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INFORMATION and COMPUTER TECHNOLOGIES

A New CSAE Technical Division

The Canadian Society of Agricultural Engineering has established a new division, Information and Computer Technologies, that will receive and evaluate manuscripts and organize technical and scientific activities.

Aims and Scope

The new division is concerned with the development and use of information and electronic technologies in the agricultural, food processing, and bioresource engineering areas. The objective is to foster the exchange of information and knowledge on the methods, approaches, tools, and applications for the design, creation, management, and teaching of agricultural systems. The division is interested in research dealing with computer hardware as well as software.

Some of the topics of interest in the hardware area are: electronics, logic circuits, microprocessor-based controllers, networking and communications technologies, automation, robotics, artificial vision, and programmable machines. Software topics include: descriptions of simple instruction sequences or algorithms, descriptions of application programs, knowledge-based systems for diagnostics, planning, control, training, decision support etc., design, development or use of knowledge-based methodologies for modeling and simulation, data management, process and system management, and applications of technologies such as artificial neural networks, hypertext, multimedia, and Geographic Information Systems.

The criteria for the evaluation of submitted manuscripts is their originality, perceived usefulness for other researchers and professionals, rigor and focus. The thrust of the submitted manuscripts must be on information and systems engineering and not on the knowledge being captured or represented unless this knowledge is itself used for the engineering of information systems. Manuscripts that are deemed to not be relevant to the division will be forwarded to other technical divisions within CSAE.

Submission of papers

Researchers and other professionals from all disciplines and geographic areas are invited to consider Canadian Agricultural Engineering as a platform for the publication of peer-reviewed articles in the domain of information and computer technologies in agriculture. Papers should be submitted (six copies) to the editor of the Journal.

For more information on the division you may contact:

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The Canadian Society of Agricultural Engineering gratefully acknowledges the financial support received from the Natural Sciences and Engineering Research Council of Canada to publish this journal.

Canadian Agricultural Engineering publishes papers covering the general field of Agricultural Engineering that fit into one of the following classifications: (1) a scientific paper based on original research; (2) a technical paper based on design, development, testing or analysis of machines, equipment, structures, processes, or practices; (3) a general paper on education relative to curricula and philosophy or trends in the teaching of agricultural systems. The objective is to foster the exchange of information and knowledge on the methods, approaches, tools, and applications for the design, creation, management, and teaching of agricultural systems. The division is interested in research dealing with computer hardware as well as software.

Some of the topics of interest in the hardware area are: electronics, logic circuits, microprocessor-based controllers, networking and communications technologies, automation, robotics, artificial vision, and programmable machines. Software topics include: descriptions of simple instruction sequences or algorithms, descriptions of application programs, knowledge-based systems for diagnostics, planning, control, training, decision support etc., design, development or use of knowledge-based methodologies for modeling and simulation, data management, process and system management, and applications of technologies such as artificial neural networks, hypertext, multimedia, and Geographic Information Systems.

The criteria for the evaluation of submitted manuscripts is their originality, perceived usefulness for other researchers and professionals, rigor and focus. The thrust of the submitted manuscripts must be on information and systems engineering and not on the knowledge being captured or represented unless this knowledge is itself used for the engineering of information systems. Manuscripts that are deemed to not be relevant to the division will be forwarded to other technical divisions within CSAE.

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The Canadian Society of Agricultural Engineering gratefully acknowledges the financial support received from the Natural Sciences and Engineering Research Council of Canada to publish this journal.
92-101. NON-LINEAR LOW GRADIENT FLOW THROUGH SAND-BENTONITE MIXTURES
T. Karthigesu and R. Sri Ranjan, Agricultural Engineering Department, University of Manitoba, Winnipeg, MB.

Sand-bentonite mixtures are used in cut-off walls to isolate contaminant spills from the surrounding area. They are also used as barrier materials in hazardous waste disposal. The flux of water through the soil, as described by Darcy’s law, is directly proportional to the gradient of the soil water potential and under saturated conditions the proportionality constant is defined as the hydraulic conductivity of the soil. The hydraulic conductivity is assumed to be a constant independent of the hydraulic gradient. Conventional methods of measurement of this parameter are carried out by measuring the water flow under imposed hydraulic gradients which are usually high to permit the measurements to be made within a reasonable length of time. A review of literature and experimental evidence on 10% bentonite-sand mixture indicate that under low hydraulic gradients the hydraulic conductivity is an order of magnitude less than that obtained under high gradients. The natural gradients prevailing in the field are low enough to cause the hydraulic conductivity to be much lower than would be used in the modelling of the flux through these barriers.

92-102. USE OF A WIND TUNNEL TO SIMULATE SPRAYER TRAVEL SPEEDS
J. Underwood, Agricultural Engineering Section; and H. Spieser, Resources Management Branch, Ontario Ministry of Agriculture & Food, Ridgetown College of Agricultural Technology, Ridgetown, ON.

A wind tunnel has been constructed to simulate travel speeds of a spray boom. Speeds of 0 to 20 km/h can be obtained. The wind tunnel contains a patterner floor with 50 mm wide troughs 3.6 m long. The effect of travel speed on spray patterns and spray loss due to travel speeds can be studied in controlled conditions.

92-103. DETECTION OF SOIL MACROPORES USING SMOKE
R.J. Fleming and S.H. Bradsahw, Agricultural Engineering Section, Centralia College of Agricultural Technology, Huron Park, ON.

Smoke bombs and a blower were used to demonstrate the presence of soil macropores. Smoke was blown into subsurface tile drains on several farms under a variety of soil conditions. Smoke emerged from the ground in a band over the tiles. This band varied in width from isolated spots to as wide as two metres. The technique has great potential as a demonstration to farmers.

92-104. DESIGN, CONSTRUCTION AND TESTS OF A SIMPLE IN SITU CAPACITANCE MOISTURE SENSOR FOR ORGANIC SOIL AND SAWDUST

A simple in situ capacitance moisture content meter was designed and constructed. The device consisted of a 2.0 x 3.0 x 0.6 cm sensor and a hand-held digital multimeter with a capacitance range. The sensitivity of this meter was compared to that of a commercially available fibreglass resistance type. In a series of experiments, two sensors (one of each type) were installed in different saturated soil and sawdust samples and the readings of the meters and weights of the samples were recorded at regular intervals. The capacitance moisture meter was found to be more sensitive to small changes in sample moisture content. With a few modifications (discussed in the paper) to the sensor design to improve accuracy, it is possible to monitor small changes in small volumes of organic soil and sawdust with a simple in situ capacitance moisture meter.

92-105. FIELD VALIDATION OF SWACROP IN ATLANTIC CANADA
I.N. Mathur, S.O. Prasher and A.K. Maheshewari, Department of Agricultural Engineering, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ; and A. Madani, Department of Agricultural Engineering, Nova Scotia Agricultural College, Truro, NS.

SWACROP, a water table management model, was validated for Atlantic Canada by comparing the measured drain outflows and midspan water table depths against the simulated values. The field measurements were made in nine test plots in 1990 and 1991 where drains were spaced at 3 m, 6 m, and 12 m intervals, each with three replicates. Based on our investigations, it can be concluded that SWACROP can be used to evaluate or design subsurface drainage systems in Atlantic Canada. Since the model can also be used to design controlled drainage or subirrigation systems, further testing of the model under these systems should be carried out.

92-106. FIELD VALIDATION OF SWACROP IN SOUTHERN ONTARIO
H.L. Aheer, I.N. Mathur and S.O. Prasher, Department of Agricultural Engineering, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ; and C.S. Tan and M. Soultani, Harrow Research Station, Harrow, ON.

SWACROP, a water table management model, was tested with experimental data from a subsurface-drained corn field in southern Ontario, Canada. Four test plots, two each for conventional drainage and subirrigation, were monitored from July 1991 to October 1991 for the midspan water table depths and drain outflows. The average absolute deviation between the measured midspan water table depths and the predicted values was 25.15 cm for conventional drainage. For subirrigation, it ranged from 30.47 to 43.28 cm. The corresponding standard errors of estimate were 27.09 cm for conventional drainage and 45.70 and 33.72 cm for subirrigation. SWACROP seems to have the potential to be used for designing or evaluating subsurface drainage and subirrigation systems in southern Ontario. However, further testing of the model is needed before drawing any concrete conclusions.

92-107. FIELD VALIDATION OF DRAINMOD IN ATLANTIC CANADA
G.P. Gupta, S.O. Prasher and C.M. Tejawat, Department of
Agricultural Engineering, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ; and A. Madani, Department of Agricultural Engineering, Nova Scotia College of Agriculture, Truro, NS.

DRAINMOD, a watertable management model, was validated with the field data measured in a subsurface-drained field in Atlantic Canada. The 5.4 ha alfalfa field was monitored for three summer months in 1990, and for five months in 1991 for the midspan watertable heights and drain outflows. The experimental data were available for three drain spacings, i.e. 3 m, 6 m and 12 m. The average absolute deviations between the measured midspan watertable heights and the simulated values ranged from 12 to 20 cm for the three drain spacings. The corresponding standard errors ranged from 18 to 27 cm. For drain outflows, the average absolute deviation between the measured and simulated values ranged from 0.08 to 0.15 cm/day for the three drain spacings. The corresponding standard errors ranged from 0.17 to 0.36 cm/day. Based on our study, it can be concluded that DRAINMOD can be used for designing or evaluating subsurface drainage systems in Atlantic Canada.

92-108. EVALUATION OF DRAINMOD FOR SOUTHERN ONTARIO CONDITIONS
C.M. Tejwatt, G.P. Gupta and S.O. Prasher, Department of Agricultural Engineering, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ; and C.S. Tan and M. Sutiani, Harrow Research Station, Harrow, ON.

DRAINMOD, a watertable management model, was evaluated with field measurements made in a subsurface-drained corn field in southern Ontario, Canada. Several test plots were monitored from July 1991 to October 1991 for the midspan watertable fluctuations and drain outflows. There were two watertable management treatments, namely subsurface drainage and subirrigation, each with two replicates. The average absolute deviations between the average measured midspan watertable heights and the predicted values were 18.51 cm for conventional drainage and ranged from 15.17 to 31.27 cm for subirrigation. The corresponding standard error was 20.01 cm for conventional drainage and ranged from 16.69 to 33.44 cm for subirrigation. Based on our limited evaluation, it can be said that DRAINMOD holds a lot of promise for designing or evaluating subsurface drainage and subirrigation systems in southern Ontario. However, further evaluation is needed before any conclusive statements can be made.

92-109. EVALUATION OF DRAINMOD FOR THE LOWER FRASER VALLEY CONDITIONS
S. Agarwala and S. Chiang, Dept. of Bio-Resource Engineering, University of British Columbia, Vancouver, BC.

Data from conventional subsurface drainage and subirrigation field experiments from Boundary Bay in the Lower Fraser Valley were used to evaluate the reliability of the water management model, DRAINMOD, for simulating the performance of subsurface drainage and subirrigation in the Lower Fraser Valley. Predicted and measured watertable depths were compared for five years, 1985, 1986, 1987, 1988 and 1989, where 1986 was a normal year from the total rainfall standpoint. Model predicted watertable depths were better for the wet season than for the whole year. The model showed a higher water storage capacity of the soil profile. For the drier than normal year, 1985, watertable depth was over predicted as evapotranspiration was under predicted by the model. Assumed deeper rooting depth for crops in 1985 increased soil withdrawal by ET and significantly improved predictions for watertable depth.

92-201. PERFORMANCE OF THIN-FILM HUMIDITY SENSORS IN POULTRY AND SWINE ENVIRONMENTS
H. Hong and J.J. Leonard, Bioresource Engineering, University of Alberta, Edmonton, AB.

Two thin-film-polymer humidity sensors, together with their associated signal conditioning and transmitting circuitry were placed in turkey, broiler chicken and swine environments for periods of six to seven weeks each. Their outputs were compared to that from a chilled-mirror dewpoint hygrometer with traceable calibration. Both sensors consistently indicated higher relative humidities than the standard although the deviations were not large (2-3% RH). Also, both sensors displayed drift with time. The rate of drift varied with each environment but could not be correlated with other variables that were measured, including ammonia and dust concentrations. The paper describes the experimental facilities and procedures as well as documenting the results of the study.

92-202. "NATVENT" SOFTWARE PREDICTIONS Versus FULL-SCALE ESTIMATES OF WIND INDUCED NATURAL VENTILATION
Y. Choinière and A. S.-Tremblay, Collège de technologie agricole et alimentaire d’Alfred, Alfred, ON; and J.A. Munroe, Centre for Food and Animal Research, Agriculture Canada, Ottawa, ON.

Ventilation rates in a naturally ventilated swine barn were estimated based on measured CO2 levels. Tests were conducted using continuous ridge opening widths of 0.25 and 1.25 mm. Ventilation rate coefficients were determined considering wind speed and direction, and size of sidewall openings. These coefficients were compared to those predicted by the NatVent software package which uses data from a wind tunnel study of a scale model of a naturally ventilated building. These comparisons indicated good agreement between the NatVent predictions and barn measurements for the three ridge openings tested. If rotating doors are used in the sidewalls instead of vertical sliding panels, the free area of the opening is more appropriate to use than the horizontally projected area when predicting wind induced ventilation rates.

92-203. NATVENT: A NATURAL VENTILATION SOFTWARE PACKAGE FOR LIVESTOCK BUILDINGS AND GREENHOUSES
A. S.-Tremblay and Y. Choinière, Collège de technologie agricole et alimentaire d’Alfred, Alfred, ON; J.A. Munroe, Centre for Food and Animal Research, Agriculture Canada, Ottawa, ON; and S. Tremblay, Département de génie rural, Collège de technologie agricole et alimentaire d’Alfred, Alfred, ON.

This paper describes how the computer software package NatVent evaluates naturally ventilated livestock and greenhouse building designs. The user interactively inputs various dimensions and characteristics of the building and NatVent suggests the best building orientation(s) based on local design temperatures and hourly meteorological data. The package can test designs across Canada since it has built-in access to historical data from 32 weather stations. The output features the Preferred Building Orientation(s) and the expected Level of Satisfaction of the tested design. A typical swine barn design was evaluated using two
different weather data sets: Ottawa, Ontario and Brandon, Manitoba. To be rated as excellent, this building design required 0.91 m high continuous sidewall openings in Ottawa, but only 0.61 m high openings in Brandon. The best building orientation for Ottawa was ESE-WNW versus N-S for Brandon. These results demonstrate the effect of sidewall, end wall and roof openings when varying geographic location.

92-204. ATTIC HEAT RELIEF SYSTEM USING NATURAL CONVECTION
D.S. Rea, Portage Manufacturing Inc., Portage la Prairie, MB; and M.G. Britton, Agricultural Engineering Dept., University of Manitoba, Winnipeg, MB.

A computer model based on basic heat transfer theory is developed to predict the roof surface and attic temperatures of a gable roof building. The attic temperatures predicted to coincide with temperatures measured (unpublished) in the attic of a pig barn. The model also predicts roof surface temperatures that coincide with published data. This computer model will be used to evaluate the operation of a proposed attic heat relief system. The proposed attic heat relief system uses solar induced natural convection as the driving force. The system consists of a second layer on the surface of a gable roof structure, which provides an air channel that allows solar heated air to flow up the roof slope and vent to ambient air at the ridge, preventing the accumulation of heat in the attic air space.

92-205. EVALUATION OF AN ELECTRONIC PIG FEEDING SYSTEM
J.J. Leonard and D.J. Grose, Bioresource Engineering, University of Alberta, Edmonton, AB.

A commercial system designed to monitor the feed intake of individual pigs was evaluated in laboratory and field tests. The system used ear tag-mounted transponders for identification of animals and feeders mounted on load cells for feed measurement. Laboratory tests were carried out to determine the effective range of the transponders and their dependence on orientation. The system was installed in a feeder barn for field testing which included monitoring calibration drift of two load cells and the use of video recording to assess identification accuracy and reliability. The laboratory tests indicated that transponder range was affected by orientation but not sufficiently to compromise identification. Over a three day monitoring period in the barn, the identification system performed satisfactorily although one pig lost its transponder. The two load cells were tested over a two-month period. One performed satisfactorily but the calibration of the other drifted to give errors of over 20%.

92-206. THERMAL BEHAVIOUR ASSESSMENT OF AN EXPERIMENTAL PIGLET WARMING PAD
R.E. Stutsky and M.G. Britton, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB; and D.G. Hodgkinson, DGH Engineering, Winnipeg, MB.

This study assessed the thermal characteristics of an experimental piglet warming pad that used water as the heat transfer media. Three water inlet temperatures and three water flow rates were evaluated. The heat loss was calculated using three different methods and the values were compared. The heat pad lost 450-600 W/m² and the top pad surface remained in the range of 30-35°C.

92-207. PROBABILITY ESTIMATION OF SILAGE EFFLUENT FROM HORIZONTAL SILOS
P. Savoie, Sainte-Foy Research Station, Département de génie rural, Université Laval, Sainte-Foy, PQ.

A silage effluent model was developed to predict daily and yearly flow from a compacted horizontal silo. Effluent was estimated for a 200 t dry matter grass crop harvested by three different systems, using 50 years of simulated daily rainfall. A direct-cut non-stop system (DCNS) with continuous harvest independent of weather, resulted in 319 t of effluent or less at 95% probability (19 years out of 20) in a wet climate (0.6 daily rain probability, 1000 mm per year, 16% initial crop DM) and 224 t of effluent in a drier climate (0.3 rain probability, 500 mm per year, 18% initial crop DM). The daily maximum flows at 95% probability were 37 t in the wet climate and 24 t in the dry climate. A direct-cut harvest system restricted to non rainy days only (DCNR) reduced total effluent to 230 t in the wet climate and 134 t in the dry climate. Daily maximum flows at 95% probability were 22 t in the wet climate and 11 t in the dry climate. A harvest system with 6-h field wilting (WS) produced total effluent of 14 t in the wet climate and 7 t in the dry climate. Daily maximum flows at 95% probability were 0.6 t in the wet climate and 0.4 t in the dry climate. Wilting almost eliminated the problem of silage effluent but the harvest period was delayed from 5 days with the DCNS system to up to 18 days with the WS system.

92-208. WITHDRAWAL RESISTANCE OF NAILS FROM THE END GRAIN OF WOOD
P. Grieger and M.G. Britton, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB.

Preliminary tests to define the end grain withdrawal resistance for three nail types (Common, Ardox, Ring) in two different wood species (Spruce/Pine/Fir, Douglas Fir) were undertaken. Withdrawal resistance of aradox nails was considerably less than common and ring nails. Douglas Fir had greater nail holding capacity than Spruce/Pine/Fir. The data tended to confirm that the withdrawal resistance at minimum levels approaches zero.

92-209. A REVIEW OF EUROPEAN, ONTARIO AND USA STANDARDS AND CODES ON INDOOR AIR QUALITY AND WORKING ENVIRONMENT IN LIVESTOCK BUILDINGS WITH RESPECT TO LIVESTOCK PRODUCTION IN ONTARIO
Y. Choiniere and A. S-Tremblay, Collège de technologie agricole et alimentaire d'Alfred, Alfred, ON; F.A. Kains, Engineering Resources Unit, Resources Management Branch, OMAF, Waterloo, ON; and J.A. Munroe, Centre for Food and Animal Research, Agriculture Canada, Ottawa, ON.

Numerous recommendations on indoor air quality inside livestock buildings from European countries were reviewed. At the present time, there is no evidence that these standards should be used in Ontario. The adoption of the present Ontario and USA OSHA codes could be easily accommodated by dairy and swine producers. However, the poultry industry would be challenged to reduce the high ammonia levels currently typical of broiler, laying hen and turkey barns.

92-210. REMOVAL OF AIRBORNE DUST FROM SWINE HOUSING BY ELECTROSTATIC PRECIPITATION
S.D. Fournier, Belhen Industries, Brandon, MB; and J.J.R.
Feddes, Bioresource Engineering, University of Alberta, Edmonton, AB.

An electrostatic precipitator in conjunction with a recirculation duct was developed to remove airborne swine dust from an environmental chamber at the University of Alberta. The collection efficiency of the electrostatic precipitator was evaluated at varying applied voltage and airspeed levels. The three applied voltage levels were: -10.3, -11.0, and -12.1 kVDC. The three airspeed levels were 0.55, 0.76, and 0.95 m/s. The overall collection efficiency of the precipitator ranged from 18.5% at an applied voltage of -10.2 kVDC to 96.4% at an applied voltage of -12.0 kVDC. Applied voltage had a significant effect (P<0.05) on collection efficiency. Airspeed did not have a significant effect (P<0.05) on collection efficiency. The optimal airspeed was 0.76 m/s for all applied voltages. Collection efficiency increased by approximately 5% when the precipitator length was increased by 50%. Inter-electrode spacing had little effect on collection efficiency. An applied voltage of -12.1 kVDC produced ozone levels of 0.21 ppm which exceeded the recommended TLV of 0.1 ppm.

92-211. WIDE NATURALLY VENTILATED BREEDING-GESTATION UNITS AND NEW RIDGE AIR INLET DESIGN FOR 26 M WIDE FARROWING-NURSERY UNITS FOR A 700 SOW COMPLEX
Y. Choinière, Collège de technologie agricole et alimentaire d’Alfred, Alfred, ON; C. Moore, DMV, St-Césaire, PQ; G. Gingras, Service du génie, MAPAQ, Ste-Foy, PQ; and J.A. Munroe, Centre for Food and Animal Research, Agriculture Canada, Ottawa, ON.

This new 700 sow complex incorporates two major innovative technologies. The 19 m x 73 m breeding-gestation unit is naturally ventilated using intermittent chimneys and continuous vertical sidewall panels complete with windbreaks. A new digital automatic control system is used to activate the sidewall openings. The farrowing and nursery units are contained in a 26 m x 64 m building. A newly developed ventilation system draws air through a wide continuous ridge opening into a central attic duct. Lateral distribution ducts in the attic then feed each room independently. This paper describes advantages of this ventilation system, as well as presents laboratory results relating air flow characteristics to ridge design.

92-212. CASE STUDY OF A VENTILATION SYSTEM TO REDUCE PNEUMONIA IN A WARM CALF HOUSE
M.R.L. Bantle, Bantle Engineering Research, Saskatoon, SK; E.M. Barber, Department of Agricultural and Bioresource Engineering, K.R. Armstrong, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK; and D. McKnight, Saskatchewan Rural Development, Saskatoon, SK.

A recent study of 20 different Saskatchewan dairy farms involving 336 calves indicated that 38% of the calves were treated for pneumonia and 1.8% died from pneumonia. Since the incidence of pneumonia in warm calf houses is so common in Saskatchewan and since environment is considered to be one of the primary causes of calf pneumonia, a project was initiated to develop and test a heating and ventilating system that would reduce the incidence of calf pneumonia in warm calf houses. A system was developed and installed at a calf house near Osler, Saskatchewan. The system employed a 472 L/s capacity air filtration system. Clinical veterinary measurements and environmental measurements were made over the winter of 1990-1991 and over the winter of 1991-1992. The installed heating and ventilating system did not reduce the incidence of pneumonia but it significantly reduced the severity of the pneumonia. It was estimated that calf health was sufficiently improved that the installed system could be paid for in 1.6 years.

92-213. APPROACHES TO THE STUDY OF RECIRCULATING VENTILATION DUCTS
K.E. Moadedeb and S.F. Barrington, Agricultural Engineering Dept., University of McGill, Montreal, PQ.

The pitot-static and piezometric wall taps were compared when used to measure static pressure along a ventilation duct. Momentum and energy equations were evaluated while used to study ventilation ducts. The combination of these equations defined an equation which links the duct air flow velocity and outlet angle and velocity to the real static pressure without any need for friction evaluation. Comparison of measured data with theoretical equations indicated that friction is an important parameter but outlet energy losses are negligible.

92-214. AUTOMATICALLY CONTROLLED NATURAL VENTILATION IN A MODIFIED ENVIRONMENT DAIRY BARN
J.A. Munroe, Centre for Food and Animal Research, Agriculture Canada, Ottawa, ON; Y. Choinière and A. Tremblay, Collège de technologie agricole et alimentaire, Alfred, ON; and D. McKnight and L. Brunet, Kemptville College of Agricultural Technology, Kemptville, ON.

Traditionally, modified environment barns have been lightly insulated and depended upon permanent or manually operated openings in the walls and ridge for ventilation. In 1991, a free-stall heifer barn at Kemptville College was renovated to incorporate a natural ventilation system consisting of a series of chimneys and automatically controlled sidewall curtains complete with windbreaks. The purpose of this study was to determine the frequency and extent of sidewall curtain movement, monitor indoor environment, and determine the minimum sidewall and ridge openings required to ensure adequate winter ventilation. Preliminary results obtained during the winter of 1991-92 indicate that the curtains moved almost every day including when the outside temperature was below -20°C. Excellent temperature regulation was observed. High relative humidity was noted (90%); however, when accompanied with indoor temperatures of 0-5°C, indoor environment appeared to be excellent.

92-215. DIRECTIONAL AIRFLOW TRANSDUCER FOR LOW AIRSPEEDS
J. Chen, Department of Agricultural Engineering, JiLin Agricultural University, Chang Chun, JiLin, P.R. China; and E.M. Barber and R.J. Ford, Department of Agricultural and Bioresource Engineering, University of Saskatchewan, Saskatoon, SK.

Measurement of low air speeds is difficult, especially when the direction of airflow also must be known. In this project, a cantilevered wind vane transducer was developed and a prototype was tested for measurement of airflow through a slotted floor in a scale model livestock building. With further calibration, the transducer holds promise for quantifying the flow of air through slotted floors.
92-216. DESIGN CRITERIA AND LEVELS OF SATISFACTION FOR NATURALLY VENTILATED LIVESTOCK BUILDINGS
Y. Choinière, A. S.-Tremblay and S. Tremblay, Collège de technologie agricole et alimentaire d'Alfred, Alfred, ON; and J.A. Munroe, Centre for Food and Animal Research, Agriculture Canada, Ottawa, ON.

Three different criteria were used to evaluate the performance of naturally ventilated buildings as predicted by the NatVent software package. These criteria included the average proximal ventilation rate and the frequency of occurrences of 1h and 3h periods when the predicted ventilation rate was below the minimum recommended. Farmers are concerned with low ventilation rates due to low wind speeds as well as the lengths of time these low ventilation conditions persist. Knowledgeable experts were asked for their opinions regarding the expected performance (excellent, very good, good, fair, not recommended) of these same building designs. These options were correlated with predicted performance criteria to establish criteria levels that could subsequently be used in the software to evaluate other building designs according to the expected performance.

92-217. A HUMIDITY-BASED VENTILATION FAN CONTROLLER
H. Hong and J.J. Leonard, Bioresource Engineering, University of Alberta, Edmonton, AB.

A conventional temperature-based fan controller was modified so that it could be used to modulate fan speed on the basis of relative humidity. The thermistor in the original controller was replaced with a field effect transistor (FET) whose gate terminal was connected to an analog output port of a computer data acquisition and control board. The same board was used to acquire relative humidity in a poultry house at set points of approximately 30% RH and 60% RH. The system provided good control at both levels although, because of the air inlet and heating systems, control was not as good at the higher level.

92-301. RESEARCH AND NETWORKING IN POSTPRODUCTION ANDEAN FOOD SYSTEMS
J.S. Townsend, Agricultural Engineering, University of Manitoba, Winnipeg, MB; and D.W. Fitzpatrick and B.M. Watts, Foods and Nutrition, University of Manitoba, Winnipeg, MB.

Postponing practices in selected foods of the Andean food system in Peru will be reviewed. The studies described will be in the area of quinoa threshing and polishing, chuno processing, and chronic consumption of glycoalkaloids found in bitter potatoes. A proposal for a networking center for research in postproduction systems in Andean countries will be described. The proposed center, based on earlier experiences with a bean networking the damp, tough, dry, and over-dry conditions for the surfaces studied. The wooden surface resulted in the least damage for both pulses with an increase in total damage in

92-302. PRESENTATION OF AIRFLOW RESISTANCE DATA OF SEED BULKS
D.D. Mann and D.S. Jayas, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB.

The lines between pressure drop across columns of seed bulks and airflow are nearly parallel when plotted on logarithmic scales. Based on this, it was hypothesized that the data for each seed can be represented using a single equation with a modifier for each seed. Nonlinear regression analysis was performed on the data for each bulk of seed using Shed's equation. The average mean relative percent error for the 22 seeds was more than 20 percent. However, when the airflow range was divided into two groups: a low (<0.05 m³·s⁻¹·m⁻²) and a high (>0.05 m³·s⁻¹·m⁻²), it was found that the average mean relative percent error was less than 5% for all seeds with the exception of six bulks (ear corn (lot 1), ear corn (lot 2), shelled corn, Estón and Laird lentils, and soybeans) which gave an average mean relative percent error of approximately 10% for the high airflow range. Considering the number of factors which contribute biological variability to the seeds, it is concluded that the airflow resistance data can be summarized using a single equation with modifier for individual bulk seed bulks.

92-303. MODELLING HEAT TRANSFER CHARACTERISTICS IN MEAT PRODUCTS
J.A. Amanie and J. Irudayaraj, Department of Agricultural and Bioresource Engineering, University of Saskatchewan, Saskatoon, SK.

A Finite Element Computer model was developed to simulate the temperature distribution in sausage represented by an axisymmetric two-dimensional prolate spheroid. The vertical cross-section of one quarter of the sausage was divided into 54 elements and 66 node points to solve the heat conduction equation. The ANSYS (Swanson Analysis Systems) computer package was used for estimating the heat transfer characteristics of sausage subjected to heat treatment in an environmental hot air oven (smoke house). The results were compared with experimental values obtained by the direct measurements of temperature with thermocouples placed at the geometric centre of the product at the simulated conditions. Excellent agreement was obtained between computer predictions and experimentally determined temperature values. This technique can be extended to other food products as well. The results from the simulation will help in the proper design of equipment for treatment and control and in the evaluation of process efficiency.

92-304. PHYSICAL DAMAGE TO PEAS AND LENTILS DUE TO FREE FALL
G.A. Bergen and D.S. Jayas, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB; and N.D.G. White, Agriculture Canada Research Station, Winnipeg, MB.

Experimental studies were conducted to study the impact damage related to storage practices to peas and lentils caused by free fall on three surfaces at four moisture contents spanning the damp, tough, dry, and over-dry conditions for the seeds. Samples were dropped on screened concrete, smooth steel, and sanded plywood from 18.3 m and 9.15 m. Damage was assessed by quantifying percentages of cracked, split, and total damage in the samples. Greater damage generally occurred at lower moisture contents and at greater drop height on the surfaces studied. The wooden surface resulted in the least damage for both pulses with an increase in total damage in
peas of 0.31 percentage points from initial total damage of 1.03% and no significant increase in damage for lentils. The concrete surface caused the greatest increase in damage with 0.60 percentage points in peas and 3.39 percentage points in lentils at the low moisture contents and a drop of 18.3 m.

92-305. MODELLING MICROWAVE DRYING CHARACTERISTICS OF SOYBEANS
B. Adu, L. Otten and R.B. Brown, School of Engineering, University of Guelph, Guelph, ON.

The drying behaviour of thin layers of Natto soybeans exposed to different levels of microwave power at 2450 MHz was investigated using a single-mode (TE_{10}) plane-wave propagation microwave apparatus designed and constructed to monitor power absorption, mass loss and temperature change during the drying process. Samples with initial moisture contents (IMC) from 24.6 to 15.2% (dry basis) were each dried at absorbed powers of 0.76 to 0.36 W/g. The drying rate of Natto soybeans decreased with absorbed power. For the same absorbed power the drying rates were the same for IMC of 22% and 24.6% but decreased with IMC below 22%. Soybeans were found to be a dielectro-hydro-diffusionally simple hygroscopic material. The time-moisture shift technique was therefore used to develop drying master curves for the power levels investigated. A two-term semi-theoretical series solution of Fick’s equation accurately described the drying behaviour over the entire drying period. Overall drying equations which predict the drying behaviour as a function of IMC, time and absorbed power are presented.

92-306. CANOLA DRYING STRATEGIES
S. Sokhansanj, Agricultural and Bioresource Engineering Dept., College of Engineering; and E.A. Arinze and G.J. Schoenau, Mechanical Engineering Dept., College of Engineering, University of Saskatchewan, Saskatoon, SK.

Canola is a major oilseed crop grown in Canada, especially in the prairies. Because of its high oil content, canola is extremely susceptible to spoilage if not properly dried before or during storage. Management strategies of in-bin drying of canola have been investigated by using a computer simulation model and typical weather data for a Canadian Prairie location. Different drying schemes with airflows of 0.5 to 2 m/s and moisture contents of 13, 16 and 19%, three harvest dates of August, September and October, natural drying and supplemental heat (including solar energy), and completing drying in 30 and 15 days were investigated. This paper discusses the methods of analysis and results.

92-322. DESIGN OF THE MODEL-BASED CONTROLLERS FOR A DIGITAL CONTROL SYSTEM FOR VARIABLE RATE NITROGEN FERTILIZATION
Y. Li, R.L. Kushwaha and G.C. Zoerb, Agricultural and Bioresource Engineering Department, University of Saskatchewan, Saskatoon, SK.

The mathematical model of the digital control system for variable rate nitrogen fertilization was introduced. Several model-based controllers were designed by utilizing different digital controller tuning criteria. The controller transfer functions derived are very useful in simulating the dynamic responses of different controllers, and further determining the best controller for the control process.

92-323. COMPUTER CONTROLLED CARBON DIOXIDE, RELATIVE HUMIDITY AND TEMPERATURE MONITORING SYSTEM FOR POTATO STORAGE
D.A. Irvine and D.S. Jayas, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB; and G. Mazza, Horticultural & Food Sciences Section, Agriculture Canada Research Station, Morden, MB.

A microcomputer based monitoring system was developed, calibrated and installed in a commercial potato storage to monitor carbon dioxide (CO2), relative humidity and temperature in three 650-t bins. Air samples from various locations were continuously drawn to infrared CO2 monitors and electrical resistance relative humidity sensors. The monitoring system has operated for a full storage season. The system has great potential for commercial development. This type of monitoring system could supplement automatic control systems and benefit manually operated storages.

92-324. STORAGE STABILITY OF FORAGE CUBES AND PELLETS
S. Sokhansanj and O.O. Fasina, Dept. of Agricultural and Bioresource Engineering, University of Saskatchewan, Saskatoon, SK.

Experiments were conducted to determine the equilibrium moisture content, rate of moisture sorption, loss of integrity and loss of durability of alfalfa pellets exposed to humid environment. Results showed that forage cubes and pellets have high rate of moisture absorption and high moisture holding capacity compared to cereal grains. Volume change of about 20% accompany the moisture sorption process. The equilibrium moisture relations obtained were related to microbial stability of forage cubes and pellets at different environmental conditions.

92-325. RESISTANCE TO AIRFLOW THROUGH CLEAN AND SOILED POTATOES
D.A. Irvine and D.S. Jayas, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB; and G. Mazza, Horticultural & Food Sciences Section, Agriculture Canada Research Station, Morden, MB.

Resistances to airflow through clean and soiled 'Russet Burbank', clean and soiled 'Norchip' and clean 'Yukon Gold' potatoes were measured as pressure drops per unit depth using 0.95 m cubes. Airflow resistances of clean potatoes were measured in both airflow directions (horizontal and vertical). All tests were performed using a 975 mm x 975 mm container attached to an air plenum and filled to a depth of 1.0 m. Small 'Norchip' potatoes with a maximum dimension of 45 mm had resistances to vertical airflow of approximately 1.5 times that of 'Norchip' potatoes with mixed sizes and 2.5 times that of larger 'Yukon Gold' potatoes. 'Russet Burbank' potatoes had 15 to 30% lower airflow resistances in the horizontal direction than in the vertical direction. Soil, uniformly added to clean potato bulks at 6% by volume, increased the airflow resistance by 3.2 to 3.7 times.

92-326. PHYSICAL CHARACTERISTICS OF COMMERCIAL FORAGE CUBES AND PELLETS
S. Sokhansanj, R.T. Patil and G. Ahmadnia, Department of Agricultural and Bioresource Engineering, University of Saskatchewan, Saskatoon, SK.

Some physical characteristics such as density, moisture, and durability of alfalfa cubes and pellets were evaluated. Most
samples were collected from port of export in Vancouver between August 1991 and May 1992. The results indicated that moisture and density of the cubes fluctuated with time; however, pellets showed consistency in these properties. The average moisture content, density and durability of the pellets were 7.6%, 1.95 kg/m³, and 75%, respectively. The average moisture, density, and durability of the minicubes were 10.0%, 0.94 kg/m³, and 89%, respectively. The standard cubes had moisture content 11.6%, density 0.75 kg/m³ and durability of 81%. The durability of the mini cubes and dehy cubes was higher than the suncure cubes. In the case of pellets the durability of small size pellets was higher. The interrelationship of durability with density, moisture and interaction of moisture density was found in the case of pellets as well as cubes.

92-327. DESIGN CONCEPT FOR A BATCH HAY DRYER TO BE USED WITH AN AUTOMATIC BALE WAGON
P.S. Pline, Public Works Canada & Agriculture Canada, Ottawa, ON; and F. Trauttmansdorff, Dunlea Farms Ltd., Jerseyville, ON.

A heated air batch hay dryer was designed for a commercial cash crop hay grower who uses an automatic bale wagon. Negative pressure airflow is used so that polyethylene curtains will seal the sides of the stacks. This paper concentrates on the design concept rather than performance results. Design considerations are discussed, evaluation criteria are summarized, and preliminary observations regarding the completed system are reported.

92-328. WILD RICE HARVEST STUDIES IN SASKATCHEWAN
W.B. Reed, Department of Agricultural and Bioresource Engineering, University of Saskatchewan, Saskatoon, SK.

The loss of wild rice when harvesting in lakes with air-boats was determined when travelling at travel speeds of approximately 15, 18 and 22 km/h. Losses from natural causes were also recorded. Total losses ranged from 35% to 55% of the total yield. Harvesting losses ranged from 11% to 25% and depended on travel speed and crop density. Too frequent harvesting had little effect on harvesting loss but reduced seed weight as did higher travel speed. A travel speed of about 21 km/h combined with four harvests per season may optimize the amount harvested and maximize seed weight. Natural losses are variable depending on weather conditions and timing of harvests relative to adverse weather.

92-329. EVALUATION OF A VEGETATION DETECTING WEED SPRAYER
J. Underwood, Agricultural Engineering Section, Ridgetown College of Agricultural Technology, Ridgetown, ON; and J. Rigby, Rigby Farms, Bienheim, ON.

The vegetation detecting weed sprayer has a sensor and solenoid control associated with each nozzle. The nozzle only activates when green vegetation is sensed. The sprayer was used to spray weeds ahead of no-till planting of corn and soybeans. The reduction in chemical use was dependent on the weed pressure but results were encouraging as a method of reducing chemical sprays for seed control.

92-401. EFFECT OF HEAD-SPEED-GROUND-SPEED RATIO ON THE PICKING EFFECTIVENESS OF A LOWBUSH BLUEBERRY HARVESTER
K.J. Sibley, Agricultural Engineering Department, Nova Scotia Agricultural College, Truro, NS.

An electro-hydraulic head-speed control system was developed and installed on a Bragg lowbush blueberry harvester. 3 x 3 factorial field experiments were used to collect data on picking effectiveness at head-speed-ground-speed ratio's (HSGSR) of 1.3, 1.5, and 1.7. Ground speeds used in the trials were 1.5, 2.1, and 2.6 km/h. Data were collected in three fields in Colchester County, Nova Scotia in August 1991. It was found that picking losses were minimized to 5% of the total crop produced if a HSGSR of 1.7 was used up to a maximum forward speed of 2.1 km/h. It was also found that berry wetness or plant height did not significantly affect picking effectiveness.

92-402. FIELD EVALUATION OF GRAIN DRILL FURROW OPENERS UNDER CONSERVATION AND CONVENTIONAL TILLAGE SYSTEMS
R.L. Kashwaha and L.L. Roth, Agricultural & Bioresource Engineering Dept.; and R.K. Foster, Crop Development Centre, University of Saskatchewan, Saskatoon, SK.

Six diverse seed drill furrow openers were evaluated on three soil types in relation to spring wheat emergence, seeding depth and final yield under conventional and conservation tillage. Amount of residue cover remaining after seeding was also evaluated. The experiment was conducted over a period of three growing seasons. Results showed a significant difference in seeding depth and plant populations at emergence, for two of the six furrow openers tested. No significant difference in grain yield occurred amongst the openers.

92-403. SEEDBED CHARACTERISTICS AND SEEDERS EVALUATION FOR SIX TILLAGE SYSTEMS IN QUÉBEC
J. Gill and S. Tessier, Agricultural Engineering Dept., FSAA, Université Laval, Québec, PQ; D. Angers, Agriculture Canada, Sainte-Foy, PQ; G. Allard, Plant Science Dept., FSAA, Université Laval, Québec, PQ; and D. Pageau, Agriculture Canada, Normandin, PQ.

To evaluate crop establishment problems with conservation tillage techniques in Québec, six tillage systems were studied at Normandin (Lac-St-Jean) on a clay soil. Hourly soil temperatures, aggregate sizes distribution in the vicinity of the seed, seed placement, and barley emergence were measured. Soil temperature and crop emergence were also monitored at two other sites. Differences were found in soil temperature in the vicinity of the seed, aggregate size distributions and seeding depth. These results show the need to improve seeding tools and techniques to ensure maximum crop establishment when adopting conservation tillage practices under Québec's climate.

92-404. MULTIPLE AXLES RUNNING GEAR FOR HEAVY AGRICULTURAL TRAILERS
C. Lague, Y. Bédard, S. Tessier, L. Chi and F. Rondeau, Département de génie rural, Faculté des sciences de l'Agriculture et de l'Alimentation, Université Laval, Québec, PQ.

Previous experimental and theoretical work has shown that multiplying the number of axles on running gears supporting heavy agricultural trailers is an effective way of reducing traffic-induced soil compaction. Theoretical relationships are presented in order to provide design guidelines for such running gears regarding steerability, tire width and tire-frame clearance. Various design alternatives in terms of number and...
location of steering axles are compared for a simulated three-axle running gear. Combined middle and rear axles steering provides both the longest decrease in sideways slip as well as the best tracking of the trailer behind the tractor during turns. An innovative hydro-mechanical steering system easily adaptable to existing or new multiple axles running gears is also presented.

92-405. REDUCTION IN CROP YIELD DUE TO SPRAYER AND TRACTOR TIRE DAMAGE
R.C. Maze, Alberta Farm Machinery Research Centre, Alberta Agriculture, Lethbridge, AB; and R.P. Atkins, Engineering Services, Alberta Agriculture, Lethbridge, AB.

Turf, tandem walking beam, lugged sprayer tires and tractor tires cause crop damage during spraying. Sprayer and tractor tire effects on crop growth during spraying season were examined. Experiments using single and dual tires on tractors (single vs. dual tractor), and single and tandem tires with tractor tires (single vs. tandem sprayer) and single, tandem and lugged (single, tandem and lugged sprayer) tires were examined. Soil factors, crop growth, tire slip and physical characteristics of transport systems were monitored and tabulated. Analysis of variance and statistical results were compiled from the data obtained and recommendations made. The later the spraying operation took place, the greater the amount of crop damage. The mass of the tank when increased from 1818 to 3637 L (400 to 800 gal) did not significantly affect the reduction in yield due to tire traffic. Mass on the tractor tires did not affect yield results.

This double EOR dynamometer prove to be a very sensitive, portable and versatile drawbar dynamometer suited to the measurement of drawbar forces exerted by most pull-type implement hitch configuration.

92-407. MODELLING EMERGENCE RESISTANCE WITH MECHANICAL PROBES
M.M. Khalid, R.L. Kushwaha and R.J. Ford, Agricultural & Bioresource Engineering Department, University of Saskatchewan, Saskatoon, SK.

A method of measuring penetration resistance and energy exerted by a mechanical seeding (a steel probe simulating a seedling) as it moved upward through the surface soil under different levels of surface compaction and soil moisture was examined. Mechanical seedings with 2.06-6.95 mm tip diameters were selected. Soil moisture contents 13, 17, and 20% were used at the beginning of the test. The penetration rate of the mechanical seedling while moving through the soil was held constant at 10 mm/min. Results showed that the emergence energy increased directly with soil surface compaction pressure, initial moisture content, and mechanical seedling diameters.

92-408. A DISCUSSION PAPER ON SEEDBED FINISHING
R.C. Maze and B.D. Redel, Alberta Farm Machinery Research Centre, Lethbridge, AB; and R.P. Atkins, Engineering Services, Alberta Agriculture, Lethbridge, AB.

A literature review of seedbed finishing was completed. Experimental and practical attempts have been made to explain why and how seedbed finishing benefits cropping practices. While research has outlined methods for optimum moisture use and minimum moisture loss, general recommendations on seedbed finishing have not been addressed for Western Canadian farming.

92-409. FINITE ELEMENT ANALYSIS OF SOIL COMPACTION INDUCED BY VARIOUS TYPES OF RUNNING GEARS FOR HEAVY LIQUID MANURE SPREADERS
L. Chi, S. Tessier and C. Lagoué, Agricultural Engineering Dept., Faculté des sciences de l’agriculture et de l’alimentation, Université Laval, Québec, PQ.

A 3-D finite model was used to predict soil compaction induced by different running gears used on heavy liquid manure spreaders on two different soils. The finite element analyses were conducted for three types of tires: conventional implement 1-1 high floatation bias tires, radial tires and low pressure R-3 tires; and three types of running gears: three and four-axle. The soil compaction under removable rubber tracks was also studied under the assumption of uniform stress distribution. The results showed that substituting radial tires or low pressure tires for high floatation bias tires reduced soil compaction level and that increasing the number of axles of the running gears lowered soil compaction significantly without increasing the width of the compacted zone. The results also implied that track based running gears would be very promising to limit traffic induced soil compaction. The simulation confirmed that axle load and the number of wheel passes were two major factors influencing subsoil compaction. The study of compaction on two soils indicated that, with similar running gears, compaction in clay soils was far more severe than that in coarsely textured soils.
92-501. UNIVERSITY-INDUSTRY COOPERATION IN UNDERGRADUATE ENGINEERING EDUCATION
M.G. Britton, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB.

Input from the “real world” makes undergraduate education more relevant to the needs of industry and the expectations of students. This paper outlines classroom experience in two specific Agricultural Engineering undergraduate design courses at the University of Manitoba. The nature of the cooperation, time demands on cooperators and potential payback are discussed.

92-502. A COMPUTER-BASED APPROACH TO TEACHING APPLIED MATH USING LINKWAY
R. Kok, Agricultural Engineering, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ.

A second-year engineering course on applied math is being taught by means of a computer-based approach. The course objectives are to familiarize the students with a number of software tools and to teach them to do mathematics with these.

The course material is delivered via a Novell network on Model 50Z machines with VGA screens. The interface software is LinkWay, an object-oriented authoring package marketed by IBM. LinkWay is used to navigate through course and lecture menus and to execute scripts. The system does not require extensive prior computing knowledge; the students access course material such as text files and graphics by clicking with a mouse on buttons. Software tools accessed are Handidat, 123, CurveFit, Derive, and Matlab. With LinkWay the course author controls software access (eg. environment variables, paths, defaults, etc.) and the students can use it without needing excessive “computerese”. During execution of the courseware and the software tools, Sidekick is used in the background to deliver additional material and to transfer information from the screen into the students’ answer and report files.

92-503. DEVELOPING COMPUTER AIDS FOR INSTRUCTION IN GRAIN STORAGE
Q. Zhang, M.G. Britton, D. Hao, D.S. Rea and S. Xu, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB.

Three DOS-based programs have been developed for design and analysis of systems for bulk solids handling and storage. Programs illustrate methods for prediction of loads in storage bins, analysis of gravity flow of bulk solids stored in bins, and analysis of pneumatic conveying systems. The packages allow students to effectively conduct parametric studies on the handling and storage systems, thus enhance their learning experience. Typical inputs and sample runs are provided to demonstrate the instructions for using the programs.

92-504. USING ARTIFICIAL INTELLIGENCE AS A FOUNDATION FOR COMPUTER BASED DESIGN-AIDS
M.G. Britton, Y. Hou and Q. Zhang, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB.

Artificial intelligence programming techniques present interesting possibilities for the development of interactive engineering design-aids. This paper outlines the intended scope and the current state of the Artificial Intelligence based design-aid research being conducted in the Department of Agricultural Engineering at the University of Manitoba.

92-505. APPLICATION OF CADD/GIS IN SMALL WATERSHED PLANNING
S. Chiepg, Bio-Resource Engineering Department, University of British Columbia, Vancouver, BC.

Watershed planning is a process to formulate and carry out a course of action involving the manipulation of natural resources so as to provide goods and services without adversely affecting the soil and water base. Any change from the existing or natural condition of the watershed by human activities affects the soil and water resources. To minimize the negative impact, careful planning through examination of all possible outcomes from any intended actions is necessary. Examination of different possible scenarios is extremely tedious and time consuming. To reduce this, modern computer-aided design and drafting (CADD) and geographic information system (GIS) techniques have been applied. This paper demonstrates the usefulness of such application of the CADD/GIS techniques in the watershed planning process.

92-506. A COMPUTER BASED DESIGN-AID FOR WOOD MEMBERS IN BENDING
Y. Hou and M.G. Britton, Department of Agricultural Engineering, University of Manitoba, Winnipeg, MB.

An interactive DOS based computer program dealing with the design of wood members, in bending, is presented. The program utilizes Limit States Design and complies with CAN/CSA-086.1-M89, the current Canadian design standard. Operational features of the program are presented. The use of appropriate Artificial Intelligence programming is illustrated.

92-507. A MODEL TRACTOR FOR THE DEMONSTRATION OF TRACTION MECHANICS
J.S. Townsend, G.A. Bergen, R.J. Kieper and D.D. Mann, Agricultural Engineering, University of Manitoba, Winnipeg, MB.

A model of a 2-wheel-drive tractor had been designed and built as a student design project some years ago. In a current design course it was decided to instrument the model tractor to demonstrate the mechanics of traction. Drawbar pull, slip, weight transfer, and stability factor are measured and/or calculated and displayed for inspection. This project was a student design project where the students gained design experience in mechanical design, traction mechanics, instrumentation, and data collection and manipulation for display. The existing 2-wheel-drive model tractor was modified to fit into a student designed frame. The frame also housed a brake drum and brake to apply resistance to the tractor drive wheels. Transducers were designed to measure drive wheel and brake drum speeds, front axle weight and drawbar pull. Computer programs were written to collect the data and calculate the desired traction parameters for display.

92-5011. SWINE MANURE NITROGEN CONSERVATION IN STORAGE USING SPHAGNUM MOSS
S.F. Barrington, R.G. Moreno and R. Cap, Agricultural Engineering Dept.; and A.F. MacKenzie, Renewable Resources Dept., Faculty of Agricultural and Environmental Sciences, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ.

Sphagnum peat moss, floating over swine manure in storage, was tested as a nitrogen conservation method. Three depths of floating peat moss were tested using six replicates: 20 cm, 10 cm, and 0 cm. The swine manure was analyzed prior to the tests and after three months of storage, from June to
August inclusively. An average of 69, 56 and 44% total nitrogen conservation was observed from the 3 respective treatments repeated over the span of 2 summers. The 20 cm cover was also found to provide sufficient sphagnum moss to manure ratio once mixed, to significantly reduce N losses by 9% during the stirring operations used to remove the slurries from storage.

92-512. APPLICATIONS OF OLIGOLYSIS TO THE CONTROL OF POULTRY MANURE ODOURS

M.R.L. Bantle, Bantle Engineering Research, Saskatoon, SK.

A laboratory experiment was developed to identify whether oligolysis, an electrolytic treatment process, could effectively control the odour from poultry manure. The experiment consisted of filling two barrels with poultry manure. Each barrel was filled with 180 L of manure. One barrel of manure was treated by oligolysis while the other barrel of manure was untreated. A test using iron electrodes was conducted from September 17, 1991, to December 31, 1991. The manure in the barrels was replaced and a second test was conducted from January 2, 1992 to February 28, 1992. In this test copper electrodes were used. These tests indicated that the oligolysis treatment nearly eliminates all of the hydrogen sulphide in the dead space above the manure but does not reduce the offensiveness of the odour from the poultry manure.

92-513. RURAL WELL WATER SURVEY

R.J. Fleming, Agricultural Engineering Section, Centralia College of Agricultural Technology, Huron Park, ON.

During the summer of 1991, a survey of rural wells in Huron County was carried out. Information was gathered on 400 wells, water samples were collected from 301 of these wells. 30.5% of the dug/bored well exceeded the drinking water recommendation of 10 mg/L for nitrate-N. This compares to 4% for the drilled wells. 37% of the wells tested had bacteria levels that would be considered unsafe based on the current standards (however only one test was performed). Once again, the dug/bored wells had significantly higher levels of bacteria than the drilled wells. Only two of the five pesticides measured were detected in any of the water samples. Atrazine was detected most often, although at concentrations well below the drinking water standard of 0.06 µg/L. Information was gathered on agricultural practices carried out near the wells. In general, there was poor correlation between most of these practices and water quality in the wells.

92-514. NITRATE LEACHING FROM DIFFERENT APPLICATIONS OF LIQUID SWINE MANURE AND CHEMICAL FERTILIZER


Threat from nitrate pollution has created the need for environmentally sound and safe applications of animal wastes and chemical fertilizers. In this experiment, a comparative study was conducted to evaluate the effects of different concentrations of liquid swine manure and chemical fertilizer applications on water quality. Chemical fertilizer was applied at the rate of 50 and 100 kg/ha whereas liquid swine manure was applied at 45 and 60 t/ha based on the Ontario provincial swine manure application guidelines. Leachate sample collection and analysis show that increasing both chemical fertilizer and liquid swine manure application rates did not significantly affect nitrate + nitrite-N concentration.

92-515. COMPOSTING OF POULTRY MANURE SLURRIES

W. Zhan and L. Fernandez, Civil Engineering Dept., University of Ottawa, Ottawa, ON; and N. Patni, Centre for Food & Animal Research, Agriculture Canada, Ottawa, ON.

Poultry manure slurry composting with high initial moisture content was investigated. With peat as the bulking agent as well as absorbent, initial moisture contents of the materials were 73% and 80%. Triplicates of both moisture treatments resulted in six piles, each with volume of 3.35 m³. Air was supplied passively through two perforated pipes located at the bottom of each pile. Intensive temperature monitoring revealed that biological degradation was occurring properly in the piles and passive aeration was quite effective. It also verified the air supply pathways. Significant similarity was observed among the triplicates. Accordingly, reliability of the operating process was confirmed. Nutrient-rich compost was produced from both treatments.

92-517. ON-SITE COMPOSTING OF SOLID DAIRY MANURES

S.F. Barrington and R. Cap, Department of Agricultural Engineering, Faculty of Agricultural & Environmental Sciences, Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, PQ; and Quang Le Phat, Ministère de l’Agriculture des Pêcheries et de l’Alimentation de Québec, Québec, PQ.

Pneumatic manure evacuators have sufficient aeration capacity to compost solid manures in storage. A solid manure pile was therefore evacuated from a barn onto a platform by means of a pneumatic evacuator. Over two consecutive winters, the manure pile was monitored for temperature to evaluate its composting activity. The manure pile temperature very seldom reached 20°C. These low temperatures indicated poor microbial activity, despite the fact that the manure pile was aerated by a pneumatic evacuator and covered with a black geotextile tarp. The lack of composting was attributed to the lack of manure porosity and the manure’s high moisture content.

92-518. EVALUATION OF ON-FARM MANURE TEST KITS

R.J. Fleming and S.H. Bradshaw, Agricultural Engineering Section, Centralia College of Agricultural Technology, Huron Park, ON.

Manure samples from Ontario livestock farms were analyzed using five on-farm rapid test kits: nitogen meter, hydrometer, conductivity pen, ammonia test kit, and ammonia electrode. The results were compared with standard laboratory analysis, The nitrogen meter and the conductivity pen showed the most promise for use on Ontario farms.

92-519. MECHANICAL STRESS IN FULL SIZE CONCRETE MANURE TANK

S. Godbout and A. Marquis, Agricultural Engineering Department, Faculté des sciences de l’Agriculture et de l’Alimentation, Université Laval, Québec, PQ.

The objective of this project was to measure wall stresses in an experimental liquid manure tank and to evaluate design ice pressures. Tank diameter was 28 m while its height and wall thickness were 3.7 m and 203 mm respectively. This two-winters study gave only an indication of the manure ice pressure, which turned out to be lower than expected. An important temperature gradient has been observed and, when combined with ice pressure, could be responsible for the deterioration of concrete manure tank.
NOTES TO CONTRIBUTORS

The Editorial Board will assess suitability and essential detail of papers submitted for publication in Canadian Agricultural Engineering. One or more reviewers will be used. Their comments and suggestions will be compiled and submitted to the author. The review will ensure that:

1. A research paper presents a piece of research carried to a well-defined stage of advancement and the conclusions are adequately supported by the experimental results.

2. A technical paper presents a clear, concise, and factual outline and interpretation of the development, design, test, or analysis under consideration and that it is a contribution in the field of agricultural engineering.

3. A general paper on education, research, or extension is pertinent to major changes in curriculum, research, or extension or to forward-looking developments in these areas.

4. A technical note on equipment development, technique of measurement, or method of analysis will have an application for other workers in the field of agricultural engineering.

MANUSCRIPT

The manuscript should be typed double-spaced on paper 216 x 279 mm (8.5" x 11") with margins not less than 30 mm. The first page should contain only the title, authors’ names, addresses (including postal codes), and contribution number where applicable. The telephone number and FAX number of the corresponding author should also be included. Tables and captions for illustrations should be on separate pages, placed after the text. Manuscript paper with numbered lines is required. Six copies must be submitted. After a paper has been accepted for publication, the author will be expected to provide a copy of the paper on floppy disk in a format compatible with MS-DOS or Macintosh systems.

The title of the paper should give an accurate description of the article, using key words that can be used for computer-indexing.

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The paper should be organized to conform with present Journal practice. All papers must include a short abstract section of about 200 words. Authors are encouraged to submit the abstract in both English and French. There will be a charge for translation services that must be provided so long as the copies are of such quality that reviewers can understand them. Original drawings must be provided when the paper is accepted for publication. If a drawing has been produced by a computer package, a copy of the file should be submitted on disk at the time that the manuscript is submitted on disk.

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