, database modelling. Baril, P., Julien C., Consultants BPR (Québec).

Agriculture Canada have prepared a scientific plan for studying the possibilities of reducing the emissions of

greenhouse gases (GHG) from the agricultural sector. Actual and future researches provide important informations and permit to use prediction models adequately. Best management practices will be selected by integrating agronomical, technological and economical point of view. A large quantity of parameters is required to determine the best local, regional and national actions. Those parameters are either included in existing database or to be define in new system. Recent approaches, using reliable expert systems, help us integrating large amount of data and treating them rapidly. The main objective of this project is then to build a database management system associated with an expert system that will help decision-maker in choosing the BMP'S reaching the plan's main objectives.
Phase I identify, among the literature, the parameters required to estimate GHG (CH_4, N_2O, CO_2)production and consumption by the different sectors of the livestock production system (animals, buildings, storage and treatment, enhancement in soils) using a baiance approach method. After a general and conceptual validation of each compartment, Phase II consists in building the relational data model and the database management system. Phase III will integrate an expert system. A regional application of the tool with simulation techniques of different scenarios will be done in Phase IV.

Measuring soil atmosphere concentration profiles as a tool for understanding N_2O production in soils. D.L. Burton*, University of Manitoba, Winnipeg, Manitoba.
The flux of trace gases such as CO_2, N_2O and CH_4 from soil are generally measured and expressed in terms of surface area. The production of these gases occurs in a three-dimensional environment however. To understand the relationship between trace gas production and soil edaphic factors (temperature, moisture) the site of production must be known. The site of gas production may change in response to soil management, precipitation and seasonal events. This study examines use of a multi-level soil atmosphere samplers to examine the distribution of N_2O and CO_2 in a soil profiles under three cropping situations (cropped to alfalfa, fallow and fallow + manure) and its relationship to the surface flux as measured by micrometeorological and core-based methods. The accumulation of N_2O in the soil profile exhibited strong seasonal and temporal variation and was influenced by precipitation and soil management. The location of carbon inputs influenced the relative amounts of N_2O accumulating in the profile *vs* that emitted from the surface. The depth of peak N_2O accumulation was not necessarily indicative of the zone of N_2O production as considerable redistribution occurred during and following production events. Measurement of soil profile N_2O production provides additional information important to the understanding of the production, consumption and loss of N_2O from soil. Measurements of surface flux based on accumulation of N_2O in the soil profile are limited by the accuracy of estimates of gaseous diffusion and are unable to provide accurate estimates when production is localized at or near the soil surface.

N_2O emission dynamics - experiment. C. Chang[*1], C.M. Cho[2] and H.H. Janzen[1], [1]Lethbridge Research Centre, Agriculture & Agri-Food Canada, Lethbridge, Alberta, [2]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba.
Nitrous oxide (N_2O) emissions not only contribute to global warming but also to the depletion of ozone (O_3). Soil are considered to be one of the major sources of stratospheric N_2O. In order to quantify N_2O emission from soils, it is essential to understand the mechanisms of N_2O formation and transport in the soil. A set of experiments was carried out to attempt to determine the competition parameters among O_2 and nitrogen compounds (NO_3, NO_2, N_2O and N). The results indicated that N_2O was relatively stable even with a small amount of O_2 in the system as predicted by previously proposed formulations.

N_2O and CO_2 emissions from corn-cropped soils: Impact of N fertilization, previous alfalfa, and soil texture. Martin H. Chantigny*[1], Danielle Prévost[2], Denis A. Angers[2], Régis R. Simard[2], and François-P. Chalifour[1], [1]Université Laval, Ste-Foy, Qc; [2]Agri-culture et Agro-Alimentaire Canada, Ste-Foy, Qc.
Agriculture management practices such as N-fertilization and plowing are believed to contribute to greenhouse gases production. To investigate the mechanisms involved in regulation of N_2O and CO_2 emissions from different corn-cropping systems, a study was undertaken, on a sandy loam and a clay loam. From 1992 to 1994, four different rates of N (10, 60, 120, 180 kg N ha^{-1} yr^{-1}) were applied to continuous corn and alfalfa-corn-corn cropping systems. A fallow treatment without fertilizer N was used as a control. During the 1993 and 1994 growing seasons, soil cores were collected monthly to a 10 cm depth. In 1993 in both soils, the amount of CO_2 evolved was significantly ($p<0.001$) higher in continuous corn than in previous alfalfa plots. Presumably, the greater plant biomass returned to soil in corn than in alfalfa plots, in 1992, generated a larger ($p<0.01$) pool of water-soluble organic C in corn plots which stimulated microbial respiration in 1993. In both soils, N_2O emissions and denitrification rates increased ($p<0.001$) with the rate of N applied to corn. However, N_2O production from corn plots receiving 120 kg N ha^{-1} or less were generally similar or lower than those recorded in fallow plots, suggesting that corn N uptake reduced N availability for denitrification. Disturbing soil cores to make slurries markedly reduced differences among treatments while adding nitrates to slurries did not change denitrification rates. It is suggested that denitrification was mainly limited by nitrate diffusion rate from surrounding soil towards hot-spots.

Scaling-up N_2O Emission Fluxes from Landscape to Regional Scale. M.D. Corre*, D.J. Pennock, and C. van Kessel, Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 4L3.

Our understanding of agricultural and other intensively managed landscapes as contributors to global N_2O fluxes is especially weak. Hence there is a need for sufficiently detailed investigations to provide reliable information about the mechanisms underlying N_2O fluxes across landscapes. Understanding the ecological controls of N_2O emission at large scales could give insights of the basis controls which, in turn, are relevant both in improving the investigation approach and in developing management strategies to reduce emissions. Our study was conducted to obtain landscape- and regional-scale estimates of N_2O emission. In this paper, a conceptual tool of investigating N_2O emission at the landscape and regional scales was developed. The delineated region was stratified based on geomorphology and land use, within which representative soil landscape systems were selected. Landscape-scale analysis technique was used at the landscape level. The use of GIS data base (*i.e.*, soil type, texture, climatic data) and remote sensing technique (for land use classification using LANDSAT TM 345) in extrapolating N_2O flux estimates to regional scale will also be presented.

Nitrous oxide profiles and surface fluxes of four crop types during spring thaw. M.W. Kagan* and D.L. Burton, University of Manitoba, Winnipeg, Manitoba.

Significant amounts of the greenhouse gas N_2O is produced in the soil. Some studies have suggested that emission of this gas increase dramatically during spring thaw. This study examined surface flux and soil profile concentration of N_2O during spring thaw in four different cropping treatments on a clay soil. Treatments were chosen on the basis of different carbon inputs and rooting systems: wheat, alfalfa, perennial native grass, and summer fallow. A multi-level sampling probe was used to allow in situ monitoring of the soil atmosphere concentration profile, while chambers were employed to estimate surface flux. Despite the presence of NO_3^- (~10 µg N/g soil), and the apparent respiratory activity throughout the profile, atmosphere sampling indicated little accumulation of N_2O in the soil. Surface flux readings were low, with a mean value of 0.5 µg N_2O $m^{-2}s^{-1}$, consistent with measured profile concentrations. Increased N_2O concentration in the profile and in the surface measurements occurred as the soil profile thawed. Significant temporal differences in both surface and profile concentrations were noted. Cropping treatment differences were not significant, suggesting that carbon was not limiting. As N_2O is an intermediate in denitrification, it is possible that conditions were such that the process continued to the N_2 endpoint.

Manure-Derived Greenhouse Gases Emitted after Field Application of Dairy Cattle Manure. R. Lessard, P. Rochette*, e.G. Gregorich, E. Pattey and R.L. Desjardins, CLBRR, AAFC, Ottawa.

N_2O fluxes (F_N) at the surface of a maize soil (fine textured) amended with dairy cattle manure (stockpiled) were measured from April to October 1993, in Ottawa, using closed chambers. The manure application rates were 0 (M0), 50 (M50) and 100 (M100) Mg ha^{-1}; the later two treatments corresponding to 224 and 448 kg ha^{-1} of total N added, respectively. Nitrous oxide concentrations in the soil profile (S_N) were quantified by sampling soil air at depths of 0.05 and 0.15 m using stationary air probes. F_N were highly episodic during the growing season, ranging from 0 to 0.070 mg m^{-2} h^{-1} on MO, 0.004 to 0.171 mg m^{-2} h^{-1} on M50 and 0.002 to 0.494 mg m^{-2} h^{-1} on M100. The rates of change of NO_3 and NH_4 in soil are the environmental conditions suggested that the F_N peak after the application of manure was mostly produced by denitrification. This episode was followed by short-lived peaks of N_2O flux that usually followed periods of rain. Absence of a strong correlation between S_N and F_N suggests that high soil water content restricted gaseous diffusion in the soil and/or that a variable part of the N_2O produced via denitrification was reduced to N_2. On the manured fields, the accumulated N_2O-N emissions at the soil surface over the first growing season amounted to 0.74% of the mineralized N added. The quantities of manure-derived greenhouse gas emitted during the snow-free season were -0.068 kg CH_4 ha^{-1}, 1.16 kg N_2O ha^{-1} and 16,740 kg CO_2 ha^{-1} per 100 t of manure. Using these emission rates, it was estimated that the application of dairy cattle manure to agricultural land in Québec and Ontario produces an amount of greenhouse gases equivalent to 3.4 Mt CO_2 annually.

Relationships between soil moisture content and nitrogen sources on N_2O/CH_4 emissions in agricultural soil. G. Lévesque*[1], H. Antoun[1], D. Prévost[2] and L. M. Bordeleau[2]. [1]Université Laval, dép. des sols et [2]Agriculture et Agroalimentaire Canada, Sainte-Foy, QC.

Two types of soil (a sandy loam and a silt loam) under different moisture content were treated with agronomic doses of organic and mineral nitrogen fertilizers and they were incubated in opened top chambers. Treatments included: fresh bovine manure, composted bovine manure, garden compost, ammonium sulfate and untreated soil. Moisture content was varied from 75% to 125% of water holding capacity (WHC). For each soil type 5 days after treatment, the N_2O/CO_2 emissions increased significantly for all treated soils with increasing moisture content (decreased oxidoreduction), while no difference was observed for CH_4 emission. In all treatments, the silt loam soil was releasing more gases than the sandy loam. Organic treatments in all soils increased significantly emission of CO_2 compared to

untreated soil. The highest N_2O emission in all soil is observed when we used both fresh bovine manure and 125% of WHC.

Emission of N_2O and NO in Irrigated Spring Wheat in Northwestern Mexico: Comparison of Fertilizer Management Practices. J.I. Ortiz-Monasterio*, P.A. Matson and R. Naylor, International Maize and Wheat Improvement Center (CLMMYT), University of California - Berkeley, and Stanford University.

Fertilized agriculture is recognized as a major source of nitrous oxide emissions into the atmosphere, accounting for up to 3 Tg N per year. Global estimates of nitrous oxide flux are based on studies done in temperate environments of the developed world, yet more than half of global N fertilizer use occurs in developing countries. To study nitrogen use efficiency in a developing world environment, fluxes of nitrogen trace gasses from fertilized and irrigated wheat systems were measured in Sonora, Mexico. Following conventional fertilizer practices, approximately 188 kg N/ha are applied as urea or anhydrous ammonia followed by furrow irrigation nearly one month prior to planting. This results in very high emissions of dinitrogen (N_2), nitrous oxide (N_2O) and nitric oxide (NO). Immediately after irrigation, N_2 losses predominate, followed 10 days later by a peak in N_2O (maximum mean flux of 290 ng/cm^2/h). Nitric oxide fluxes become dominant as soils dry and water-filled pore space is reduced. Fluxes peaked at 320 ng/cm^2/h, 17 days after fertilization and remained high for several weeks. Studies comparing conventional fertilization practices with a number of experimental practices suggest that fertilizer losses can be reduced and yields maintained by applying 1/3 of the N fertilizer rate at planting and 2/3 45 days post planting. Yield differences among these practices will be presented as well as N fertilizer use and importance in the area.

Carbon storage in forest ecosystems of the RESEF (Réseau d'Étude et de Surveillance des Écosystèmes Forestiers) Quebec long-term monitoring stations. Rock Ouimet[1], Sylvain Saint-Laurent[2], Claude Camiré[2] and Gilles Gagnon[1], [1]Ministère des Ressources naturelles et [2]Université Laval, Sainte-Foy, Quebec.

The objectives of the network for the observation of forest ecosystems RESEF are to 1) provide basic information essential to any comparative analysis, 2) follow long-term dynamics of ecosystems, 3) assess climatic changes and their importance on forest ecosystem evolution, and 4) analyse existing relationships between ecological criteria and factors of natural stresses or of anthropogenic origin. The network of 31 climax forest stands covers the main forest ecosystems in Quebec. The study focuses on atmospheric depositions and gazes, forest stand growth and productivity, and element pools in the ecosystem. Forest biomass is evaluated on 0.5 ha for deciduous stands and on 0.25 ha for coniferous stands. Growth is measured on an annual basis. Four to six soil pits are excavated every five years and sampled to assess bulk density and physico-chemical properties. The sampling design permits a statistical data evaluation. Estimates of total carbon pools in the deciduous ecosystems show larger values than in the coniferous ones (228 ± 11 (± SE) and 191 ± 10 T.ha^{-1}, respectively). In the deciduous sites, carbon is mainly stored in the aboveground biomass (111 ± 8 T.ha^{-1}) and in the mineral soil (88 ± 8 T.ha^{-1}). In the coniferous sites, carbon pools (aboveground biomass, forest floor, and mineral soil) are of similar size (57 to 69 ± 7 T.ha^{-1}). On average, the forest floor reservoir of organic C in the coniferous sites is larger than the one in the deciduous stands (57 ± 7 vs 30 ± 3 T.ha^{-1}, respectively), reflecting a different rate of the carbon cycling in these contrasting forest ecosystems.

Soil Surface CO_2 fluxes under Contrasting Tillage Practices. P. Rochette*[1], M.-C. Fortin[2] and E. Pattey[1], AAFC, Ottawa[1] and Vancouver[2].

Conversion to alternative tillage systems increases carbon content of agricultural soils by reducing soil erosion and oxidation rate of organic matter. Conversion may also have an impact on emissions of CO_2.. This study was conducted to 1) determine if CO_2 emissions are reduced in the first years after a conversion to no-tillage relative to conventional tillage, 2) evaluate whether the differences in soils CO_2 emissions between tillage treatments can be related to soil temperature differences, and 3) determine if soil CO_2 emission measurements can provide early estimates of the impacts of soil management practices on soil organic carbon. In 1992 and 1993, soil CO_2 fluxes, soil temperature and water content, and phytomass were measured on conventional and no-tillage plots planted to small-grain cereals in Ottawa, Ontario, on a Dalhousie silt loam. The average CO_2 fluxes for an entire growing season varied from 0.10 mg CO_2 m-2 s-1 in no-tillage in 1992 to 0.15 mg CO_2 m-2 s-1 in both tillage treatments in 1993. Differences in soil CO_2 fluxes between tillage treatments were related to differences in soil temperature ($r^2 = 0.67$). This relationship was used to estimate yearly differences in organic carbon under conventional tillage relative to no-tillage. This value (0.068 kg C m-2 y-1) was in the same range as an independent estimate based on the analysis of the long-term tillage experimental data. Therefore, soil CO_2 flux measurements may provide early estimates of soil management practices impacts on soil organic carbon.

Carbon dioxide efflux from the floor of an aspen forest. C. Russell, Land Resource Science, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

Concern that global warming may be accelerated through the increased release of CO_2 from the boreal biome has highlighted the need for reliable estimates of C dynamics within these ecosystems. In this study, day-time soil CO_2 efflux (soil Fc) from the floor of a mature Saskatchewan

aspen (*Populus Tremuloides*) forest was measured between April and September 1994. Measurements were made with a dynamic closed chamber via an infra red gas analyzer. Two locations were studied, the first intensively to provide a seasonal pattern of soil Fc, the second to evaluate the effect of landscape position on soil Fc. Soil CO_2 concentrations were also measured along with soil temperature and moisture (TDR). Over the course of the study soil Fc ranged from 0.027 to 0.411 mg m^{-2} s^{-1}. Soil Fc exhibited a distinct seasonal trend which responded strongly to soil temperature (Q_{10} + 4.0). A linear regression of 0.1 m soil temperature and the natural logarithm of soil Fc explained 89% of the variability. However, soil moisture and soil organic matter content did not influence soil Fc. No significant differences in soil Fc were observed over a typical slope where soil temperatures and soil moisture differed noticeably. Estimates of annual soil Fc from this ecosystem were made from the empirical relationship with soil temperature.

Rate of Change of Carbon Content in Agricultural Soils in Canada for the Year 1990. W. Smith[1], P. Rochette[1*], C. Monreal[1], A. Jacques[2], R.L. Desjardins[1] and E. Pattey[1], Ottawa; Environ. Canada[2], Hull.

The Century model (a site specific computer simulation of the dynamics of soil organic matter) was used to estimate the rate of change of carbon in Canadian soil for the year 1990. Soil, climate, crop coverage, tillage, and crop rotation data were obtained for 1229 soil landscape of Canada polygons. For Century runs, sampling of the polygons was carried out at a rate of 15%. The analysis was stratified into major soil zones (Brown Chernozem, Dark Brown Chernozem, Black Chernozem, *etc*.), and into soil textural classes. For each sampled polygon Century was run for 1 to 5 types of crop rotations under conventional tillage. It was also run for no-till practices for periods when no-tillage represented 5% or more of the agricultural area within a polygon. Results from polygons within each soil zone were aggregated by country, province, soil region, and soil texture. From the Century simulations, it was estimated that the overall Canadian rate of carbon loss from agricultural soils for the year 1990 was 39.8 kg ha^{-1} y^{-1}. This implies that 1.97 Mt of carbon or 7.22 Mt of CO_2 was lost from Canadian soils. The loss represents 69% of the annual amount of CO_2 released by the burning of fossil fuel used on farms in Canada. The total carbon loss in the Prairies comprised 93% of the carbon loss in Canada. Alberta and Manitoba had the highest rate of carbon loss in 1990 at 74.5 and 66.1 kg ha^{-1} y^{-1}, respectively. In the Eastern provinces (Atlantic, Quebec, and Ontario) the average provincial rate of carbon loss never exceeded 35 kg ha^{-1} y^{-1}. Higher carbon loss rates were typically found in soil regions with greater native carbon contents. Estimated loss for sampled polygons in the two soil regions with the highest native carbon content, the Brown Chernozemic and Dark Gray Chernozemic/Dark Gray Luvisolic regions, were 84.1 and 59.6 kg ha^{-1} y^{-1}, respectively, more than double of any other soil region. More loss was also found in soils with coarser texture. Carbon loss in fine, medium, and coarse textured soil was estimated to be 14.3, 51.8, and 81.4 kg ha^{-1} y^{-1}, respectively.

Urea granule size: a factor in N_2O production in soil? M. Tenuta[*] and E. Beauchamp. Land Resource Science, University of Guelph, Ontario, N1G 2W1.

Previous studies in our laboratory showed higher N_2O production in soil with urea addition than other fertilizers. A laboratory study was conducted to determine if N_2O production was dependent upon the size of urea granules. Urea (equivalent to 150 kg N ha^{-1}) was added to a silt loam soil as a powder, commercial prills (1-3mm diam.), small urea supergranule (pellet: 6.6mm diam. by 2.8mm) and a large urea supergranule (pellet: 9.6mm diam. by 8mm). The percent of urea-N evolved as N_2O increased with granule size from powder (0.18), prills (0.21), small urea supergranule (0.25) to large urea supergranule (0.65). Similarly, the period from urea addition to half the total N_2O produced increased from powder (1.8d), prills (3.8d), small urea supergranule (5.0d) to large urea supergranule (9.5d). The rate of N_2O production during the incubation was dependent upon the NH_+^+ content of soil with the powder, prills and small urea supergranule treatments. The rate of N_2O production with the large urea supergranule was dependent upon NH_+^+ concentration up to the time of peak production and thereafter on NO_2^- concentration. Further studies are required to determine the relationship between N_2O and NO_2^-. Nitrous oxide production from urea appears to be dependent upon granule size with implications to the contribution of agricultural systems to global N_2O production.

Numerical Simulation of Gas Diffusion in Soil - an Ancillary Procedure to Direct Measurement of N_2O emissions. R. Well[*] and D.D. Myrold, Oregon State Univ.

Common methods for measuring soil denitrification and N_2O emission *in situ* include monitoring the accumulation of N_2O or ^{15}N-labelled N_2 in soil surface covers. Gas diffusion is considered to be the main accumulation process. Because accumulation of the gases decreases concentration gradients between soil and cover with time, gas production rates are underestimated if calculated from cover concentrations. A numerical model for simulating gas diffusion in soil was used in order to determine the significance of this source of error. A field experiment for measuring denitrification with the ^{15}N gas emission and acetylene inhibition methods was conducted. The ability of the model to predict the time pattern of gas accumulation was evaluated by comparing measured $^{15}N_2$ and N_2O concentrations to simulated values.

Factors Affecting Leachate and Gas Emissions at the Vancouver Landfill Site at Burns Bog. K. Wreford. Soil Science, University of British Columbia, Vancouver, BC, V6T 1Z4.

Landfill gas represents either a potential energy source when recovered and modified, or a significant contributor to the build-up of greenhouse gases in the troposphere when released. An analysis of short-term and long-term variation in landfill gas production and composition in response to fluctuations in temperature, barometric pressure and precipitation was undertaken at the Burns Bog Site located in Delta, B.C.. Gas composition (TCH_4, $\%CO_2$, $\%O_2$, $\%C_2H_4$) and production measurements were undertaken at individual wells spanning the entire active gas producing area of the site, in addition to measurements from the header lines. Leachate samples were obtained from the pumping station of the collection ditch, and analyzed for the parameters of interest (COD, VFA, TOC, pH, NH_4^+-N). Preliminary results indicate that precipitation is the predominant factor affecting gas composition, with high CH_4 and relatively low CO_2 production following periods of heavy rainfall. This is most likely due to increased methanogenesis under the enhanced anaerobic conditions, in addition to the dissolution of CO_2 and release in the leachate. The relative production of the key parameters of the gas and leachate were analyzed in order to determine possible effects of the measured climatic factors on this balance. Spatial and temporal trends in the production and composition of the landfill gas are highlighted in order to augment present understanding of the decomposition process of the refuse following burial, and the management practices which may lead to its optimization.

Dynamique des éléments dans les Écosystèmes terrestres - Communications orales

Réponse du maïs au phosphore dans un rejet minier sulfuré. A. Aajjane*, R. Guay, L.É. Parent et A. Karam, É.R.S.A.M., Département des sols, F.S.A.A., Université Laval, Sainte-Foy, QC.

Les parcs à résidus miniers acides constituent un problème environnemental majeur au Québec. La présence de métaux lourds et la forte acidité de ces résidus influencent la nutrition phosphatée des plantes lors de leur mis en végétation.

L'objectif de cette étude est d'évaluer l'effet des doses et des sources de P sur la croissance du maïs cultivé en serre sur un rejet minier acide. Différentes sources (organiques et minérale) et doses de phosphore (0, 22,4, 44,8 et 89,6 mg kg-1) ont été utilisées. Le pH des milieux de croissance a été ajusté à 5, 6 et 7. Les résultats ont montré que la source et la dose du phosphore ainsi que le pH ont un effet très significatif sur le rendement en matière sèche du maïs. De même, le phosphore de l'engrais minéral (KH_2PO_4) était plus facilement utilisé par la plante quoique le phosphore organique a également donné de bons résultats. Dans tous les traitements, le rendement maximum fut obtenu à pH 6 à la dose 44,8 mg P kg-1. Bien que le contenu en métaux lourds soit plus élevé dans les résidus miniers que dans les sols agricoles, l'analyse élémentaire des tissus végétaux montre que le contenu en métaux dans la partie aérienne du maïs est comparable à celui généralement trouvé chez la même plante cultivée sur des sols agricoles.

Soil quality and ecosystem health. D.W. Anderson* and M.M. Boehm, Soil Science Department, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 5A8.

Soil quality, as a mainly qualitative measure of the soils capability to produce crops in agricultural systems or trees in forestry is not a new concept. Recent advances have been to make soil quality parameters more quantitative, to identify key soil attributes or indicators, and to monitor the dynamics of the attributes in order to assess positive or negative change. An added role for soil, to function within ecosystems, implies linkages between ecosystem health and soil quality. Those linkages will be discussed, from the perspective of considering soils at different integrative or hierarchical levels of increasing complexity and scale of processes and the concept of soils as self-organizing systems, an integral and functional part of self-organizing ecosystems. For example, at the point or pedon level, a key function of soil is to receive, store and recycle nutrients, water and energy to produce plant biomass; at the landscape level, dimensions of reducing losses of nutrients or biotoxic elements are added; whereas, at global scale the role of the pedosphere in global climate, carbon or nutrient cycles must be considered.

Cinétique de l'incorporation de la matière organique dans les agrégats de sol au cours de la décomposition de paille de blé marquée $^{13}C^{15}N$. D.A. Angers, S. Recous et C. Aita. Agriculture et Agroalimentaire Canada, Ste-Foy, QC, INRA, Laon, France et UFSM, Brésil.

Au cours de leur décomposition dans le sol, les résidus végétaux sont en contact étroit avec la phase minérale. L'objectif de cette étude était de déterminer la cinétique

d'incorporation de la matière organique néo-formée dans les agrégats du sol stables à l'eau. Dans une expérience au champ, la paille de blé doublement marquée ($^{13}C^{15}N$) a été incorporée uniformément à un sol de texture limoneuse (Luvisol). Des échantillons de sol, prélevés de façon périodique pendant 18 mois, ont été séparés en fractions d'agrégats stables à l'eau (<50, 50-250, 250-1000 et 1000-4000 μm) sur lesquelles les teneurs en C, ^{13}C, N et ^{15}N ont été déterminées. Le taux d'incorporation de la matière organique marquée dans les agrégats est important et rapide. Après 200 jours, environ 30 % du C 35 50 % du N apportés se retrouvent dans les agrégats stables >50 μm. Par la suite, la fraction de matière organique marquée associée aux agrégats >250 μm décroît alors que celle présente dans les agrégats de 50-250 μm continue d'augmenter de sorte qu'après 400 jours, plus de 50 % de la matière organique néo-formée se retrouve dans cette fraction. Cette étude illustre bien l'aspect dynamique de l'incorporation de la matière organique jeune dans les agrégats et suggère, que pour ce sol, la fraction stable de 50-250 μm est particulièrement importante dans le processus de stabilisation physique de la matière organique néo-formée.

Détermination des paramètres du cycle de l'azote par données de terrain et modélisation mathématique (AgriFlux). O. Banton et M. Larocque. INRS-Eau. U. du Québec. Ste-Foy, Qué.
Identification of representative parameter values is an important aspect of nitrate leaching modelling, because many parameters are unavailable and difficult to evaluate. Reversed modelling was performed using a conceptual simulation model together with nitrate concentrations from a field near Quebec City in order to identify an optimal parameter set. A sensitivity analysis of the model to the unavailable N cycle parameters identified three parameters related to the organic N transformations which greatly control the entire soil N dynamics. The available parameters and those of lesser influence were kept constant while all the combinations of the three influential parameters were used to simulate the agricultural field. The lowest RMSE identified the optimal parameter set and isocontouring confirmed its uniqueness. For the site studied, low values of the constant of mineralization of the humus pool, combined with low values for the efficiency of the microbial biomass and small transfers from the litter pool to the humus pool generated the nitrate concentrations offering the best representation of measured values. However, the goodness of fit between simulated and measured concentrations seemed to be limited by other non-optimized parameters or by some processes not differentiated in the model.

Évaluation de la contamination des eaux souterraines par les nitrates par le modèle AgriFlux : application au Québec et en France. O. Banton, M. Larocque, M. Cormier, A. Dupuy et M. Razack, INRS-Eau, U. du Québec, Ste-Foy, Qué. et U. de Poitiers, France.
Dans la zone non saturée des sols agricoles, de nombreux processus biochimiques et hydrodynamiques ont lieu conditionnant la quantité et le transfert des nitrates (NO_3^-) qui s'infiltrent jusqu'à la nappe. Sont présentés ici l'intérêt la pertinence de la modélisation en zone non saturée dans l'étude hydrogéologique de la contamination des eaux souterraines en milieu agricole. Le modèle AgriFlux utilisé est un modèle mécaniste-stochastique qui simule les flux d'eau, les transformations de l'azote et le transfert des NO_3^- dans la zone non saturée du sol. Dans un premier temps, l'intérêt d'un tel modèle est démontré par une simulation de l'évolution temporelle des concentrations dans l'eau interstitielle de la zone racinaire d'un sol agricole. Par la suite, le modèle est utilisé pour évaluer le niveau des concentrations de NO_3^- dans l'aquifère sur plusieurs sites agricoles d'une même région du Québec et sur un ensemble de puits d'observation d'un petit bassin versant du Poitou (France). Ces applications montrent la pertinence du modèle pour la simulation du transfert des NO_3^- dans la zone infra-racinaire et montrent comment le modèle peut simuler de façon très réaliste les entrées en NO_3^- dans le système aquifère. Dans certaines conditions, la modélisation des risques de contamination nécessiterait toutefois le couplage entre un modèle tel qu'AgriFlux et un modèle hydrodynamique en zone saturée. La réalisation d'un tel couplage pourrait se faire à différent niveaux de complexité et permettrait une grande flexibilité d'application de l'outil résultant et une évaluation fiable des risques de contamination des ressources.

High-Ni Sewage Sludge for barley. G.M. Barnett*, D. Massicotte and S.P. Guertin, Agriculture and Agri-Food Canada, Lennoxville; Envirosol, Drummondville; MAPAQ, St-Hyacinthe.
Sewage sludge should be recycled to the soil-plant system, if at all possible. This study was conducted to evaluate the possibility of applying high-Ni sewage sludge to barley. A Greensboro loam (pH 5.0) was limed to pH 7.3 and 7.7 with 8 and 16 t ha^{-1} of $CaCO_3$ Sludge rates of 0, 1,5, 3.0, 4.5, and 5.0 t ha^{-1} (dry) and mineral fertilizer rates were applied to provide a total nutrient application rate in kg ha^{-1} of 106 N, 201 P_2O_5, and 75 K_2O. Sludge therefore supplied 0, 25, 50 75 and 100% respectively of the total fertilization. Total plant yield and root mass increased linearly with sludge rate. Sludge rate linearly improved leaf yield at 0 and 8 t ha^{-1} of lime but not at 16. Increased sludge rate reduced soil pH and soil P at 8 and 16 t ha^{-1} with no effect on soil P in unlimed soil. Available soil-Ni increased linearly with sludge rate in unlimed soil but there was no effect when limed. There were no sludge effects on plant-Ni concentration. Thus, 373 ppm Ni sludge on a dry matter basis did not negatively affect plant growth but P may not be as available as predicted.

Spatial variability of soil enzyme activities and related properties. D.W. Bergstrom*, C.M. Monreal, J.A. Millette, D.J. King, C. Young and E.G. Gregorich, Agriculture and Agri-Food Canada, Ottawa and Guelph, ON.

We studied the spatial variability of biochemical properties of a Gray Brown Luvisol by testing for an effect of slope position, and by measuring spatial dependence using geostatistical methods. Samples were collected on three dates from a no-till and a conventionally tilled field and the intervening woods at a site in central Ontario. The two fields were cropped to soybeans (*Glycine max* L.), and had different cropping histories. Dehydrogenase, urease, glutaminase, alkaline phosphatase, arylsulfatase and β-glucosidase activities were measured. The conventionally tilled field was sampled once in the fall to measure the spatial dependence of the six enzyme activities, as well as water, organic C and ergosterol contents, and the light fraction of soil organic matter. In general, enzyme activities were greater at the foot-slope position, relative to the mid-slope; and in the no-till field and the woods, relative to the conventionally tilled field. Greater enzyme activity in the no-till field can be attributed, in part, to previous cropping with forages. Geostatistical analysis indicated that soil properties differed in spatial dependence. Water and organic C contents, and phosphatase and arylsulfatase activities were strongly spatially dependent, and had similar ranges (110-120 m). The light fraction, ergosterol content, and glutaminase and β-glucosidase activities showed little spatial dependence.

Distribution spatiale du risque d'érosion dans un petit bassin versant du nord de la France, à l'aide du Cs-137. C. Bernard*, S. Wicherek, M.R. Laverdière, MAPAQ, CNRS/ENS (France), Univ. Laval.

Diverses modifications apportées au paysage rural du nord de la France depuis les années 1970, sous l'impulsion des politiques agricoles de la France et de la CEE, se sont traduites par une augmentation importante du processus érosif. L'agrandissement des parcelles et la généralisation des monocultures ont laissé les sols limoneux et faiblement structurés de cette région en position de grande vulnérabilité, malgré des conditions climatiques généralement peu agressives. Si bien que des taux d'érosion de l'ordre de 30 Mg ha^{-1} an^{-1} ne sont plus exceptionnels. Le Cs-137 a été utilisé pour estimer l'importance de l'érosion à l'échelle d'un petit bassin d'une superficie de 180 ha, situé près de Vierzy, à quelque 80 km au nord-est de Paris. Les teneurs du sol en Cs-137 suggèrent que les retombées de Chernobyl ont été faibles dans la région étudiée. De plus, il s'est avéré que les variations spatiales de l'activité du sol en Cs-137 réflétaient bien celles de la topographie. Nos mesures ont permis d'estimer des mouvements nets de sol, variant d'un gain de 5 Mg ha^{-1} an^{-1} à une perte de 33 Mg ha^{-1} an^{-1}. Pour l'ensemble du bassin, la perte nette de sol a été estimée à 12 Mg ha^{-1} an^{-1}. Des mesures effectuées depuis deux ans à l'exutoire du bassin par le Centre de Biogéographie-Écologie de l'ENS de Fontenay-Saint-Cloud, indiquent des pertes nettes de sol inférieures à celles estimées à l'aide du Cs-137. Les observations effectuées par l'ENS confirment cependant une des conclusions des mesures de Cs-137: la redéposition à l'intérieur des limites du bassin de Vierzy est importante et l'exportation nette de sol à l'exutoire du bassin ne révèle qu'une fraction des mouvements de sol.

Minéralogie des gleysols argileux dans la plaine de Montréal. M. Blackburn, Université Laval, Sainte-Foy, QC.

Six séries de sol développées sur 3 facies argileux des sédiments de la mer Champlain ont été étudiées. Des échantillons provenant de tous les horizons de surface ainsi que d'autres prélevés en profondeur à tous les 10 cm jusqu'à 4 m, ont été analysés. Les sables et les limons grossiers ont été examinés au binoculaire. Par la suite, on a étudié par diffraction-X, les limons sous forme de poudre et les argiles sur lames orientées. L'analyse des fractions argileuse (<0.2 um et 0.2-2 um) comportait 6 balayages plus des traitements à l'hydrazine et au HCl, ainsi qu'une évaluation semi-quantitative basée sur la surface des pics. La minéralogie des sables et des limons varie peu alors que celle des fractions argileuses caractérise les facies. La chlorite se retrouve surtout dans les sédiments d'origine des sols Ste-Rosalie et St-Urbain, la vermiculite dans ceux des sols St-Hyacinthe et Kierkoski alors que l'illite abonde dans ceux des sols Providence et Des Chenaux. Par contre, la vermiculite domine en surface dans tous les facies. Enfin, l'argile fine (<0.2 um) qui représente environ la moitié du contenu en argile total se distingue par la présence d'interstratifiés 10 1 - 14 Sm, par l'abondance de vermiculite et par l'absence de kaolinite.

Soil quality differences among three Prairie farming systems. M.M. Boehm* and D.W. Anderson, Soil Science Department, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 5A8.

Soils is vital to agricultural production, but non renewable in human time scales. Maintenance of soil quality and sustainability of agroecosystems are strongly linked. In sustainable agroecosystems, soils must be managed so that they remain resilient to environmental forces or farming practice stresses. Although farmers recognize this, low commodity prices and the need for high yields often require that they operate to ensure short-term economic survival sometimes at the cost of stewardship concerns and the maintenance of soil quality. Goals of the study were to measure the effects of farming practices on soil quality, in order to identify innovative farming systems that enhance or maintain soil quality relative to conventional farm practices, and soil properties that can be used to indicate differences in soil quality that result from changes in farm practice. Twenty

fields located west of Saskatoon, on loamy to sandy-textured Dark Brown soils, were studied. They represented three rotations that are used in the area: a two year crop-fallow rotation; longer rotations of five crops-fallow; and, 10 to 15 years of continuous cropping with no fallow. The continuous crop soils had more organic C, a lower bulk density, higher infiltration, more water stable aggregates, more available N and P, a higher nitrifying potential, more microbial biomass, and more mineralizable C than the crop-fallow soils. The differences, mainly attributable to larger additions of crop residues and nutrients to the continuous crop soils, have improved their function with regard to nutrient cycling, resistance to erosion, carbon sequestration and water storage.

Proton Binding and Cd Complexation Constants for a Soil Humic Acid using a Quasi-particle Model. Kim A. Bolton[*1] and Leslie J. Evans[2], [1]Division of Physical Sciences, Scarborough Campus, 1265 Military Trail, University of Toronto, ON, [2]Land Resource Science, University of Guelph, ON.

In order to better understand the fate of Cd in the environment, it is important to assess the role of humic substances on the retention of Cd in soils. In this study the acid-base and Cd complexation properties of a humic acid fraction extracted from a soil were investigated using potentiometric titrations. A number of electrostatic and non-electrostatic equilibrium models were considered in order to obtain the simplest model that would best describe the titration data. All proton binding and Cd complexation constants were determined using the optimization procedure in the computer program FITEQL. The model which best fit the experimental data was a non-electrostatic model, which included two diprotic acids, H_2A and H_2B. The dissociation constants for H_2A were calculated to be $\log \beta_{-1,0,1,0} = -4.00 \pm 0.02$ and $\log \beta_{-2,0,1,0} = -9.31 \pm 0.03$ and for H_2B were calculated to be $\log \beta_{-1,0,0,1} = -7.43 \pm 0.24$ and $\log \beta_{-2,0,0,1} = -16.66 \pm 0.31$. The model indicated the presence of four Cd complexes, $CdHA^+$, CdA^o, CdB^o and $CdOHB^-$ with complexation constants calculated to be $\log \beta_{-1,1,1,0} = -1.31 \pm 0.10$, $\log \beta_{-2,1,1,0} = -5.88 \pm 0.06$, $\log \beta_{-2,1,0,1} = -12.15 \pm 0.17$ and $\log \beta_{-3,1,0,1} = -21.10 \pm 0.16$.

Interactions between tree species and humus forms with respect to soil C and N dynamics. R. Bradley[*] and J. Fyles, Macdonald Campus of McGill University, Ste-Anne de Bellevue, Québec.

Broad distinctions can be made about the physico-chemical nature of the organic substrates available to nutrient-mineralizing soil microbial communities in a mineral ***mull*** soil compared to those in an organic ***mor*** layer. The collective evidence supports the hypothesis that nutrient dynamics are more elastic with respect to root-released C in energy-limited mull SOM than they are in mor SOM. Eight species of seedlings were grown on mull and mor humus and soil respiration rate, available-C, microbial biomass, extractable and mineralizable-N and seedling N uptake were measured after 14 and 22 weeks of growth. A bioassay was performed on the harvested soils using the acid tolerant grass *Agrostis* sp. Significant ***soil*** X ***species*** interactions were found in all soil available-C and available-N indices. The root-related CO_2 evolving only from the mull soil significantly increased total soil respiration. Similarly, significant species effects on soil available-C indices and microbial biomass were observed on the mull soil only. All species significantly reduced the mineral-N pool on both soils. Soil-N mineralization rates were significantly increased by the presence of seedlings on the mull soil but were significantly decreased on the mor soil. Only in the mull soil were significant positive correlations found between soil respiration and indices of soil-N availability. Species effects on *Agrostis* N uptake during the bioassay are less clear and must be interpreted in terms of the microbial biomass in conjunction with the size of the soil the mineral-N pool. The results are discussed in terms of two different processes controlling N availability in the two humus forms.

Assessment of Two Chemical Extraction Methods as Indices of Available N. C.A. Campbell, Y.W. Jame, A. Jalil and J. Shoenau

A test to estimate the amount of N a soil will mineralize during a growing season is needed so as to improve fertilizer use efficiency. Soil samples taken from the top 15 cm of 43 soils representing all agroecological regions in Saskatchewan, were used to determine if the potentially mineralizable N (N_O), measured in a 24-wk nerobic incubation at 35°C, could be related to NH_4-N extracted by: (i) 2M KCl heated at 100°C for 4 hr, or (ii) a steam distilled phosphate-borate solution buffered at pH 11.2. The NH_4-N extracted with 2M KCl was more closely associated with N mineralized in 24 wk ($r^2 = 0.79^{***}$) than was NH_4-N extracted with the phosphate-borate extractant ($r^2 = 0.70^{***}$). When NH_4-N extracted with cold 2M XCl was subtracted from the NH_4-N extracted with hot extractants (method recommended by Gianello and Bremner) the relationships to N_{min} were weaker ($r^2 \leq 0.50$). There was a close association between N_O and the hot 2M KCl extracted NH_4-N ($r^2 = 0.78^{***}$); the relationship to the buffer NH_4-N was slightly less precise ($r^2 = 0.73^{***}$). The rate coefficient (k), in the first order kinetic equation used to describe rate of N mineralization, was generally constant, averaging 0.067 wk^{-1} (std. dev. of 0.018). We discuss how it may be possible to integrate information obtained from the KCl - NH_4-N, and the k value at 35° C in a crop growth model and, using soil characteristics and long-term weather data, estimate probable N mineralization during a growing season, for fallow-wheat and continuous wheat systems, over a 22-yr period at Swift Current.

Pression interne dans les agrégats suite à l'immersion. Caron*, J., E. Reid et L.Trépanier. Département des Sols, Université Laval

La stabilité structurale est importante pour préserver la qualité physique des sols et de l'environnement agricole. L'élaboration de pratiques culturales visant à maintenir cette qualité passe par une compréhension des mécanismes de stabilisation structurale. Suite au contact de l'eau de pluie, les agrégats ont tendance à éclater. Les agrégats de sols vierges éclatent beaucoup moins que les agrégats de sols sous culture intensive. Cette réduction de l'éclatement a été attribuée à une cohésion plus grande des agrégats dont la teneur en matière organique est plus élevée, à une réduction du gonflement lors de l'humectation, ou à une réduction du rythme d'entrée de l'eau à l'intérieur de l'agrégat, résultant en des pressions internes moins importantes dans les agrégats de sols vierges. Cette étude compare les rythmes d'évolution de pression interne suite à l'immersion, à l'intérieur d'agrégats d'un luvisol brésilien vierge ou en culture continue. Les agrégats du sol vierge enregistrent des pressions internes maximales moins élevée que ceux provenant d'un sol sous culture. L'analyse des spectres de variation de pression interne indique des pertes de pression suite à l'évacuation d'air dans les agrégats du sol vierge. La stabilité structurale était négativement corrélée à la pression maximale interne enregistrée. Il semble donc que l'atteinte de pressions internes plus faibles dans les agrégats du sol vierge leur permet de maintenir leur intégrité structurale et que l'échappement d'une partie de l'air interne comprimé par l'entrée rapide de l'eau agisse comme mécanisme régulateur de réduction des pressions maximales atteintes.

Characterizing the condition of a Tignish loam after long term moldboard and chisel plowing. M.R. Carter, AAFC, Research Centre, Charlottetown, PE, Canada C1A 7M8

A tillage study was conducted in Prince Edward Island with 2-yr rotations of spring cereals and soybean (*Glycine max* L. Merr.) over 9-yr period on a Tignish loam, a well drained Podzolic Gray Luvisol. Fall moldboard plowing and chisel plowing, both conducted to the 25-cm soil depth, were evaluated for their effects on soil physical and biological properties. All secondary tillage (10-cm) was conducted in the spring using a rotary harrow. Plant productivity tended to be similar between tillage systems. Differences in primary tillage over the 9-yr period influenced both soil structural form and permeability, and the redistribution of soil organic matter over the depth of tillage. Soil bulk density profiles indicated a significantly (p = 0.065) greater soil density at the 22.5- to 25.0-cm soil depth under moldboard, compared to chisel plowing, suggesting the presence of a plow pan. Excessive soil compaction in both tillage treatments was observed below the zone of tillage. Tension infiltration measured at the 15-cm soil depth did not reveal differences in soil macro-structure, between tillage treatments. Saturated infiltration, which was slightly but significantly (p = 0.096) greater for the chisel plowing, was relatively high for both treatments. Microbial biomass C, expressed both on a concentration and volume basis, was significantly (p = 0.017) greater at the 0- to 10-cm soil depth under chisel plowing, compared to moldboard plowing. Increased levels of microbial biomass C were associated with an improved soil structural stability at the soil surface. Differences in organic C or total N were not evident between tillage treatments.

Glucosamine and muramic acid used as indicators of the impact of fungi and bacteria on soil aggregate stability. Martin H. Chantigny*[1], Denis A. Angers[2], Danielle Prévost[2], Louis-P. Vézina[2], et François-P. Chalifour[1], [1]Université Laval, Ste-Foy, Qc; [2]Agriculture et Agroalimentaire Canada, Ste-Foy, Qc.

Bacteria and fungi produce an external layer of polysaccharides which is able to bind soil particles into aggregates. However, the measurement of these polysaccharides does not allow to discriminate the respective contribution of fungi and bacteria in soil aggregation and stabilization. To investigate a possible differential contribution of fungi versus bacteria in the process of macroaggregate formation and stabilization, fungal glucosamine, bacterial muramic acid, acid-hydrolysable carbohydrates (AHC) and soil macroaggregation were determined on a silty clay loam and a clay loam cropped with six different species. After three years of cropping, mean-weight diameter of water-stable macroaggregates (MWD) was higher under reed canarygrass (2.45 mm for the silty clay loam and 2.26 mm for the clay loam) and timothy (2.26 and 2.13 mm) than under wheat (1.57 and 2.06 mm) or faba bean (1.92 and 1.89 mm). A closer relationship was found between MWD and the amount of fungal glucosamine (R^2=0.74*** for the silty clay loam and 0.69*** for the clay loam) than between MWD and muramic acid (R^2=0.55*** and 0.44**) or AHC (R^2=0.42** and 0.05). The data suggests that [i] changes in water-stability of soil macroaggregates among cropping systems were primarily of microbial origin, and that [ii] fungi played a more important role than bacteria in macroaggregate formation and stabilization. The approach used here may provide a simple and reliable way to investigate separately the role of fungi and bacteria in soil aggregation.

Comparative efficiency of Mn and K on crop resistance to cold. B.T. Cheng, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation, Service des sols, 2700 rue Einstein, Complexe scientifique, Ste-Foy (Québec) Canada, G1P 3W8.

Under an artificially controlled environment growing chamber, the yield of cauliflower, subjected to low temperature treatment, was much improved by K and Mn addition. The treatment increased Mn content in the plant

and has a tendency to cause migration of Mo from the shoot to root, potentially improving protoplasmatic viscosity of the root and thus raise freezing resistance. In the field plot trial, a better growth index of cherry tree was attained by using 5 gm Mn and 50 gm K per tree treatment. Interaction of Mn, K and temperature on the nutrient parameter of shoot and root part of plant and the corresponding soil sample is discussed.

Le compostage des résidus de désencrage : évolution des propriétés physico-chimiques et microbiennes. Marie-Hélène Charest* et Chantal J. Beauchamp, Département de phytologie, Centre de recherche en horticulture, Université Laval, Sainte-Foy, QC.
Au Québec, de plus en plus de résidus papetiers sont générés suite à l'implantation d'usines de désencrages. L'option du compostage des résidus de désencrage se présente comme une avenue intéressante afin de disposer de façon sécuritaire de ces résidus. Toutefois, deux facteurs limitent l'utilisation des résidus de désencrage dans un système en compostage : sa faible teneur en azote et ses composés lignocellulosiques difficilement biodégradables. Trois tas à base de résidus de désencrage ont été formés. Des fertilisants azotés ont été ajoutés afin d'atteindre des concentrations finales d'azote d'environ 0.6 %, 0.7 % et 1.0 %. La durée de l'expérience a été de 6 mois et l'échantillonnage a eu lieu à tous les 28 jours. Le but de cette recherche consistait à isoler des microorganismes capables de dégrader les résidus de désencrage. Les objectifs spécifiques étaient les suivants : (1) suivre par dénombrement sur un milieu à base de résidus de désencrage l'évolution des populations totales de bactéries, de champignons et d'actinomycètes; (2) suivre l'évolution de paramètres physico-chimiques tels la température, le pourcentage de carbone et d'azote (3) évaluer la maturité du compost par colorimétrie. Les résultats seront discutés au cours de la présentation.

Sorption du cuivre et du zinc dans quelques sols organiques du Québec. Caroline Côté, A. Karam et L.É. Parent.
L'objectif de cette étude était de déterminer la capacité de sorption de 28 horizons de surface de sols organiques à l'égard du cuivre (Cu et du zinc (Zn). Les données de sorption du cuivre ont été obtenues en ajoutant à un gramme de sol une solution de $CaCl_2$ 0,01 M contenant différentes concentrations de cuivre et de zinc dans des tubes à centrifugation. Les tubes ont été laissés à l'équilibre pendant 48 heures avec agitations intermittentes. Après centrifugation et décantation, le cuivre ou le zinc dans la solution d'équilibre a été dosé au spectrophotomètre d'absorption atomique.
Les données de sorption du cuivre et du zinc ont été incorporées aux isothermes de Freundlich et de Langmuir. L'analyse des coefficients de corrélation simple a démontré que la capacité de sorption maximale des sols pour le cuivre est influencée par les paramètres suivants : pH (eau), pH ($CaCl_2$ 0,01 M), capacité d'échange cationique (CEC), somme des cations basiques échangeables et contenu en (hydr)oxydes de manganèse (dithionite, oxalate, pyrophosphate). Les paramètres de sorption du zinc étaient corrélés avec la somme des cations basiques échangeables, le contenu en matière organique et la valeur de la capacité d'échange cationique.

Comparaison des teneurs en N-$NH4^+$, N-$NO3^-$ et N total de tourbières naturelles et résiduelles. M. Croft*, L. Rochefort et C.J. Beauchamp, département de Phytologie, Université Laval, Ste-Foy, QC.
Les tourbières ombrotrophes, souvent appelées bogs, sont des milieux humides composés d'une accumulation de matière organique partiellement décomposée. L'alimentation exclusive par des eaux de précipitation rend cet écosystème pauvre en éléments minéraux. De plus, isolés des eaux souterraines, les bogs ont un pH de 4. L'exploitation des tourbières ombrotrophes pour la récolte de tourbe engendre des sites qui ne se régénèrent pas facilement. Plusieurs facteurs sont mis en cause tels que l'hydrologie, le micro-climat, la dispersion des diaspores et la microbiologie. Les microorganismes des tourbières sont impliqués dans l'apport et la transformation d'éléments nutritifs au milieu et dans l'assimilation de ces éléments aux végétaux. Le but principal du projet est de mieux comprendre les facteurs microbiens et physico-chimiques des substrats tourbeux naturels et résiduels afin de faciliter la restauration des tourbières exploitées. Les populations totales des bactéries et des champignons ainsi que les populations de microorganismes impliqués dans le cycle du carbone semblent être plus nombreuses dans les tourbières naturelles que dans les tourbières exploitées. Également, la biomasse microbienne est plus importante dans les tourbières naturelles que dans les tourbières résiduelles. Plusieurs paramètres physico-chimiques ont été déterminés pour caractériser les substrats tourbeux tels que le pH, la conductivité, le pourcentage d'humidité et le rapport C/N. Les teneurs en azote inorganique ont été mesurées suite à une période d'incubation au champ et en laboratoire afin d'évaluer le potentiel de minéralisation de l'azote des substrats tourbeux naturels et résiduels. Ces résultats seront discutés lors de la présentation.

The effect of water content stratification on the TDR-observed apparent dielectric constant. H.D. Dadfar* and P.H. Groenvelt, University of Guelph, ON
Water contents, calculated from TDR-observed dielectric constants, for severely inhomogeneously distributed water, are compared with the "double-Topp" values. Observations using the "view-difference" method are compared with those using the "tangent-method. This is particularly of interest for low water content conditions.

Comparaison de paramètres physico-chimiques de substrats amendés en résidus de désencrage d'un bioessai avec l'aulne crispé (*Alnus crispa* (Ait.) Pursh.). P. Filiatrault*, C. Camiré, J. Norrie, A. Gosselin et C.J. Beauchamp. Univ. Laval. Ste-Foy, QC.

Le Québec compte 10 000 sablières et environ 450 anciennes carrières. Ces sites dégradés, par les activités de l'homme, se caractérisent généralement par un sol pauvre en matière organique et en éléments nutritifs, en plus d'être sujets à l'érosion. Les volumes croissants de résidus de désencrage, provenant de la récupération du papier, constituent une nouvelle source de matière organique pour revégéter ces sites à l'abandon. L'expérience, menée en serre, consistait à étudier l'aulne crispé (*Alnus crispa* (Ait.) Pursh.) dans différents substrats amendés en résidus de désencrage. Les objectifs étaient les suivants : 1) caractériser les substrats et suivre leur évolution; 2) évaluer la croissance des plantes. Ainsi, une expérience à deux facteurs (doses de phosphore et de résidu) a été effectuée sur une période de cinq mois. Les doses de phosphore variaient de 0,000 % à 0,150 % par kg sec de résidus. Un premier substrat à base de sable et additionné de 0 à 30 % de résidus de désencrage (base de volume) a été étudié. De plus, un deuxième substrat, à base de sédiment du fleuve St-Laurent et additionné de 0 à 80 % de résidus (base de volume) a également été étudié. Les paramètres physico-chimiques de ces substrats et leurs impacts sur la croissance des aulnes seront présentés. Les résultats préliminaires démontrent que les résidus de désencrage s'avèrent être un bon intrant organique chez l'aulne crispé.

Manure management and nitrogen availability to wheat. M.J. Garand*[1], R.R. Simard[2], C. Hamel[1] and A.F. MacKenzie[1], [1]McGill University and [2]Agriculture and Agri-Food Canada.

Before the advent of inorganic N fertilizers, N needs of crops were fulfilled through mineralization of N from legume residues, manures and soil organic matter. With increasing concerns over the need to use farmyard manures efficiently and to reduce water contamination, research about best management practices is of a renewed interest. In order to compare different types of manures applied at different times with a mineral fertilizer on wheat (*Triticum aestivum* L. cv. Algot), a two year study was conducted on a Humic Gleysol (Sainte-Rosalie serie) at the MAPAQ research station at St-Bruno. Dairy solid manure (DSM), composted dairy manure (CDM) and swine liquid manure (SLM) were applied at a rate of 80 N kg ha^{-1} before seeding, at the Zadoks 12 growth stage and after harvest. Mineral fertilizer was applied as NH_4NO_3 at 0, 40, 80, 120 or 160 kg N ha^{-1} at seeding. Treatments included red clover (*Trifolium pratense* L. cv. Arlington) which was plowed under in late fall. The highest efficiency coefficients were obtained with SLM applied before seeding and at the Zadocks 12 stage (46 to 71%). CDM at the Zadocks 12 stage gave poor results: the coefficients obtained were 30% in 1993 and -16% in 1994. Red clover increased N availability from organic sources by over 30%. In 1994, clover companion crop increased wheat yields significantly: 2.2 T ha-1 compared to 1.9 T ha^{-1} without clover. Preliminary results indicate that a companion crop and spring applications may improve N availability from organic sources.

Comparison of soil erosion on partly-frozen soil by simulated spring rainfall and snowmelt. G.Q. Geng* and G.R. Mehuys, Department of Natural Resource Sciences, McGill University-Macdonald Campus, Ste Anne de Bellevue, QC.

Soil erosion by snowmelt and spring rainfall simulated in the laboratory were studied and compared under varied land slope (2 and 9%), thaw depth to frozen subsoil (1 and 3 cm), and intensity (5, 10, and 30 mm/h) and duration of events. Simulated snowmelt drops (mean drop diameter 0.17 mm) were assumed to have no impact on soil particles. Simulated spring rain drops (mean drop diameter 0.37 mm) produced lower intensity and impact energy as compared with summer rainfall. Rainfall produced significantly higher sediment concentration, soil loss rate, and total soil loss under all treatments. Erosive agent (rainfall and snowmelt) acted very strongly as a factor and interacted with the other factors. The interactions between intensity and other factors were also stronger in rainfall events than in snowmelt events. Theses positive interactions increased soil loss. Overall, rainfall produced about 3 times as much soil loss as snowmelt did. The stronger impact energy of rainfall also initiated the formation of branchings of rills, thereby might accelerate the formation of rills and increase soil loss rate and total soil loss.

Utilisation du test des nitrates du sol en vue d'une recommandation d'azote pour l'orge et le blé. M. Giroux* et T.S. Tran, Service de recherche en sols, MAPAQ, Sainte-Foy, QC.

L'évaluation de la fertilité des sols est nécessaire pour améliorer la fiabilité des recommandations des engrais azotés pour les cultures. Le but de cette étude est d'établir la relation existant entre la teneur en nitrates des sols (0-40 cm) avec le rendement relatif de l'orge et du blé (rendement sans N ÷ rendement maximum avec N x 100). Elle a aussi comme objectif d'établir un modèle permettant de prédire la recommandation optimale d'engrais azoté en se basant sur ce test. La relation entre le rendement relatif et la teneur en $N\text{-}NO_3$ a été établie, selon quatre modèles : linéaire plateau (R^2 = 0,61**), quadratique-plateau (R^2 = 0,59**), quadratique (R^2 = 0,59**) et Mitscherlich (R^2 = 0,64**). Les fonctions de production de l'azote ont été mesurées dans 26 champs expérimentaux selon un modèle quadratique. Une grille de fertilisation tenant compte de la teneur en nitrates des sols, du pourcentage du rendement maximum visé et des aspects économiques (prix des grains et du kilo d'azote) a été établie. D'après cette grille, en considérant un

rendement relatif de 98 %, les sols contenant 100 kg N-NO_3/ha et plus (0-40 cm) ne répondent pas à l'application des engrais azotés et peuvent être considérés comme très riches. Entre 80 et 100 kg N-NO_3/ha les sols sont riches et devraient recevoir entre 0 et 30 kg N/ha. Pour des sols présentant une teneur entre 60 et 80 kg N-NO_3/ha, la dose optimale se situe entre 30 et 70 kg N/ha. Pour une teneur entre 40 et 60 kg N-NO_3/ha, elle varie entre 70 et 105 kg N/ha. En sols pauvres, contenant moins de 40 kg N-NO_3/ha d'azote, elle se situe entre 105 et 125 kg N/ha.

Reactions of dissolved organic carbon with soils and soil constituents. C.C. Gomez*, R.A. Jansen and W.B. McGill. Department of Renewable Resources, University of Alberta, Edmonton, Alberta.
Dissolved organic carbon (DOC) is a heteropolydisperse organic material containing a range of compounds from simple sugars to complex humic substances. DOC influences acidity, nutrient availability, toxicity, and has been implicated in the transport of metals and contaminants within the soil profile because of its high affinity for inorganic and organic chemicals. The concentration of DOC sorbed to soils is dependent on the chemical characteristics of the soil constituents and the DOC. We hypothesize that hydrophobic components of DOC are more readily sorbed by the organic-rich A horizon, while hydrophilic components will be more readily sorbed by the mineral dominated B and C horizons resulting in horizon-specific fractionation. We have observed high concentrations of DOC leaching from compost and large quantities of DOC are extractable from manure. We equilibrated DOC from composted manure with surface and subsurface soil samples from an Eluviated Black Chernozemic soil and measured sorption up to 1000 mg kg^{-1} soil. Spectrophotometric analysis before and after exposure to soil has provided evidence that some components of DOC are more readily sorbed to soil than others. The ratio of absorbance values at 465 and 665 nm (E4/E6) for DOC increased after equilibration with soil for both surface and subsurface soil samples.

Organic matter turnover and corn residue carbon storage in some Ontario soils. E.G. Gregorich*, B.H. Ellert, C.F. Drury, and B.C. Liang, Agriculture & Agri-Food Canada, Ottawa ON, Lethbridge AB, Harrow ON.
The amount of organic matter in soil is a function of the amount of plant residues returned to the soil and the rate at which those residues decompose. To evaluate organic matter turnover and C storage measurements of total organic C and natural ^{13}C abundance were made on density and size fractions and whole soils under forest and continuous corn in eastern and southwestern Ontario. About 25-30% of the soil C in the plow layer was derived from corn in fertilized soils, the proportion was lower in unfertilized soils. Estimated half-lives of surface soil C indicated that fertilization did not alter the decomposition rate of C3-derived C. Turnover of organic matter was fastest in the light fraction (LF) and slowest in the silt-size fraction. About 70% of the LF C was derived from corn. A substantial amount of LF was occluded within aggregates, and fertilization affected the amount of corn-derived C in the free and occluded LF. Estimates of corn residue inputs and yield data from long-term field studies indicated that 15-25% of the total corn residue C inputs remained in the soil after more than 25 yr of continuous corn cropping. Simulated changes in soil C are discussed.

Salinity and matrix conductivity measurement as determined by the TDR trace. P.H. Groenevelt* and E.D. Dadfar, University of Guelph, Guelph, ON
The determination of soil salinity and soil matrix conductivity from TDR traces only is discussed and compared to the method in which a cell constant is involved.

Modelling Proton Binding in Humic Acids. J. Hou*[1], K.A. Bolton[2] and L.J. Evans[1], [1]Land Resource Science, University of Guelph, ON, [2]Division of Physical Sciences, Scarborough Campus, 1265 Military Trail, University of Toronto, ON.
Proton binding with humic acids was studied using potentiometric titrations in the presence of 0.01, 0.05, 0.10 and 0.20 M LiCl. Three humic acids from different sources were studied: the purified form of a commercially available humic acid and two extracted soil humic acids. The humic acids were assumed to act as simple organic acids and were represented by two types of sites, H_nL and $H_mL^{"}$. The relative proportions of the functional groups were determined by solution ^{13}C-NMR spectroscopy. Values for the proton dissociation constants, log β, were determined from potentiometric titration data and using the linear least square optimization program, FITEQL. The titration data could be best modelled by assuming the humic acid behaved as two diprotic acids, $H_2L + H_2L^{"}$. The total site concentrations were found to increase with increasing ionic strength, while values for the proton dissociation constants were found to decrease with increasing ionic strength. The three humic acids studied had similar proton dissociation constants. This result is consistent with the assumption that the functional groups in each humic acid can behave similarly but are not necessarily chemically identical.

Boron Complexation Models with Humic Acid. J. Hou*[1], L.J. Evans[1], and K.A. Bolton[2] [1]Land Resource Science, University of Guelph, ON, [2]Division of Physical Sciences, Scarborough Campus, 1265 Military Trail, University of Toronto, ON.
Results from an investigation on the interaction of boron with humic acid were modelled using both a mixed ligand and a quasi-particle model. Formation constants for B complexation with simple organic ligands were

used to develop a mixed-ligand model. The amount of the various complexant functional groups in humic acid were determined by ^{13}C-NMR spectroscopy and titration data. The final mixed-ligand model chosen assumed that humic acid contained a discrete mixture of four complexant organic ligands: α-hydroxyisobutyric acid, salicylic acid, catechol and mannitol. The modelling results suggested that phenolic groups were the most important functional groups involved in B complexation by humic acid. A quasi-particle model was investigated by titrating three humid acid solutions in the presence of boric acid in 0.01, 0.05 and 0.10 M LiCl. The linear least square optimization program, FITEQL, was used to estimate B-humic acid stability constants for both 1:1 and 1:2 complexes. The value of log β increased with increasing ionic strength from 0.01 to 0.10 M LiCl. Results from speciation calculations indicated that the extent of B complexation with humic acids was determined by the types of functional groups present, total concentration of proton binding sites and the solution pH.

Seasonal and spatial variation in bioavailable nitrogen, phosphorus and sulfur in an aspen forest soil. W.Z. Huang* and J.J. Schoenau, Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5A8.

Bioavailability of nitrogen (N), phosphorus (P) and sulfur (S) was measured by sequential burial of strips of ion exchange resin membrane *in situ* over six months in the forest floor horizons (L, F, H) and mineral soil (Ae) of an old aspen stand in Prince Albert National Park, Saskatchewan, Inorganic N (NO_3^- and NH_4^+), P and SO_4^{2-}S accumulated on the membrane were determined every two weeks after *in situ* burial, and the quantity of nutrient ion sorbed on the resin used as an index of relative nutrient release rates and bioavailability. Water soluble organic carbon (WSOC) was determined monthly. Nutrient bioavailability was significantly different among L, F, H, and Ae horizons, with the highest quantities of resin-sorbed nutrients occurring in the litter horizons. Of horizons, the L horizon had the highest WSOC, and resin exchangeable NH_4^+ and P concentrations followed by F, H, and the Ae horizon. Large increases in WSOC, which coincided with the onset of litterfall in late summer and fall, were associated with increases in resin exchangeable ion. In general temporal and depthwise variability should be considered when sites are assessed with respect to the bioavailability and distribution of N, P, and S.

Seasonal changes in VA-mycorrhizal development as affected by tillage practices and fertilizer application. Z. Kabir*, I.O'Halloran, J. Fyles and C. Hamel, Dept of Natural Resource Sciences, McGill University, 21111, Lakeshore Road, Ste.Anne de Bellevue, Quebec, H9X 3V9.

Tillage systems and manuring may affect the growth and development of vesicular-arbuscular mycorrhizal (VAM) fungi. In the present study, we measured VAM hyphal densities and VAM root colonization of corn cultivated under different tillage intensities and using either dairy manure or inorganic fertilizers. The experiment was conducted in a sandy loam and in a clay soil. Samples were collected in spring, at the 10 leaf stage, at silking stage and in the fall. VAM hyphal densities were not affected by the fertilization. Total hyphal densities and % viable hyphae in the sandy loam soil were slightly but significantly lower under no tillage than under reduced tillage (RT). Conventional tillage (CT) reduced total and viable hyphal densities in the spring compared to RT and NT treatments. The hyphal densities remained lower under CT up to the harvest in fall. The percent root infection was also lower under CT than under RT and NT, VAM growth development pattern followed that of corn.

Effets cumulatifs de l'application de poussières de four de cimenterie sur les propriétés chimiques du sol. Lafond*, J. et R.R. Simard, Agriculture et Agroalimentaire Canada, Normandin et Sainte-Foy, Québec.

L'impact des poussières de four de cimenterie (PFC) sur les propriétés chimiques des sols est peu documenté. L'objectif de cette étude est de déterminer les effets d'applications répétées de PFC sur le pH, la teneur en K et en métaux lourds du sol sous culture de pomme de terre. Un dispositif en blocs complets aléatoires avec 4 répétitions est utilisé. Les traitements consistent en 4 doses de PFC, de chaux et de KCl appliqués lors des 2 premières années et seulement de KCl la dernière année. Des échantillons de sol ont été prélevés lors de la récolte pendant 3 années. Le pH du sol est mesuré dans l'eau (1:1) et le K et les métaux lourds ont été extraits par la solution Sr-citrate. Le pH du sol n'a pas été influencé par les applications répétées de PFC. Le pH reste stable même si une baisse de 0.4 unité est survenue lors de la première année. Il se produit un appauvrissement en K (72 vs. 42 kg ha^{-1}) pour l'ensemble du profil du sol (0-60 cm) même avec les fortes doses de PFC. Dans l'horizon de surface, les niveaux de Cd, Co, Ni et Pb ont augmenté par rapport au niveau initial dans toutes les parcelles. La teneur en Cr est restée relativement constante au cours de l'expérience. Ces résultats suggèrent que les PFC peuvent être une source intéressante de K pour la culture de pomme de terre. L'impact des PFC sur les métaux lourds du sol est non significatif à court terme (3 ans) alors que l'acidité du sol n'est pas diminuée par les faibles doses de PFC utilisées.

Composition en sucres simples des matières organiques associées aux fractions granulométriques de sols tropicaux. M.C. Larre-Larrouy* et C. Feller, ORSTOM, Laboratoire d'étude du Comportement des Sols Cultivés, BP 5045, 34032 Montpellier Cedex, France.

Dans le cadre des recherches menées sur la caractérisation (nature, origine) des différentes formes de matière organique impliquées dans les variations des propriétés du sol en milieu tropical, nous nous sommes intéressés à l'analyse des sucres, traceurs de l'activité microbienne et des restitutions organiques. Deux sols ferralitiques à teneurs en matière organique bien différentes, et leurs fractions granulométriques ont ainsi été soumis à une série d'hydrolyses acides avant de doser les sucres libérés par chromatographie en phase gazeuse (CPG). À la méthode de dérivation habituellement utilisée en CPG (réduction en acétates d'alditols), nous avons préféré la silylation, plus rapide et simple à réaliser. Cette dernière méthode permet d'obtenir des teneurs en monosaccharides neutres comparables à celles fournies par la méthode classique et offre, à la différence de celle-ci, la possibilité d'identifier sucres acides et aminés, pour des temps d'analyse identique (15 min.).

Parmi les sucres (8 ou 12 suivant la méthode de dérivation employée) que nous avons pu identifier dans les sols bruts non fractionnés, le glucose est le plus abondant, suivi par le mannose. Il en est de même dans les fractions granulométriques de ces sols, à l'exception de la fraction grossière (> 200 µm) où le xylose, sucre essentiellement d'origine végétale, devient le sucre le plus important après le glucose, ce qui est en accord avec le caractère figuré végétal de cette fraction. Le rapport galactose | mannose/arabinose | xylose qui caractérise l'importance de la décomposition des débris végétaux et de l'accumulation de produits de synthèse microbiens, augmente dans un rapport de 1 à 4 des fractions grossières aux fractions fines. La valeur de ce même rapport calculé pour les sols non fractionnés, se rapproche de celles trouvées dans la littérature pour des sols tempérés.

Seasonal comparisons of nitrous oxide emissions on two soil tupes in north-central Alberta. Lemke, R.L.*, Solberg, E.D., Izaurralde, R.C., and Nyborg, M. University of Alberta and Alberta Agric. Food and Rural Development, Edmonton.

Substantial uncertainty still remains in the global atmospheric budget of nitrous oxide. Some of this uncertainty is due to a lack of quantitative knowledge concerning the contribution of agro-ecosystems. Field studies were conducted at four sites to characterize seasonal N_2O fluxes from soils in north-central Alberta under various managements and conditions. These sites represented two major soil orders, two cultivation regimes, several N-source amendments, and one simulated erosion level. A regular schedule of N_2O measurements was maintained during spring thaw and the growing seasons of 1993, 1994, and is continued into 1995. Gas samples were drawn from a head space created by placing a vented cover on the soil surface. Nitrous oxide concentrations were determined by gas chromatography. Peak fluxes of N_2O-N occurred during the spring thaw period (mode: 100 µg m^{-2} h^{-1}). Sustained periods of emissions were also measured during the growing season (mode: 30 µg m^{-2} h^{-1}) and included plots with simulated erosion. The combination of moisture regime, nutrient status and soil type led to major differences in the magnitude and the seasonal pattern of nitrous oxide emissions. Fluxes were generally greater on conventional-tillage plots than on zero-tillage plots.

No stripping vs Trenchline 2-lift stripping Pipeline Construction Techniques in Solonetzic, Native Prairie in S.E. Alberta. L.A. Leskiw[1] and J.D. Burke[2*], Can-Ag Enterprises Ltd., NOVA Gas Transmission Ltd.

NOVA Gas Transmission Ltd. commissioned and worked with Can-Ag Enterprises Ltd. to design and conduct a soil and vegetation research project to assess the effects of two pipeline construction techniques: No-Strip and Trench 2-Lift (Two-Lift for trench line extra depth stripping). The overall goal of this study is to determine the best soil handling procedure for pipeline construction in the sensitive native prairie areas of southeastern Alberta in accordance with government direction. The ERCB IL (92-12) states that the primary issue of industrial development concerning the fragile native grassland environment is to "ensure native prairie areas are not permanently destroyed or subject to unnecessary impacts as a result of petroleum and natural gas activity" and that "... any disturbance should be minimized because of the difficulty in re-establishing native species". The initial findings of this soil research project on Brown Solodized Solonetz soils in native prairie indicates that Two-lift extra depth stripping is superior to No-strip, 1 year after construction, on small diameter pipelines (<25 cm) based on soil capability in terms of salinity, organic matter content, and structure and consistence of the surface material. The main limitation to vegetative success in this region is low moisture supply in the soils. For Solonetz and Solod dominated soil units in the Brown Soil Zone, surface soil material should be stripped to 20-25 cm depth in units with shallow (10 cm or less) topsoil such as is found in blowout areas. Overall goals of this study were best achieved with the Trench line 2-Lift extra depth stripping soil handling procedure in the short-term (1 to 2 years). Surface stripping widths were minimized, there was adequate surface soil material for blowout areas and landscape and soil capability were matched or improved after construction with Trench 2-lift.

Comparison of two-lift and three-lift soil handling on saline black Chernozems. L.A. Leskiw[1], J.D. Burke[2] and N.M. Finlayson[3] Presentor: Robert Faye[2]. [1]Can Ag Resources Ltd. [2]NOVA Gas Transmission Ltd. [3]Land Resources Network Ltd.

NOVA Gas Transmission Ltd. commissioned a soils research project to compare two pipeline soil handling procedures (standard 2-Lift and alternative 3-Lift) in the Black Solonetzic Soil Zone of Alberta. The 3-Lift guidelines were set up to reduce industry's risk while pipelining through soils with unsuitable (saline or sodic) lower subsoil materials. It was thought that if these materials were brought close to the surface the long term capability of the soil would be impaired. The 3-Lift guidelines were also established as interim guidelines until additional research could be conducted to assess their effectiveness at managing environmental risk (Three-Lift Task Force 1992). The goal of the study is to determine which procedure returns disturbed soils with unsuitable lower subsoil material to an equivalent or better soil capability after five years and meets the intent of the regulations - returning soils to equivalent capability in a five year time frame. The study concentrates on results of soil salinity (EC), as this is the dominant soil factor triggering alternative 3-Lift soils handling. The study plots arc located immediately west and south of the town of Vegreville in central Alberta, east of Edmonton. The results indicate that both methods of soil handling result in elevated salt levels (2-Lift in the topsoil and upper subsoil, 3-Lift in the upper subsoil). The impact from both procedures is confined to the area over the trench. After two years on saline Black Chernozems there is significant salt leaching in the upper 50 cm root zone. The increased levels of salts should not impact soil capability. When considering all soil types, the limited extent of impact and the high rate of salt movement, it appears that 2-lift handling is superior by virtue of decreased area of disturbance and maintenance of soil capability for all soils present.

The effects of slope gradient, tillage depth and tillage speed on tillage translocation and tillage erosion measured using Cl as a tracer. D.A. Lobb[1*], R.G. Kachanoski[2] and M.H. Miller[2]. [1]Eastern Canada Soil and Water Conservation Centre, University of Moncton, Grand Falls, New Brunswick E0J 1M0 and [2]Department of Land Resource Science, University of Guelph, Ontario N1G 2W1.

Tillage translocation and tillage erosion were measured throughout the topographically complex landscapes of two fields in the upland region of southwestern Ontario. Translocation of soil by tillage was measured by labelling plots of soil with Cl and measuring its displacement in response to single tillage passes by four implements (mouldboard plough, chisel plough, tandem disc and C-tine cultivator). Tillage erosion (net translocation) was measured between plots along the path of tillage. A relationship between tillage translocation and slope gradient was observed, as other studies have shown; however, the variability in translocation could not be explained by slope gradient alone. Slope curvature may have been responsible for some of the translocation. Tillage depth and speed were subject to considerable and intermittent manipulation by the operator in response to changing topographic and soil conditions. This manipulation is typical for tillage in complex landscapes and was presumed largely responsible for the variability in the results.

Broad-level characterization of agroecosystems in the Great Lakes-St Lawrence lowlands region. K.B. MacDonald[*] and F. Wang, Agriculture and Agri-Food Canada, Guelph, ON.

The region of the Great Lakes basis and St Lawrence Lowlands includes some of the most productive agricultural land in Canada. The agroecosystems developed here have displaced natural areas of mixed coniferous and deciduous forest ecosystems particularly in areas of high quality natural resources with suitable topography. An ARC/Info geographic information system (GIS) is used to study the relationships among natural resources and agriculture using data from the national soils database (NSDB), satellite imagery (AVHRR -advanced very high resolution radiometer) and Census of Agriculture (CoA). Within the region, agricultural activity occurs on about 15% of the land area almost exclusively within the Mixedwood Plain Ecozone. The spatial distribution of the agro-ecosystem in association with natural, urban and aquatic ecosystems is examined. The current status of the agroecosystem is characterized by the distribution of crops and livestock and the intensity of farming activities. A comparison between 1981 and 1991 CoA data provides an indication of trends in crop distribution and management practices.

A case study is also presented to illustrate how these data can be used to provide a context for detailed localized studies and also to determine the kinds of information available to scale-up and generalize field and plot research results.

Large Scale Mapping of Solonetzic Soils Using Image Analysis and Global Positioning Systems (GPS). [*]B.L. McCann and D.J. Pennock, Department of soil Science, University of Saskatchewan.

Image analysis is a valuable tool that can be used to map soil properties that affect management practices in Solonetzic-Chernozemic soil landscapes. Because of the highly variable nature of these soil landscapes, only large-scale maps can provide the level of detail necessary for farm-scale planning. Image analysis of black and white aerial photographs can be used as a cost effective method to delineate soil landscape units within these soil landscapes. In this study, extensive field sampling and laboratory analysis were used to create a soil landscape model for a Brooking (Solonetzic)-Amulet (Chernozemic) soil landscape. Soil landscape units

derived from this model were closely related to soil subgroups which in turn were associated with tonal variation on the scanned black and white aerial photograph. Image classification was achieved by grouping the digital values on the scanned photograph into classes based on soil landscape units. This procedure had a mapping accuracy of 71.4% at the specific sampling site pixel and 85.7% at a one pixel or 3 meter radius from the site. These levels of accuracy would indicate that this technique shows considerable promises for mapping soil landscape units within Solonetzic-Chernozemic map units.

P status of organically amended soils on changing redox potential. F. Ajmone-Marsan[*], R.R. Simard and D. Côté, Università di Torino, DI.VA.P.R.A.-Chimica Agraria, Torino, Italy, Agriculture and Agrifood Canada, Sainte-Foy, MAPAQ, Sainte-Foy.

Phosphorus concentration in freshwaters is of major concern for the risk of eutrophication it can cause. Soils can contribute to the release of P to water bodies especially in areas of intensive agriculture. Land disposal of farm organic residues may result in the acceleration of the P cycling in the soil thereby increasing its leaching to the water table. This effect might be enhanced if the soil undergoes a decrease in redox potential as iron reduction and organic matter consumption by the anaerobic microorganisms could release the phosphorus which is associated with these compounds. A Le Bras silt loam was studied that had received different doses of liquid hog manure (LHM) for 15 years. The soil was sampled at different depths and was submerged and incubated at 20°C for up to 8 weeks. The Eh of the soil decreased after the first week of incubation and more rapidly where the highest dose of LHM was applied. At the same time an increase of the pH was observed. The influence of Eh reduction was observed on the P intensity as measured by the exchange with a resin membrane and by percolation. Also P quantity, described in terms of phosphorus fractions, total organic phosphorus and total biomass phosphorus underwent marked modifications.

Hydraulic Conductivity and ion transport in earthen manure lagoons C.P. Maulé[*1] and T. Fonstad[2], [1]Dept Agricultural & Bioresource Engineering, University of Saskatchewan. [2]UMA Engineering Ltd. Saskatoon.

In the Prairie Provinces the economics as well as climatic considerations favour earthen lagoons for anaerobic storage of pig and diary manure until they can be spread on fields. However it is recognized that more information is needed about upon seepage rates of ions from the manure. The purpose of our study is to provide recommendations for improvement of lagoon construction so as to minimise ion movement to groundwater. Part of our methodology utilizes a lab column study to evaluate the effect of pig manure upon soil hydraulic conductivity and ion transport. Seven different textures are investigated. The lab columns have 20 cm of soil packed to 90% of optimum with a 60 cm head of pig manure (6.5% suspended solids).

Reported here are preliminary results after 6 months in a 2 year study. Within 1 month hydraulic conductivities had reduced to between 1.5×10^{-9} and 1.3×10^{-9} m/s for all textures. Texture did not have an effect upon hydraulic conductivity reduction but does upon ion transport. After 5 months chloride concentrations in the effluent was 22% of that in the manure (3250 mg/L) for the CL soil and 36% for the S soil while K concentrations were 0.7% and 3% of that of manure (3000 mg/L) for the CL and S soils respectively.

Agroenvironmental pressure indicators for water quality projects. Aubert Michaud, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Québec, QC.

Ensuring that tangible environmental gains result from resources invested in water quality in rural areas brought up the idea of intervention at the watershed level. The watershed approach is in itself a huge challenge in terms of planning and intervention implementation. The dynamics of non-source water contamination in agricultural areas requires a massive participation from enterprises which are the most at risk. Agroenvironmental indicators have been developed to support the decision-making process inherent to water quality initiatives. Indices derived from farm-based spatially referenced data are available through desk-top computers and enable users to study the cropping systems, manure and mineral fertilizer management characteristics in the region under study. Indices are very efficient in supporting the various actions essential to water quality projects, namely:

- the awareness of stakeholders in agroenvironmental issues;
- the formulation of quantified and realistic objectives;
- the targeting, planning and follow-up of interventions.

Nitrogen dynamics in alfalfa-corn cropping systems. Mvondo Awono, J.-P.[*1], R.R. Simard[2] and F.P. Chalifour[1]. [1]Département de phytologie, Université Laval, Sainte-Foy, QC, [2]Agriculture and Agri-Food Canada, Sainte-Foy, QC.

Current interest in sustainable agricultural systems increases the use of legumes in rotations to provide N to subsequent crops. Experiments were conducted from 1992 through 1994 in Eastern Québec at Saint-Anselme on a Beaurivage sand and, at Saint-Nicolas, on a Neubois clay loam to determine the impact of N fertilization and cropping systems on soil NO_3^-. Corn (*Zea mays* L.) preceded by alfalfa (*Medicago sativa* L. var Nitro) in the first year or in monoculture received 10, 60, 120 or 180 kg N[/ha. Soil NO_3^- was monitored four times per year during two consecutive growing seasons and at three depths (0-30 cm; 30-60 cm and 60-90 cm). First-year alfalfa significantly increased NO_3^- concentrations in soil profiles at both sites the following spring (1993). At-

Saint-Anselme, in the 0-30 cm layer, spring NO_3^- was 138 kg/ha with proceeding alfalfa fertilized with 10 kg N/ha and 86 kg/ha with proceeding corn fertilized with 180 kg N/ha; Saint-Nicolas values were 148 kg N-NO_3^- /ha and 72 kg N-NO_3^-/ha respectively. The alfalfa effect on residual soil NO_3^- decreased with depth and in time. In 1994, no residual effect of alfalfa on residual soil NO_3^- was observed. These results show that a single year of alfalfa increases soil NO_3^- and should be taken into account in subsequent corn fertilizer programs.

Pore space organization and plant response in peat substrates. N. Nkongolo* and J. Caron. Soil Science Department, Faculty of Agricultural and Food Sciences, Laval University, Ste-Foy, Québec, G1K 7P4.
In peat substrates, attempts to relate plant growth and the physical conditions of the root zone have been restricted to air-filled porosity (AFP) and oxygen diffusion rate (ODR). This study investigated how pore tortuosity (τ) and gas relative diffusivity (Dp/Do) are affected by particle sizes and how these parameters relate to plant response in peat mixes. Forty percent of wood bark (WB) was mixed to 50% of peat and 10% of sand (by vol). Peat and sand particles remained constant, but WB particle size was varied (1-2, 2-4, 4-8 and 8-16 mm). *Prunus* and *Spirea* plants were potted in the media. Saturated hydraulic conductivity (Ks) was measured with a Coté infiltrometer and tension tables were used to measure the water desorption curve. τ and Dp/Do were calculated from the moisture release curve and Ks. Dp/Do ($p=.004$), Ks ($p=.034$), and τ ($p=.050$) were significantly affected by WB particle size. AFP remained unaffected by WB particle size. *Spirea* shoot ($p=.0001$, $r=.612$) and root ($p=.0001$, $r=.645$) dry weights were correlated with Dp/Do. *Spirea* root dry weight was also correlated with τ ($p=.0001$, $r=.645$) and AFP ($p=.05$, $r=.338$). Since varying component particle size may affect gas exchange through its effect on gas diffusivity without affecting AFP and since gas diffusivity influences plant response, it may be useful to measure Dp/Do and τ on top of AFP when evaluating the suitability of media for plant growth.

Dynamique de la matière organique dans deux sites repères du réseau national de surveillance de la qualité des sols. M.C. Nolin[1] et A. N'Dayegamiye[2*]. [1]CRTRB, Agriculture et Agroalimentaire Canada, Ste-Foy et [2]Service des sols, MAPAQ, Ste-Foy.
La modification des pratiques culturales peut affecter la qualité de la matière organique du sol (MOS) à court terme. L'objectif de cette étude consiste à évaluer les changements à court terme (1989-1992) des teneurs en C du sol et des fractions particulaires du sol (active et stable) dans une argile de la série de Providence sous prairie et sous rotation conventionnelle. La succession des cultures depuis 1987 était constituée de quatre années de fourrage (luzerne + mil + brome) et d'une année de maïs-grain suivie d'un engrais vert dans la prairie et de «maïs-grain - maïs-grain - soya - soya - orge» dans la rotation conventionnelle. Les pratiques culturales consistaient en deux labours tous les cinq ans dans la prairie et en labour alterné avec le chisel dans la rotation conventionnelle. La caractérisation de la MOS a été effectuée par fractionation particulaire: la fraction active C-*fa* (63 - 2000 μm) et la fraction stable C-*fs* (<63 μm). La proportion du C-*fa* était plus élevée dans la prairie avec des valeurs moyennes de 24 % et 32 % du C total du sol en 1989 et 1992 respectivement comparativement à 20 % et 27 % dans la rotation conventionnelle. Inversement, la fraction stable était plus élevée dans la rotation conventionnelle que dans la prairie. De 1989 à 1992, une augmentation temporelle significative de C-*fa* ($P<0,01$) et une diminution de C-*fs* ($P< 0,001$) ont été observées dans les deux systèmes étudiés. L'introduction d'engrais vert dans la prairie et/ou le travail du sol dans les deux systèmes pourraient avoir augmenté la fraction active constituée principalement de biomasse microbienne, conduisant en même temps à la diminution graduelle de la fraction stable par une minéralisation accrue. Aucune différence significative entre les deux systèmes et entre les deux années de mesure n'a été cependant observée pour le C total du sol. Par contre, la prairie a augmenté significativement le diamètre moyen pondéré (DMP) des agrégats ainsi que le pourcentage des macroagrégats du sol (>2 mm), tandis que la rotation conventionnelle a accru le pourcentage de microagrégats (<2 mm) au détriment des macroagrégats. Ces résultats démontrent la spécificité et la complexité de la dynamique de la MOS dans les différents systèmes culturaux.

Effect of organic waste amendments on soil properties and growth of horticultural crops. G.H. Neilsen*, D. Neilsen and E.J. Hogue. Agriculture and Agri-Food Canada, Summerland, BC V0H 1Z0 Canada.
Several municipal biosolids, including waste from Vancouver, Kelowna and Penticton, and other compost wastes, are in the process of being tested for use as soil amendments in southern interior British Columbia. Yield and elemental uptake of carrots (*Daucas carota* L.) and chard (*Beta Vulgaris* L.) have been compared after annual applications of 45 mT/ha of the various wastes to a Skaha loamy sand soil. In the first two years, amendments containing high and Zn concentrations significantly increased yield relative to check plots receiving only production Guide recommended rates of inorganic fertilizer. Nutrient and metal concentration of plant tissue was affected by the type of waste applied although metal concentrations of waste and tissue were relatively low. Organic wastes increased water holding capacity, plant available water and pH buffering of the loamy sand. The cumulative evidence from this research presently suggests a possible market for organic wastes to improve the physical condition and fertility of the two thirds of soils used by the horticultural industry in

southern British Columbia which otherwise have coarse texture, and poor nutrient and water holding capacities.

What is early in early-time analysis of the field-saturated hydraulic conductivity? B.P. Odell*, D.E. Elrick and P.H. Groenevelt, University of Guelph, Guelph, ON.
Equations by Elrick and Reynolds for the pressure infiltrometer determination of the field-saturated hydraulic conductivity are used to delineate the time domains of early-time and steady-state analyses based on the initial soil water content.

Cycle des éléments dans l'écosystème forestier: illustrations provenant de la forêt boréale mixte. D. Paré. Biodôme de Montréal, Groupe de recherche en écologie forestière UQAM.
Trois particularités du cycle des éléments dans l'écosystème forestier sont discutées à l'aide de résultats provenant de travaux de recherche réalisés dans la forêt boréale mixte:
1- le cycle biochimique et l'efficacité de l'utilisation des nutriments. La biomasse vivante représente un important réservoir d'éléments pour l'écosystème forestier et la dynamique des éléments dans cette biomasse peut avoir des répercussions sur la circulation des éléments dans et hors de l'écosystème. La retranslocation du feuillage et dans le bois contribue de façon significative aux besoins nutritifs des forêts et peut permettre de perpétuer l'effet de la fertilisation.
2- La variabilité des flux d'éléments avec le développement de la forêt. En plus des variations saisonnières et annuelles des flux d'éléments qui sont généralement dépendantes des conditions climatiques, l'intensité de la circulation des éléments varie en fonction du stade de développement de la forêt. Le synchronisme entre les besoins nutritifs de la forêt et la disponibilité des éléments dans les sols n'est pas parfait et constitue une avenue de recherche intéressante qui pourrait permettre de limiter les pertes d'éléments hors de l'écosystème et de favoriser la croissance des plantes.
3- L'effet plante-sol. Les forêts sont généralement composées de plusieurs essences qui ont une influence différente sur le cycle des éléments. La prédiction de l'effet d'une essence dans une communauté qui en comprend plusieurs est difficile puisque cet effet n'est pas nécessairement proportionnel à l'abondance de l'essence en question.

Influence de l'azote dans la production de graminées fourragères sous climat frais. G. Parent[1*], R.R. Simard[2], J. Lafond[1] et C. Lafrenière[3]. Agriculture et Agroalimentaire Canada, Normandin[1]. Ste-Foy[2], Kapuskasing[3]
La région de l'Abitibi-Témiscamingue présente des conditions climatiques particulières et des sols argileux lourds spécifiques à la région. Les besoins en azote de la fléole des prés cultivée dans ces conditions semblent différents de ceux du reste du Québec. L'objectif de cette recherche est de déterminer l'effet de la fertilisation azotée sur la dynamique de l'azote du sol ainsi que sur les rendements et la qualité nutritive des fourrages. L'expérimentation a débuté au printemps 1994 sur 4 sites. Le dispositif expérimental est en blocs complets aléatoires répétés 4 fois avec 5 traitements d'azote (0, 60, 120, 180 et 240 kg ha^{-1}) sous forme de nitrate ammoniacale de calcium. La moitié de la dose d'azote était appliquée au printemps et le reste après la première coupe. Une régie de deux coupes a été appliquée et le sol échantillonné à 3 reprises et à 3 profondeurs. De fortes doses d'azote entraînent une augmentation notable de la quantité de nitrate dans les 30 premiers cm du sol. Aucun effet des traitements sur l'azote ammoniacal du sol n'a été détecté. Les plus fortes doses d'application accroissent la qualité d'azote total dans le profil du sol. Des doses variant entre 120 et 240 kg/ha du fertilisant azoté maximisent le rendement total en fourrage. L'utilisation de doses importantes d'azote entraîne une augmentation de la teneur en nitrate, en azote total et en fibre du fourrage tout en limitant la croissance des légumineuses déjà présentes.

Some considerations for extrapolating site measurements to regional assessments. W.W. Pettapiece*, Agriculture and Agri-Food Canada, Edmonton
The research community has gone through an extensive phase of developing models to represent complex natural phenomena such as erosion, organic matter degradation, nutrient balance and water movement in soils. We are now being asked to use these models for predictions or assessments of agricultural sustainability. The request is reasonable but, as one changes scale from a research site to a regional assessment there are a multitude of questions relating to data requirements and management which must be addressed. The variation in process controlling factors such as land use, slope, soils and water relationships is quite restricted at a research site but becomes increasingly complex as the area expands. When and how does one aggregate increasing amounts of data? What issues should be considered when integrating several different data sources? To help in our decision making, we need a framework for organizing what we have, extending where appropriate or targeting omissions. The concern for scaling and extrapolation is relatively recent and from our natural resource (soils) perspective it appears that there are two basic ingredients required for the geographic application of soils-based models. These are:
1. a standard hierarchical framework that can be used as a common reference for scaling -preferably with an ecological orientation, and
2. soil landscape models for managing, aggregating and applying detailed information.

Methane Fluxes from Boreal Forest Wetlands in Saskatchewan. Holly Rask*, Darwin W. Anderson, and Jeff Schoenau, Saskatchewan Centre for Soil Research, University of Saskatchewan Saskatoon, SK.

Methane flux measurements from static chambers indicate boreal forest wetlands are important contributors to the global natural CH_4 emission. Methane fluxes from peats of different depth and hydrology ranged from 176 to 2250 mmole CH_4 m^{-2} yr^{-1} exceeding those reported for other freshwater wetlands around the world. The elongated wetland included a margin of forest peat (about 0.5 m depth), grading to a horizontal fen (1 - 2.7 m) and a string fen (>2 m) in the central portion. Moving from the edge to the horizontal fen area resulted in increases in CH_4 flux rates from 1.08 to 13.80 mmole CH_4 m^{-2} d^{-1} and then a decrease in two profiles in the central part of the fen to 12.01 and 3.77 mmole CH_4 m^{-2} d^{-1}. The water level relative to the peat surface became deeper moving from the fen edge to the centre. Methane flux and water levels and temperature were correlated for all locations except the two in the central part of the fen. The lower importance of water levels and temperature in the profiles in the centre of the fen may be attributed to greater influence by water flow. The steady water flow appears to have lowered the CH_4 flux by increasing CH_4 oxidation. Methane flux rates in the profiles with little water flow were positively correlated with inorganic phosphorus concentrations in interstitial water at 50 cm depth, the depth where CH_4 production is likely to occur.

Impact of cement kiln dust on metal fractions in a humo-ferric podzol. I. Royer[*1]; R.R. Simard[2] and M.R. Laverdière[1]; [1]Université Laval and [2]Agriculture and Agri-Food Canada, Ste-Foy, Québec.

The use of cement kiln dust (CKD) in agriculture is an excellent way to recycle this residue. The chemical analysis of the CKD reveals that they are a good source of K, Ca and in micronutrients such as Cu, Zn and Mn. However, CKD contain various amounts of heavy metals so their use may result in soil and surface water contamination.The objective of this study was to investigate the migration of heavy metals after application of CKD and dairy liquid manure (DLM) in a Parent sandy soil (humo-ferric podzol). A column leaching experiment was conducted and a sequential extraction was subsequently done to study the fate of the applied metals in soil. The soil was treated with 4 doses of CKD (0, 3, 6 and 12) and 2 doses of DLM (0 and 50 m^3/ha) before the leaching experiment. The results show that the metal concentration in the leachates was always below the standards for drinking water. Small amounts of Cu, Ni, Zn and Mn in very labile forms were extracted by H_2O and $Mg(NO_3)_2$ whereas Cd was undetected. The non-labile HNO_3 extractable fraction was the most important for all metals except Cu. The results of the present study suggest that the environmental impact of CKD for their contribution to heavy metal contamination of soil, surface and groundwater is limited.

Évaluation de la fertilité biologique et chimique des sols dans des systèmes de production biologique et conventionnelle. Sbih, M.[*], A. N'Dayegamiye, A. Karam

On ne connaît pas encore tout à fait les facteurs biologiques et chimiques du sol reliées à la minéralisation d'azote dans les sols sous prairies. Cette étude comparative visait à évaluer les relations entre le potentiel de minéralisation de l'azote du sol avec les facteurs physiques, chimiques et biologiques des sols sous prairies en système de production biologique ou conventionnelle. Les pratiques de fertilisation consistaient en un apport de fumier seul, ou de fumier avec engrais minéraux et pesticides respectivement pour le système de production biologique et conventionnelle. L'étude incluait 6 sols de différentes classes texturales. De façon générale, les résultats indiquent que la minéralisation de l'azote et la biomasse microbienne ne sont pas différentes entre les systèmes. Cependant, la minéralisation de l'azote tend à varier en fonction des facteurs intrinsèques des sols. En effet, l'analyse statistique démontre une forte corrélation entre la minéralisation de l'azote et la teneur en argile, la teneur en azote total ainsi que le carbone (R^2 = 62-75; P < 0,0001). De même, une corrélation significative a été observée entre la minéralisation de l'azote et la teneur en M.O. légère (R^2 = 34; P < 0,05). Des corrélations significatives étaient également obtenues entre la minéralisation de l'azote, la biomasse microbienne, la phosphatase acide et alcaline et l'ammonification de l'arginine (R^2 = 56-62; P < 0,0005), ainsi que entre l'uréase (R^2 = 40; P < 0,01). La procédure stepwise de la régression multiple indique cependant que c'est principalement l'azote total et le C-Biomasse qui déterminent le plus la minéralisation de l'azote dans les sols étudiés (N-min. = 255,84 Nt + 0,04 C-bio + 28,84. R^2 = 60; P < 0,001). Cette étude démontre donc que le potentiel de minéralisation de l'azote du sol sous prairies est fortement relié à la teneur en azote total du sol mais également à la biomasse microbienne, celle-ci étant une composante principale de la fraction légère de la M.O.

Composition chimique et valeur fertilisante des effluents d'une usine de compostage de fumiers et de boues de papetières. Christian Scraire[*] et Antoine Karam, Département des Sols, Université Laval, Québec, G1K 7P4.

Dans les conditions climatiques du Québec, les opérations de compostage à ciel ouvert génèrent d'importants volumes d'effluents. Ces sous-produits liquides sont étudiés ici en tant que source potentielle d'eau d'irrigation. Un compost de fumiers et deux composts de boues de papetières ont été mis en service aux fins de l'étude. Le compost de fumiers est en phase active de décomposition de même que l'un des composts de boues de papetières. Le deuxième de ceux-ci est en fin de maturation (il est stabilité). On a comparé la composition chimique des effluents générés par chacun

de ces composts en suivant leur évolution pendant les six mois d'une saison de fermentation (mai à octobre). Les échantillons d'effluents ont été prélevés dans les bassins d'entreposage de l'usine. les résultats d'analyse montrent des teneurs appréciables en N et K. Les contenus en métaux lourds sont inférieurs aux recommandations pour la qualité de l'eau d'irrigation. Cependant, les concentrations en coliformes totaux et les niveaux de conductivité électrique leurs sont largement supérieurs. L'effluent du compost de fumiers est le plus lourdement contaminé. De juin à octobre, la charge polluante des effluents s'atténue graduellement. Afin d'évaluer le potentiel fertilisant des effluents, un essai cultural en serre a été réalisé sur deux plantes potagères et une graminée fourragère. Préalablement à la mise en culture, un terreau a été enrichi au moyen des effluents à raison de cinq doses croissantes jusqu'à concurrence de 2 L par dm^3 de terreau. L'enrichissement a causé une hausse sévère de la salinité du terreau. Sa réserve en éléments nutritifs assimilables s'est accrue proportionnellement aux doses appliquées, ce qui s'est traduit par une intense stimulation des rendements. Aux fortes doses cependant, l'effluent du compost de fumiers a provoqué une inhibition de la germination et une réduction des prélèvements totaux en N, P et K. La graminée s'est montrée la plus tolérante aux traitements. De façon générale, la composition chimique des effluents et leur valeur fertilisante ont varié en fonction de la nature et du degré de stabilité des matériaux compostés.

The enigma of soil nitrogen revisited. Y.K. Soon*, Agriculture and Agri-Food Canada, Beaverlodge, AB.
Ten to thirty percent of applied N are commonly not recovered: this loss of N, the enigma of soil N, has been traditionally attributed to leaching and/or denitrification. Since 1966 when Allison last reviewed the topic, considerable advances have been made in our understanding of N fluxes in the soil-plant system. Recent studies of leaching and denitrification losses are reviewed. Two other loss mechanisms, viz. rhizodeposition of N and emission of ammonia from plant foliage, and their fluxes will be discussed in relation to the nitrogen cycle. Loss of ammonia from the foliage of temperate arable crops is of similar magnitude as denitrification N loss from moderately fertilized soils, commonly 1 to 15 kg N ha^{-1} an^{-1}. The few estimates of N rhizodeposition suggest that it may be in the range of 20-60 kg N ha^{-1} an^{-1}.

Flux measurement of nitric oxide from agricultural soils. N.M. Taylor, E.G. Beauchamp, G. Thurtell and G. Kidd, Land Resource Science, University of Guelph, Guelph, ON, N1G 2W1
Nitric Oxide (NO) flux from agricultural soils was estimated using an aerodynamic gradient method. NO concentrations were measured in air samples at 0.5 and 1 m above the soil surface using a chemilumi-nescent analyzer and from this, hourly concentration gradients were estimated. Eddy diffusivity values estimated hourly from wind profile data were combined with hourly averaged NO concentration gradients to estimate a flux. The study site is a 1 hectare plot located on a Conestogo silt loam at the Elora Research Station, Elora, Ontario. In the fall of 1993, an established alfalfa stand was incorporated and canola was planted in the spring and harvested in the fall of 1994. Daily averaged fluxes have not often exceeded 1 ng NO m^2 s^{-1} during the period of data collection; from early January to the end of April, 1995. Periodic episodes of negative fluxes were observed in which NO seemed to enter the soil; these episodes lasted for a few hours. Hourly averaged ambient NO concentrations were, generally, less than 1 ppb but occasional abrupt increases in NO concentrations were observed. These increases may be related to wind direction and unknown sources. The method used for NO flux determination may be a useful technique for episodic and long-term NO quantification of fluxes from soil.

Effets résiduels attribués aux résidus de désencrage utilisés comme amendements agricoles. G. Thériault*[1], J. Caron[1], J. Gallichand[2], L. Trépanier[1] et D. Langlois[1], Départements des sols[1] et de génie rural[2], Université Laval, Sainte-Foy, Qc.
Des résidus de désencrage ont été ajoutés à un sol agricole (loam limoneux) pendant deux années consécutives, soit en mai 1992 et 1993. Préalablement à l'expérience, le sol était sous prairie et a été cultivé en pomme de terre pendant les trois années subséquentes. Des doses de 0, 6, 12 et 18 tonnes anhydres de résidus par hectare ont été appliquées. En plus de la fertilisation azotée de base (135 kg-N/ha), des doses supplémentaires d'azote de 0, 45, 90 et 135 kg-N/ha ont été ajoutées aux différentes doses de résidus afin de réduire l'immobilisation. Pour qualifier et quantifier les effets de ces amendements, plusieurs paramètres chimiques et physiques ont été mesurés. Le pH, le % de matière organique (%MO) et les teneurs en éléments minéraux et en métaux lourds ont été les paramètres chimiques principaux, tandis que la teneur en eau et la stabilité structurale ont été les paramètres physiques principaux. Le suivi de ces paramètres s'est échelonné sur trois années, c'est-à-dire, pendant les deux années d'épandage, soit 1992 et 1993, et pendant l'année 1994 où aucun résidus n'a été épandu. Les résultats démontrent d'une part que le %MO est le seul paramètre chimique qui ait varié significativement. Une augmentation de 1% avec les doses de résidus les plus élevées a été observée, quoique cette variation ne s'est pas maintenue en 1994. D'autre part, un effet significatif sur la stabilité structurale a été observé à partir de la deuxième année d'épandage. Une augmentation de près de 20% aux plus fortes doses de résidus a été mesurée et cet effet s'est maintenu pendant l'année 1994.

Effet des doses et des modes d'application de l'engrais azoté marqué au ^{15}N sur le blé panifiable. T. Sen Tran* et G. Tremblay. MAPAQ, Sainte-Foy et Saint-Bruno, QC.

Le rendement et la qualité du blé panifiable dépendent grandement de la fertilisation azotée. L'effet des doses d'azote variant de 0 à 180 kg N ha^{-1} et de deux modes d'application (à la volée au semis ou à l'anthèse) sur la production du blé AC Pollet et sur l'efficacité de cet engrais (^{15}N), a été étudié dans une expérience au champ à Saint-Bruno (argile limoneuse Sainte-Rosalie) pendant deux ans. L'effet des doses d'azote sur le rendement et la qualité des grains était très significatif. Les doses économiques optimales de N variaient de 90 à 120 kg N ha^{-1} en 1993 et 1994. La proportion de N dérivé de l'engrais (Ndff) et les coefficients d'utilisation par le blé de cet engrais étaient plus élevés dans les traitements de l'application à l'anthèse pour toutes les doses de N. L'application tardive de l'engrais azoté était donc utilisée plus efficacement par le blé panifiable. L'engrais ^{15}N résiduel dans ce sol à la récolte du blé se trouvait surtout sous forme organique ou fixée qui variait de 40 à 50 % de la dose appliquée. Par contre, les quantités d'engrais résiduel sous forme minérale étaient très faibles et correspondaient à seulement 1,5 % de cette dose pendant les deux années de l'étude. La perte de l'engrais azoté était en moyenne 15 % de la dose appliquée.

Effet du fractionnement de la fertilisation azotée d'appoint, en culture de pomme de terre, à la suite de l'incorporation au sol de bois raméaux fragmentés. J. Tremblay* et C.J. Beauchamp, Département de phytologie, Centre de recherche en horticulture, Université Laval, Sainte-Foy, QC, G1K 7P4

Une des principales causes de la dégradation des sols sous monoculture de pomme de terre (*Solanum tuberosum* L.) au Québec est la diminution de leur contenu en matière organique. L'utilisation du bois raméal fragmenté en copeaux (BRF) comme amendement organique suscite un intérêt grandissant. L'effet de l'incorporation de BRF sur les propriétés physico-chimiques et microbiologiques du sol et sur les rendements de la pomme de terre a été évalué en 1992 et 1993. L'effet de l'apport, en post-levée, d'azote (N) d'appoint, nécessaire pour contrer l'immobilisation, et fractionné en une, deux ou trois applications a aussi été étudié. L'incorporation de BRF a fait augmenter la biomasse microbienne et les teneurs du sol en N total et en carbone total. La quantité d'N d'appoint, appliquée afin que les BRF aient une teneur en N total équivalente à 1 % sur une base sèche, a permis d'obtenir des rendements similaires à ceux du témoin. De plus, il y a eu un effet résiduel positif des BRF sur les rendements l'année suivant leur incorporation. Le fractionnement de la fertilisation azotée d'appoint n'a pas permis d'augmenter les rendements. Par contre, le fractionnement en trois applications a fait augmenter les teneurs du sol en nitrates à l'automne 1993.

Impacts environnementaux associés à l'entreposage des résidus de désencrage du papier. L. Trépanier[1], J. Gallichand[2] et J. Caron[1], [1]Sols et [2]Génie Rural, Université Laval, Québec, Canada.

Le recyclage du papier a pour effet de produire une quantité considérable de résidus. Ces résidus sont généralement enfouis ou incinérés, mais ils peuvent également être utilisés comme amendement organique sur les sols agricoles compte tenu de l'importante source de biomasse qu'ils représentent. Cette pratique implique que les résidus doivent être temporairement entreposés chez les producteurs. Il est donc important d'évaluer l'impact sur la qualité de l'eau de surface et souterraine de cet entreposage temporaire. Pour ce faire, des résidus de désencrage ont été caractérisés chimiquement, puis des essais de terrain ont été réalisés sur une plate-forme imperméable afin d'évaluer la quantité et la qualité de l'eau percolant dans les résidus. Les résultats ont démontré que 22% et 30% du volume des précipitations ont percolé à la base des résidus en 1993 et 1994 respectivement. Les échantillons prélevés à l'exutoire de la plate-forme ont démontré que l'ensemble des composés chimiques analysés dans l'eau de percolation étaient sous la limite permise par le ministère de l'environnement du Québec, sauf pour la DBO5 et les acides gras et résiniques. Ces produits sont biodégradables et semblent présenter peut de risques de contamination.

Root distribution and activity for Boreal Mixedwood species in different age stands. K.C.J. Van Rees* and M.A. Thick, Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 5A8.

Concern over the impacts of harvesting and site preparation on soil processes and the successful reestablishment of new forests has resulted in a need for an understanding of the role root systems play in capturing potentially leached nutrients. The objective of this study was to 1) investigate the rooting distribution of aspen and white spruce in an aged chronosequence of mixedwood stands and 2) determine the root activity of aspen and spruce in the litter and Bt horizons using a strontium tracer. Root distributions were determined by taking cores to 120 cm depth in a 10, 20 and 110 year old mixedwood stand. Strontium was applied in 2m^2 plots either on the litter or through augers holes at a 90 cm depth and foliar samples collected throughout the summer and analyzed for strontium. The majority of roots (50%) for each species were found in the LFH horizon for all three sites. Root length decreased with soil depth which also corresponded to the low soil temperatures (5-7^{o}C) found at 50 to 100 cm. Total root length for spruce and aspen increased with increasing stand age but generally decreased for grass and other understorey species. Root activity was highest in the LFH horizon, with aspen roots being more active than spruce

roots. Root activity was highest for the 10 year old stand. These results suggest that aspen are quite competitive with spruce for below ground resources particularly in the LFH horizon.

L'engazonnement des berges de cours d'eau agricoles et ses effets de mitigation sur l'érosion hydrique. Luc Vézina, Service des sols, MAPAQ, Sainte-Foy (Québec).
Plusieurs associations de graminées gazonnantes ont été ensemencées au printemps et à la fin de l'été 1986 sur les talus de six cours d'eau aménagés dans des sols de textures différentes, afin d'évaluer leur potentiel à s'établir rapidement et former des couverts végétaux. La couverture au sol de plantes sur les talus n'a été suffisante que pour seulement la moitié des cours d'eau, soit ceux drainant des sols meubles et fertiles, dont les surfaces sont parsemées de cavités et de petites fentes. De toutes les espèces mises à l'essai, la fétuque rouge traçante a été celle qui s'est le mieux implantée dans les divers milieux. Parmi les mélanges évalués, ceux composés de fétuque rouge, d'agrostide blanche et de ray-grass vivace ont généralement donné les meilleurs résultats. Les graminées gazonnantes ont réduit les manifestations des phénomènes d'érosion hydrique sur un des deux cours d'eau mis sous observation, alors que les talus d'un troisième aménagé dans une argile limoneuse lourde, demeuraient stables, même sans enherbement.

Stable carbon isotope of calcitic pendants from Chernozemic soils in Saskatchewan D. Wang* and D.W. Anderson, Soil Science Department, University of Saskatchewan, Saskatoon, Saskatchewan. Canada S7N 5A8.
Carbonate pendants occurring beneath pebbles in soils represent almost pure pedogenic carbonate forming in an environment that contains lithogenic carbonate minerals. The pendants were sampled at several depths from an Orthic Black soil, and from the Cca horizons of four Dark Brown soils with different proportions of C_3 and C_4 plants. All the soils were developed from medium- to fine-textured glacial till deposits which contained about 10 to 20% $CaCO_3$ equivalent. Scanning electron microscope analyses showed that pedogenic carbonates in the form of calcite had minute crystals, joined together to form layered clusters about 0.5 to 4 μm in diameter. The carbonate pebbles exhibit fine- and close-structured dolomite with large rhombohedral crystals. Analyses by X-ray diffraction showed that dolomite is the major mineral in the carbonate pebbles, with the ration of $CaCO_3/MgCO_3$ about 1.3. The carbonates in the pendants are dominated by calcite, with Mg-bearing calcite resulting in a right skewness of the calcite peak at 3.03 A. The degree of skewness was proportional to the ratio of $CaCO_3/MgCO_3$ in the pendant.
Variations in $\delta^{13}C$ values of the carbonate pendants in the Black soil profile reflect the $\delta^{13}C$ of the soil organic matter (-25.0 to -26.0‰), with a relatively consistent fractionation factors of +16.9 to +17.9‰. A slightly higher $\delta^{13}C$ values than the theoretical numbers in the carbonate pendants might have resulted from the inclusion of primary carbonate within pendants. More positive $\delta^{13}C$ values of the carbonate pendants from Dark Brown soils reflect the $\delta^{13}C$ values of the soil organic matter (-25.4‰ to -21.8‰), as related to the relative proportion of C_3 and C_4 plants, at present and in the past, landscape position and the influence of atmospheric CO_2 in the upper horizons.

Sol, agriculture et environnement; exemple de l'Europe de l'Ouest. S.P. Wicherek, Centre de Biogéographie-Écologie, ÉNS, URA 1514 CNRS Le Parc - 92211 - Saint-Cloud, Paris, En collaboration avec Mme M.O. Boissier.
Actuellement, les plaines de grande culture d'Europe du Nord et de l'Est sont touchées par une dégradation des sols, en particulier par l'érosion hydrique qui entraîne une perte de leur fertilité naturelle; ceci est compensé par l'apport d'engrais chimiques et de pesticides qui influencent par la suite la qualité des eaux superficielles et des nappes phréatiques. Le coût de cette dégradation est évalué à 2 milliards de $ US par an. Pour mémoire la France représente environ 25 % de la production globale agricole de l'U.E. Ainsi les sols et les eaux pollués interviennent directement sur la qualité des végétaux récoltés et en conséquence sur la qualité de la santé humaine. Responsable? L'Homme. Tout a commencé avec l'introduction de l'agriculture intensive et extensive vers 1970, en Europe de l'Ouest, avec le remembrement et le changement des modes et techniques de l'agriculture et en Europe de l'Est avec le système de collectivisation; compte tenu de leur mauvaise gestion agricole dans le passé, il est urgent de reconsidérer ces problèmes pour leur éviter de faire les erreurs des autres grands pays agricoles (ex. U.E.). La question est: De quelle façon peut-on remédier à ce problème sans bouleverser les systèmes socio-économiques déjà en place? Les solutions existent. De nombreuses expérimentations de terrain, entre autres celles de notre Centre, à différentes échelles spatiales (parcelles, bassins versants, communes), débouchent sur des propositions d'utilisation et d'aménagement des espaces ruraux pour faciliter le développement d'une agriculture durable.

Competitive sorption and nonlinear isotherms in soil organic matter. B. Xing*, J.J. Pignatello, and B. Gigliotti, The Connecticut Agri. Exp. Station, P.O. Box 1106, New Haven, CT 06504, U.S.A.
Competitive sorption and isotherm nonlinearity can provide insight into sorption mechanisms and properties of sorbents. We here examine competitive sorption between Atrazine and other co-solutes and their isotherm linearity in suspensions of sorbents including a topsoil with ~3% soil organic matter (SOM), a peat with 93% SOM, soil humic acid with 99% SOM, hydrophobic (polyethylene) and hydrophilic (cellulose, and chitin) polymers, and a porous silica. The co-solutes included *s*-

triazine herbicides (Prometon, and Cyanazine), non-herbicide atrazine analogs (2-chloro-4,6-dimethoxy-s-triazine and 5-chloro-1,3-dimethoxybenzene), and trichloroethylene (TCE). For the polymers, no competition occurred between Atrazine and Promoton or between Atrazine and TCE, and the single-solute isotherms were linear. For silica and all the SOM-containing sorbents, competition occurred between Atrazine and its analogs, but was weak or zero between Atrazine and TCE, and the single-solute isotherms were typically nonlinear. The organic polymers behave as a partition medium. Silica behaves as though the triazines and TCE were sorbing in different domains on or near the surface. We propose that SOM as a dual-mode sorbent containing both partition and Langmuir (site-directed) domains, internal to the matrix, and where sorbates may experience different Langmuir sites depending on their chemical and physical properties.

Dynamics of soil phosphorous fractions in a long-term monoculture corn system. T.Q. Zhang* and A.F. MacKenzie, Department of Natural Resource Sciences, McGill University, P.Q.

Potential for grain corn (*Zea mays* L.) production has made monoculture corn a common management practice. The fate of fertilizer P in intensive management of grain corn must be determined to achieve sustainable crop production and environment quality. Objectives were to quantify soil P fractions as related to annual additions of manure and inorganic P in a long-term continuous corn experiment. With manure P plus 44 kg P ha^{-1} y^{-1} inorganic P, soil Pi decreased linearly as the result of increase in labile Pi and a decline of moderately labile Pi. High P rates of 132 kg P ha^{-1} y^{-1} plus manure P increased soil Pi from accumulations of labile Pi, moderately labile Pi, and stable Ca-bound Pi. Inorganic P at either rates combined with manure P decreased soil labile Po and increased soil moderately labile Po. The net gain of soil Po increased with inorganic P rate when manure was present. Without manure, 44 kg P ha^{-1} y^{-1} resulted in no changes in soil P fractions except for residual P which decreased, indicating a sustainable soil P system from a P rate of 44 kg ha^{1} y^{-1}. Soil Po and Pi levels increased continuously when soil was fertilized with 132 kg P ha^{-1} y^{-1} inorganic P. Path analysis showed interactions among soil P fractions. For the manure-inorganic system, moderately labile Pi constituted the major soil P sink derived directly from added inorganic P and indirectly from Ca-bound Pi. Soil residual P constituted the second soil P sink which was mainly supplied from added organic P through moderately labile Po. For this system, 86% of available Pi was supplied directly from added inorganic P. Moderately labile Pi was also a major sink for added P in the inorganic system, but release rapidly to maintain soil available P level. Therefore, changes in both labile and moderately labile Pi should be taken into account in determining P fertilizer requirements of continuous corn systems.

Effets des régimes de coupe et de la fertilisation potassique sur le rendement, la qualité et la persistance de la luzerne. J. Zizka*, R.R. Simard, R. Michaud, et G. Allard.

La luzerne (*Medicago sativa* L.) a besoin de quantités importantes de potassium pour maintenir une haute productivité. Il a déjà été démontré que des apports de K augmentent les rendements, le taux de survie et la valeur nutritive de la luzerne. Cela est particulièrement important dans des systèmes de production intensive. Les objectifs de cette étude étaient de déterminer l'influence de la fertilisation potassique et des régimes de coupe sur le rendement, la survie, la qualité et la composition minérale ainsi que sur l'évolution des teneurs en potassium du sol. L'étude s'est déroulée de 1990 à 1993 sur deux sols, un sol Saint-André et un sol Saint-Nicolas. Quatre doses de K (0, 100, 200 et 400 kg ha^{-1}) et neuf régimes de coupe (6 de trois coupes et 3 de quatre coupes). Aucune augmentation de rendement n'a été obtenue avec les doses de K sur le sol Saint-Nicolas pour les trois ans tandis qu'un effet significatif a été obtenu sur le sol Saint-André deux années sur trois. Le pourcentage de survie de la luzerne a augmenté avec les doses de potassium. Les régimes à quatre coupes n'ont pas présenté d'avantage par rapport aux régimes à trois coupes. La concentration en K a augmenté avec les doses de K tandis que celles de Ca et Mg diminuaient. Les doses de K n'ont eu aucun effet sur la teneur en protéines de la luzerne. Sur le sol Saint-Nicolas, la teneur en K rapidement échangeable à la fin de l'expérience était presque identique à celle du début de l'expérience dans le témoin tandis que sur le sol Saint-André il a fallu appliquer 200 kg ha^{-1} de K par année pour maintenir le niveau de départ en K rapidement échangeable.

Dynamique des éléments dans les écosystèmes terrestres - Affiches

Evaluation of closed chamber and soil core methods of measuring denitrification. M. Abbott*, F. Cadrin, M.X. Fan, and A.F. MacKenzie. Dept Natural Resource Sciences, Macdonald Campus, McGill University, Ste.-Anne-de-Bellevue, Québec, H9X 3V9.

Measuring denitrification N-loss from soils is an important part of studies aimed at improving agricultural management systems. The objective of this research was to study two closed-chamber methods of measuring denitrification, one in the field and the other in incubation jars. Both used acetylene (C_2H_2) inhibition of

the reduction of N_2O to N_2. The N_2O emissions measured for the two methods were correlated with variables that would affect the rate of denitrification (temperature, water filled pore space, N-fertilizer rate, tillage, crop type). The two methods were also correlated with each other. It was found that water filled pore space, N-rate, soil ammonium and nitrate concentration were highly correlated with the N_2O emissions for the two methods. The two methods were also highly correlated with each other, so they should be interchangeable for experimental purposes.

The Health of Our Soils: Toward Sustainable Agriculture in Canada. D.F. Acton* and L.J. Gregorich, Agriculture & Agri-Food Canada, Saskatoon, Sask.
This report summarizes results of Agriculture and Agri-Food Canada's Soil Quality Evaluation Program and includes contributions from leading Canadian soil scientists in the non-government sector. Soil health, also called soil quality, is defined from an agricultural perspective, and the factors affecting it are described, including land use and management practices. A GIS-based description of soil health in southern Ontario and the Prairie provinces is given, followed by an outline of the national benchmark monitoring system. Research findings relating to soil quality are presented for the following processes: loss of soil organic matter, structural degradation, erosion, salinization, soil contamination, and agrochemical entry into groundwater. A summary chapter interprets trends in soil quality and management practices, and makes recommendations for polity change. The report is a highly graphical presentation written for non-scientists and featuring explanatory side-bar's, many new maps, and a practical glossary.

Compositional nutrient diagnosis of P status in potato crops. A.A. Adou Rahim* and L.É Parent, Soil Science department, Laval University, Québec, Canada.
In Quebec, potato crops are largely grown on light acid soils altered by podzolization. The plow layer is made of an impoverished A horizon and a Fe- and Al-enriched B horizon. The abundance of sesquioxides and the low organic matter content in the cultural profile provide high P-fixing capacity. Liming to pH not exceeding 5.6 and the banding phosphate fertilizers improve the P status of the soil-plant system. Plant response to those treatments could be diagnosed by yield evaluation and the foliar analysis. Agricultural lime, dolomitic limestone and basalt were applied on an acid soil (pH 4.6). Ordinary superphosphate, treble superphosphate, diammonium phosphate impregnated with humic peat and biosuper-phosphate were banded at two or three rates. Highest tuber yield was 40 t/ha. There was no response to liming materials as pH did not exceed 4.9. There was significant response to P fertilizers. Nutrient balance assessment of the foliage by compositional Nutrient Diagnosis indicated a critical "d" range of 1.46 to 1.67 and a critical P index of 0.8.

Persistance au champ de deux herbicides dans deux sols sous trois travaux primaires du sol. M.-H. April*, P. Lafrance, O. Banton, INRS-Eau, U. du Québec, Ste-Foy, QC.
Les pratiques culturales peuvent influencer le destin des herbicides dans les systèmes sol-eau. La présente étude vise à évaluer les effets du type de travail primaire du sol (conventionnel, chisel et semis direct) et du mode d'épandage des herbicides (pulvérisation en surface totale ou en bande) sur la persistance de l'atrazine et du métholachlore dans deux sols (loam de la série Blandford et argile de la série St-Urbain) non drainés et cultivés en maïs-grain. Le dispositif expérimental est un factoriel en blocs aléatoires complets avec trois répétitions. Un échantillonnage de sol a lieu à deux profondeurs (0-10 et 10-20 cm) durant la saison de croissance afin de déterminer, suite à leur extraction, la concentration résiduelle des deux herbicides. Au site de Varennes, les concentrations en herbicides (0-10 cm) diminuent très faiblement au cours du temps, indiquant une persistance apparente très élevée. Ce résultat s'explique par une fréquente saturation du sol en eau due, à la fois, à des précipitations abondantes et au comportement du sol peu perméable, ce qui cause des conditions anaérobies et une faible infiltration verticale. Bien que les concentrations résiduelles d'herbicides dans le sol soit généralement plus faibles avec l'épandage en bande, de telles conditions rendent difficile l'évaluation de l'impact des travaux du sol. Au site de Frelighsburg, les concentrations d'herbicides (0-10 cm) décroissent selon une allure exponentielle (demi-vie de 5 à 10 jours). Pour ce site, les travaux du sol ont un faible impact sur la persistance des herbicides, les concentrations résiduelles après deux semaines étant légèrement plus élevées sous chisel. Pour les deux sols, et dans la plupart des cas, les concentrations à 10-20 cm sont faibles et voisines de la limite de détection. L'étude montre que la prise en compte de la nature du sol est un important facteur lors de l'évaluation de la persistance d'herbicides sous différents travaux du sol.

A Model for Estimating Water Use by Potatoes. G.H.B. Ash, C.F. Shaykewich*, University of Manitoba, and R. Raddatz, Winnipeg Climate Centre.
A model for estimating water demand by potatoes solely from meteorological inputs has been developed. Percent ground cover and root growth are estimated from "P days" calculated from air temperature. Potential evapotranspiration is estimated from daily surface and upper air measurements. Crop water demand is calculated by multiplying potential evapotranspiration by percent ground cover. Field testing of the model includes measurement of root growth, ground cover, phenological development and soil water content.

Strategies to reduce nitrate leaching in sandy soils. B. Ball-Coelho* and R. Roy, Agriculture and Agri-Food Canada, Delhi, ON.

Nitrate leaching losses from non-irrigated corn grown on coarse-textured soil are greatest following growing seasons when yield is limited by drought. We monitored soil (to 1.5 m) and soil solution (at 1 and 1.5 m) nitrate concentrations in corn systems side-dressed with 150 kg N/ha (the maximum economic N rate). After a dry year (1993), subsoil and soil solution nitrate concentrations were greater with conventionally=tilled than no-till corn, and were reduced by a cereal rye cover crop in both systems. Following a growing season with adequate rainfall (1994), subsoil and soil solution nitrate concentrations were lower (than in 1993), and the smaller rye cover crop did not reduce solution nitrate concentrations. In the dry year, subsoil and solution nitrate concentrations were also reduced where conventionally-tilled corn was irrigated once, due to improved corn growth and greater N uptake. Relative to side-dressed UAN (urea-ammonium-nitrate), soil solution nitrate concentrations were further reduced by side-dress sources containing more N as NH_4 (anhydrous ammonia and a nitrification inhibitor added to UAN).

Phosphate release potential of overfertilized soils of important agricultural areas of the EC: Implications for the sustainability of agricultural systems and for the environment. E. Barberis, F. Ajmone-Marsan, R. Scalenghe, DI.VA.P.R.A.- Chimica Agraria Universita di Torino, Italy, A. Lammers, U. Schwertmann, Institut fur Bodenkkunde, Technische Universitat Munchen, Germany., A.C. Edwards, R. Maguire, M.J. Wilson, Soils and Soil Microbiology Division and Plants Division, The Macauly Land Use Research Institute - Aberdeen, UK. A. Delgado, J. Torrent, Departamento de Ciencias y Recursos Agricolas y Forestales, Universidad de Cordoba, Spain.

Heavy applications of phosphate fertilizers have resulted in high levels of phosphate in many soils of the European Community. This implies economic waste and environmental hazard. The present project aims at understanding the soil and other environmental factors that control phosphate release from the solid phase of the soil to an aquatic environment. The study will deal with overfertilized soils from agricultural areas of the EC namely, Italy, Germany, Great Britain and Spain.

The objectives of this research are:

- Identification of the indigenous or neoformed soil constituents acting as phosphate sinks in moderately to heavily fertilized soils of important, contrasting agricultural areas of the EC.
- Knowledge of the relationships between the nature of the P-sinks and the mineralogy and chemistry of the selected "benchmark" soils.
- Knowledge of the P-desorption characteristics of the benchmark soils in relation to P forms, P-sorption properties, mineralogy, chemistry, structure and other soil properties.
- Evaluation of the P-release characteristics of the soils materials that, for selected agricultural systems and soil types, are transported by runoff and constitute a possible source of eutrophication of waters.

The adopted methodology included the characterization of the chemical, physical and mineralogical properties of the selected soils, the identification of P-containing compounds and study of P forms, the study of the kinetics of the P release under different environmental conditions. This will include the comparison between calcareous and non-calcareous soils, the release in aquatic environments also of different salinity and the release of P by eroded soil materials as well as by soils under varying redox conditions. The results (a) will permit a better appraisal of the residual P fertility of overfertilized soils; (b) should lead to a better understanding of the impact of changing climatic conditions on the release of P in overfertilized soils and (c) will clarify the potential of overfertilized soils to cause eutrophication of continental and estuarine waters.

Sorption/desorption kinetics of P in agricultural and forested soils. S. Beauchemin*[1], R.R. Simard[2] and D. Cluis[1], [1]INRS-eau and [2]Agriculture and Agri-Food Canada, Ste-Foy, Quebec.

A miscible displacement technique was used to study the mobility of P in A, B and C horizons of soils under contrasting land uses: forest and hay fields of farms with no surplus or a known surplus of manure nitrogen. Leaching experiments, using a solution of 0,01M KCl containing 5 mg P/K for the sorption phase and a P-free electrolyte solution of the desorption, were conducted in glass columns. Breakthrough curves were calculated; sorption/desorption kinetics of P were also described with an incremental first-order model. Breakthrough curves showed that, in the surface horizon, the sorption front appeared earlier in agricultural than in forest soils. Although sorption curves i the B horizon were comparable for all soils, the earliest sorption front was still associated with the highest animal density in the C horizon. This land use also showed a weaker retention of previously added P in the C horizon. Results of kinetic studies revealed that the amounts of sorbable P were reduced with the increase in animal density for the A and C horizons. In spite of its large sorption capacity, B horizon presented amounts of desorbable P two times larger in agricultural than in forest soils. The results of the present study suggest that P leaching is more probable in soils from farms with surplus manure than in soils from farms of smaller animal density.

Rotation légumière et fertilisation azotée en sols organiques : incidence sur les propriétés physiques du sol et les pertes d'azote par lessivage. C. Bélec[1], J. Caron[1], N. Tremblay[2], L.E. Parent[1], [1]Département des Sols, Université Laval, [2]Agriculture et Agro-alimentaire Canada, Station de St-Jean, QC.

L'introduction d'orge dans la rotation légumière a permis de produire un couvert végétal important et d'améliorer la qualité du sol organique de la station de Sainte-Clotilde, Qué. Une élévation rapide de la conductivité hydraulique saturée et de la rétention d`eau a été constatée l'année même d`implantation de l'orge. Toutefois, l'effet s'est dissipé au cours de l'année suivante, suite à la remise en culture de la carotte. D'importantes quantités d'azote sont minéralisées annuellement par les sols organiques cultivés depuis longtemps. Nos données préliminaires indiquent que les recommandations d'azote doivent être réévaluées pour la carotte, afin de tenir compte de cette minéralisation. En effet, dans une série d'expériences où des doses d'azote variant de 0 à 75 kg/ha ont été appliquées, aucun effet significatif de la fertilisation azotée n'a été observé sur les rendements de carotte. Le mouvement de nitrates à travers le profil de sol a été suivi dans les différents traitements. On a remarqué que les doses d'azote plus élevées amenaient de plus grandes quantités de nitrates sous la zone racinaire, augmentant ainsi le risque de contamination de la nappe d'eau souterraine. L'introduction d'orge dans la rotation n'a pas affecté significativement les besoins azotés de la carotte.

Effects of texture and tillage on soil enzyme activities. D.W. Bergstrom, C.M. Monreal, A. Tomlin and J. Miller, Agriculture and Agri-Food Canada, Ottawa and London, ON.

The objective of this study was to test for effects of texture and tillage on six enzyme activities. Soil samples were collected from a soybean (*Glycine max* L.) field in south west Ontario on four dates, from sites with and without conventional tillage, on fine (SiCL) and coarse (FSL) textured soils (Gray Brown Luvisol-Humic Gleysol complex). Soil was sampled at two depths: 0-8 cm, and 8 cm to the bottom of the Ap horizon. Four enzymes responded similarly to texture. Phosphatase, β-glucosidase and arylsulfatase activities were greater in coarse textured soil. Glutaminase activity was greater in coarse textured soil, within the lower layer. In absence of an effect on dehydrogenase, increased activity of these four enzymes in coarse textured soil could not be attributed to increased microbial activity. All enzymes responded similarly to tillage. Dehydrogenase, urease, glutaminase and β-glucosidase activities were greater in the surface layer of no-till soil. Arylsulfatase activity in fine textured soil, and phosphatase activity were greater in no-till plots at both depths. Activity of all enzymes except arylsulfatase varied temporally. Determination of V_{max} for air-dried samples, and activity measurements of field-moist samples gave similar information for β-glucosidase, but only in part for phosphatase.

Étude de l'évolution de la qualité des sols en parcelles de longue durée à Saint-Lambert (Québec). IV- Effet de la rotation et du type de fumure sur la susceptibilité au ruissellement et à l'érosion. C. Bernard, MAPAQ-Service des Sols, Sainte-Foy, QC.

Des essais de longue durée sur la production du maïs sont en cours depuis 1978 à la station expérimentale de Saint-Lambert du MAPAQ. Les traitements étudiés sont les suivants: culture en continu ou en rotation (maïs-maïs-blé-orge), fertilisation minérale (aucune ou NPKMg), fertilisation organique (aucune ou 20 t ha^{-1} an^{-1}) de fumier solide de bovin (base de matière sèche). Une pluie simulée de 30 minutes, à une intensité de 65 mm h^{-1} a été appliquée sur ces parcelles, afin de mesurer l'effet des traitements sur le ruissellement, l'érosion hydrique et l'entraînement d'éléments nutritifs sous forme soluble et particulaire. La rotation a permis de réduire le volume d'eau ruisselée et la perte de sol de 55%. Pour les nutriments, les réductions ont été de 50, 15, 60 et 45% pour N, P, K et le C organique respectivement. La fertilisation complète (minérale et organique) a produit des réductions de l'ordre de 60% pour le ruissellement et la perte de sol. Les pertes de N, P, C organique ont été diminuées de 63, 40 et 63% respectivement, alors que celles de K augmentaient de 5%. La fertilisation complète s'est cependant traduite par des concentrations plus élevées dans l'eau de ruissellement (formes dissoutes) et sur les sédiments (formes particulaires), et ce pour les quatres nutriments mesurés. La rotation, quant à elle, a eu pour effet de réduire les concentrations de tous les nutriments, à l'exception de celles en phosphore qui ont augmenté.

Changes in phosphatase activity on reduction of a soil amended with pig slurry. N. Bissonnette[*1] , F. Ajmone-Marsan [2] and R. R. Simard[1] , [1]Agriculture and Agri-Food Canada, Sainte-Foy, Québec and [2]Università di Torino, DI. VA.P.R.A.-Chimica Agraria, Torino, Italy.

The use of organic amendments such as liquid hog manure (LHM) could have a significant effect on soil microorganisms and affect nutrient cycling in soil particularly in areas of intensive agriculture. During thaw season, soils undergo submerged conditions for various periods of time. Changes of the soil microbial populations to facultative and anaerobic microorganisms could release the phosphorus associated with these organic amendments and possibly cause P leaching to the water table. Soil samples of 0-20 and 20-40 cm layers from a Le Bras silt loam amended for 15 years with different doses of LHM were submerged and incubated at 25°C. Periodic measurements of phosphodiesterase, acid and alkaline phosphatase activities and reduction potential were made during 8 weeks. The three phosphatase activities were largest in the soil amended with the highest dose of LHM in both soil layers. In the lower soil layer, enzyme activities associated with the LHM high dose amended soil were up to six times more

elevated than with the other LHM amendments and were comparable to the activities found in the upper depth layer. The results of the study indicate that LHM applications stimulated enzymatic activity associated with P cycling in poorly drained soils.

Estimating shoot:root ratios and annual carbon inputs in soils for cereal crops in eastern Canada. M.A. Bolinder*, D.A. Angers and J.P. Dubuc, Agriculture and Agri-Food Canada, Sainte-Foy, QC.

The annual C inputs in soils is one of the major factors determining the soil organic matter levels in agroecosystems, and is consequently an important driving variable in simulation models. In this study, root biomass measurements were made for different cereal species and cultivars at maturity at two sites (Ottawa and Québec) in eastern Canada to estimate below-ground C production. Soil cores were taken in two soil layers (0-15 and 15-30 cm) and at three different positions: within the row, between rows and in an intermediate position. Shoot:root ratios were calculated using available data on grains yields and harvest indices. The results indicate that the three sampling schemes influenced the root biomass measurements only in the 0-15 cm layer. Shoot:root ratios varied from about 6.0 for winter wheat, to 2.5 and 2.0 for oats and barley, respectively. Hypothesizing that an additional amount of 50% of C are produced below-ground from exudation and small-root turnover, the total annual C inputs for average yielding cereal crops in Québec would range from 100 g C m^{-2} to more than 200 g C m^{-2}. The variations in total annual C inputs from cereal crops are highly dependent on whether the straw is removed or left in the field after harvest. This research is part of the C balance evaluation project of the Green Plan Ethanol Program and is currently expanded to include estimates of annual C inputs for forage species.

Spatial variability of soil trace gas emissions in the boreal forest. I. Boucher* and R.P. Voroney, University of Guelph, Guelph, Ontario.

Spatial variability and seasonality in precipitation influence nutrient dynamics and efficiencies in forest ecosystems. This variability in nutrient inputs must be considered in the calculation and validation of whole ecosystem measurements. The purpose of this study was to describe the spatial and temporal dynamics of Carbon and Nitrogen under an aspen forest canopy, located in Prince-Albert National Park. To meet these objectives, hydrological, gas flux, composition of soil solution and soil moisture measurements were taken during summer 1994. Gas flux measurements (N_2O and CO_2) using gas chambers were taken on transects established between trees. Collection of samples was driven by rainfall events. Also along these transects, the measurement of soil-water content was accomplished using the time domain reflectometry (TDR) technique. Measurements were taken regularly to identify drying and wetting cycles. Rainwater samples of throughfall, stemflow and interception were taken to monitor the redistribution effect of precipitation. Effects of these different factors on nutrient cycling dynamics will be discusses.

Tree species effects on mineralization of nitrogen in boreal forest soils in western Quebec. Susann M. Brown* and James W. Fyles, Department of Natural Resource Sciences, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, QC.

Net nitrogen mineralization was determined by the buried bag incubation method in the forest floor and mineral soil of stands of different ages following fire dominated by birch, aspen, and conifers at Lac Duparquet, Quebec. The field incubations were conducted from June to August, and from August to October 1994. The forest floor ammonium mineralized from June to August displayed a significant interaction between the species*soil. The birch site soil mineralized the least ammonium of the three stand types on clay, yet mineralized the most ammonium on till. The mineral soil displayed a significant species effect with the conifer site soil mineralizing much less ammonium than that of birch or poplar. Ammonium mineralization in the mineral soil of the second incubation period indicated significant interactions between the species*soil*date. Nitrate displayed a significant species effect in the mineral soil. The net nitrate mineralized on conifer sites was much less than that mineralized on birch or poplar sites. The collective data demonstrates that tree species are important determinants on the amount of nitrogen mineralized in the boreal forest.

Spatial Variability of Soil Tests for Available Nitrogen in Relation to Topography. T.W. Bruulsema*, Potash & Phosphate Institute; G.L. Malzer, P.C. Robert, J.G. Davis, and P.J. Copeland, Univ. of Minnesota.

Responses to N fertilizer often vary spatially across landscapes. Four on-farm studies were conducted in southwest Minnesota in 1994 in order to examine spatial variability in soil N availability indices. Areas under study within the fields ranged from 4 to 6 hectares. Indices included ammonium and nitrate forms of inorganic N, total N, phosphate-borate extractable N and hot KCl extractable N, measured in both October 1993 and June 1994, and anaerobically mineralizable N and active soil N by isotope dilution (ASN) in June 1994 only. Spatial structure of the variability of these indices was evaluated using semivariograms and terrain analysis of digital elevation models of the landscapes. Multiple regression against derivatives of topography and soil phototone explained more variability in soil N indices than did classification by landform elements. Total N and ASN showed stronger spatial structure than other soil N indices. Soil water was highly correlated with ASN. Nitrate N measured in June showed stronger spatial structure than that measured in October, lending support

to interpreting late spring nitrate as a robust index of soil available nitrogen.

Peat-ammonia mineral fertilizers for potato crops. A.N. Cambouris[*1] and L.É. Parent[2]. [1]Fondation François-Pilote Inc. et [2]Département des sols, Université Laval.
Potato cropping systems are mainly conducted on acid light soils in Eastern Québec. Those soils are susceptible to N leaching and to organic matter depletion. Peat-ammonia mineral fertilizer (PAMF) could be considered as a slow release source of N and may enhance phosphate availability in the vicinity of the granule. PAMF's also increase the C input to the soil, thus contributing to the maintenance of soil organic matter levels. Our PAMF granules contained 30 % organic matter and 70 % inorganic materials and were produced from well decomposed acid peat. Since 1992, a conventional mineral fertilizer treatment was compared to two PAMF treatments (with or without micronutrients) in local farming systems under intensive potato production at five sites. Preliminary results (1992-1994) showed that PAMF increased commercial yields by 2 t ha^{-1} in average in the potato cropping systems of Eastern Québec.

Transformations of added nitrogen in a forest soil on northern Vancouver Island. S.X. Chang[*], C.M. Preston and G.F. Weetman, University of British Columbia, Vancouver BC and Canadian Forest Service, Victoria, BC.
Ammonium sulphate, labelled with ^{15}N, was applied to 1 m^2 plots of a cutover site of a western red cedar (*Thuja plicata* Donn ex D. Don) - western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) forest on northern Vancouver Island, British Columbia, at a rate of 200 kg N/ha. Fertilizer application was timed so that when samples were collected they have been labelled with ^{15}N for 24 hours, 7 and 31 months, respectively. In a 42-day aerobic incubation, the carbon mineralization rate had the following order: 7-month > 24-hour > 31-month treatment. Net mineralization of total and applied nitrogen was greatest in the samples from the 24-hour treatment followed by those from the 31-month treatment. The percentage of applied N found in the total N mineralized (net) ranged from 76.6 to 87.4, 13.1 to 42.0 and 10.6 to 14.0% in samples from the 24-hour and 7- and 31-month treatments, respectively. Net mineralization of C and N were poorly correlated with each other. Anaerobic incubation showed net mineralization for the 7- and 31-month treatments but net immobilization for the 24-hour treatment for both total and applied N. Both total and applied N in the extractable organic N fraction and in the N flushed after fumigation with chloroform had the following order: 24-hour > 7-month > 31-month treatment. The results confirm that N fertilizer is being immobilized within hours after application by the soil organic matter through the microbial population and that the immobilized N has a low mineralization potential.

Les sols du comté de Rouville. J.-M. Cossette et L. Grenon, CRTRB, Agriculture et Agroalimentaire Canada, Ste-Foy, QC
Le comté de Rouville est une région agricole de 600 km^2 située à environ 40 km à l'est de Montréal. Elle est comprise dans l'écozone de la plaine à forêts mixtes. Les levés pédologiques effectués à l'échelle semi-détaillée (1:20 000) ont permis de reconnaître 75 séries de sols et 165 unités cartographiques distinctes. La carte comporte 1 600 délimitations. Les sols sont répartis dans deux régions physiographiques. Dans celle de la plaine étale des basses terres du Saint-Laurent à l'ouest et au centre on retrouve davantage des sols argileux et sableux d'origine marine, ou fluviatile, tandis que dans celle des terres hautes des rebords de la vallée du Saint-Laurent, les sols loameux, d'origine glaciaire, dominent. Les possibilités d'utilisation agricole des sols du comté, telles qu'évaluées selon le système de l'Inventaire du Canada, sont généralement bonnes puisque les sols des classes 2 et 3 constituent 82 % des sols cartographiés.

Étude de l'évolution de la qualité des sols en parcelles de longue durée à Saint-Lambert (Québec). V - Seize années d'application de lisier de porc en postlevée du maïs: Efficacité fertilisante et effets sur les propriétés du sol. D. Côté[*] et T.S. Tran, MAPAQ, Sainte-Foy, QC.
Une étude de longue durée a été réalisée sur le loam Le Bras pour évaluer l'effet cumulatif de l'application du lisier de porc sur la production du maïs fourrager et sur l'état de fertilité du sol, en pratique de non labour. Le lisier a été épandu en postlevée du maïs, au stade 6 à 8 feuilles, pendant 16 ans aux doses annuelles de 0, 30, 60, 90 et 120 Mg ha^{-1}. Le rendement maximal du maïs a été obtenu généralement avec la dose de 60 Mg ha^{-1} qui correspondait à un apport annuel de 246 kg ha^{-1} de N total (139 kg de N-NH4). Les apports annuels de P et K par cette dose étaient respectivement de 42 et 82 kg ha^{-1}. À cette dose optimale, les prélèvements annuels moyens en P et K par la récolte étaient respectivement de 15 et 74 kg ha^{-1}. Après 16 ans, l'examen du profil de sol par tranches de 10 cm entre la surface et 50 cm de profondeur, montre un enrichissement des premiers 20 cm de sol en P-Mehlich-3 de 123 et 304 kg ha^{-1} respectivement pour les traitements de 60 et 120 Mg ha^{-1} en les comparant au témoin sans apport de lisier. Pour le K disponible, cet enrichissement était de 82 et 288 kg K ha^{-1} pour ces deux traitements. Aucun enrichissement en P et K totaux ou disponibles n'a été observé dans les horizons 20-50 cm pour toutes les doses appliquées. L'absence de labour conventionnel a permis d'observer des teneurs en P et K deux fois plus élevées dans l'horizon 0-10 cm que dans celui des 10-20 cm des parcelles fertilisées. La monoculture en maïs fourrager a fait baisser la teneur en matière organique de façon uniforme pour le témoin et toutes les doses de lisier, de

5,32 % en 1979 à 3,62 % en 1994 pour l'horizon 0-30 cm, en dépit du travail réduit du sol. En conclusion, la fertilisation du maïs en postlevée, avec une dose de 60 Mg ha^{-1} de lisier de porc sans apport complémentaire d'engrais minéral, est une pratique recommandable dans les sols ne présentant pas un niveau très riche en P et K disponibles.

Options for upgrading and maintaining soil resource inventory databases. K.A. Denholm*, K.B. MacDonald and H.D. Moore, Agriculture and Agri-Food Canada, Guelph, Ontario and Gregory Geoscience Ltd., Kanata, Ontario.

Recent land resource inventories collect information at a specified level of detail and organize it for use in computerized formats as well as conventional published maps and reports. In areas with older soil inventory information additional data need to be collected and reorganized with existing data to current formats to achieve regional and provincial consistency. As information needs and data collection procedures continue to evolve there will be an ongoing need to maintain currency of land resource information. The objective of this project is to evaluate a methodology to upgrade the information of older soil surveys to a standard minimum level of detail and precision. We selected two areas in Ontario and in each area compared a soil survey upgrade methodology with a conventional resurvey approach at a soil intensity level (SIL) three. The results of the two mapping strategies were compared at the level of the soil and landscape attributes of the maps and at the level of the interpretations derived from the maps and associated databases. The upgrade methodology could accurately depict mode of deposition and soil attributes such as surface texture and drainage. It did not define slope with the same degree of accuracy. In the CLI (soil capability ratings for agriculture) maps there was no significant difference in the area mapped with similar ratings between the upgrade or the resurvey. The difference between the CLI rating of the original soil survey and either of the two other mapping approaches was not significant. The upgrade methodology is useful for adding soil attribute information to existing soil resource inventories but the benefits to soil survey interpretations requires more evaluation.

Impacts des pratiques culturales sur les populations de vers de terre. I. Impacts du travail du sol et des rotations de cultures dans la production de l'orge. J. Desforges*[1], F. Pagé[2] et M. Laverdière[1]. [1]Université Laval, Sainte-Foy, QC. [2]MAPAQ, Sainte-Foy, QC.

Dans cette expérience, l'impact de quelques pratiques culturales sur les populations de vers de terre a été évalué. Les travaux étaient réalisés à la ferme expérimentale d'Agriculture Canada de La Pocatière (QC) sur un dispositif en parcelle partagé une fois, avec quatre répétitions. On retrouvait en parcelles principales l'orge en monoculture et le trèfle rouge (année 2) en rotation avec l'orge. On retrouvait comme traitement en sous-parcelles le travail du sol : 1. labour conventionnel (15-18 cm), 2. labour réduit (12-15 cm) et 3. sans labour ou travail minimal. L'échantillonnage était réalisé à l'automne 1992. Les résultats ont indiqué que le travail minimal du sol a favorisé davantage la biomasse des vers de terre que le labour conventionnel ($p < 0,001$), et que le labour réduit a été plus favorable au vers de terre que le labour conventionnel ($p < 0,037$). Par ailleurs, la culture en rotation a favorisé les populations lombriciennes comparativement à la monoculture ($p < 0,012$). Les populations lombriciennes étaient constituées des espèces *Aporrectodea caliginosa*, *Lumbricus terrestris* et *Lumbricus rubellus*.

Aggregate stability as affected by tillage and cropping practices by H. Dinel, C. Monreal and D. Bergstrom.

Long term cropping reduces soil productivity and quality by altering soil structural properties. Quantitative measurements were made to determine the effects of cropping practices on aggregate stability of fine texture soils at two sites in Southern Ontario. The first site included forested land and conventionally tilled fertilized and unfertilized sod and corn. The second site included two adjacent fields cropped with fertilized soybean under conventional and no-till. Principal-component analysis showed that fertilized and unfertilized sod was less detrimental to soil structure in Ap1 and Ap2 than corn and soybean crops. The relative position on the structural stability status scale for no-till and conventionally tilled soybean suggests that the no-till practices may be beneficial to minimize the physical deterioration of fine texture soils.

Étude de l'évolution de la qualité des sols en parcelles de longue durée à St-Lambert (Québec) I - Effets de l'apport prolongé de fumier de bovin et de fumures minérales sur les populations lombriciennes. B. Estevez, A. N'Dayegamiye*, D. Coderre, D. Côté et F. Pagé, Service des sols, MAPAQ et Université du Québec à Montréal.

L'apport prolongé de fumier et de fumure minérale peut améliorer plusieurs caractéristiques du sol et augmenter les populations lombriciennes. Une étude des populations lombriciennes en relation avec les propriétés du sol a été effectuée à partir d'un essai de longue durée établi en 1978 et recevant les doses de fumier (0, 20 t ha^{-1}) en parcelles principales et la fertilisation minérale (témoin, NPKMg) en parcelles secondaires. Ces traitements sont effectués dans une rotation de quatre ans : maïs, maïs, blé, orge. Les résultats montrent que les espèces *Aporectodea juveniles* et *Aporrectodea turgida* étaient dominantes, dans le sol étudié, représentant 98 à 100 % de la population lombricienne. Quelques autres espèces notamment *Lumbricus juveniles* et *Allobophora chlorotica* étaient également présentes uniquement dans les parcelles ayant reçu des apports de fumier. L'apport

prolongé de fumier a augmenté l'abondance lombricienne et la diversité des espèces comparativement au traitement avec fumure minérale seule. De même, la stabilité structurale du sol et l'activité biologique (CO_2) ont été améliorées par l'apport de fumier. La fumure minérale n'a pas eu d'effet significatif sur ces propriétés du sol. Une corrélation positive a été obtenue entre l'abondance lombricienne, l'activité biologique et la stabilité structurale du sol ($P < 0,05$). Cette étude a démontré que les populations lombriciennes et l'activité microbienne présentent une action synergique importante au niveau de la fertilité potentielle des sols.

Soil nitrate and ammonium levels under a corn-soybean-alfalfa rotation at varying fertilizer nitrogen rates. G. Galiano*, and A.F. MacKenzie, Department of Natural Resource Sciences, Macdonald Campus, McGill University, Ste-Anne-de-Bellevue, QC.

The production of corn (*Zea mays* L.) under monoculture and conventional tillage systems may lead to soil degradation, erosion, and requires high N fertilizer inputs that can cause nitrate pollution of surface and groundwater. A way to avoid these problems could be the use of rotation systems and no-tillage practices. This study deals with the impact of tillage, corn (C)-soybean (S)-alfalfa (A) rotations and different fertilizer N rates on soil NO3-N and NH4-N levels, for a 1 m depth, on a Ste. Rosalie clay (Humic Gleysol) and an Ormstown silty clay (Humic Gleysol). In both soils tillage effects on soil NO3-N or NH4-N were minimal. Higher spring NO3-N levels compared to fall values were probably the result of greater nitrification and/or mineralization than leaching. Low soil NH4-N levels, particularly in spring may also indicate that nitrification processes were active. Significant differences among the seven rotations used were found. No differences were observed due to N rates, in the Ormstown soil. For Ste. Rosalie, N fertilizer effects varied with the rotation.

Étude de l'évolution de la qualité des sols en parcelles de longue durée à Saint-Lambert (Québec) VI -Effets de différents systèmes culturaux sur l'évolution des principales propriétés du sol et le rendement du maïs-ensilage. M. Giroux* et D.A. Angers, Service de recherche en sols, MAPAQ, Sainte-Foy, QC et Agriculture et Agroalimentaire Canada, Sainte-Foy, QC.

Cet essai a pour but de mesurer l'évolution des principales propriétés physiques, chimiques et biologiques des sols soumis à différents systèmes culturaux utilisés pour la production du maïs-ensilage. Après douze années de culture, la monoculture de maïs-ensilage et la rotation maïs-céréale ont fait subir une perte de matière organique de 0,4 à 0,8 % dans les sols. Lorsque les plantes fourragères étaient présentes dans la rotation, au moins 50 % du temps, la matière organique des sols, l'activité biologique et la fertilité azotée se maintiennent à un niveau élevé.

La dose d'azote optimale pour la production du maïs-ensilage est moindre d'environ 20 kg N/ha et le rendement plus élevé d'environ 1 t/ha avec la rotation maïs-herbages par rapport à la monoculture de maïs ou la rotation maïs-céréale. L'utilisation de la technique au carbone 13 et l'étude de la stabilité des agrégats ont démontré que les résidus de matière organique, abondants dans la rotation maïs-herbages favorisent la formation de macro-agrégats et améliorent l'aération des sols.

Soil factors determining leek response to mycorrhizal inoculation are biological. C. Hamel*, S. Parent, Y. Dalpé et V. Furlan; MAPAQ, St-Bruno (Qc), Tourbières Premier, Rivière-du-Loup (Qc); Agriculture et Agroalimentaire Canada, Ottawa (Ont) et Sainte-Foy (Qc).

Mycorrhizal inoculation of crops yields unpredictable results. This study was undertaken to determine the soil conditions for the utilization of arbuscular mycorrhizal inoculum. The relationship between the response of leek plants to inoculation with *Glomus intraradices* or *G. versiforme*, and the chemical, physical and biological characteristics of 81 agricultural soils, was studied using Principal Component analysis and Regression analysis.

The type of relationship between certain soil variables and plant response depended on soil P level. At low levels, for example, plants responded better in well aggregated soils, while at high P levels, the response was better in poorly aggregated soils. Plant response to inoculation appeared to be mainly determined by factors related to the indigenous mycorrhizal flora of soils. The abundance of specific indigenous mycorrhizal species was related to specific soil characteristics.

Effect of peat additions on potato production and N budget of sandy soils. L. Hong* and L.É. Parent, Soil Science Department, Laval University, Québec, Canada, G1K 7P4.

Sandy soils have lower organic matter content (OM) and productivity than loamy soils used for potato production. Rotations with clover-seeded cereals maintain or only slowly improve OM levels in the soil. In Quebec, many peat deposits are situated near potato fields. Peat was added to soil at rates of 0, 25, 45 and 60 t/ha (dry matter basis) and combined with three fertilizer rates: below, at and above recommended rates (150, 175 and 200 kg N/ha). The peat-fertilizer interaction was significant on tuber yield and N uptake, soil pH, soil nitrate (0-40 cm) in the fall and soil OM. During the wet season of 1994, peat increased tuber yield linearly from 36 to 43 t/ha, 11% in average as compared to control. Peat incerased OM content by 3,6% in average. Due to the wet season, 60 to 120 kg N/ha was leached out of the profile. Considering residual soil nitrate in the fall, more than 200 kg N/ha could be contributive to diffuse pollution. Peat additions and N budgets could improve the quality of potato soils.

Where does the carbon sequestered from the atmosphere reside in soil? N.G. Juma* and S. Pawluk, Department of Renewable Resources, University of Alberta, Edmonton, Alberta.

Soils have been identified as one of the potential sinks for atmospheric C. The objective of this study was to compile visual information on distribution of particles, pores, aggregates and organisms in Chernozemic soils of Alberta using a collection of soil thin sections and relate it to biochemical transformations of organic C added through plant residues, roots and root-derived materials. Biochemical transformation of C results in the formation of new heterotrophic biomass, CO_2, transformed organic materials and humus. The C which is not assimilated by soil fauna is excreted as fecal material which is either recycled or humified in soil. Visual examination of soil thin sections suggests that fauna are responsible for creating micro-aggregates (10^{-5} to 10^{-4} m) and macro-aggregates ((10^{-4} to 10^{-2} m) in soil. These may be the sites in which C is stabilized in soil. In order to correctly understand the location of sequestered carbon in soil, it is necessary to comprehend the scale and the sites at which the processes are occurring in soil.

Contrôle de l'érosion et des pertes de phosphore par les résidus de culture. N. Koro[1], C. Bernard[2*], M.R. Laverdière[1], [1] Univ. Laval, dép. des Sols [2] MAPAQ, Sainte-Foy, QC.

L'efficacité de quatre niveaux de résidus de culture (0, 500, 1000 et 2000 kg ha^{-1}) à réduire le ruissellement, l'érosion et la perte de phosphore par ruissellement superficiel a été évaluée sur deux sols à texture contrastée. L'application de trois pluies artificielles aux 24 unités expérimentales a en outre permis d'estimer l'effet de l'humidité initiale du sol sur les paramètres mesurés. Le volume d'eau ruisselée et les pertes de sol ont augmenté avec la séquence des pluies, mais diminué avec l'augmentation de la quantité de résidus laissés à la surface. La présence de quantités croissantes de résidus s'est traduite par une réduction des pertes de P total. Cette réduction est attribuable au contrôle de l'érosion exercée par les résidus, puisque les pertes de P dissous ont pour leur part augmenté avec la quantité de résidus. Globalement, les pertes de P biodisponible ont donc été réduites par les doses croissantes de résidus, mais dans un proportion moindre que les pertes de P total. Ainsi, avec 2000 kg ha^{-1} de résidus laissés en surface, les réductions moyennes, par rapport au témoin, ont été de 56% pour le ruissellement, de 86% pour l'érosion, de 61% pour le P total et de 43% pour le P biodisponible, alors que les pertes de P soluble augmentaient de 35% en moyenne. Cette étude tend donc à démontrer que le maintien des résidus à la surface du sol est très efficace pour le contrôle de l'érosion. Cependant, le gain environnemental escomptable de cette pratique, en termes de réduction des pertes de phosphore en général et de phosphore biodisponible en particulier, n'est pas aussi important.

Manure and tillage effects on forage yield and nutrient uptake. Lafond*, J., R.R. Simard, J. Zizka and R. Drapeau. Agriculture and Agri-Food Canada, Normandin and Saint-Foy, Québec.

Manure application and reduced tillage are proposed ways to promote the nutrient availability component of soil quality. The objective of this work was to determine the effects of manure and tillage on forage (timothy and red clover) yield and nutrient uptake. The study was initiated in 1989, on a Normandin clay (Humic Gleysol). A split-split plot design with 4 replicates was used. The main plots included the first (F1) and the second (F2) year of forage production. The subplots consisted of two primary tillage: chisel (CP) and mouldboard plow (MP). the sub-sub-plots referred to nutrient sources: mineral (M) and dairy liquid manure (DLM). In 1992, forage yields were 10% larger under CP than MP, and in 1993, yields were 13% larger under M than DLM and 26% larger in F2 than F1 plots. In other years, there was no significant difference. Nutrient uptake (N-P-K) varied widely among years. P and K were influenced by nutrient sources. P uptake was 13% larger with M than DLM in 1993 and 6% larger in 1994. K uptake was 14% larger under M fertilizer than DLM in 1993 whereas the reversed was observed in 1994. N uptake was 5% larger under MP than CP in 1993. These results of this study indicate that chisel is more economical and equally efficient in nutrient availability than mouldboard plowing in forage production on these clay soils.

Tillage and Cropping Effects on Organic Matter in a Degraded Soil. B.C. Liang*, E.G. Gregorich and W.E. Curnoe, Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada, Ottawa, K1A 0C6, and Kemptville Agricultural College of Technology, Kemptville, K0G L1O.

Understanding short-term changes in soil organic matter is important in planning management strategies for sustainable agriculture. The purpose of this study was to evaluate the remedial effects of tillage and perennial alfalfa on levels of soil organic carbon (OC), microbial biomass carbon (MBC) and total N (TN) in a structurally degraded soil that had been under continuous corn for more than 20 years. Treatments were a continuous corn under no-tillage or mouldboard plowing, and 1-5 years of alfalfa. No-tillage corn and more than two years of alfalfa increased soil OC and TN only in the surface 0-5 cm. More than two years of alfalfa were needed to significantly increase MBC and MBC/OC ratios in the 0-5, 5-10, 10-25, and 0-25 cm layers. Both MBC and MBC/OC were good indicators of early changes in soil properties.

The impact of tillage translocation and tillage erosion on the estimation of soil loss using ^{137}Cs. D.A. Lobb[1*] and R.G. Kachanoski[2]. [1]Eastern Canada Soil and Water Conservation Centre, University of Moncton, Grand Falls, New Brunswick E0J 1M0 and [2]Department of Land Resource Science, University of Guelph, Guelph, ON, N1G 2W1.

Tillage translocation and tillage erosion are not accounted for in existing methods of estimating soil loss using ^{137}Cs. These methods use point measurements of ^{137}Cs within a landscape and assume that the soil moved into a given point by tillage has the same mass and cesium concentration as the soil moved out from that point. This assumption is shown to be false in topographically complex landscapes where tillage translocation and tillage erosion occur. After 10 sequences of simulated conventional tillage (mouldboard plough, two passes of tandem disc, and C-tine cultivator) on a convex landform, tillage translocation and tillage erosion resulted in underestimation of soil loss on the crest-slope (> 20%) and overestimation further downslope. Soil loss was estimated where no soil loss occurred on the back-slope. These errors increased in magnitude and aerial extent with the number of tillage sequences. Selected methods of estimation differed in their accuracy. A simple linear regression relationship between tillage translocation and slope gradient was used as a model for tillage erosion, and an exponential decay function was used as a model for tillage translocation.

The effect of livestock manure and inorganic N fertilizer on denitrification in the field. P.J. Loro[1*], D.W. Bergstrom[2], and E.G. Beauchamp[3]. [1]New Brunswick Dept of Agriculture and Rural Development, Fredericton, NB, [2]Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada, Ottawa, ON, [3]Dept of Land Resource Science, University of Guelph, Guelph, ON.

The primary regulators of denitrification are aeration status, NO_3^* concentration and carbon substrate availability. These regulators are affected by the addition of manure to soil. The objective of this study was to determine the effects of liquid dairy cattle manure (LCM), solid beef cattle manure (SBM) and NH_4NO_3 on denitrification in surface and subsurface horizons. Treatments studied were 450 kg N ha^{-1} as LCM, 600 kg N ha^{-1} as SBM, 225 kg N ha^{-1} and no N (control) in either the spring or fall from 1991 to 1993. Soil core samples were obtained from the 10, 20, and 40 cm depths in the fall of 1991 and spring of 1992 once following treatment applications; and from the cultivated layer on 11 to 13 dates during the summer of 1993. In the surface soil, the manure treated plots, particularly the SBM, resulted in elevated denitrification compared with the NH_4NO_3 and control treatments. Carbon availability was mainly responsible for these differences. The supply of C with SBMM was greater than LCM. Nitrate played a minor role in the regulation of denitrification compared to C availability. Ammonium concentration along with C availability were significantly involved in regulating denitrification. In the subsurface soil, carbon substrate availability was too low to support denitrifiers.

Catch crops for reducing nitrate leaching following potato harvest on Charlottetown fine sandy loam. J.A. MacLeod[*] and J.B. Sanderson, Agriculture and Agri-Food Canada, Research Centre, Charlottetown, PEI. C1A 7M8.

Potato crops were grown on Charlottetown fine sandy loam in each of three years. The two N fertilization treatments used in the study were 150 N ha^{-1} banded at planting without and with an additional 50 N ha^{-1} topdressed in late June. Potato crops were harvest in late August. After harvest, the top meter of soil contained 112 and 160 kg nitrate-N ha^{-1}, respectively for the without and with topdress N treatments. Catch crops were seeded in early September. Results of the study indicate that catch crops can take up significant quantities of nitrate in the fall. The quantities of N taken up by the catch crops were not consistently increased by the addition of topdressed N. Oilseed radish was the most effective catch crop studied in taking up N and releasing to the subsequent crop. Fall rye was also effective as a catch crop. Other crops studied were less effective than oilseed radish or fall rye. Although catch crop are effective in taking up residual nitrate the quantities that can be taken up are limited.

Improving effectiveness of P fertilizer in alfalfa stands. S.S. Malhi[*] and K. Heier, Agriculture and Agri-Food Canada, Lacombe, Alberta T0C 1S0.

Our previous research has shown that the majority of fertilizer P recovered in soil as extractable P remains in the top 5 cm layer, even after long-term application of P to grass or alfalfa. This suggests that P fertilizer would be less effective when surface-broadcast. A field experiment was initiated in 1992 on the existing alfalfa stands on a P-deficient Black Chernozem soil in central Alberta to compare the effects of surface-broadcasting versus subsurface banding (using a special disc drill) and low annual versus one-time high initial rates of P on dry matter yield (DMY). There was a substantial increase in DMY from annual P applications in all the three years. Disc-banding at 15 cm spacing produced greater forage yield than surface-broadcast application, regardless whether P was applied annually or as single initial applications. Single initial applications produced greater forage yield than annual applications in the first and second year, but in the third year forage yields tended to be lower with single applications than annual applications. In conclusion, the results indicate that forage productivity can be increased by improving availability of applied P to forage stands by placing it below the soil surface using a special disc-banding technique on P-deficient soils.

Age, Turnover and Molecular Diversity of Organic Matter in Relation to Clay Minerals in Soil Aggregates. [1]C.M. Monreal*, [1]H. Kodama, and [2]H.-R. Schulten. [1]Agriculture and Agri-Food Canada, Ottawa, Ontarion; [2]Fachhochshule Fresenius, Wiesbaden, Germany.

The dynamics of organic matter through soil aggregates has not ben defined. We examined soil organic C (C) dynamics through aggregate fractions obtained from a native and cultivated Gleysol in eastern Ontario. Radiocarbon dating showed that young C (< 100 y) was contained in macroaggregates > 250 μm. Old C (>200 y) was stored in microaggregates < 50 μm. The turnover time for young C was 11 y, 61 y for C in aggregates 50-250 μm and 275 y for C in aggregates < 50 μm. Organic matter (OM) associated with clay fraction of aggregates has a lower C-to-N ratio than whole aggregates indicating a high state of humification. Pyrolysis-Field Ionization Mass Spectrometry indicates that young and old OM consisted mainly of lipids, carbohydrates, phenolics and lignin monomers, alkylaromatics and N containing compounds. Geo-biopolymers associated with plant and microbial components were absent from microaggregates containing old C.

Étude de l'évolution de la qualité des sols en parcelles de longue durée. II. Effet de l'apport prolongé de fumier et de fumures minérales sur la qualité de la matière organique. A. N'dayegamiye*, M. Goulet et M.R. Laverdière, Service des sols, MAPAQ et Département des sols, Université Laval.

La fréquence du maïs-ensilage dans une rotation peut influencer l'évolution du niveau de M.O. à cause de ses faibles retours organiques au sol. L'objectif de cette étude consistait à évaluer la quantité et la qualité de la M.O. d'un loam argileux (série Le Bras) suite à des essais de longue durée portant sur le fumier (0, 20 t ha^{-1}) en parcelles principales et la fumure minérale (0, PK et NPK) comme traitements secondaires. La rotation consistait en maïs-ensilage, maïs-ensilage, blé, orge. La caractérisation de la M.O. a été réalisée en 1994 par fractionation densimétrique avec une solution de NaI (>1.59 g cm^{-3}) et également par tamisage humide du sol sur une série de tamis (5-8 mm, 2-5 mm, 1-2 mm, <1 mm). Après seize ans d'essais, la M.O. (C x 1.72) a diminué respectivement de 9 % et 12 % chez le témoin et le traitement NPK sans fumier. Une augmentation de la M.O. de 26 % et 10 % était observée respectivement dans les traitements de fumier seul et de fumier combiné à la fumure minérale (NPK). Les résultats obtenus montrent donc que seule la fumure organique a eu un effet significatif sur le contenu en C du sol et ce, au niveau de la couche 10-20 cm seulement. De plus, l'apport prolongé de fumier a favorisé également une accumulation significative de C au niveau de la fraction dense de la M.O. ainsi que dans les agrégats de taille supérieure à 2 mm. La fumure minérale principalement par le biais de son azote a permis le renouvellement du C de la fraction légère mais a par contre conduit à une accumulation de C dans les agrégats fins (<2 mm). Il ressort que les apports prolongés de fumier ont amélioré de façon importante la quantité et la qualité de la M.O. du sol étudié grâce à l'augmentation de la fraction stable de la M.O. et à la stabilité accrue des agrégats >2 mm, comparativement à la fumure minérale.

Étude comparative de deux types de rotation sur l'évolution de la qualité d'un sol argileux de la plaine de Montréal. M.C. Nolin[1*], C. Wang[2], M.J. Deschênes[1] et C. Lévesque[1], Agriculture et Agroalimentaire Canada, CRTRB, [1]Sainte-Foy et [2]Ottawa.

Les deux sites retenus pour cette étude font partie du réseau national de sites repères établi depuis 1989 pour assurer le surveillance de la qualité des sols des principaux agroécosystèmes canadiens. Les sites 17-QU (ferme laitière mixte à St-Marc-sur-Richelieu) et 18-QU (ferme céréalière à St-Antoine-sur-Richelieu) ont été appariés afin de comparer l'effet de deux types de rotation (17-QU: 4 ans en fourrage de légumineuses et de graminées suivi d'une année en maïs-grain *vs* 18-QU: soya-orge-maïs-blé) sur l'évolution de la qualité d'un sol argileux (Gleysol humique orthique) de la plaine de Montréal. Les caractéristiques initiales (t_0 = printemps 1989) de chaque site (5 *ha*) ont été déterminées au moyen d'une cartographie très détaillée des sols et de la topographie (échelle de 1:2500) et d'un échantillonnage systématique des principales couches de sol à partir d'une grille d'observation de 30 *m* x 30 *m* (51 pédons). Par la suite, différents indicateurs de la qualité des sols et de l'environnement sont mesurés suivant une fréquence (*v.g.* chaque année, à tous les cinq ans, *etc.*) fixée d'après la variabilité intrinsèque de l'indicateur, les ressources humaines et monétaires disponibles et les objectifs spécifiques de l'étude. La caractérisation initiale des sites a révélé un contenu en argile de la couche de surface légèrement supérieur dans le site 17-QU (54%) que dans le site 18-QU (47%). La gestion plus intensive associée au système cultural du site 18-QU s'est traduit par un contenu en K échangeable de la couche de surface supérieur (0,77 *cmol* kg^{-1}) à celui du site 17-QU (0,55 *cmol* kg^{-1}). Le rééchantillonnage réalisé au printemps 1992 a révélé la même tendance avec des valeurs significativement supérieures cependant. L'inclusion de fourrage dans le système de rotation du site 17-QU semble entraîner une meilleure stabilité structurale de la couche de surface (automne 1992) comparativement au site 18-QU. Les résultats obtenus jusqu'ici indiquent toutefois que l'effet du type de rotation sur la qualité des sols demeure fort complexe et nécessite d'intégrer dans l'interprétation l'ensemble des composantes du système cultural (travail du sol, date et conditions des travaux aratoires, intrants, *etc.*) ainsi que la structure spatio-temporelle de la variance des indicateurs étudiés.

Evaluation of Improved technologies for conservation farming in the humid and subhumid tropics of Africa. A. Olu Obi, Department of Soil Science, Obafemi Awolowo University, Ile-Ife, Nigeria.

This paper reviews the improved technologies that enhance conservation farming in the humid and subhumid tropics of Africa. These are discussed under physical and biological control measures that improve physical and chemical conditions of the soil and also offer protection against the destructive forces of raindrop impacts. Experimental data on the effects of various improved technologies on soil properties and sustainable crop productivity are presented, discussed and assessed in relation to conservation farming. Both the merits and limitations of their applicability under different ecosystems are highlighted. Greater prospect for conservation farming can be achieved through the biological control measures that include sound agronomic and soil management practices.

Impacts des pratiques culturales sur les populations de vers de terre. II. Impacts des apports de paille et de fumier de bovin dans la production du maïs. F. Pagé*[1], D. Coderre[2] et B. Estevez[2]. [1]MAPAQ, Sainte-Foy, QC, [2]UQAM, QC.

Il est reconnu que les vers de terre contribuent à assurer des conditions favorables à la croissance des plantes. Cette expérience avait donc pour but de vérifier si, dans une culture de maïs, un travail du sol réduit (profondeur du labour = 10-15 cm) et des apports de paille (5 et 10 t ha^{-1}) et de fumier de bovin (20 et 40 t ha^{-1}), appliqués séparément ou en interaction, permettaient de maintenir un nombre élevé de vers de terre. Le dispositif expérimental, situé à la ferme du MAPAQ à Saint-Lambert (QC), comprenait 3 blocs aléatoires de 9 traitements. Les résultats indiquaient que les vers de terre étaient constitués principalement des espèces *Aporrectodea caliginosa* et *Lumbricus terrestris*, et que leur nombre augmentait avec la dose de paille ou la dose de fumier appliquée ($p < 0,01$). L'interaction paille-fumier n'a pas eu d'effets significatifs sur les populations de vers de terre avec les doses de fumier appliquées séparément, mais permettait des augmentations du nombre de vers ($p < 0,01$) par rapport aux parcelles témoins ou avec celles caractérisées par des doses de pailles appliquées séparément. Le nombre moyen de vers de terre passait de 39 m^{-2} dans les témoins à 111 avec 10 t ha^{-1} de paille, et à 205 avec 40 t ha^{-1} de fumier de bovin.

Impact de la présence du ver de terre *Aporrectodea caliginosa* sur la réduction de la sévérité de l'infection de la pomme de terre par *Rhizoctonia solani*. F. Pagé[1], B. Otrysko[2] et S. Côté[3]. [1]MAPAQ, Sainte-Foy, QC, [2]MAPAQ, Les Buissons, QC, [3]Université Laval, QC.

Cette expérience était réalisée dans les serres du MAPAQ (Sainte-Foy) dans le but de vérifier si une population de 350 vers de terre m^{-2} de l'espèce *Aporrectodea caliginosa* pouvait réduire l'infection de la pomme de terre par *Rhizoctonia solani*. Il s'agissait également de vérifier si les vers de terre pouvaient avoir un impact positif sur le rendement de la pomme de terre. La culture de la pomme de terre était réalisée en pots selon trois traitements : 1) semences saines, 2) semences inoculées par *R. solani*, 3) semences inoculées par *R. solani* + vers de terre. Le dispositif formaient 5 blocs randomisés de 3 traitements. Les résultats ont indiqué que les vers de terre avait eu un impact positif sur la structure du sol et la croissance des plants. La mesure de l'indice de chlorophylle a montré une meilleure absorption de l'azote par la plante en présence de vers de terre. Aucune différence significative n'a été observée entre les indices d'infection et de sclérotification de la pomme de terre des divers traitements. Néanmoins, l'amélioration de la croissance des plants et du pourcentage des tubercules vendables ($p < 0,01$) en présence des vers de terre indiqueraient une plus grande résistance à la maladie lorsque la pomme de terre pousse en présence des vers de terre.

Effect of boron addition on ergot development and productivity of barley. D. Pageau, G. Charron and R.R. Simard*, Agriculture and Agri-Food Canada, Normandin and Sainte-Foy, QC.

Ergot fungus (*Claviceps purpurea*) causes significant barley and yield losses in the Saguenay-Lac-St-Jean region of Québec. Field trials were conducted from 1992 to 1994 in the Lac-St-Jean region (Québec, Canada) to study the effect of B addition on ergot occurrence and yield of barley (*Hordeum vulgare*). The cereal was seeded at four locations and four application rates of B (0, 0.5, 1.0 and 2.0 kg B ha^{-1}) were applied on two barley cultivars: Léger (sensitive to ergot) and Laurier (resistant to ergot). Boron was sprayed at the 15 Zadoks stage. No artificial inoculation with the ergot fungus was carried out. Although B addition had little effect on ergot content and yield components of cultivar Laurier, it decreased the ergot content of cultivar Léger. Adding 1.0 kg B ha^{-1} reduced ergot content by 90% in 1992, by 97% in 1993 and by 82% in 1994. An application of 1.0 kg B ha^{-1} increased grain yield of cultivar Léger by 25% in 1992, by 15% in 1993 and by 12% in 1994. These yield increases were associated with a larger number of grains produced per spike but were not always associated with larger B contents in plants tissues. Boron addition also decreased the 1000-grain weight. This study suggest that boron induced a better pollination and the positive effect of B addition on barley grain development is also cultivar dependant.

Characteristics and quality of composts derived from waxed corrugated cardboard and other organic wastes. D.A. Raymond[1*], R.P. Voroney[1], and C. Chong[2], [1]Department of Land Resource Science, University of Guelph, Ontario. [2]OMAFRA, Horticultural Research Institute of Ontario, Vineland Station, Ontario.

Composting organic wastes for use as soil amendments or in potting substrates offers great potential for diversion of these wastes from landfills. The characteristics and quality of twelve composts containing, by volume, spent mushroom substrate (50%), waste waxed corrugated cardboard (WCC, 0%, 25% or 50%), and/or pulverized wood wastes (PWW, 50%, 25% or 0%) were measured and evaluated after two separate composting periods (14 weeks). Supplemental N was added to some composts as poultry manure, and/or soybean processing wastes. During the first 8-10 weeks composts containing 50% WCC tended to reach and maintain higher temperatures, but subsequently cooled more rapidly. Microbial activity (CO_2 evolution) also was initially higher in these composts. The paraffin wax in WCC containing composts was almost completely degraded (>95%). Total N (1.2-1.6% DW), P (0.30-0.55%), and K (0.9-1.2%) concentrations were within typical ranges and highest in composts containing 50% WCC. KCI extractable NH_4-N (494 mg-N * kg^{-1}) and NO_3 +NO_2-N (281 mg-N * kg^{-1}) were highest and lowest, respectively, in composts containing 50% WCC. Electrical conductivity (4.5-8.5mS * cm^{-1}) and pH (7.5-8.5) were high in all composts and highest in composts with 50% WCC as was the concentration of phenolic compounds. C:N ratios were lowest in composts with 50% WCC (16:1). Greenhouse-grown bedding plants grew poorly in all composts but were unaffected by the level of WCC. Container-grown nursery crops grew well in most composts and most grew better in composts with WCC. Two ornamental shrubs, deutzia and silverleaf dogwood, grew better in the compost with 50% WCC than in a control potting mix (80% pine bark: 15% peat: 5% sand).

Impact of tillage system and the Conservation Reserve Program on soil quality in North Dakota. M.J. Rosek[*], B.S. Miller, and J.C. Gardner. North Dakota State University, Carrington Research Extension Centre, Carrington, ND, USA.

Recognizing properties that function as indicators of soil quality induced by management practice is essential to develop and assess sustainable agricultural practices. A study conducted at long-term cropping system sites at Carrington (10 years) and Mandan (8 years), North Dakota, and Brookings (6 years), South Dakota, USA, examined the effect of tillage and fertility level on soil quality. Surface bulk density significantly decreased and infiltration rate significantly increased from conventional to no=till at Carrington. Microbial respiration significantly increased from conventional to no-till at Carrington and Brookings. Surface nitrate content significantly decreased at Mandan and Brooking, but increased at Carrington from conventional to no-till. Surface nitrate content and pH were significantly affected among all fertility levels at Mandan and Carrington.

Another study, conducted in North Dakota, examined soil quality changes in response to the Conservation Reserve Program (CRP). In this study, annually cropped lands were placed into perennial grasses for an average of 5.3 years. Twenty-three paired (CRP-cropped) sites were sampled to a depth of 20 cm for determination of physical, chemical, and biological properties. Microbial biomass and respiration were significantly increased while nitrate content was significantly reduced under CRP. The results of these studies indicate biological properties are the first to be affected by changes in soil management and are impacted to the greatest extent by those changes. This research also indicates biological properties are good indicators of management-induced changes in soil quality.

Soil water repellency as a long term consequence of terrestrial oil spills. J.L. Roy[*] and W.B. McGill. Department of Renewable Resources, University of Alberta, Edmonton, Alberta, T6G 2E3.

Many hydrocarbon-contaminated soils become severely water repellent and structurally dispersed as they age. This condition, which typically affects only the top 10-15 cm of the soil, is presumed to develop very slowly because it does not generally become apparent until several years or decades after oil contamination. Little is currently known about the substances causing soil water repellency at old, oil-contaminated sites. Alternative hypotheses are that these substances consist of petroleum residues, products of microbial origin, or organic transformation products resulting from abiotic processes. We are currently characterizing water repellent substances from three nonwettable soils of contrasting physico-chemical properties and management histories. These soils were contaminated with crude oil between 20 and 50 years ago, but began to display severe water repellency and structural deterioration only in the last decade or so. Even though it is now no longer possible to tell that these sites were ever contaminated with crude oil based on examination of the surface soil, residual volatile petroleum compounds are typically found in horizons below the dispersed, nonwettable soil. This finding suggests that volatile petroleum compounds irreversibly sorbed onto the surface of soil particles could be the cause of some soil water repellency problems. Characterization of the water repellent substances by gas-chromatography/mass spectroscopy and Fourier transform infrared spectroscopy necessitated their extraction from soil. Of several solvents tested, only one, the amphiphilic mixture isopropanol/15 M ammonia (7:3, v/v), was effective at completely removing the water repellent character of the three studied nonwettable soils. In this poster presentation, we provide background information the water-repellent soils under study, and

describe some of the most interesting results we have obtained from ongoing characterization work.

Selection of soil-water characteristic model using inverse methodology. B. Si*, C. Chang, and G. Travis, Land Resource Dep., University of Guelph, Guelph, Ontario.
Soil water and pollutant modelling require accurate representation of soil water retention function and hydraulic conductivity function. This study was conducted to analyze the accuracy of the available closed-form soil-water characteristic relationships from the One-step outflow experiments of 75 soil samples with a wide range of organic matter content and texture. The inverse methodology of Kool (1985) which couples the nonlinear least square procedure with the numerical solution of Richards' equation was adopted by. Fifteen hydraulic models including the often-used hydraulic characteristic models of van Genuchten (VG) and Brooks & Corey (BC) were evaluated for the accuracy and consistence for the experiment. Among the fifteen models, the four parameter VB models, which are combinations of the van Genuchten retention functions with the Brooks & Corey hydraulic conductivity functions under either Burdine or Mualem conditions, were the most accurate and consistent model. The second case of VB models, which were the four parameter VB models with the pore-connectivity parameter λ fixed to 2 under Burdine condition or 0.5 under Mualem condition, were the second to the four parameter VB models in term of accuracy. The VB models had small MSD, almost zero proportion of bias and deviation from the 1:1 line for overall predicted vs. experimental outflow for the 75 soils. They also had small median of RSS and AIC and their maximums of RSS and AIC were reasonably low on the individual basis.

Évolution des nitrates dans deux sols sous trois travaux primaires du sol. M. Simard*, O. Banton, P. Lafrance. INRS-Eau, U. du Québec, Ste-Foy, Québec.
L'utilisation intensive de fertilisants minéraux en milieu agricole peut entraîner un risque de contamination des eaux souterraines et de surface par les nitrates. La présente étude vise à caractériser l'évolution des nitrates dans le sol sous trois travaux primaires du sol. Les deux sites à l'étude, cultivés pour le maïs, sont localisés à Varennes (argile de la série St-Urbain) et à Frelighsburg (loam de la série de Blanford). Le dispositif expérimental utilisé dans les deux cas est un factoriel en blocs aléatoires complets, avec trois blocs constituant chacun un réplicat de l'expérience. Le dosage des nitrates dans les échantillons de sol, prélevés à la tarière, a été réalisé à l'aide d'une électrode spécifique. Le suivi de l'évolution des nitrates dans le sol s'est échelonné sur une période de quarante jours après le semis, et ce pour cinq profondeurs allant jusqu'à 1 mètre. Pour le site de Varennes, les concentrations en nitrates montrent une tendance à l'augmentation dans le temps, ainsi qu'une légère diminution avec la profondeur. Cette décroissance verticale peu marquée des concentrations peut être attribuée à une homogénéisation dans la couche racinaire, résultat de la remontée occasionnelle de la nappe phréatique à la surface du sol. Dans le cas du site de Frelighsburg, les concentrations en nitrates évoluent régulièrement dans le temps, avec une croissance de l'ordre de 200 à 300 % en 40 jours. L'évolution verticale des concentrations est également bien marquée, avec une diminution régulière avec la profondeur. L'influence des travaux de sol semble se traduire par une augmentation des concentrations en nitrates avec l'intensification du travail du sol.

Boron Soil Tests for Barley in cool climates. R. R. Simard, D. Pageau. and G. Charron, Soils and Crops Research Centre, Agriculture and Agri-Food Canada, 2560 Hochelaga, Sainte-Foy, Quebec, Canada, G1V 2J3.
Boron deficiencies limit crop yields on clay soils rich in organic matter of Eastern Canada. The objective of this study was to calibrate a B soil test for barley on Humic Gleysols of the Lac Saint-Jean area, province of Quebec, Canada. Two barley (*Hordeum vulgare L.*) cultivars were grown on 12 sites over three cropping seasons. On average, the Mehlich 3 solution extracted more B (5.3 mg kg^{-1}) than Sr-Citrate (3.2 mg kg^{-1}), hot water (1.3 mg kg^{-1}), mannitol-$CaCl_2$ (0.8 mg kg^{-1}), $CaCl_2$ (0.6 mg kg^{-1}) and cold water (0.5 mg kg^{-1}). The response to B fertilizer was cultivar specific. Mannitol-$CaCl_2$ was most closely related to barley B uptake ($r= 0.62^{**}$), whereas Mehlich 3 best predicted fertilizer response. The relationship between plant uptake and amounts of soil B extracted was most improved when soil pH was included in the equation. Higher critical levels of Mehlich 3 extractable B than found in the literature were determined. This may be due to the large soil organic matter contents which increase soil B sorption capacity and decrease B intensity. The results of the present study suggest that soil pH should be included in a soil-test B index to predict fertilizer B needs of barley growing on these clay soils.

Nitrogen derived from winter rye residues for tobacco production. A. Siregar*, R.P. Voroney and R.P. Beyaert. University of Guelph and Agriculture Canada, Delhi, ON.
Nitrogen (N) available during the growing season is a critical factor influencing the yield and quality of the cured tobacco leaf. The objective of this research was to quantify the inputs of N derived from winter rye residues, chemical fertilizer and soil organic matter for tobacco production. This research was conducted using a winter rye (*Secale cereale*)- tobacco (*Nicotiana tabacum*) rotation system set out on a Fox loamy sand at the Agriculture Canada Research Station, Delhi, Ontario. Winter rye residues at three stages of maturity (dough, maturity and late maturity), and with and without grain harvested, and with and without additional N fertilizer

were incorporated in fall; tobacco was grown the following spring. Applications of ^{15}N-labelled NH_4NO_3 and urea were used to distinguish inputs of fertilizer N from that derived from rye residues and from soil organic matter. Tobacco plant growth was measured as Leaf Plastochron Index (LPI) and measurements were made of total plant N content. Winter rye residues did not affect the LPI of tobacco but leaf yields and total N content were increased. Nitrogen derived from rye residues accounted for 6.6 to 21.1 kg/ha of the tobacco leaf N. Furthermore, the quality of the tobacco green leaves (total N) was improved, confirming the importance of rye residue management to tobacco production.

Effect of field pea on mineral N accumulation and uptake during the following growing season. Y.K. Soon* and G.W. Clayton, Agriculture and Agri-Food Canada, Beaverlodge, AB.

We determined the effect of a preceding pea or wheat crop on nitrogen transformation in a loamy sand soil and uptake by wheat because an increasing acreage in western Canada is cropped to pea. Mineral N to 1.2m depth at four different times during the 1993 and 1994 growing seasons, including a pre-seeding sampling, were quantified. Plant N uptake was also determined at the other three post-seeding samplings. Nitrogen uptake and grain yields of wheat, fertilized according to a fall soil test, were not affected by the previous crop. Soil nitrate to 1.2m depth at pre-seeding was twice as high where the previous crop was pea compared to wheat. A substantial accumulation of nitrate occurred below the 60 cm depth under a previous pea crop. In general, nitrate initially increased with time then decreased as the crop matured. Ammonium-N was generally low, less than 10 kg ha^{-1}, to all sampling depths and throughout the growing season.

Genetic and Edaphic influences on leaf litter chemistry and decomposition in black spruce (*Picea mariana* (Mill.) B.S.P.). U. Stoklas* and J.W. Fyles, Macdonald Campus of McGill University, Ste.Anne de Bellevue, Quebec.

Infraspecific variation in foliar litter chemistry and decomposition were studied as a function of genotype and the edaphic environment using senescent needles collected from four full-sib families of *Picea mariana* (Mill.) B.S.P. grown on two sites at the Petawawa National Forestry Institute (Chalk River, Ontario). Significant parental effects suggest that initial Ca and lignin concentrations are under genetic control, whereas the variability in N and cellulose contents appear to be governed by site and within-site differences. Concentrations of K and Mg seem to be influenced by both the environment and genetics. Preliminary analyses of a year-long litter bag decomposition experiment in a mixed spruce planation (Ste.Anne de Bellevue, Quebec) reveal that differences in initial leaf litter chemistry, as determined by genetics and/or soil conditions, are reflected by variations in decomposition rates and short term patterns of nutrient release. These results in turn help explain significant family and site differences in long term accumulation of organic matter and soil nutrient status.

Recycling irrigation water in nursery production. P. Tardif*, J. Caron, I. Duchesne, and J. Gallichand. Département de génie rural, Université Laval, Sainte-Foy, Québec Canada. G1K 7P4

Overhead sprinkler systems in nurseries use large amount of water and fertilizers and generate runoff losses that may alter the quality of surface or subsurface waters. Moreover, the cost associated with these losses is important. Water recycling may reduce that cost and the losses to the environment. The objective of this experiment was to evaluate the performance of two recycling systems (recycling and storing water in tank and recycling solution through subirrigation on capillary mats) relative to a conventional overhead sprinkler system with no recycling. Two species (*Prunus X cistena* and *Spiraea japonica* 'Little Princess') and seven substrates were used on plots subject to these irrigation practices. Treatments were compared for water balance and plant growth. After the first season, preliminary results showed that water and nutrient consumption were 65% less with both recycling systems. Plant yield and soil water content were statistically the same for the three treatments.

Étude de l'évolution de la qualité des sols en parcelles de longue durée à Saint-Lambert (Québec). III. Effet de l'apport prolongé de fumier de bovin et de fumures minérales sur les formes et la disponibilité du phosphore. T.S. Tran* et A. N'Dayegamiye. MAPAQ, Sainte-Foy, QC.

L'application à long terme du fumier et des engrais minéraux peut affecter les formes et la disponibilité du phosphore du sol. Ces effets cumulatifs ont été évalués sur le loam limoneux Le Bras cultivé en maïs ensilage. Le dispositif expérimental est du type split-plot dont le facteur principal est le fumier solide de bovins appliqué aux doses annuelles de 0 et 20 t ha^{-1}. Le facteur secondaire est constitué de différentes formules d'engrais minéraux (NK, NP, PK, NPK, NPKMg et un témoin sans engrais). Les fractions inorganiques (Pi) et organiques (Po) du sol ont été déterminées par des extractions séquentielles avec la résine HCO_3, $NaHCO_3$, NaOH, HCl et le P résiduel par la digestion dans H_2SO_4. En moyenne, le P labile représente environ 17 % du P total (Pt), tandis que les formes du P modérément labile extraites par NaOH et les formes plus stables correspondent respectivement à 40 et 36 % du Pt. L'application à long terme du fumier et des engrais minéraux a augmenté les teneurs des fractions Pi extraites par la résine, $NaHCO_3$, NaOH ainsi que les niveaux de Pt. Cependant, la fraction de NaOH-Po a été diminuée par l'apport de P dans les traitements NPK et NPKMg, tandis que l'application du fumier à maintenu ce

pool de Po du sol. Les fractions stables du P n'ont pas été affectées dans tous les traitements. Les prélèvements annuels en P étaient reliés étroitement avec toutes les fractions de Pi labiles, modérément labiles et le P total. L'application à long terme du fumier solide de bovins laitiers à raison de 20 t ha^{-1} annuellement a accru surtout les fractions de Pi, et maintenu également les formes de Po dans le sol étudié.

In Situ Measurement of Vadose Zone Denitrification by ^{15}N Gas Emission. R. Well*, T.H. Nielsen, and D.D. Myrold, Oregon State Univ.

Measurements of vadose zone denitrification with indirect or laboratory methods have indicated that this process can contribute significantly to reduce nitrate leaching to the ground water. These results have not yet been verified with direct methods *in situ* because appropriate procedures were not available. A new method for measuring subsoil denitrification by ^{15}N gas emission *in situ* is presented in this paper. It consists of the following three steps: Application of ^{15}N nitrate to a roughly spherical volume of the subsoil, measuring the steady state $^{15}N_2$ concentration in the centre of the ^{15}N-labelled soil volume, and calculating the denitrification rate using a numerical gas diffusion model. For ^{15}N-labelling and sampling the soil atmosphere a subsurface probe was developed. The gas diffusion model was evaluated by comparing measured and simulated concentration profiles of a test gas which was applied to different subsoils at a constant rate. The method was tested in a field experiment. Three subsurface probes were installed at a depth of 70 cm in a Woodburn silt loam. After applying 3 L of a $^{15}NO_3$ solution (20 mg NL^{-1}, 99 atom % ^{15}N) the $^{15}N_2$ concentration in the sub soil was monitored during 4 weeks. Preliminary results indicate that the method is suitable for detecting subsoil denitrification.

First-year response of Douglas-fir and western hemlock to N and P fertilization. J.B. White*, Department of Forest Sciences, University of British Columbia.

Western hemlock (*Tsuga heterophylla* [Raf.] Sarg.) is the dominant species in several coastal Timber Supply Areas in British Columbia now facing timber shortages. Though operational fertilization of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) is now common in the Pacific Northwest, fertilization of western hemlock has remained unviable due to the inability of both forest researchers and managers to accurately predict its response. An immature stand composed of both Douglas-fir and western hemlock was fertilized in an attempt to compare the nutritional requirements of these two species. The following treatments were tested: (1) control (no fertilizer applied), (2) N (224 kg/ha), (3) N (224 kg/ha) + P (100 kg/ha), (4) N (224 kg/ha) + P (500 kg/ha), (5) N (224 kg/ha) + P (100 kg/ha) + Blend (230 kg/ha), (6) N (224 kg/ha) + P (500 kg/ha) + Blend (230 kg/ha). Nitrogen was applied as ammonium nitrate and phosphorus as triple-super-phosphate. The blend application included potassium sulphate, magnesium sulphate, copper sulphate and zinc sulphate. Douglas-fir trees exhibited an increase in needle weight in response to nitrogen fertilization and the response was increased with the application of P at the rate of 100 kg/ha and the blend fertilizer. The application of P at a rate of 500 kg/ha resulted in a negative growth response. In sharp contrast, hemlock trees showed no evidence of response to nitrogen fertilization alone and the best growth response was observed when P was applied at a rate of 500 kg/ha. Analysis of foliage collected during the winter season revealed that hemlock foliage had higher concentrations of the amino acids arginine, glutamine and asparagine following fertilization than that of Douglas-fir trees.

Dynamics of humic substances formed during the decomposition of glucose and wheat straw. G. Zhao*, R.P. Voroney and L.J. Evans. University of Guelph, ON.

Humic substances are important reservoirs of biologically resistant, sequestered carbon (C) in soil organic matter. Cropping systems and other management practices such as tillage intensity influence the quantity and quality of the inputs for formation of humic material. The objective of this research was to investigate the contributions of the decay products from plant residues and microbial biomass to formation of humic substances. A loamy sand soil was amended with ^{14}C-glucose and with ^{14}C-wheat straw and the quantity of microbial biomass and humic substances formed and their dynamics were measured during an incubation for 120d. Microbial biomass- ^{14}C formed quickly in the ^{14}C-glucose amended soil, accounting for 78% of the added ^{14}C after the first day of incubation. In soils amended with wheat straw, ^{14}C-microbial biomass at 9.5% of the added C was maximum by day 2 of the incubation. A greater proportion of the C derived from glucose was recovered in newly formed ^{14}C-humic acid compared to that with wheat straw. By day two when essentially all of the glucose had decomposed, 6.2% of the added ^{14}C was recovered in the humic acid fraction. Much more ^{14}C-fulvic acid was also formed with the glucose amendment. However, these newly formed substances recovered in the humic fractions during the first 15d of incubation decayed much more quickly than those formed from wheat straw. After this period the amount of ^{14}C-fulvic acid was higher with wheat straw than with glucose. Stabilized ^{14}C-humic substances accumulated in both treatments after 60d of incubation.

Comparison between DRIS and compositional nutrient diagnosis norms for alfalfa in eastern Canada. N. Ziadi*, R.R. Simard, L.É. Parent, G. Allard, J. Zizka. Université Laval and Agric. and Agri-Food Canada, Ste-Foy, Québec.

Diagnosis and Recommendation Integrated System (DRIS) and Compositional Nutrient Diagnosis (CND) norms were developed for alfalfa (*Medicago sativa* L.) at the 10% bloom stage. These norms were generated from a data bank of plant yields and tissue N, P, K, Ca, and Mg concentrations. The data bank was collected in the province of Québec, Canada, between 1990 and 1992 from one experiment conducted on the effects of cutting management and K fertilization on yield, mineral composition, and quality of 'Apica' alfalfa. A threshold yield of 2.5 Mg ha^{-1} per cut was used to separate high- from low- yielding subpopulations. CND multinutrient ratios were reduced to four principal components which were designated as (K^-, Ca^+),(P^-),(Mg^-), and (N^+). These principal components explained 99% of the total variation in the high-yielding subpopulation and can describe nutrient status and equilibria in tissues. DRIS and CND nutrient indices were highly correlated (r = 0.85 to 0.99). DRIS and CND norms developed are highly valuable in improving the diagnosis of nutrient imbalance in alfalfa

Événements à venir en 1996

1996

24 janvier, Colloque sur la fertilisation intégrée des sols: Auberge Universel Drummondville.

6-12 juillet, Congrès de ls Societe Canadienne des Sols et de l'Institut Agricole Canadien, Lethbridge, Alberta.

17-24 Mars: 4ieme Symposium International sur les interactions sol-plante à bas pH, Belo Horizonte, Bresil.

16-20 juin: Atelier nord-américain de biologie forestière: impacts de l'aménagement forestier sur les fonctions de l'écosystème, Québec, Canada.

19-23 (?) août: Atelier sur la dynamique des perturbations en forêt boréale, Rouyn-Noranda, Canada

3-8 novembre: Congrès de la Société Américaine de Science du Sol: Indianapolis USA

4-6 novembre: Application of GIS remote sensing, geostatistics and solute transport modelling for the assessment of non-point source pollutants, Riverside, Californie.

8-15 septembre: 9ieme Colloque International sur l'optimisation de la nutrition des Plantes, Prague, République Tchèque.

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