

ANNUAL REPORT



Agricultural and Biosystems Engineering North Dakota State University

Teaching and Research Programs — July 1, 2002 - June 30, 2003
Extension Program — October 1, 2001 - September 30, 2002

Annual Report for Agricultural and Biosystems Engineering

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Annual Report for Agricultural and Biosystems Engineering

Teaching and Research Programs -- July 1, 2002 - June 30, 2003

Extension Program -- October 1, 2001 - September 30, 2002

I. Goals for Current Year

1. To provide high quality undergraduate and graduate education in Agricultural and Biosystems Engineering (ABEN) and Agricultural Systems Management (ASM).
2. To attract and retain quality students (undergraduate and graduate).
3. To maintain/increase scholarly activities that extend the knowledge base for:
 - a. enhancing agri-production efficiency, profitability and/or sustainability
 - b. maintaining quality and/or adding value to North Dakota's agricultural products
 - c. developing efficient use and stewardship of North Dakota's soil and water resources.
4. To provide extension and outreach education focused on:
 - a. agri-production systems (machinery mgt., agri-chemical efficiency, agri-structures/waste mgt)
 - b. post-harvest engineering (storage, drying, quality maintenance, processing)
 - c. water resources management (irrigation systems, water quality)
 - d. agricultural safety.
5. To achieve/ maintain effective constituent relationships.

Accomplishments

A. Instruction and Student Success

1. Teaching Initiatives

This is the third year of the partnership of the ABEN department with John Deere to educate/train future farm equipment dealership managers. Part of the requirement for the specialization in dealership management is two internships with John Deere dealerships. After some reluctance by dealerships to participate, they have reported that students have been very willing to learn and they have been very productive. And, in each case, they have asked the student to return for a second internship. Participating dealerships include RDO equipment in Fargo and Bismarck, ND and Breckenridge, MN, Saylor Implement in Wishek, ND, Borud Implement in Stanley, ND, Clay-Becker Equipment in Hawley, MN, and Eis Implement Inc. in Two Rivers, WI. To date, John Deere has provided \$15,000 in

scholarships, a new 6410 tractor (replaced with a 6420 tractor in May, 2003) and equipment/instrumentation to support instruction in precision agriculture technology.

Student program fees were again utilized to add hardware and software updating to the department's student computer cluster. Six computers were replaced, the XP operating system was added to all computers, and new chairs were ordered.

Mechanical engineering students were again enrolled in ABEN 482 (Instrumentation and Measurements) in lieu of ME 412.

Department faculty responded to the installation of in-place computer-audio visual equipment installed in room 201 by re-developing their pedagogy to make use of Power Point and video presentations.

Laboratory improvements included: replacement Bobcat skidsteer loader, replacement of a model 6410 John Deere tractor with a model 6420 John Deere tractor, and six replacement computers for the department's student cluster.

Faculty development activities were extensive. Examples include: workshops (instrumented classroom training, Blackboard, academic advising, PRS training, developing measurable learning objectives and outcomes), conferences (learning on-line, ASAE meeting), seminars (scholarship of teaching, problem-based learning, FIEL workshops/luncheons), and tours/visits (John Deere dealerships).

Significant enhancements/modifications to departmental courses were as follows. ABEN 110-2, Introduction to Ag. and Biosystems Engineering, – new Power Point materials for all presentations; ABEN 189-1, Skills for Academic Success, - all lectures were developed in Power Point, emphasis was placed on the location and types of services available to students; ABEN 255-3, Computer Aided Analysis and Design, – multiple choice questions were used for quizzes and exams, an on-line mid-term test was used ; ABEN 263-3, Biological Materials Processing,– new Power Point presentations; ABEN 377-3, Numerical Modeling of Bioresource Systems, – a new textbook was selected; ABEN 458-3, Food Process Engineering, - introduced open-ended design projects to teams, provided a field trip to a food processing plant, used Blackboard for course material; ABEN 464-4, Resource Conservation/Irrigation Engineering, - revised lectures to include topics on GIS/GPS and hydrologic models, revised labs to enhance problem solving and teamwork skills; ABEN 473/673-3, Agricultural Power, - used Blackboard, pre- and post tests; ABEN 482-3, Instrumentation and Measurements, - the PRS system was used for quizzes and review, Blackboard was used for dissemination of course information; ABEN 486/487-1, 2cr, Design Project I, II, – design projects were assigned by the second week in October, and changed timeline for final reports allowing more time for report editing and feedback.

ASM 115-3cr, Introduction to ASM -- developed new Power Point materials for 100 percent of presentations, and added many pictures and illustrations; ASM 225-3cr,

Computer Applications, – textbook was revised, on-line test was used; ASM 259-1cr, Measurements in Natural Resources Management, - labs were revised/developed to use GPS/palm computers; ASM 264-3cr, Natural Resource Management Systems,– added new GIS/GPS applications and revised most labs to emphasize problem solving skills and added more writing and oral report; ASM 323-3cr, Post Harvest Technology,– updated all lectures to Power Point and incorporated many pictures and illustrations; ASM 354-3cr,- Electricity and Electronic Applications, updated PLC lab; ASM 373-3cr, Tractors and Power Units, - updated lectures with graphics, developed cut-aways; ASM 378-3cr, Machinery Principles/Management, - some Power Point presentations changed; ASM 454-3cr, Site Specific Agriculture, - more lectures were presented by primary instructor; ASM 475-2, Management of Agricultural Systems, – revised presentation evaluation procedures, developed more feedback requirements.

2. Incorporation of Technology into Courses and Programs

Installation of an “instrumented classroom” available to department courses and faculty resulted in an increased use of technology by both faculty and department students. All department faculty use Powerpoint. All require use by students of word processing, spreadsheets, and e-mail. Most faculty make assignments requiring students to use website resources. Faculty continue to advance their use of websites for their courses, providing a syllabus, assignments, learning resources, etc. Several faculty advanced their use of Blackboard software packages. Department courses include use of Microsoft Office, AutoCAD, ProEngineer, ANSYS finite element analysis, ArcInfo and Surfer Geographic Information Systems, Global Positioning Systems, and computer imaging. A department file server and a CD server are used for instructional delivery. The CD server provides student access to unique information such as engineering standards and research data and to purchased CD’s that supplement course materials.

3. Advising Efforts

Freshman students are also introduced to the concept of developing and maintaining a student portfolio. Freshman students are introduced to the required problem solving and writing format used in the department.

Several faculty advisors attended on-campus seminars to update their knowledge of NDSU academic policies, general education requirements, and available student services.

Check sheets for each curriculum/option were updated and reviewed with faculty advisors so that consistent information and advising are provided to the department’s majors.

A faculty member very actively provides or relays notices to the department’s students regarding cooperative education opportunities or advertisements. He also works closely with graduating seniors to help them gain appropriate placement/employment.

Feedback information, regarding faculty advising, is obtained by using the COA form for student evaluation of advising and in senior exit interviews with the Chair. The information from these interviews is used by the chair in the annual review discussions with faculty.

Four faculty are involved as advisors or co-advisors of one or more department student organizations. One faculty is an advisor to a campus fraternity. One serves on the COA Advising Committee.

4. Curriculum Development Including New Programs, Deletion of Programs, Administrative Changes

One faculty member taught several sections of ME 412 for the Mechanical Engineering Department.

5. Accreditation or Other Reviews

No reviews were scheduled for the 02-03 academic year.

6. Activities in Student Recruitment/Retention, Enrollment Management, and Other Student Activities

The department maintains an ongoing contact with the Office of Admissions. As names of prospects and/or accepted students are identified, follow-up correspondence and recruitment materials are sent from the department to maintain contact with these potential students. We also mail information to most of the prospects that indicate they are undecided or intending to enroll in General Engineering.

Mailings are made to all high schools in ND and Western Minnesota. Similarly, department recruiting materials are supplied to the respective college deans for their use.

The chair and several faculty participated in all on-campus Discover NDSU events. The chair or teaching coordinator also met with all ABEN and ASM student prospects and parents that came to campus. Faculty visits were made to several high schools in North Dakota.

Fact Sheets and the department's website materials pertaining to prospective students were reviewed and updated as needed. A new ABEN brochure was developed by the College of Engineering and Architecture.

The department offers ABEN 189-1cr, First Year Experience, to its majors.

To promote retention of students, faculty and upperclass students promote efforts to involve freshman and sophomore students in department activities. A Fall Kickoff event

is sponsored by the student clubs. ABEN 189 students complete an assignment to meet with their adviser and find information specific to their program and the ABEN building. Freshman-senior interaction is accomplished in ABEN 110. Upperclass student club members recruit underclass students to participate in the annual Agricultural Engineering Show and department professional student organizations. All faculty are encouraged to advocate the benefits of co-op placement experiences.

7. Employment of Graduates

Assisting graduates to achieve employment in areas related to their field of study and career goals is a high departmental priority. Students receive career planning assistance, beginning in the introductory courses (ABEN 110 and ASM 115). Subsequent assistance occurs as part of student advising. The senior seminar classes (ABEN 491 and ASM 491) further prepare students for their individual job searches. To also enhance placement opportunities, the department actively encourages all students to pursue co-op placements, and a department faculty member provides active assistance to students in their placement efforts.

For the '02-'03 academic year, placement of 15 ABEN B.S. graduates is 87% complete (as of June 25, 2003). Based on student reports, starting salaries ranged from \$39,500 to \$57,000 (\$50,100 average).

For the '02-'03 academic year, placement of 11 ASM B.S. graduates is 82% complete (as of June 25, 2003). Based on student reports, starting salaries ranged from \$38,000 to \$42,600 (\$42,100 average).

8. Senior Professors Teaching Freshman and Transfer Students

Professor Backer teaches the department's introductory courses (ABEN 110, ABEN 189, and ASM 115). Student evaluations continue to be very positive.

9. Summer School Activities

The department offers special topics, individual studies and thesis credits in the summer semester.

10. Awards and Recognition of Faculty/Staff/Students

Leslie Backer

- a. William J. and Angelyn A. Austin Advising Award for Excellence - College of Agriculture, Food Systems, and Natural Resources Faculty/Staff Awards
- b. Dean's Award, Excellence in Teaching 2002 - College of Engineering and Architecture

Kenneth Hellevang

- a. Elected chair of the ASAE International Meetings Committee - responsible for organization and execution of the annual meeting with 141 technical sessions

Tom Scherer

- a. NDSU Extension Services Recognition - 15 years of service

Elton Solseng

- a. 2003 Honorary Minnesota FFA Degree - Minnesota FFA Association

Jana Seaborn

- a. NDSU Employee Recognition - 5 years of service

Kristi Tostenson

- a. NDSU Employee Recognition - 10 years of service

ABEN Students

- a. First Runner-up in the annual AEM awards competition at the ASAE International Meeting. Chicago, IL July 2002.
- b. Yunling Zheng, PhD candidate
 - Graduate Researcher of the Year, College of Engineering and Arch., NDSU, May 2003.
 - AOCS Honored Student Award 2003, American Oil Chemists' Society
- c. Joshua Dukart, ABEN undergraduate, 2002-2003 Who's Who Among Students in American Universities and Colleges award.
- d. Erika Hodgson, ABEN undergraduate, 2002 William J. Adams Jr. and Marijane E. Adams Scholarship - ASAE.

ASM Student

- a. Kurtis Riffey, ASM undergraduate, 2002-2003 Who's Who Among Students in American Universities and Colleges award.

B. Research/Scholarship

1. Highlights of Research and Scholarly Activity

The department's overall mission is to develop and extend knowledge in engineering and technology that serves to advance the productivity of agriculture, the value-added processing and utilization of agricultural commodities, and the sustainable management of environmental resources.

Its research programs generally involve multi disciplinary collaborations that are focused in the areas of: 1) value-added processing and handling technology, 2) bio-information and machine systems for agri-production and processing applications, and 3) environmental resources management.

Accomplishments/impacts include the following:

- a. Production Practices for High-Yielding Irrigated Wheat.** A two-tower center pivot irrigation system at the Carrington Research Extension Center was used during the 2002 season for a study of irrigation water management, fertility management, and variety selection. A split-split-plot experimental design with four replications was used, with main plots consisting of the following irrigation water management regimes: 1) a straightforward "Checkbook" approach, 2) a modified Checkbook approach in which irrigations were either added or removed from the schedule according to growth stage, and 3) no irrigation. Split plots consisted of nitrogen fertility amounts corresponding with yield goals of 60, 80, and 100 bu ac⁻¹. Split-split plots consisted of seven wheat varieties, i.e., Alsen, Keene, Russ, Reeder, Dandy, Norpro, and Briggs. Irrigated treatments produced lower test weights and later maturity compared with the nonirrigated plots. Fertilizer rates above that the 60 bu ac⁻¹ yield goal did not improve yields or test weights. The highest yield and test weight was attained by the Dandy variety. The experiment will be continued during the 2003 season.
- b. Ground Water Quality.** A manuscript summarizing over eleven years of ground water quality research near Oakes was published in the *Vadose Zone Journal*. Collaboration continues with colleagues in the Soil Science Department to collect data at the field site as part of a study of the effects of precision agriculture on ground water quality. Data collection (soil N levels, irrigation and rainfall data) has been restarted for a ground water quality monitoring project at an irrigated potato field site near Pettibone in east-central ND.
- c. Potato Planting Configurations.** Studies of potato planting configurations were continued and expanded. Funding from the Northern Plains Potato Growers Association was obtained for the research. Replicated small plot field experiments were conducted in 2001 and 2002 at both Oakes and Dawson/Tappen, ND. A two-row planter has been modified to accomplish both hill and furrow planting operations. Cultural practices previously developed for the conventional hill production system to grow the potatoes have been used, including identical schedules and amounts of irrigation, fertilizer, herbicide, and fungicide for both planting configurations (but allowing for year-to-year and site-to-site variations). Testing has included yield measurements and determination of tuber size profiles, as well as tests for specific gravity, the incidence of hollow heart defects, French fry color, and limited testing for the sugar end defect. Soil moisture and soil temperature have been measured at several locations in each type of planting configuration. Results so far have indicated that, compared with the conventional hill configuration, the furrow configuration tends to have larger tuber size (and often significantly larger yield), equivalent tuber quality, faster emergence and development, and generally a wetter and more uniform soil moisture regime. In 2001 at Dawson, average values indicate furrows outyielded hills by 36% for tubers greater than or equal to 6 oz. in size (\$ 6 oz./tuber), 26% for tubers 4 oz. in size or larger (\$ 4 oz./tuber), and 25% for total yield. In 2002 at Tappen, average values indicate furrows outyielded hills by 33% for tubers \$ 6 oz., 17% for tubers \$ 4 oz., and 10% for total yield. Virtually no green

tubers have been found in either the furrow or hill configuration for either year or site of this research project. Based on drawbar power testing for a one-row lifter at harvest time in 2002, we anticipate little or no difficulty for commercial machines to harvest the tubers in the furrow configuration.

- d. Food Uses of Flaxseed.** Flaxseed is an outstanding source of lignans and of oil that is rich in linolenic acid. Studies indicate that both may protect against several major causes of death in the U.S., especially breast and prostate cancer and heart disease. The recognition of the value of flaxseed lignans is recent, and the fact that flaxseed lignans exist almost exclusively in the hull now provides a compelling incentive for developing efficient dehulling technologies, as well as for technology to press the dehulled seed (embryo). Retail sales of flaxseed oil were estimated at \$38 million in 2000 and increased 19% from the previous year.

The use of gas chromatographic (GC) analysis of headspace volatiles from flaxseed oil is being developed in cooperation with the Cereal and Food Science Department. This is expected to be a valuable tool for evaluating the effect of process parameters on flaxseed processed for food use, and should be a more sensitive method than methods of oil quality analysis currently in use (e.g. peroxide value).

A mathematical model was developed to examine the steady state energy balance in a screw press under cold press conditions. Consequently, it was shown that heat conduction from the press barrel to the press stand is an important component of the energy balance, though ignored in some published analyses. Conduction and convection were estimated in order to improve the estimated mechanical energy input. This mechanical energy input was then shown to be heavily dependent upon both moisture content and fraction of hull removed.

In the case of whole seed, conditions that improved the oil recovery achieved by screw presses also resulted in greater friction within the press, and thus raised the oil temperature. The increased temperature is a concern with flaxseed oil for edible use, because the oil may develop an off-flavor by oxidation at increased temperature.

Screw press temperature profiles were recorded using thermocouples and a datalogger, and aided the quantification of this temperature rise in the press. Thus, it was shown that dehulling the seed before pressing allowed the oil to be expressed at significantly lower temperature. Removal of hull apparently reduced friction within the press. Use of dehulled seed greatly increased press capacity with only a modest decrease in oil recovery. Press performance using deep-dehulled seed did not increase steadily with a decrease in moisture content, unlike whole seed, rather reached a peak at 8.5 to 9% moisture and then fell.

A prototype of an impact flaxseed dehuller developed by senior ABEN students in 2001-2002 was compared with a leading commercial impact dehuller (loaned by Codema), and found to give comparable results with flaxseed.

- e. Engineering for a Bio-based Industry and Economy.** Computer-based advanced information technologies and intelligent sensor technologies have tremendous potential for evaluation and characterization of agricultural crops and food products. This will allow us to develop tools/techniques for objective and consistent evaluation of feed stocks for biofuels, biomaterials and biochemicals and will contribute to the emerging needs of bio-based industries. Work was focused on the development and evaluation of portable and field scale sensors for rapid and non-destructive and accurate characterization and quantification of feed stocks for biofuels, biomaterials and biochemicals. A state-of-the-art review has completed. Current work focuses on adapting our developed portable spectrometer-based plant sensor for characterization of feed stocks.
- f. Intelligent Quality Sensors (IQS) for Safe Food Products.** Computer-based advanced information technologies and intelligent sensor technologies have tremendous potential for evaluation and characterization of food and agricultural products. This research investigates the applicability of electronic nose technologies for predicting the safety of meat and grain products for the consumer. Thus, this project addresses one of the critical needs of the region and of the nation. Experiments were conducted to evaluate the performance of M-Module (metal oxide-based) of the electronic nose system for spoilage of meat (beef) at two storage temperatures i.e, 37 and 50 degrees F. A previously designed M-module was further modified to use Teflon materials in the sensing chamber to eliminate the possibility of chemical reaction of the VOCs (volatile organic compounds) coming from the meat samples. Parallel experiments were conducted to evaluate a P-sensing module (a portable commercially available electronic nose system (Cyranose, CA)), for quality evaluation of meat (beef) at two storage temperatures. Techniques were developed to process the acquired signal from both the electronic nose modules (P and M-sensing modules). Statistical and neural network approaches were developed to further process the acquired signal for classifying a meat sample into one of the two classes (spoiled or not spoiled). A maximum classification accuracy of 83 % was achieved for classifying meat sample at both 37 and 50 degrees F while using P-sensing module and Back-propagation neural network. On the other hand, the M-sensing module provided a maximum accuracy of 100% at both 37 and 50 degrees F while using a Radial basis function network. Work is continuing to evaluate additional features for processing the signals and to develop models for predicting bacterial populations (in cfu). Investigations are being carried out to develop experimental techniques for identifying the significant VOCs using GC-MS. Parallel work is also going on to use these electronic nose-systems for assessing bacterial contamination on meat.

A new prototype electronic nose system utilizing MMOS (Mixed Metal Oxide Semiconductor) gas sensors has been designed and developed . An extensive materials study on target gas chemical compatibility was performed prior to system component selection. The sensing chamber was machined from inert PTFE (polytetrafluoroethylene) round stock. A small diameter flow passageway through

the length of the sensing chamber minimizes dead space and delivers effluent directly across the sensor heads. Provision was made for mounting sensors by milling close tolerance holes perpendicular to the flow path. Incorporating a check valve in the sensing chamber design prevents over pressurization of the gas sensors. The flow system comprises a gas pump with EDPM diaphragm, two-way solenoid valve, three three-way solenoid valves, Teflon and FDA approved nylon fittings, and THV (tetrafluoroethylene hexafluoropropylene vinylidene) tubing.

Two MMOS sensors have been procured (City Technology Ltd., Portsmouth, Hampshire, UK) and installed in the electronic nose system. Temperature and humidity measurement were accomplished through a SHT 75 (Sensirion, Zurich, Switzerland) sensor. Data acquisition was accomplished through a previously procured USB (Universal Serial Bus) data acquisition system and laptop computer. The electronic nose system entails a reconfigurable headspace sampling system design, allowing semi-automated selection of three different headspace sampling and sensing configurations. A microcontroller based control system is currently in development and will soon be incorporated to fully automate the MMOS electronic nose system. A preliminary system performance evaluation conducted in a controlled condition evaluated different headspace sampling configurations. Preliminary experimentation has been conducted to evaluate sensor performance on predicting meat spoilage based on a parallel microbiological study. Work is continuing the MMOS-based electronic nose system for evaluation of spoilage and contamination in meat.

Additional work is continuing to develop a L-B thin film-based sensing module. A generalized test chamber is being developed to test the performance of different thin-film-based sensing modules.

- g. Nutrient Management Zone Determination.** Precision farming technology has potential to increase sustainability and profitability in crop production. This project deals with the development of computer-based artificial intelligence technique to provide critical information that will be used for adopting precision farming/improved crop production management practices. The overall goal of this project is to develop nutrient zone management techniques for predicting soil as well as plant nitrate based on imagery and non-imagery information of the field. Aerial and satellite images of the research sites in Crookston, Minot, Williston, Oakes and Malta were geo-referenced. Red, green, blue, and NIR bands were extracted using an image extraction procedure. The bands were analyzed using different clustering and other image processing techniques. A Radial basis function neural network (RBFN) model was developed to predict the soil nitrate (at 0-15 cm depth from the surface) at the Crookston research site. Non-imagery information, such as deep and shallow electrical conductivity, topography and yield, were also used as the input to the neural network. The developed model showed an average prediction accuracy of 80% using test data. Further, the error analysis was also conducted to determine the performance of the model. Similarly, the use of RBFN (Radial basis function) neural network and

PCR (principal component regression) techniques to predict plant nitrate from the aerial images at the Oakes research site was investigated. Eight principal components, extracted from forty-two histogram features, were applied as input to the radial basis function neural network model to predict plant nitrate. The average prediction accuracy obtained from the model was 93.6%. In addition, the average prediction accuracy obtained from the PCR was 87.5%. The neural network model performed better than the corresponding statistical model. Additional image processing techniques were used to extract statistical and five different textural features of multi-spectral bands of aerial images. Two different neural network architectures (e. g. Back Propagation and Radial Basis Function) were used to develop twenty different models to predict plant (corn crop) nitrate at the Oakes research site. These neural networks used extracted image features as their inputs. A new algorithm was developed to evaluate the performance of neural network models based on the simultaneous comparison of multiple parameters and to find optimum models based on the multiple comparisons. Five different performance criteria were used to evaluate the performance of these neural network models. Radial basis function model based on green vegetation index textural features provided the best performance with an average prediction accuracy of 92.1% and correlation coefficient of 0.72.

h. Use of Dehulled Flaxseed to Increase Omega-3 Fatty Acids in Farm-raised Fish.

The theory that dehulled flaxseed is a viable feed ingredient for increasing the healthful omega-3 fatty acid content in farm-raised fish was tested. A simple, inexpensive mechanical dehulling process was demonstrated last year, thereby yielding flaxseed that is both low in fiber and high in the desired type of fat. The hull is rich in lignans, and is therefore a valuable co-product for human consumption. The dehulled flaxseed was incorporated into extruded fish feed at three levels (0, 9 and 18%) and fed to yellow perch for 6 months, alongside a commercial feed (control). Performance of the fish was not significantly different from the commercial control in terms of feed conversion ratio, weight gain and survival. The content of omega-3 fatty acid in the fish increased in proportion to the flaxseed in the diet. Therefore, dehulled flaxseed is a promising alternative to marine fish oils for elevating the content of omega-3 fatty acid content in farm-raised fish. These findings should be extended to other fish species; however, the future of further testing is uncertain due to the recent closing of the Aquaculture Research Center in Carrington. These results point the way towards flaxseed diets as a low-cost alternative for boosting the content of omega-3 fatty acids in farm-raised fish. This alternative will likely become very attractive as the supply of marine fish oil tightens and the public recognizes the importance of dietary omega-3 fats. The removal of the flaxseed hull is a low-cost method for obtaining an acceptable low-fiber ration.

A listing of departmental research projects and more detailed annual progress reports are available in the **Appendix IV supplement** to this report.

2. Grants/Contracts

A listing of grant/gift/in-kind funding in support of research and academic programs for the period July 1, 2002 to June 30, 2003 is given in the **Appendix VI** supplement. A summary of grants is as follows:

Funded

PI/Co-PI = \$244,045

Unfunded

PI/Co-PI = \$782,409

Gifts and in-kind support for teaching programs totaled \$92,000.

3. Articles/Publications

a. Refereed Journals

Borhan, M.S., S. Panigrahi, J. Lorenzen, and H. Gu. 2003. Evaluation of multi-spectral imaging techniques to predict chlorophyll and nitrogen status of potato leaves in the field. *Journal of South Pacific Agriculture*. Vol. 8(1): 31-36.

Chtioui, Y., S. Panigrahi, and L. Backer. 2003. Self-organizing map combined with a fuzzy clustering for color image segmentation of edible beans. *Transactions of the ASAE*. Vol. 46(3): 831-838.

Wiesenborn, D., K. Tostenson, and N. Kangas. 2003. Continuous, abrasive method for mechanical fractionation of flaxseed. *Journal of the American Oil Chemists' Society*. 80(3):295-300.

Zheng, Y., D.P. Wiesenborn, K. Tostenson, and N. Kangas. 2003. Screw pressing of whole and dehulled flaxseed for organic oil. *Journal of the American Oil Chemists' Society*, accepted.

Casey, F.X.M., N. Derby, R.E. Knighton, D.D. Steele, and E.C. Stegman. 2002. Initiation of irrigation effects on temporal nitrate leaching. *Vadose Zone J.* 1:300-309.

Singh, K.K., D. Wiesenborn, N. Kangas, and K. Tostenson. 2002. Characterization of preparation parameters for improved screw pressing of crambe seed. *Transactions of the ASAE*, 45(4): 1029-1035.

Walter, J.D. and L.F. Backer. 2002. Sugarbeet yield monitoring for site-specific farming, Part I - Laboratory tests and preliminary field tests, *Precision Agriculture*, accepted for publication, July.

Wiesenborn, D., R. Doddapaneni, K. Tostenson, and N. Kangas. 2002. Kinetic characterization of cooking-induced changes in crambe seed prepared for expelling. *Journal of Food Engineering*, 55: 157-163.

Zhang, Q., S. Panigrahi, S. Panda, and M. Borhan. 2002. Techniques for yield prediction for corn aerial images - a neural network approach. *Journal of Agricultural and Biosystems Engineering*. Vol. 3(1): 18-28.

Hall, T.L., L.F. Backer, V.L. Hofman, and L.J. Smith. 2001. Sugarbeet yield monitoring for site-specific farming, Part II - field testing, *Precision Agriculture*, accepted for publication, August.

In Review

Derby, N.E., F.X.M. Casey, R.E. Knighton, and D.D. Steele. 2003. Mid-season nitrogen fertility management for corn based on weather and yield prediction. *Agron. J.*

Panda, S. and S. Panigrahi. 2003. Heuristics-integrated self-organizing map (SOM) network for clustering and aerial images. In review for publication in *Engineering Applications of Artificial Intelligence*.

Borhan, M.S., S. Panigrahi, J.H. Lorenzen, and H. Gu. 2002. Multispectral imaging techniques for nitrate and chlorophyll determination in potato leaves. In review for publication in *Transactions of the ASAE*.

Casey, F.X.M., J. Lee, and D.D. Steele,. 2002. Development and evaluation of a novel mechanistic-stochastic method for field-scale solute transport prediction. *Water Resour. Res.*

Panda, S. and S. Panigrahi. 2002. Application of vegetation indices for crop yield prediction using neural network techniques. Submitted for possible publication in *Precision Agriculture*.

Singh, K.K., D. Wiesenborn, N. Kangas, and K. Tostenson. 2002. Screw pressing characteristics of dehulled crambe seed. *Transactions of the ASAE*.

b. Proceedings/Book chapters/Monographs

Gautam, R., S. Panigrahi. 2003. Image processing techniques and neural network modes for predicting plant nitrate using aerial images. *Proceedings fo the International Joint Conference on Neural Networks (IJCNN)*. July 20-24. Portland, OR.

Gautam, R., S. Panigrahi, S. Panda, and D. Franzen. 2002. Nutrient zone management using non-imagery information. *Proceedings of the 6th International Conference on Precision Agriculture*. Paper No. 2002-124. July 14-17. Minneapolis, MN.

Wiesenborn, D., K. Tostenson, N. Kangas, and C. Osowski. 2002. Mechanical fractionation of flaxseed for edible uses. Proceedings of the 59th Flax Institute, Fargo, pp. 25-29.

Wiesenborn, D., K. Tostenson, N. Kangas, Y. Zheng, C. Hall III, R. Lee, F. Manthey, M. Niehaus, P. Jarvis, W. Twombly, and J. Schwarz. 2002. Processing flaxseed for food and feed uses. Proceedings of the Annual Meeting of the Korean Society of Food Science and Technology, Muju, Republic of Korea (invited presentation).

Zheng, Y. D. Wiesenborn, N. Kangas, and K. Tostenson. 2002. Bench scale screw pressing of flaxseed and flaxseed embryos. Proceedings of the 59th Flax Institute, Fargo, pp. 30-37.

Other - Citable Publications

Derby, N.E., D.D. Steele, and F..X.M. Casey. 2002. Factoring weather in to mid-season corn fertility decisions. In Agronomy Abstracts. Madison, WI: ASA.

Steele, D.D. 2002. Potato planting configurations. In NDSU Potato Research Irrigated Field Trials, Tappen, ND (field day report packet), 3 pages. 6 Aug. Fargo: Dept. of Plant Pathology, NDSU.

Panda, S.S., D.D. Steele, and S. Panigrahi. 2002. Precision water management using automated crop yield modeling. ASAE-CIGR Meeting Paper No.022251. St. Joseph, Mich: ASAE.

Steele, D.D., R.G. Greenland, and H.M. Hatterman-Valenti. 2002. Planting configurations for sprinkler irrigated potatoes on coarse textured soils. ASAE-CIGR Meeting Paper No. 022176. St. Joseph, Mich.: ASAE.

c. Bulletins, Circulars, Reports, Media, Software, Product or Equipment Developed, Etc.

Panigrahi, Suranjan. Sugar Beet Patent Application: spent a significant amount of time on follow-up work for developing and submitting response to the patent examiner's response.

Steele, D.D. 2002. New irrigated potato research site near Tappen, ND. In: Water Spouts, No. 197 (July):(2-3). Fargo: N. Dak. State Univ. Ext. Serv.

Steele, D.D. 2002.; Potato planting configuration research. In: Water Spouts, No. 194 (April):3-4. Fargo: N. Dak. State Univ. Ext. Serv.

Steele, D.D., D. Kirkpatrick, and R. Greenland. 2002. Research on potato planting configurations. In 2001 Annual Report: Oakes Irrigation Research Site, 72-75. Carrington: N. Dak. St. Univ. Res. Ext. Center. Also available 11 July 2002 at <http://www.ag.ndsu.nodak.edu/oakes/2001Report/popm01.htm>.

Steele, D.D. 2002. Researchers study furrows, hills. Valley Potato Grower Jan.: 4-6.

Other

Prepared AES project report on subsurface and surface drainage optimization and design in North Dakota. April 2003. (Lowell Disrud).

Updated material on the departmental homepage. (Leslie Backer).

Worked with CEA and COAFSNR College Coordinators to develop ABEN and ASM related stories for the College newsletter, 2003. (Leslie Backer).

Manuscripts, Grant Proposals, Station Projects, etc. Reviewed

Thomas et al. 2002. The UGA easy pan: size really does make a difference. Reviewed for Appl. Engr. Agric. (Dean Steele).

Thomas et al. 2002. Sprinkler irrigation scheduling with the UGA EASY pan. Reviewed for Appl. Engr. Agric. (Dean Steele).

Campos, A.A., M.S. Fabbito, L.S. Pereira, J. M. Goncalves, M.I. Valin, Y. Liu, Y.N. Li, Z. Mao, and B. Dong. Reviewed for ASAE Annual International Mtg., Chicago, IL. 28-31 July. (Dean Steele).

Provided review for the senior design reports for the ABEN program. (Dean Steele).

Reviewed ASM 475 reports for program assessment activities. (Leslie Backer).

Reviewed 11 AES project proposals. (Leslie Backer).

Reviewed a grant proposal for approval from the Mechanical Engineering Department on hydraulic engine mounts. (Elton Solseng).

Reviewed safety course syllabi. (Elton Solseng).

Reviewed an extension bulletin on Biodiesel. (Elton Solseng).

Reviewed one bulletin for extension safety. (Elton Solseng).

Reviewed/edited field sprayer calibration manual by Vern Hofman. (Elton Solseng).

Reviewed/edited extension small grain calibration manual by Vern Hofman. (E. Solseng).

Reviewed/edited safe use of big round balers publication by George Maher. (E. Solseng).

Editing of Publications related to research

Wrote parts and edited “North Dakota AgMag,” April 2003 for Becky Koch, Extension (a magazine about agriculture for North Dakota elementary students. (Leslie Backer).

Vigneault, Clement, Naro R. Markarian, Andres da Silva, and Bernard Goyette. 2003. Pressure drop during forced-air circulation of various horticultural produce. Transactions of ASAE, March 18, 2003. (Leslie Backer).

Panigrahi, Suranjan. 2002. Multi-spectral imaging techniques for nitrate and chlorophyll determination in potato leaves. For journal publication. March 28. (Leslie Backer).

Panda, Sudhanshu Sekhar, Suranjan Panigrahi, and Nathan Derby. 2002. Application of vegetation indices for crop yield prediction using neural network techniques. For journal publication. September 19. (Leslie Backer).

Zheng, Yunling, Dennis P. Wiesenborn, Kristi Tostenson, and Nancy Kangas. 2002. Screw pressing of whole and dehulled flaxseed for Omega Oil. For journal publication. October 10. (Leslie Backer).

Serve on AES Project Review Committee: reviewed 14 projects in 2002-2003. (Leslie Backer).

Reviewed manuscript, Soil and nutrient losses from agricultural conservation practices, for ASCE Journal of Irrigation and Drainage. (Lowell Disrud).

Reviewed NRI proposal, High-resolution digital elevation models for soil erosion research. (Lowell Disrud).

d. Papers Presented

Singh, K.K., D. Wiesenborn, N. Kangas, and K. Tostenson. 2003. Characteristics of dehulled crambe seed (*Crambe abyssinica* J.) In screw pressing. Paper No. PFE-2003-II-15. 27th Annual Convention of the Indian Society of Agricultural Engineers, Maharana Pratap University of Agriculture & Technology, Udaipur (Rajsthan), India, Jan. 29-31.

Zheng, Y. (Honored Student Award Winner), D.P. Wiesenborn, K. Tostenson and N. Kangas. 2003. Bench scale screw pressing of flaxseed and flaxseed embryos. 94th American Oil Chemists’ Society Annual Meeting, Kansas City, KS, May 4-7.

Disrud, Lowell. 2002. Electric power use by irrigators. North Central Region ASAE meeting.

Gautam, R., S. Panigrahi, and S. Panda. 2002. Prediction of petiole nitrate using statistical and neural network approach. ASAE Paper No. 02-1043. St. Joseph, MI.

Panda, S., S. Panigrahi, and R. Gautam. 2002. Analysis of clustering techniques for predicting No₃-N from aerial images. ASAE Paper No. 02-3090. St. Joseph, MI.

Panigrahi, S., U. Kizil, S. Balasubramanian, C. Doetkott, C. Logue, M. Marchello, H. Gu, A. Kubiak, L. Nolan, J. Schneider, and R. Wiens. 2002. Electronic nose system for meat quality evaluation. ASAE Paper No. 02-6094. St. Joseph, MI.

Scherer, Thomas, Lowell A. Disrud, Ryan M. Waters, and Andrew J. Poeckes. 2002. Pump inlet designs for irrigating from low flow meandering rivers. North Central Inter-Sectional ASAE Conference, Saskatoon, SK, Canada. ASAE Paper No. MBSK 02-304.

Steele, D.D., R. G. Greenland, and H.M. Hatterman-Valenti. 2002. Planting configurations for sprinkler irrigated potatoes on coarse textures soils. Paper No. 022176 presented at the ASAE Annual International Meeting / CIGR XVth World Congress, Chicago, Illinois, USA, 28-31 July.

Twombly, W. and D. Wiesenborn. 2002. Review of extrusion temperature measurement and estimation, North-central Intersectional ASAE & CSAE Conference, Saskatoon, SASK, Sept. 27-28.

Other

Kizil, Unal and Lowell Disrud. 2002. Vegetative filter strips modeling of a small watershed. North Central Inter-Sectional ASAE Conference, Saskatoon, SK, Canada. Submitted to Transactions of the ASAE for publication.

Panigrahi, S. and P. Das. 2002. Fundamentals of database and data mining techniques for agricultural applications. One-day continuing Professional Development Session #9. International ASAE Annual conference at Chicago, IL. July 28, 2002.

Panigrahi, S. 2002. Emerging technologies for bioscience research and development at universities. Invited to talk by the Department of Physics, University of North Dakota, Grand Forks, ND. December 13, 2002.

AG 150 class presentation on Agricultural Systems Management. (Leslie Backer).

Presentation at Sun Grant Conference, Brookings, SD on relevant North Dakota activities, Aug. 6-7. (Dennis Wiesenborn).

Presentation on irrigation pump inlets at Irrigators' Workshop in Bismarck, ND. December 2002. (Lowell Disrud).

Presentation on Biofuels on behalf of NDAES to delegation from Minot, Sept. 12. (Dennis Wiesenborn).

Presented lecture/discussion changes in Mechanized AG at the North Dakota Ag Teachers Fall Convention. August 2002. (Elton Solseng).

Presented program on State FFA Contest at the North Dakota Ag Teachers Fall Convention. August 2002. (Elton Solseng).

e. Theses

Bon, Thomas

Ph.D. Dissertation Title: Development of a Mechanical Broccoli Harvester, Analysis and Optimization of Selected Subsystems
Advisor: Dennis Wiesenborn
Year: May 2003

Panda, Sudhanshu Sekhar

Ph.D. Dissertation Title: Data Mining Application in Production Management of Crop
Advisor: Suranjan Panigrahi
Year: May 2003

Borhan, Md. Saidul

Ph.D. Dissertation Title: Multispectral Imaging and Sensing Techniques for Chlorophyll and Nitrate Determination in Potato Plants
Advisor: Suranjan Panigrahi
Year: December 2002

Shae, Jerry

M.S. Paper Title: Comparison of Irrigation Scheduling Methods for Potatoes
Advisor: Dennis Wiesenborn
Year: August 2002

C1. Extension and other Outreach

The Extension Agricultural and Biosystems Engineering program annually reaches about 16,000 people through about 250 educational presentations. Individual education and technical assistance is provided through about 1,000 telephone, 1,500 correspondence, 150 office, and 50 on-site consultations, and the distribution of about 600 regional handbooks, 100 building plans and 100 CDs. Engineering information distributed through the media include about 70 news articles, 50 radio and television programs, 20 electronic releases, and 20 magazine articles. Educational materials developed include about 25 technical articles, 30 slide/video/display/power point programs, 20 publications, 15 newsletters, and web site information. Peer review was completed on about 25 publications and articles. The use of the ABEN extension website continues to grow with current use at more than 500 successful page requests per day. There were 110,671 distinct hosts served during the past year.

1. Major Efforts

a. Post Harvest Engineering

Ken Hellevang responded to requests for technical assistance from 302 people from a wide geographical area. This technical assistance impacted approximately \$7.2 million worth of crops; 8,000 bu x \$3.00/bu x 302 calls. Post harvest engineering information was provided to about 1,303 people during 17 educational presentations.

Research:

1. Bean Color Influence by Harvest Date:

Eleven farmers from different areas in North Dakota collected bean samples while harvesting during September 2002. There was much variability, but the bean color was darker with later harvest dates. A darkening of the pinto beans was noted when the length of the growing period exceeded 120 days.

2. Influence of Temperature and Moisture Content on Bean Breakage Susceptibility:

Research was conducted to determine the relationship of pinto and navy bean moisture content and temperature and breakage susceptibility. The breakage of navy bean breakage was constant at moisture contents of 19% to 16%. Breakage increased dramatically at moisture contents less than 16%. Pinto bean breakage was minimal and increased slowly as moisture contents decreased from 19% to 16%. Breakage increased more rapidly at moisture contents less than 16%. With both navy and pinto beans at 16% moisture content, there was an increase in breakage with a decrease in temperature.

3. Bean Breakage at Selected Drop Heights onto Concrete and Beans:

Research was conducted to determine if damage as beans are dropped into a storage bin, either onto concrete or onto beans, was large enough to justify using a

bean ladder. Damage to pinto beans and navy beans at 12%-13% moisture content increases linearly with drop height. The damage to both types of beans was excessive for both being dropped onto concrete and onto other beans. This validates the need to use a bean ladder when placing beans into storage or other places where the beans might be dropped.

4. Controlling Fan Operation with a Humidistat to Natural Air Drying Pinto Beans

Research was conducted to determine a natural-air drying system that would dry pinto beans to 15%-16% moisture content. An airflow rate of about 2 cfm/bu was used for drying. The fans were controlled using a humidistat set to shut the fans off if the relative humidity was below 60% to prevent over-drying. A rain sensor shut the fans off if it rained more than 0.5 inch. The beans were dry after 830 hours of fan operation. The color quality, lightness and redness, of the beans was maintained during drying.

5. Moisture Loss of Carrots Stored at Selected Relative Humidities

A research procedure was developed to obtain selected relative humidities using a saturated salt solution. A chest freezer was modified to provide the desired temperature of about 35 F. The amount of shrink occurring was found to be related to the relative humidity with an increasing loss as the relative humidity level decreased. Carrots stored for three months at 100% RH lost 44 grams of weight; at 95% RH they lost 245 gram; at 86% RH they lost 451 grams; and at 77% RH they lost 605 grams. This stresses the need to store carrots at as near to 100% relative humidity as possible.

b. Structures and Environment Engineering

Ken Hellevang responded to requests for technical assistance from 240 people. Technical assistance impacted a building value of approximately \$2.4 million, assuming that each call effected \$10,000. Since many calls were related to indoor air quality, the health of many people was also affected. Questions were answered about mold and flood remediation for two days at the county fair in Roseau, MN. Certificates of participation were distributed to 56 - 5th grade students for their participation in the 2002 State Radon Poster contest. This was a cooperative effort with the North Dakota Health Department and the ND Chapter of the American Lung Association. Permission was granted to a Cleveland, OH, educational program to use "Keep Your Home Healthy" and "Remove Mold for a Healthy Home" publications for educational programs targeted at schools. The "Keep Your Home Healthy" publication was featured in December, 2001, Volume 17, Issue 2 of the MA Report: Allergy & Asthma Network, Mothers of Asthmatics. The title of the article was "Worth Writing For." Mold Inspector at www.moldinspector.com is selling the videotape program "Mold in Homes: Health Effects, Ecology, Detection, and

Mitigation” for \$25.00. They are purchased in bulk from the NDSU Extension Service. Hellevang was selected to serve on the national Healthy Indoor Air for America’s Homes Leadership and Training Committee with a primary focus related to biologicals (mold, etc.).

c. **GIS/GPS**

1. Geospatial Knowledge and Skills Program:

Twenty-four one-day seminars were conducted for 68 NDSU extension personnel during 2002. In addition, 28 other individuals participated in the NDSU Geospatial Education Program. This included farmers and ranchers, crop consultants, NDSU agriculturalists, NRCS, and local government personnel. Participants learned to use handheld computers to measure fields and overlay field boundaries on satellite imagery and digital soil maps. These 96 individuals also learned basic skills needed to use GIS computer software in desktop computers, and basic principles of GPS technology and their applications to agricultural and natural resource management. Twenty-five other geospatial workshops and seminars were delivered to adults in North Dakota and Minnesota with a combined audience of 975. Ten GIS/GPS presentations were made to a combined youth audience of 400.

2. Geospatial Education for Water Quality:

Several program components related to the use of geospatial concepts and methods for water resource protection have been coordinated and delivered by Bruce Seelig. Water resource management was linked to the NASA grant for Geospatial Education. This includes coordination with the North Dakota Department of Agriculture to deliver the Groundwater Protection from Pesticides Strategy. A working relationship has been formed with a visiting associate professor from the Geologic Engineering Department at the University of North Dakota to investigate the importance of denitrification in North Dakota aquifers. Results of this work will improve the reliability of groundwater assessments.

3. Hand-Held Computers in Extension Education:

Sixty-five NDSU extension educators are using handheld computers to teach geospatial skills and for a variety of other computer technology applications as part of a NDSU Geospatial Education Program coordinated by extension specialist, John Nowatzki. They are using handheld Compaq IPAQ computers in conjunction with handheld global positioning systems (GPS) units to mark field boundaries and determine area, mark GPS points, and to demonstrate uses of satellite imagery and aerial photography in crop and range management. Other extension educators are using the geospatial equipment to teach youth to use geographic information system (GIS) computer programs and apply GIS, GPS and remote sensing technologies in community projects. The agents can also

access most agronomic extension publications using the IPAQ computers by inserting an SD memory card containing the publications into the hand-held computers.

d. Machine Systems

1. Biodiesel Fuel:

Biodiesel is an excellent alternative to diesel fuel. ABEN Extension has been providing educational information on biodiesel. Vern Hofman demonstrated the process of producing the fuel from vegetable oil and using it to fuel an engine at most of the NDSU Research and Extension Center field days. A new publication on biodiesel fuel is available from the Extension Service. Results of engine tests completed on a 4-cylinder Cummings engine using biodiesel were reported in an ASAE paper.

2. Spray Equipment and Pesticide Application:

Hofman presented information at several pesticide training programs on new spray nozzles that reduce spray drift. Aerial pattern testing was done on about 40 spray planes in ND and western MN. A project on improving spray coverage on sunflower heads was completed for the National Sunflower Association. This was done to investigate improving the amount of Birdshield deposited on sunflower heads that will help repel blackbirds away. It looks to be helpful as a bird repellent, but needs to be used in conjunction with other methods.

e. Safety

1. Agricultural Safety:

George Maher taught four Tractor Safety Schools in 2002. Schools were taught at Finley (13 youth), Park River (24 youth), Carrington (11 youth), and Beach (12 youth). He taught 38 units on PTO Entanglement and four units on Hazards of Caught In The Grain (Grain Bin Safety) to groups of mixed adults and youth. Observers of these educational units are always amazed at how quickly grain can trap a person and how much force the grain mass can have on a trapped body.

2. AgrAbility:

Twelve AgrAbility projects/presentations/visits were conducted in the state. A hand clutch and tractor steps were installed on a tractor for a farmer with severe hip and back pains limiting his ability to mount and drive his tractor. A ramp being built by a volunteer for a church was evaluated. Several other clients were evaluated for assistive technology to offset various disabilities. Considerable effort was expended helping Easter Seals in develop their grant proposal for the AgrAbility program. However, the grant was not funded.

f. Land Use Data

Data Mita developed a ground truth database for the 2002 land use/cover classification exercise. He also participated in the 2002 ND Agricultural Statistics Service's June Agricultural Survey (JAS is the major source of remote sensing ground truth data.) He completed the land use/cover classification of ND for the 2002 agricultural season, produced the 2002 state and county numerical crop estimates for ND Agricultural Statistics Service, created an annual land cover resource inventory of 1997 to 2002, and developed an inventory of land use data for 25 watersheds of the southern Missouri River. A total of 154 CDs containing the 2000 and 2001 state and county land use categorization dataset were distributed to state agencies, extension agents, producers and agricultural and resource managers.

Three workshops were conducted in Fargo and Bismarck on "Working with Land Use and Satellite Imagery Using ArcView GIS". The workshops provided GIS tools so people can extract greater value from the land cover datasets. A total of 32 participants attended. A one-day international seminar on GIS/remote sensing procedures for land cover classification and acreage estimates was presented. The seminar involved 10 participants from Europe and Asia who were guests of USDA.

The official web page for the project was updated and redesigned: (<http://www.ageng.ndsu.nodak.edu/geodata/documents/index.html>.) An online training session on "Working with Remotely Sensed Land Use Data" was developed. The session objective is to provide users with GIS tools so that they can extract greater value from the land cover datasets. The session is published on the project web page in html and PDF formats.

g. Water Quality

1. Groundwater Protection Strategy

Sheri Fox presented information at seven pesticide recertification workshops attended by approximately 300 participants. North Dakota groundwater resource protection from pesticide and nutrient contamination information was presented to approximately 60 youth at a camp conducted in Dickey County by John Nowatzki, Sheri Fox and Dath Mita. This is a cooperative activity between NDSU Extension, ND Health Department, ND Forestry Service, NRCS, and the US Fish and Wildlife Service. Steele and Wells county Pesticide Assessments were completed and made available for viewing through the Internet.

2. Water Quality Websites

The Water Quality Program in Agricultural & Biosystems Engineering maintains two websites related to water quality issues; one for the six states in the Northern Plains and Mountains Region (EPA Region 8) (<http://waterq.ndsu.nodak.edu/>), and the North Dakota Water Quality site (<http://waterqnd.ndsu.nodak.edu/>). Water

quality information generated by NDSU has been compiled and organized into the following categories: 1) Grazing and Riparian Management; 2) Irrigation Water Management; 3) Manure Management (AFO/CAFO); 4) Nutrient Management; 5) Pesticide Management; 6) Salinity; 7) Watershed Management; 8) Wellhead Protection; 9) Wetlands; 10) Water Quality Programs for Specific Audiences; 11) Partners for Water Quality; and 12) North Dakota Water Quality Links. All NDSU Extension publications related to water quality can be easily accessed from this site. The site also provides the user with connections to faculty and staff at NDSU involved in teaching, research, and extension programs and provides links to various state, federal, and local sources of water quality information. Seelig provides coordination and development of the web sites assisted by a full-time website technologist.

h. Irrigation

1. Developing Irrigation Pump Intakes for Shallow Water Sources:

NDSU has an agreement with the Bureau of Reclamation to help irrigation organizations along the Heart River develop water conservation methods and technologies. Irrigators along the Heart River identified shallow water pump intakes for their centrifugal pumps as their greatest problem. Problems include vortexing that can cause loss of prime on the pump, plugging due to floating debris, and removing silt from pipes. Lowell Disrud and Tom Scherer, with help from a senior design team and technician, designed, built and installed three types of improved pump intakes. Two floating intakes and one submersible intake were installed and tested on the Heart River last year. The farmers noted a significant reduction in plugging, no vortexing, and increased capacity from their pumps. Two irrigation dealers became interested in the designs and one dealer has built two intakes (both floaters) for his customers and the other dealer had a student organization build two floating intakes. Another senior design team recently completed an engineering design report that provided details on using an infiltration gallery under the riverbed to obtain sediment and debris free water for a center pivot irrigation system.

Using Surge Valves

Under the guidance of Tom Scherer, two surge valves and associated gated pipe were purchased and installed on two farms in the Lower Heart Irrigation area. One farmer said it cut his irrigation time in half (for that particular piece of land), and the other farmer said it reduced his irrigation time by one-third. After using the surge valves for one year, both farmers are making changes to their irrigation piping systems to better use the valves. A field tour of the surge valve and pump intake systems was held in August. It was attended by about 60% of the irrigators along the Heart River. Feedback from the farmers and the Bureau of Reclamation was very positive.

Irrigation Technology

To demonstrate emerging irrigation technologies, a variable speed motor controller was installed to control submersible pump that supply a two-tower research pivot at Carrington. A computer version of the checkbook irrigation scheduling method was developed for the Palm Pilot PDA. In addition, a working model of a data logger for collecting the necessary parameter for input into the checkbook methods was developed and tested. The PDA computer program can be used alone or to download the data from the data logger.

Misting for Scab Research

The work associated with helping Dr. McMullen design a misting system for foliar disease research in 2000 seems to have peaked the interest of many plant pathologists. That work contributed to procuring a grant to develop an automated misting system. The misting system, with automated control, was installed this year and drew a great deal of attention at the National FHB forum. Scherer received several requests for help and guidance with misting systems at other research institutions. Although this is not a traditional form of irrigation, it does make use of agricultural micro-sprinklers, a relatively new technology for North Dakota. Another grant has been received to continue this work. In addition, Scherer has been asked by the director of the Scab Initiative to develop a web page on how to design a misting system.

Irrigation Conservation Practices

Nationally, concern about irrigation conservation practices has been increasing. The switch from surface irrigation to center pivot sprinkler irrigation is increasing the interest in the performance of sprinkler packages on drop tubes. The distribution pattern (can tests) and application rate of the Oakes lateral (two nozzle sizes), the Carrington research pivot, and a new lateral move at Tappen were evaluated. Results were not very good and matched the observations from my counterparts in Kansas. Scherer spent a day with a KSU Extension Agricultural Engineer and discussed their can evaluation test results. The results from the testing were used for training irrigators and irrigation dealers. The results have also demonstrated that there is a lack of research data on the new sprinkler packages in regard to spacing and sprinkler height effects on erosion and runoff.

2. Grant Funding of Extension Programs

A listing of grant/gift/in-kind funding in support of extension programs for the period July 1, 2002 to June 30, 2003 is given in **Appendix VI** supplement. A summary of grants is as follows:

Funded

Total Extension grant funding . . PI/Co-PI = \$248,893

Unfunded

Extension grants PI/Co-PI = \$2,856,333

3. Extension Publications and other Educational Materials

Kenneth Hellevang

Publications

Hellevang, Kenneth. 2002. Vegetable Storage System. Encyclopedia of Agricultural, Food, and Biological Engineering. Marcel Dekker, Inc., New York, New York. 8 pages.

Hellevang, Kenneth. 2002. Soybean Drying, Handling and Storage, p 112-123, Soybean Production Field Guide for ND & NWMN, A-1172. NDSU Extension Service, ND Soybean Council, and MN Soybean Research & promotion Council.

Hellevang, Kenneth and Hofman, Vern. 2002. Fuel Cost Comparison Chart. AE-1015. NDSU Extension Service, NDSU, Fargo, ND, 58105. 4 pages

Granted permission to the Illinois Extension Service to use the material in my “Remove Mold for a Healthy Home” publication with credit under an Illinois logo.

Requested Edit/Referee Articles

University of Wisconsin, Help Yourself to a Healthy Home, pgs 17-22. Mold and Moisture: Should You Be Concerned; Questions to Ask; Action Steps; When in Doubt, Check it Out.

Mathematics and Computers in Simulation, Special Issue. Forage drying models for oats and vetches under Mediterranean climate conditions.

ASAE FPE-1790, Aeration Strategies for Reconditioning Dry Soybeans.

Journal of Sugarbeet Research, Airflow Resistance of Sugarbeets.

Popular and Technical Articles

County Agent News

<u>Date</u>	<u>Topic</u>
Jan 02	Eliminate Condensation on Windows
Jan 02	Check Your Roof for Ice Dams
Jan 02	Prevent Mold Growth in Closets and Storage Areas
Feb 02	Carbon Monoxide Detectors Save Lives
Sep 02	Natural Air Drying Barley in 2002
Oct 02	Drying Grain in Late October
Nov 02	Grain Harvest, Drying, and Storage Tips

Technical Articles

<u>Date</u>	<u>Topic</u>	<u>Publication</u>
	Pinto Bean Storage	Northarvest Bean Growers Research Report

Newsletters

<u>Date</u>	<u>Topic</u>	<u>Publication</u>
Jul 02	Natural Air Drying Barley	NDSU Crop and Pest Report
Jun 02	NASA Supports Geospatial Education; Home Moisture and Indoor Air Quality Education; Web-based Support for Extension Education; Model Airplane for Remote Sensing	ABEN Dept Newsletter

Displays

<u>Date</u>	<u>Topic</u>	<u>Location</u>
Dec 02	Keep Your Home Healthy	Wells County Winter Show, Fessenden

Mass Media Activities/Materials

News Releases

<u>Date</u>	<u>Topic</u>
Oct 01	New Publication Provides Guidance on Keeping Your Home Healthy
Oct 01	New Web Site Provides Extensive Information Related to Moisture in the Home
Jul 02	Barley Likely to Need Natural Air Drying
Oct 02	Information of Manure Management is Now Available
Oct 02	Ag Engineer Says Drying Grain in Late October a Challenge

Magazine/Newspaper

<u>Date</u>	<u>Topic</u>	<u>Publication</u>
Dec 02	Getting Sunflower Ready for Winter Storage	The Sunflower Magazine
Dec 02	Corn Drying and Storage Seminar at the Fargo Farm Show	Farm & Ranch Guide
Jul 02	Outdoor Grain Piles: Maintaining Grain Quality in Temporary Storage, Pt 1	Grain Journal

Aug 02	Outdoor Grain Piles: Maintaining Grain Quality in Temporary Storage, Pt 2	Grain Journal
Aug/Sep 02	Maximizing Your Sunflower Quality & Profit Potential	Natl. Sunflower Magazine
Nov 02	NDSU Extension Ag Engineering Housing Resources on the Web	The Builder, HBA of FM
Nov 02	Don't Turn Fans Off Too Early, Keep "Killers of Stored Seed Quality" at Bay	Natl. Sunflower Magazine
Jul 02	Proper Storage Prep Promises Better Returns	UAO Newsletter
Oct/Nov 02	Are Your Seeds Ready for Winter Storage?	The Sunflower Magazine

E-News (DTN)

Natural Air Drying Barley in 2002
Grain Harvest, Drying & Storage Tips to Rural Electric
Cooperatives, ND Grain Dealers, and AgDakota

Radio/TV

<u>Topic</u>	<u>Station</u>
Mold	River 95 FM
Manure Management	KFYR
Handling Wet Corn	RR Farm Network
Pressure Treated Wood Health Concerns	WDAY TV
Flood Mitigation: Mold and Drying	Channel 4 TV
Late Season Corn and Sunflower Drying & Storage Tips	Today's Ag & Fox Stations

Vern Hofman

Publications

Hofman, V., 2003. Biodiesel Fuel, AE-1240, NDSU Extension Service, Fargo, ND

Hofman, V., and E. Solseng, 2002. Biodiesel Fuel Use in an Unmodified Diesel Engine, ASAE Paper MBSK02-109, North Central Intersectional Meeting, ASAE, St. Joseph, MI

Hofman, V., 2002. Site-Specific Farming in Western ND Annual Progress Report, USDA-ARS Northern Great Plains Research Center and Area IV SCD, Mandan, ND

Hofman, V., K. Hellevang and others, 2002. Soybean Production Field Guide, NDSU Extension Service and ND Soybean Council, Fargo, ND

Hofman, V., and others, 2002. Dry Bean Production Guide (Revised), NDSU Extension Service, Fargo, ND

Hofman, F., 2002. Biodiesel - An Alternative to Diesel Fuel, EARS Report, NDSU Extension Service, Fargo, ND

Popular and Technical Articles

Displays

Biodiesel Display
Site-Specific Display
Spray Drift, PowerPoint
Variable Rate Application, PowerPoint
GPS Guiding Systems, PowerPoint

Mass Media Activities/Materials

Magazine/Newspaper

<u>Topic</u>	<u>Publication</u>
Sprayer Maintenance	
New Spray Equipment	
Planter Maintenance	
Spray Drop Sizes	
Biodiesel Use in Engines	
Spray Drift Reduction (2)	
Precision Agriculture	
Biodiesel Use (2)	
Traction Efficiency	
-	Farm and Ranch Guide (2)
-	Dakota Farmer

Video Programs

Spray Drift Reduction
Sprayer Calibration

Radio/TV

<u>Topic</u>	<u>Station</u>
Spray Drift Reduction	Radio
Biodiesel Use in Engines (2)	Radio

Fungicide Application	Radio
Traction Efficiency	Radio
Biodiesel	TV
Site-Specific Farmer	TV
International Crop Expo	TV

George Maher

Mass Media Activities/Materials

News Releases

Carbon Monoxide is a Silent Killer
 Use Space Heaters the Safe Way
 Use Extreme Caution at the Grain Bins
 Is Your Standby Generator Standing By?
 Celebrate the Holiday Safely
 Lake and River Ice is Not Safe Yet!
 Stop, Look and Listen Still Works!
 First Aid Kits - Be Prepared!
 Emergency Preparedness is Essential
 Farm Safety: The Rewards are Priceless!
 Remove Grain from Bins with Care
 Take Care When Using Portable Pressure Washers
 Include Safety When Shopping for a Tractor
 Anhydrous Equipment Needs Frequent Safety Inspections
 Move Nurse Tanks Safely on the Road
 Farm Machinery is Not a Play Toy!
 When Can I Drive the Tractor?
 NDSU Schedules Tractor Safety Schools
 Roaring Tractors will Damage Your Hearing!
 Use Care When Selecting a Pesticide Respirator
 Control Your Exposure - Manage Pesticide Risk!
 Just Cut the Grass...Please!
 Sunscreen Should be Farm Equipment Too!
 Just Bale the Hay!
 Protect Yourself When Cleaning Out Grain Bins
 Fire Extinguishers for Home and Farm
 Don't Lift Accident Rates with Grain Augers
 Safety is Always First on the School Bus
 Farm Trucks Present Risks at Harvest Time
 Carbon Monoxide is a Silent Killer
 Space Heaters Have Some Safety Concerns

County Agent Articles

Check Outdoor Outlets Now for Safety
Work with Care at the Grain Bins
Safe Winter Travel Requires Planning
Tractor Safety is a Winter Concern, Too!
Tips for Your Fire Safety
Light Up Your Equipment!
Lawn Mowers - No Short Cuts to Safety!
Farm Equipment is Intended to be Pulled by Tractors!
Six short messages on Harvest Safety
Walking for Your Health Should be Safe Walking

Ag Communications Radio/TV

Carbon Monoxide is a Silent Killer
Is Your Standby Generator Standing By?
Lake and River Ice is Not Safe Yet!
Tractor Safety is a Winter Concern, Too!
First Aid Kits - Be Prepared!
Farm Safety: The Rewards are Priceless
Remove Grain from Bins with Care
Take Care When Using Portable Pressure Washers
Anhydrous Ammonia Safety Equipment
Taped 12 harvest radio short messages with Extension Communications
Taped Safety Is Always First on the School Bus
Taped Farm Trucks Present Risks at Harvest Time
Taped Carbon Monoxide is a Silent Killer
Taped Space Heaters Have Some Safety Concerns
Taped ten radio shorts for National Farm Safety Week (9/15-22)

Radio/TV

<u>Topic</u>	<u>Station</u>
Shop Safety for Used Tractors	KXMR, Bismarck
Time Management for Spring Planting	KXMR, Bismarck
Anhydrous Ammonia Safety Practices	KXMR, Bismarck
Move Nurse Tanks Safely on the Road	KXMR, Bismarck
Farm Machinery is Not a Play Toy!	KXMR, Bismarck
NDSU Schedules Tractor Safety Schools	KXMR, Bismarck
Roaring Tractors Will Damage Your Hearing!	KXMR, Bismarck
Control Your Exposure - Manage Pesticide Risk!	KXMR, Bismarck
Sunscreen Should be Farm Equipment Too!	KXMR, Bismarck
Discussed "Don't Lift Accident Rates with Grain Augers"	KXMR, Bismarck

John Nowatzki

Publications

Nowatzki, J.F., 2002, Protecting Groundwater from Pesticide Contamination. No. AE-1197. Fargo: North Dakota State University Extension Service.

Publications Related To Extension

Circulars	6
Proceedings	2
Fact Sheets	1
News/DTN Releases	30
Video Tapes	1
Magazine Articles	2

Mass Media Activities/Materials

News Releases

GIS Computerized Application of Pesticide Assessment System (9)

Magazine/Newspaper

Interview: Geospatial
Education Program (5)

Web Page

Groundwater Protection from Pesticides in North Dakota
(<http://www.ageng.ndsu.nodak.edu:83>)

Radio/TV

<u>Topic</u>	<u>Station</u>
Interview: Geospatial Program	Radio
Interview: Geospatial Program,	TV
GPS Applications for Youth (2)	

Thomas Scherer

Publications Related To Extension

Refereed Journal Articles

Narayanan, R., D.D. Steele, T.F. Scherer, 2002. Computer Model to Optimize Aboveground Drip Irrigation Systems for Small Acreages. *Applied Engineering in Agriculture*, 18(4):459-469.

Bulletins and Circulars

Scherer, T.F., 2002, AE-1156 (Revised), "Septice System Installation and Construction Permit Requirements in North Dakota", Extension Circular, North Dakota State University, Fargo, ND, 4 pages.

Technical Papers and Posters

Scherer, T.F., D. Kirkpatrick, and M.P. McMullen, 2002. Poster: Automated Control of a Misting System for Scab Research, National Fusarium Head Blight Forum, Cincinnati, Dec 6-7, 2002.

Scherer, T.F., D. Kirkpatrick, and M.P. McMullen, 2002. "Automated Control of a Watering system for Fusarium Head Blight Research" in Proceedings of the 2002 National Fusarium Head Blight Forum, US Wheat and Barley Scab Initiative, Michigan State University.

Scherer, T.F., L.A. Disrud, R.M. Waters, and A.J. Poeckes, 2002. "Pump Inlet Designs for Irrigation from Low Flow Meandering Rivers", Paper MBSK01-304, North Central Region Intersectional Meeting of the ASAE/CSAE, Saskatoon, SK, September 27-28, 2002, 10 pages.

Scherer, T.F., D. Kirkpatrick, and M.P. McMullen, 2002. "Automated Control of a Watering System for Fusarium Head Blight (Scab) Research", Paper MBSK01-305, North Central Region Intersectional Meeting of the ASAE/CSAE, Saskatoon, SK, September 27-28, 2002, 11 pages.

Brochures and Fact Sheets

Maher, G., and T.F. Scherer, 2002. Technical Service Provider Fact Sheet, 2 pages.

Walters, R.M., T.F. Scherer, and L. Disrud, 2002. "Floating and Submersible Irrigation Intake Structures", 4 pages.

Scherer, T.F., 2002. Irrigation Handbook, Updated, 10 section in 3-ring binder.

Computer Programs and Internet Homepages

Haq, A., and T.F. Scherer, 2002. Checkbook Irrigation Scheduling Program on the Palm Handheld.

Kirkpatrick, D., and T.F. Scherer, 2002. Website to show the dynamic monitoring results from the misting system used for scab research.

Contributed Presentation, Papers, or Displays

<u>Date</u>	<u>Topic</u>
Jan 02	Feasibility of Tile Drainage, Richland County Farm Improvement Annual Meeting
Jan 02	Landscape Drainage, North Central Turf Grass Association Annual Meeting
Feb 02	Tile Drainage and Salinity Management, Tile Drainage Workshop, Crookston, MN
Mar 02	Wind Energy Potential in ND, Extension Spring Conference, Fargo, ND
Aug 02	Pump Intakes, Heart River Irrigation Tour
Aug 02	Sprinkler Package Selection, Oakes Field Day
Sept 02	Pump Inlet Designs for Irrigating from low Flow, Meandering Rivers, Intersectional ASAE/CSAE Meeting, Saskatoon, SK
Sept 02	Automated Control of a Watering System for FHB Research, Intersectional ASAE/CSAE Meeting, Saskatoon, SK
Oct 02	Construction of Water Wells - Health Concerns, NDEHA Annual Meeting, Minot, ND
Nov 02	The State of Irrigation in ND, Irrigation Workshop, Carrington, ND
Dec 02	How Uniform Are Irrigation Sprinkler Systems?, Irrigation Workshop, Bismarck, ND

Bruce Seelig

Publications Related To Extension

Proceedings

Seelig, B.D., Assessing Nitrogen Contamination Potential via Remote Sensing, National Water Quality Monitoring Council Conference, May 20-23, 2002, Madison, WI.

Invited Presentations

Saline Soils in North Dakota, Great Plains Ag Meeting, Feb 14, 2002, Fargo.

Soil Drainage and Salinity Impacts, Red River Valley Drainage Workshop, Feb 26, 2002, Crookston, MN.

Assessment for Potential Nitrogen Contamination to ND Aquifers, Annual ND-SD 319 Project Coordinator Conference, Feb 28, 2002, Bismarck.

Soil Compatibility with Irrigation Water Quality, Ft Berthold Extension Meeting, Mar 26, 2002, New Town.

GIS Training with ArcView and Remote Sensing, Dickinson State University Ag Department Workshop, Mar 27-28, 2002, Dickinson.

Animal Waste and Water Quality, Barnes Co. SCD Water Project Tour, Oct 11, 2001, Valley City, ND.

Salinity and Sodium in ND Soils, Soils 444 Class, Oct 19, 2001, Fargo, ND.

Saline Seepage in North Dakota, Annual North Dakota Water Users Conference, Dec 5, 2001, Bismarck, ND

The Relationship Between Soil and Water Quality, Soils 210 Class, Dec 12, 2001, Fargo, ND.

Mass Media Activities/Materials

News Articles 3

Dath Mita

Publications Related To Extension

Contributed Presentations or Papers or Posters

Mita, D., Toepke-Peterson, M., Richardson, J.L., Padmanabhan, G., Lin, W., 2002, "A Preliminary Evaluation of the Influence of Groundwater Flow and Quality on the Cattail Population of Restored Wetlands in Hamden Slough Wildlife Refuge, Becker County, MN." Presented at the 47th Annual Midwest Groundwater Conference, Fargo, ND.

Mita, D., Seelig, B., Beard., L., 2002, "Assessing Nitrogen Contamination Potential Via Remote Sensing." Presented at the National Water Quality Monitoring Conference, Madison, WI.

Sheri Fox

Publications Related To Extension

Web Pages

Groundwater Protection from Pesticides in North Dakota, <http://www.ageng.ndsu.nodak.edu:83>

USA Sunflower Survey, <http://139.129.78.3/sunflower>

C2. Other Outreach

1. Professional Service

Faculty are extensively involved in service through committee activity at the department, college and university levels.

All faculty are active in professional societies (ASAE, AICE, IFT, AAAS, SME) and are involved in associated technical committees at section, region, and national levels. One faculty holds officer positions at the Division level of ASAE. Drs. Steele, Scherer, Hellevang, and Stegman serve on the Executive Committee of the RRV Section of ASAE.

Regional USDA-CSREES committee work, Midwest Plan Service, field day and workshop/seminar presentations, and peer reviews of technical papers provide additional opportunities for professional service. Drs. Hellevang and Scherer are active in MidWest Plan Service. Each have authored chapters in handbooks in subject matter areas of grain drying/aeration and irrigation systems.

Department faculty are involved in campus governance via service on college and university committees and University Senate.

Faculty are additionally involved in numerous commodity, government, and industry groups/committees/boards.

2. Alumni Events and Other Community Relations

A partial listing of departmental/faculty activities during the year are as follows: The Agricultural Engineering Show, Discover NDSU, College Engineering and Architecture and College of Agriculture, Food Systems, and Natural Resources Scholars Recognition, off-campus student recruitment, commencement exercises, Big Iron Show, Field Days at Research/Extension Centers in ND, Career Fairs, FFA Agricultural Mechanics contests, Marketplace 2003, tours of the NDSU Pilot Plant Laboratory, assistance of alumni in their search for new employment opportunities, scoutmaster, water resource/water quality education for junior and senior high school teachers, 4-H and other youth, farm and other safety education, and farmstead assessments for point and non-point source pollution.

3. Fund Raising Accomplishments

Contacts are maintained with alumni to solicit their help in obtaining gifts (monetary or equipment) from various sources (manufacturers, distributors, etc.) for the purpose of upgrading laboratory teaching equipment. A Melroe Bobcat gift-lease (\$23,000 value) was renewed for use in our teaching programs.

Scholarships totaling \$5,000 were funded by John Deere Development Foundation. A 6420 tractor (\$60,000 value) was provided by John Deere. Funding support for scholarships was solicited via the department's newsletter. Support received from alumni and friends totaled \$10,503. Other gifts and in-kind support for teaching programs totaled about \$92,000.

D. Special Initiatives

1. Cultural Diversity

The department promotes cultural diversity via its graduate program. Current international students are from China, India, Turkey, and Thailand. An associate in extension programs (GIS remote sensing) is from Malawi, Africa and a research specialist hire is from China.

Department faculty and their families contribute to the cultural diversity of the department. Dr. Panigrahi is a native of India.

2. Affirmative Action/Equal Opportunity

No new positions were filled

3. Cooperative Programming/Interdisciplinary Efforts/Interinstitutional Activities

The department's research projects involve cooperation and/or collaboration as principal investigators or co-PI's in the departments of Cereal and Food Science (protein recovery from agri-biomass, fractionation of flaxseed, and expeller-pressing of crambe seed); Soil Science (site-specific nutrient management, neural networks for analysis of remotely sensed plant information, livestock waste management, irrigation systems management); Animal and Range Science, Carrington Research and Extension Center, Civil Engineering (livestock waste management, aquaculture); Plant Pathology (in-situ spray deposition analysis on plant leaves); Plant Science, Carrington Research and Extension Center, Williston Research and Extension Center (irrigation management of high value crops); and USDA Laboratories at Mandan, ND (site-specific management, ag practice effects on water quality).

Dr. Wiesenborn holds a joint appointment in Agricultural and Biosystems Engineering and in Cereal and Food Science. He is actively involved in the interdisciplinary B.S. and M.S. programs in Food Science. Dr. Steele and Professor Disrud serve on the COAFSNR committee that guides the Natural Resources Management curriculum (an interdisciplinary program).

The department's extension programming is coordinated with the NDSU Extension Service Program Council and its associated interdisciplinary program planning teams.

Extension faculty in Agricultural and Biosystems Engineering and Soil Science Departments are collaborating in applied research in site-specific farming, and with several COA departments in post-harvest quality maintenance of agricultural commodities.

The department's Agricultural and Industrial Equipment Option in the ASM program involves collaborative programming with the North Dakota State School of Science. A new program option (Dealership Management) involves collaborations with John Deere Co. and with John Deere dealerships in ND and MN.

Mr. Solseng represents the department on the NDUS Post Secondary Articulation Committee which involves agricultural programs at NDSU and other NDUS schools.

4. International Activities

All faculty frequently respond (by telephone, correspondence, or by e-mail) to requests for information from foreign countries. Collaborations by Dr. Panigrahi are also ongoing with partners in Thailand and Europe. Several faculty have participated on extension programs in Canada. Professor Hofman serves as an advisor to the Program Planning Board for the Zero Till Association for ND-Manitoba.

5. Economic Development Efforts

Faculty programs are contributing to economic development by developing and extending knowledge and technology that advances the productivity of agricultural production, enhances the processing and utilization of agricultural products, and/or promotes the sustainable use or management of environmental resources. Activities in production agriculture (precision farming, agri-chemical application, post-harvest handling/storage and quality maintenance, irrigation systems management) are providing information to help producers improve efficiencies and/or reduce costs of production and to produce high quality products. Activities in agricultural product utilization (sensors/bio-information, processing technology, storage/handling and new use technology) are contributing to entrepreneurial activity (in alternative crops and oil seeds processing) and to improved processing efficiency or product quality in ND processing facilities (i.e., processing or handling of potatoes, beans, crambe, flax, sunflower). Activities in environmental resources management are contributing to improved management of irrigation systems for high value crop production and the use of BMP's for a more environmentally friendly production agriculture.

Department extension programs are helping people gain knowledge of GIS-GPS technology for improved management of their agricultural production operations. Livestock waste management information is assisting producers to achieve cost-effective waste management compliance with environmental regulations. Department faculty have assisted the North Dakota Irrigation Caucus in updating its statewide strategic plan for irrigation development. Department faculty are cooperating with other departments and

industry in developing improved spray technology/management methods. Applied site-specific research/demonstration is identifying conditions for cost-effective variable rate application of agri-chemicals. Assessment-based management methods (including GIS applications) are being developed for improved water resource protection from pesticides and from nitrogen fertilizer leaching. Improved storage environments are being studied for quality maintenance of pinto beans.

6. Assessment

Assessments of ABEN program educational objectives and outcomes reflect ABET EC-2000 criteria for engineering program accreditation. These criteria have also guided the department faculty in their definition and selection of methods and processes for learning outcomes assessment. Faculty panels apply rubrics for assessment of capstone design-project reports and for assessment of student communication skills. Assessment data are also obtained from senior exit interviews, from alumni and employer surveys, and from course/instruction evaluations.

Assessment of ASM program educational objectives and outcomes is focused also on evaluations of student performance in the senior capstone course. Faculty panels apply rubric-based methods to evaluate problem solving abilities, application of curricular learning, and communication skills.

II. College/Unit Planning Functions/Activities/Accomplishments

A. Future Challenges, Program Strengths, Plans

The department views the following challenges as keys to its future, i.e.:

- a. department head selection
- b. faculty vitality
- c. strong student numbers
- d. strong external funding
- e. modern facilities and equipment
- f. relevant/productive programs
- g. supportive constituencies

Department strengths in its academic programs are:

- a. enrollments that equal/exceed those of other Agricultural/Biosystems Engineering departments in the region
- b. excellent placement of graduates at salaries ranging from \$36,000 to \$57,000 in the ABEN major and \$30,000 to \$47,000 in the ASM major
- c. accreditation of the ABEN program by ABET, and approval/recognition of the ASM program by ASAE.
- d. partnership and support by industry
- e. continuous faculty efforts in curriculum strengthening activities, i.e., course revisions/updates, new course development, development of students' problem solving and communication skills, use of current technology in teaching, and curriculum update.
- f. faculty commitment to student advising, career planning, and placement of graduates
- g. strong faculty commitment to development activities that benefit their teaching programs.

Program strengths in research/extension are in:

- a. Crop production systems
 - irrigation systems/management
 - agri-chemical application, crop protection
 - post harvest quality
 - precision/site-specific management and sensing technology
 - environment protection
 - agricultural safety
- b. Livestock production systems
 - waste management/utilization
 - housing/environment
- c. Value-added processing and new uses
 - oilseeds processing, new uses
 - alternative crops processing/uses
 - sensing/intelligent systems for improved processing and marketing

The department's planning is focused on an *annual updating of objectives* per its ongoing goals as outlined at the beginning of this report. These are based on maintaining

awareness of needs, opportunities, and trends. Awareness is based considerably on benchmarking (internal and external to NDSU), use of surveys, and by discussions with faculty and others.

The department's current planning is summarized as follows.

Department Vision: To be an informed and growth oriented department creating and extending new knowledge in the application of engineering and technology to agricultural, food, and environmental systems through teamwork and collaborations that result in high quality career opportunities for departmental graduates, continuous faculty/staff development, and enhanced economic opportunity, productivity, and quality of life for ND citizens.

Department Mission: To develop and extend knowledge through research, teaching and extension programs in engineering and technology that advances the productivity of agricultural production, the utilization and processing of agricultural commodities and products, and the sustainability of environmental resources management.

Goal 1) To provide high quality undergraduate and graduate education in Agricultural and Biosystems Engineering and in Agricultural Systems Management.

Objectives

- a. *Improve facilities for teaching high quality courses*
 - i. *Lab 222-Computer hardware/software - computer upgrades, software upgrades (AutoCAD, ProE, Microsoft Office, ANSYS - FEA, ProMechanica, GIS-ArcInfo, Surfer, TK-Solver), server-based software*
 - ii. *Classroom technology - seek ITS support to add full instrumentation to room 208*
 - iii. *Laboratory teaching equipment; lab 123- added hydraulics equip., computer software for CAT engine, JD planter units/modules; lab 210C –add oscilloscope, replace meters, add data logging units; lab 127B– improve biomaterials properties instruments; lab 124–update machine tools*
 - iv. *Industry equipment support – Bobcat, CNH, CAT, John Deere*
 - (1) *Seek support for classroom that is instrumented for distance education– exchange courses with NE, SD, TX*
- b. *Promote faculty development activities in:*
 - i. *Attending appropriate conferences, workshops, continuing ed opportunities*
 - ii. *Teaching pedagogy (dept faculty seminars, workshops, cont. ed. peer teams)*
 - iii. *Teaching technology (web-based applications/methods/materials/course, use of CD-based materials, Blackboard, distance education)*
 - iv. *Bioscience knowledge improvement--workshops, use of videos, CD's, guest lecturers, auditing of university courses*

c. *Curriculum review/strengthening activities*

i. **ABEN**

- (1) *Offer students more business/communications course opportunities in the ABEN curriculum*
- (2) *Re-evaluate Biomaterials and Environmental Systems emphasis electives*
- (3) *Develop “recommended” curricular checksheets for emphases in Machine Systems Engineering, Environmental Engineering, Food Engineering, Biomedical Engineering*
- (4) *Offer new elective course in biorenewable resources engineering*
- (5) *Promote biology for engineers course – a potential CEA course*
- (6) *Promote collaborations in bioengineering*
- (7) *Promote active learning methods (PBL, hands-on, group mini-design projects, design and build)*
- (8) *Conduct new alumni survey*
- (9) *Hold advisory board meeting—next steps re: curriculum support*
- (10) *Strengthen bioscience integration with engineering science in ABEN courses*
- (11) *Strengthen student abilities to use computer technology for analysis, design, and communications—ProE, Project Mgt., ANYSIS*
- (12) *Strengthen communication (oral, written, graphic) and leadership skills of students (more oral and written practice; faculty seminars on oral communications, and evaluation)*
- (13) *Investigate teaching collaborations with industry, other ABEN departments, industry adjuncts*

ii. **ASM**

- (1) *Consider a sophomore seminar course – careers focus*
- (2) *Consider new course(s)--Computer Applications II*
- (3) *Consider web/distance delivery of courses--ASM 115, 264, 323*
- (4) *Strengthen communication and leadership skills*
- (5) *Strengthen active/problem based learning skills*
- (6) *Strengthen computer software skills, Microsoft Office, AutoCAD, Precision agr, Business Plan Pro*
- (7) *Strengthen quantitative skills*

d. **Graduate - M.S., Ph.D.**

- i. *Propose ABEN Ph.D. program collaborations with other CEA departments*
- ii. *Increase grad student stipends*
- iii. *Develop/re-develop courses to serve a wider clientele of students*
- iv. *Develop interdisciplinary collaborations in selected areas (environmental/water resources mgt, biomaterials/food processing, sensor/decision support systems, bioenvironmental control)*
- v. *Investigate feasibility of having “outstanding” undergraduate students take a “dual” track program (beginning in Junior yr) towards both completion of their B.S. program and an M.S. by the end of one additional academic year.*

Goal 2) To attract and retain quality students (undergraduate and graduate) to build/maintain enrollments.

Objectives

- a. *Maintain/revise informational brochures, displays, presentations, homepage, and related materials*
- b. *Increase emphasis on recruitment including non-traditional students; females, urban, and minority (visit more urban high schools in '03-'04)*
- c. *Develop/expand placement opportunities for graduates with non-traditional employers (visit potential employers)*
- d. *Increase scholarship funding*
- e. *Increase grant funded support and recruitment of graduate students*
- f. *Benchmark programs showing high success in retention of women and urban students in ABEN*

Goal 3) To maintain/build scholarly activities that extend the knowledge base for:
a. enhancing agri-production efficiency, profitability and/or sustainability, b. maintaining quality and/or adding value to North Dakota's agricultural products, and c. developing efficient use and stewardship of North Dakota's soil and water resources.

Objectives:

- a. *Promote active development programs/plans by all faculty*
- b. *Conduct comprehensive annual performance reviews and annually review/set faculty goals/action plans*
- c. *Seek and participate in interdisciplinary, interdepartmental collaborations*
- d. *Emphasize external funding activity by all faculty*
- e. *Improve support staffing (graduate students, postdoctoral)*
- f. *Strengthen department's programming by seeking a new faculty position with expertise in biomaterials processing with expertise in areas such as biomaterials science, biochemical engineering, food engineering, and bioprocessing*
 - i. *research focused in separation, conversion, and processing of agricultural commodities into value-added products, chemicals, fuels, and specialty bioproducts, and to develop innovative processing technologies for ND commodities*
- g. *Strengthen department's programming by seeking a new faculty position with expertise in advanced crop production technology, sensors and controls, and precision technology*
 - i. *research focused in specialty-crop machinery systems, optimized pest management systems, sensing/precision technology, and decision support systems*
- h. *Strengthen department's programming by seeking a new faculty position with expertise in animal systems engineering, bioenergetics and bioenvironmental engineering*

- i. *research focused on science and engineering to enhance animal productivity, well being, waste utilization, and worker health through proper design and management of animal facilities and their environments.*

Goal 4) To provide extension and outreach education focused on: a. agri-production systems (precision agr., agri-chemical applic., ag. structures/waste mgt), b. post-harvest engineering (storage, drying, quality maintenance, processing), c. water resources management (irrigation systems, water quality–GIS based assessment and resource mgt), and d. agricultural safety.

Objectives

- a. *Promote extension programming via interdisciplinary collaborations, web-based delivery resources, distance education technology, and partnering with extension colleagues in the region, and industry/agribusiness.*
- b. *Promote applied research, grantsmanship, impact assessment/evaluation techniques,*
- c. *Utilize clientele, advisory groups, and other interactions to guide changes/improvements in extension/outreach programming.*
- d. *Promote continuing integration of department faculty activities*

Goal 5) To achieve/ maintain effective constituent relationships.

Objectives

- a. *Promote faculty interactions with students*
- b. *Publish department newsletters (at least annually)*
- c. *Conduct alumni surveys (at 5 year intervals)*
- d. *Hold annual meeting with department advisory committee*
- e. *Invite periodic visits by NDSU administration to department*
- f. *Promote faculty visits/interactions with industry*

B. Vision--where do we want to be as a department in 5-10 years

1. Research/Extension Programs

a. Focus Areas in Agri-production Systems Engineering

(1) crop production

- a. *irrigation systems–water and environmental/pollution mgt for high value crops*
- b. *crop protection – agri-chemical effectiveness, alternative technology*
- c. *post harvest technology – IP storage and quality mgt. for conventional and designer crops*
- d. *precision/site specific technology, geospatial tools, decision support*

- (2) *livestock production*
 - a. *production facilities–cost and environmental mgt.*
 - b. *waste utilization and new uses*
 - c. *precision technology*
 - b. *Focus Areas in Agri-processing Systems Engineering*
 - (1) *oil seeds technology*
 - (2) *biofiber processing, new uses*
 - (3) *bioprocessing*
 - c. *Focus Areas in Bioenvironmental Engineering*
 - (1) *BMP’s, optimized management–irrigated environments*
 - (2) *GIS-- modeling, and remote sensing applications*
 - (3) *watershed management*
- 2. *New/Replacement Faculty–see needed new positions outlined above*
 - a. *Fill department head position*
- 3. *Facilities Development*
 - a. *Building/Laboratory remodeling*
 - b. *New building*
- 4. *Student Goals*
 - a. *100 or more students in ABEN*
 - b. *70 or more students in ASM*
 - c. *15 or more graduate students*
- 5. *External Support Goals*
 - a. *\$100K per research/extension FTE*
 - b. *Industry collaborations/partnerships*
 - c. *Scholarship support for entering freshman*

C. ABEN Priorities 2004

- 1. *Academic programs*
 - a. *Student recruitment*
 - b. *Retired faculty replacement*
 - c. *Seek further ITS support for instrumented classrooms*
 - d. *Facilities/laboratory improvements*
 - e. *ASM curriculum review and improvements*
 - f. *ASM–Dealership Management Option enrollment/placement*
 - g. *ABEN curriculum/course improvements*
- 2. *Research programs*
 - a. *Encourage faculty grantsmanship*

- b. *Develop collaborations with Value-Added Agricultural Processing Center*
 - c. *Seek support for biomaterials engineering/biomaterials science faculty position*
 - i. *Broaden research in agri-processing*
 - d. *Strengthen research in precision technology for agri-production and processing*
 - e. *Strengthen research in post harvest technology for alternative crops*
 - f. *Maintain technical support for irrigation research*
 - g. *Add technical support in precision technology*
3. *Extension programs*
- a. *Encourage grant-based support of extension activity*
 - b. *Encourage applied research components in support of extension activity*
 - c. *Promote continuing development of department's extension capabilities in GIS applications to agricultural production and natural resources management*
 - d. *Foster GIS applications to ag production and natural resources management*

D. Department's Strategic Priorities

- 1. *New faculty hires/replacements*
 - a. *Department Head*
 - b. *Biomaterials engineering/ processing and new uses emphasis*
 - c. *Advanced crop production systems, sensing and precision technologies*
 - d. *Livestock systems engineering and bioenvironment*
- 2. *Diversification of student clientele*
 - a. *Strengthened curricular emphasis areas in*
 - i. *biological systems*
 - ii. *biomaterials systems*
 - iii. *environmental systems*
 - b. *Women, urban recruitment emphasis*
 - c. *Diversified placement opportunities*
- 3. *Facilities improvements*
 - a. *New building*

E. Use of Assessment Data in Decision Making

Methods of conducting assessments and collecting data were described in section I.D.6. Data analysis and associated faculty discussions have resulted in continuing emphasis on communication activities in most courses. Attention is also being given to development of team skills, leadership, and problem solving skills. Engineering students are also being introduced to engineering design methods earlier, and are given more open-ended or less structured laboratory learning assignments.

F. Student FTE's for Academic Year 2002-2003

Agricultural and Biosystems Engineering (ABEN)

Student Credit Hours 807

FTE 1.80

Agricultural Systems Management (ASM)

Student Credit Hours 849

FTE 1.34

Totals SCH 1656

FTE 3.14