

Soil Science and Pedology Disciplines in the North Dakota 1862 Land Grant College of Agriculture: A Review

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ABSTRACT

Soil science as a discipline has been an integral part of the North Dakota Agricultural Experiment Station (NDAES) over its entire existence. Both locally and nationally, the relatively high prominence held by the Land Grant Colleges of Agriculture, Agricultural Experiment Stations, and Departments of Soil Science has declined. The historic mission of Soil Science within NDAES includes study of soil fertility, chemistry, management, physics, genesis (pedology), and agricultural climatology. Accomplishments in these areas through many years have had tremendous economic impact on North Dakota. Additionally, Soil Science's efforts have periodically filled emerging needs such as research into reclamation of coal mined land and environmental impacts of anticipated irrigation development, among others. A strength of the Department has been to skillfully complete these ad hoc tasks and move on to new missions. The present need for the Department to chart a continuing strong role is a challenge for the faculty and staff because position numbers have declined and funding sources have shifted. However, the functional base of the Department is strong, as reflected by multiple individuals in the department receiving College awards for their outstanding current work. A thoughtful and substantial restructuring of our Long Range Plan and consideration of an external review process for the plan is suggested. Care should be taken that new planning be broad-based within the Department. The Department should maintain its disciplinary core while forging new and strengthened links to appropriate multidisciplinary efforts.

When the Land Grant college of agriculture (LGCA) system was created by the 1862 Morrill Act

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there was no State of North Dakota and there was no discipline of either soil science or pedology. Dokuchaev's description of the Russian Chernozem in 1883, the birth of pedology, preceded North Dakota statehood (1889) and the founding of North Dakota's agricultural college (1890) by only a few years. Yet North Dakotan's appreciation of soil is deep seated, as evidenced by the coat of arms of North Dakota bearing the motto "Strength from the Soil."

The North Dakota Agricultural College (AC) included soil as part of the subject matter of its agricultural courses from its founding in 1890. The first course name to specifically relate to soils was 'soil physics' listed in the 1899-1900 catalog. The first reported response of wheat yield to commercial fertilizer in North Dakota was in 1903 by Schollander (Bauer et al., 1966). A 'soils emphasis' became an option for a degree in the Department of Agronomy in 1925 or 1926. Charles Kellogg brought one of the first pedology courses taught in the United States to the AC in 1932 (Simonson, 1997). Kellogg was on the faculty from 1930 to 1933 and left to become Chief, Division of Soil Survey, Bureau of Chemistry and Soils, USDA. There he produced the first edition (Kellogg, 1937) of the American Soil Survey Manual (Thompson, 1992, p 43). In 1950 the 'Soils Train' of six cars toured North Dakota with a variety of soils-related displays, including soil monoliths (Vasey, 2004). Soil Science became an independent department in 1959 and the AC became North Dakota State University (NDSU) in December, 1960. By the mid-1960s NDSU was producing a steady stream of advanced as well as baccalaureate degrees in soils. In 1974 Soil Science became home to the office of the North Dakota State Climatologist. The Land Reclamation Research Center (LRRC) was part of the Department in the 1980s.

Abbreviations: AC, North Dakota Agricultural College; CAFSNR, College of Agriculture, Food Systems, and Natural Resources; COA, college of agriculture; CSRS, Cooperative State Research Service; IFAFS, Initiative for Future Agriculture and Food Systems; IJC, International Joint Commission; LGCA, Land Grant college of agriculture; LRRC, Land Reclamation Research Center; NDAES, North Dakota Agricultural Experiment Station; NDFR, North Dakota Farm Research Bimonthly Bulletin; NRI, National Research Initiative; SBARE, State Board for Agriculture Research and Education.

Today the prevailing trend of soil science as a discipline is widely perceived to be retrenchment. A recent panel discussion announcement by the Soil Science Society of America (SSSA, 2002) said, "While traditional agronomy departments are being disbanded as universities and colleges reorganize, soil science is disappearing from view. Some questions to be considered are: What is soil science and what is/are its scope(s): field and/or laboratory science, pure and/or applied science, agricultural and/or environmental science - alone or in combination?" The announcement seems to tell us that soil science is more ambivalent about the future than is generally the case for other disciplines within LGCA system. Meanwhile, the LGCA system is itself embroiled in pressures for change (National Research Council, 1996).

The objective of this paper is to set the background against which the NDSU Department of Soil Science must prepare for the future and to provide some analysis of potential Departmental initiatives. The initiatives considered comprise a few basic ideas which can be further developed through continuing dialogue with interested parties. We attempt here to accurately characterize our constraints, our duties, and our aspirations in a manner consistent with the land grant philosophy of providing higher education and service to citizens of ordinary means

RECENT HISTORY

Despite their demonstrated role in ensuring a plentiful domestic food supply, the LGCAs today face unease (Meyer, 1993). This is not new. Significant reductions in student enrollments in the 1950s led to creation of new associated disciplines but decreased emphasis on production agriculture. In the 1960s changes continued with the addition of environmental and natural resources programs and with a steady flow of name changes. A broader mission of safeguarding the earth's systems which undergird food, fiber, and natural resources is now evolving (Meyer, 1998). Most who are associated with the LGCAs are aware of numerous reform efforts and studies coming forth in recent years. A few examples of these are: Meyer (1992, 1995, 1997, 1998), National Research Council (1996), and Fischer and Zuiches (1994). A highly visible effect has been the changing of names and associated mission redefinition for the LGCAs. At NDSU the former College of Agriculture (COA) is now called the College of Agriculture, Food Systems, and Natural Resources (CAFSNR). Despite the changes, the view that the LGCAs have turned away from

their mission and are headed for longer-term trouble has currently been expressed (Fribourg, 2004).

At NDSU the trends may be muted compared to elsewhere, but are still evident. Enrollments in the NDSU COA (now CAFSNR) increased from 600 at the beginning of the 1990s to about 1000 in the late 1990s and have held about steady at that level. In 1980 COA enrollment was about 800, or 900 depending on majors included. The overall picture is, therefore, that COA enrollments have not changed a lot over the last 20 years.

With respect to enrollments Nationwide in undergraduate soil science curricula, Collins et al. (2002) compiled 10-year undergraduate enrollment data for the "soil science" major at numerous LGCAs distributed across the country. Numerous schools had names not exclusive to soil science (e.g. agronomy/soils) or changed the name during the period. However the data is exemplified by the enrollments at UC-Davis, University of Florida, University of Nebraska, and Washington State University. In the aggregate, these schools had 74 soil science graduates at the peak of the early 90s and 16 in 2001. At Ohio State University (Eckert, 2004) students studying undergraduate soils have gone from about 50 in 1994 to less than five currently. Soil Science at NDSU is in a very similar situation. Undergraduate soils enrollment in the mid-90s was about 15 and recently has fluctuated near five. Incidentally, plant science enrollments at the same times were about 115 and 120 (NDSU 2002/2003 Program Review).

BASIC MISSION

The North Dakota Agricultural Experiment Station (NDAES) has changed much over its existence of more than a century. According to Danbom (1990), however, NDAES's purpose and the value system of its scientists have changed little. The NDAES has primarily sought greater economic security for farmers and the state. Its scientists have exhibited belief in human possibility and progress, devotion to service, and integrity, unafraid to tell North Dakota the truth, even though it has sometimes been unpleasant.

By far the single most recognized contribution of NDAES to agricultural research has been in plant breeding (Danbom, 1990, p 128). Considering the serious problems with wheat rust and other diseases which NDAES breeders have helped to overcome, this is not surprising. Important contributions by soil science and other disciplines are less well known. Here we will unabashedly describe how soil scientists have contributed to promoting North

Dakota's interests. These have been considerable despite the sparing mention of soil science in Danbom's (1990) overall historic account of the NDAES.

Several general areas of work have been central to the Soil Science mission. The soil testing and soil fertility programs have gone hand-in-hand in the task of maintaining soil fertility and increasing yields. Integrated management techniques improved water use efficiency as well as fertilizer use efficiency. Examples of the preceding include work on reduced tillage systems and on air-seeding of small grains. Inventorying and understanding our state's soil resource has been enhanced through soil surveys at several scales. Successful introduction of new crops, another enduring activity of NDAES, inherently requires adequate evaluation of soil fertility considerations. Evaluations of other management techniques, such as snow harvesting and moisture-conserving tillage, have long benefited producers in important ways. The climatology of North Dakota in relationship to its agriculture has been a long-term subject of study. Physical relations of soils are important for both crop production and resource conservation, through prevention of soil erosion, for example.

The soil testing laboratory at NDSU was established as a distinct entity in 1951 and began processing farmer samples in 1952 (Vasey, 2004). Commercial fertilizer distribution in North Dakota was very limited before the late 1940s but expanded greatly during the following decades. Relatively early work on nitrogen (N) fertilization of hard red spring wheat was done at NDSU by Vasey (1957), who later led extension programs promoting N fertilization of wheat in North Dakota. Coordination of soil test recommendations by NDSU, South Dakota State University and the University of Minnesota is unique in the US.

One way to get a feel for the relative contributions of Soil Science to NDAES efforts is to catalog a sample of research published in the North Dakota Farm Research Bimonthly Bulletin (NDFR). The sample was 12 issues of NDFR from 1967 through 1971. These were not selected dates or issues. They were simply taken as a grab sample from the shelf. Ten of the 12 bulletins had soils articles in them. There were a total of 24 soils articles. At about eight articles per issue this places soils as representing about 25% of NDAES research. While this number is subject to a large uncertainty, it does underline the role of soils as one of the absolute grounding points of NDAES research.

From the articles in the grab sample two are quite pertinent in illustrating the expanding importance of

fertilizers to North Dakota agriculture starting in the middle of the 20th century. First, Schaffner (1967) chronicled the rise in tonnage of fertilizer sales in North Dakota for 15 years from 1951 to 1965. During that period the trend of use was sharply upward throughout, expanding from a base of 17,017 tons in 1951 to 233,726 tons in 1965, a 13.7-fold increase. Still only barely more than 50% of wheat acres were fertilized. Research on fertilizers and promotion of the economic impact by extension certainly must have caused and to a degree enhanced this historic trend. Second, Cassel et al. (1973) analyzed nutrient additions and removals from North Dakota soils. The results showed that from 1945 to 1970 the proportion of phosphorous (P) removed in harvested crops to that added through use of commercial fertilizers jumped from near zero to around 80%. Nitrogen added in commercial fertilizers, of course, showed the same sharp increase as reported by Schaffner six years earlier and also a continuing rise for the intervening years. Still, the fraction of N replaced yearly at the end of the time covered by the study, 1970, stood at only about 20%.

More recently, the knowledge of NDSU pedologists about the soils and hydrology of wetlands has been beneficial for North Dakota (Richardson, 2004). The Swamp Buster provisions of the 1985 farm bill presented some real problems during implementation in North Dakota and adjoining states. However, work started earlier at NDSU provided hydrology models and wetland delineation procedures which have proven to work clearly and consistently in our region. Three soil scientists trained at NDSU were involved in a landmark Federal Court case on this issue.

ADJUNCT MISSIONS SUPPORTED BY SOIL SCIENCE

Over the years the Soil Science faculty at NDSU has initiated and supported several ad hoc or adjunct activities which proved important for North Dakota at specific time periods. Cooperation with the out state research stations and extension centers has of course been continuous, often involving research plots at those sites. Here, however, we particularly refer to some special situations that have arisen and to which NDSU soil scientists have responded with special programs as follows: First, a substantial body of research has been conducted on mined land spoils and reclamation of land disturbed by surface mining for coal. These efforts were initially conducted by Soil Science Department personnel located at Mandan. They later became the initial

staff of the LRRC. Second, the Department for a considerable period of time maintained an active and much larger support function for the US Cooperative Soil Survey than is currently the case. Third, special irrigation research was undertaken in support of the State interest in developing irrigation via the Garrison Diversion Project. Finally, two examples will be given of other ad hoc work.

Land reclamation research was funded first in 1974 by the Old West Regional Commission. The initial grant identified specific research to be conducted on mined land spoils and was conducted by Soil Science Department personnel located at Mandan. Several employees were added over the years and in 1981 the LRRC was established. Personnel at Mandan were transferred to the LRRC and became adjunct to the Soil Science Department. The purpose of the LRRC was to continue to research and develop methods to successfully reclaim land influenced by surface coal mining. Some of this activity was mandated because of State and Federal laws pertaining to surface mining. The LRRC was disbanded in 1996. The knowledge base created by the reclamation research done in North Dakota continues to serve the State today as mined land is converted to post-mining use.

Staff from AC was involved in Soil Survey from 1902 onward, beginning with the survey in Grand Forks County (Thompson, 1992). North Dakota was one of the first states to use soil survey as a basis for property tax assessment (Thompson, 1992). Although ultimately well-accepted, this approach generated some controversy at its inception.

The support functions provided by NDSU professors to the soil survey effort over many years helped insure the quality of the work and the usefulness of resulting surveys for State use. Their studies of ND soils, supported by laboratory analyses, answered questions which arose during active mapping and improved the understanding of the soil resources of our State. Portions of the published soil surveys of North Dakota were written by Soil Science faculty, for instance Patterson (1981). Local governments were assisted in efforts to evaluate farmland for tax purposes using economic productivity as rated from soil survey information. Service to the State Water Commission was provided to help develop irrigation guide categories. The Irrigation Task Force was also supported by NDSU pedologists. In addition, Soil Science representatives participated in field review of SCS soil surveys as they progressed and were completed (for example, see 1981 Soil Science annual report). Largely due to NDSU-NDAES efforts, North Dakota was the first state to complete general soil maps for all counties

and to publish a state soil map (Sweeney, 2004). Detailed soil surveys of organized irrigation districts were completed and incorporated with SCS county soil survey reports (Hopkins and Sweeney, 1987).

The Department today maintains a small but critical cooperative effort related to soil survey. The effort has shifted to a more interpretive focus with relatively low activity currently at the Federal level in North Dakota. The interpretive effort usually encompasses our research focus in the pedology area, such as the wetland genesis (hydropedologic) effort. In addition, Federal National Resources Conservation Service (NRCS) soil scientists are housed with the Department, which has only occurred over about the last 10 years, enhancing cooperation between NDSU and the NRCS. The department continues to provide soil-irrigation water compatibility determinations for North Dakota irrigators.

During the years when irrigation was a substantial goal of the Garrison Diversion Project the department was researching a broad range of issues resulting from the proposed project. Specialists in pedology assessed irrigability of lands with potential for development under the project. The influence of irrigation on agricultural production on soils typical of the irrigable lands was extensively researched. Environmental consequences of the project became a controversial stumbling block and soil science researchers addressed those concerns with research spanning more than 15 years.

Increased productivity by irrigation of sandy soils was documented through extensive plot research at Oakes and Carrington. Dr. J.C. Zubriski headed up research at Oakes which documented production increases when corn was irrigated. His studies spanned 1974 to 1983 and involved evaluation of N fertilization with different levels of irrigation. Zubriski found corn yields increased from about 20 bushels per acre with no irrigation to 175 with optimum irrigation and soil fertility (Oakes Irrigation Field Trials Annual Reports, 1974-1983). This is just one example of production research related to irrigation.

The environmental research included studies on the fate and transport of N fertilizers and pesticides. Nitrate contamination of waters flowing to Canada was a major concern of the International Joint Commission (IJC, 1976). This concern subsequently resulted in funding through the US Bureau of Reclamation of lysimeter and other research at Oakes to address the question of nitrate pollution of irrigation return flow water, as recommended by the IJC (1976) in their report. Resulting research indicated that subsurface irrigation return flow nitrate N concentrations as measured by lysimeters were

lower (Prunty and Montgomery, 1991) than some of the levels feared in the IJC report of 1976. Other research found that a wetland near Oakes, ND removed substantial nitrate-N from irrigation-return-flow water. Over a four-year period 9140 kg nitrate-N entered the marsh in return flow while only 990 kg left (Moraghan, 1994). Field N-balance studies were also conducted in the marsh (Moraghan, 1993).

The Department recently assisted the North Dakota State Health Department in developing sodium standards for land application of high-sodium agricultural processing wastes. Criteria for potential nitrate contamination and a P index for North Dakota soils were developed in response to USDA-CSRS and EPA needs.

SOURCES OF RESEARCH SUPPORT

The source of dollars to buy research equipment, supplies, and labor has shifted dramatically over recent years. Substantial support for each scientist formerly came through the NDAES. Now most funding comes through grants from diverse sources. Last year funding in Soil Science came from: National Science Foundation, USDA IFAFS program, USDA-NRI, Garrison Diversion Conservancy District, North Central Regional Canola Research Program, North Dakota Soybean Council, SBARE, Red River Basin Institute, US Department of Energy, and others.

An exhaustive listing and analysis of funding sources would be burdensome to include here. However, one, the fertilizer checkoff idea, is further considered below. It would have the advantage of relative long-term stability and centrality to an important part of our mission.

POTENTIAL SUPPORT FROM A FERTILIZER CHECKOFF

Efforts in other states to support crop production research through a checkoff tax on the sale of fertilizers have had some success. Such funds replace to some extent those formerly available from the Tennessee Valley Authority fertilizer test program, but it ended in the 1980s and fertilizer industry support dwindled thereafter. The soil test laboratory has also lost state support of its soil test calibration program. Thus, it is difficult to conduct necessary field research with fertilizers in North Dakota.

In North Dakota legislative provision for a fertilizer checkoff was discussed and a bill introduced in the 55th legislative assembly (1997),

but was unsuccessful. It was estimated (Brun, 1995) that farmers can obtain two to three dollars in return for every dollar spent on fertilizer. With \$140 million in North Dakota annual fertilizer sales the difference between \$2 and \$3 return is also \$140 million. The question should be if a research expenditure of \$250 or \$500 thousand per year can provide information allowing better optimization of the return. Capturing 5% of the \$140 million swing attributable to insufficiently defined optimum economic fertilizer rates would provide a 15- to 30-fold return on such a research expenditure.

In other states, where this approach has been enacted into law, new initiatives in production agriculture research have resulted. States where a checkoff program of one type or another are in place and have resulted in funding of fertilizer research include Arkansas, Illinois, Minnesota, Texas, Montana, Kansas, North Carolina, Utah, and Oklahoma. Some states use a fertilizer checkoff and in other states checkoffs on specific crops such as soybeans or wheat support fertilizer as well as other types of research.

EVALUATING AND CHARTING A COURSE OF ACTION

Many alternatives have been offered on how to alter the perceived trend of the soil science discipline toward low visibility, obscurity, or worse. Some dominant themes appear to have emerged. One is an increased focus on environmental issues. Another is to promote increased awareness among students coming from non-agricultural backgrounds. Broadening the base of the SSSA beyond the traditional academic core has been mentioned. Consultants, for example, would be one such group. In academic settings, alignment with renewable or natural resources programs has gained attention. The National Academy of Science has established a 'National Committee for Soil Science - National Research Council' charged with studying the undergraduate enrollment situation. At the LGCA level there have been somewhat similar but not exactly parallel concerns. The literature at the LGCA level is fairly abundant (Fisher and Zuiches, 1994; Meyer, 1992; National Research Council, 1996). In setting our priorities, NDSU Soil Science needs to integrate the following factors.

Previous Assessments

Formal reviews of Soil Science were most recently conducted in 1975, 1984, 1989, and 1997.

The 1975 effort was by an internal task force formed by Dean and Director A.G. Hazen. The remaining reviews were under auspices of the Cooperative State Research, Education, and Extension Service (CSREES) or its predecessor, CSRS. Here we will summarize results only of the two most recent reviews.

The overarching 1989 CSRS review recommendation to administration was to "Organize and activate immediately a Long-Range Planning Committee in the Department of Soil Science..." along with presentation of this plan to College Administration and subsequent promotion of the plan by them. Specific recommendations were made in each area of effort within the department. Several of these recommendations were for increased staff and equipment.

In their report on the 1997 review, the review team stated that many concerns had been addressed in the 1994 Long Range Plan but that remedies needed to be pursued via strategic planning. The review team overview of most of the specialty areas within the department was favorable, with two of four areas being cited for good progress in implementing the recommendations from the 1989 review team. On the other hand, the overall summary and closing statement included alarming statements about the need to improve both undergraduate and graduate enrollment. The curriculum also needed updating, according to the review. The remaining summary and closing statements were quite favorable.

The past reviews can be used to stimulate our thinking about the current situation. Perhaps our current faculty should convene and thoroughly analyze these past reviews as part of our search for the current best path by which we may serve North Dakota as an integral part of that same effort within NDAES. A thorough analysis and updating of the Long Range Plan would logically serve as a part of this effort. Analysis of the present status, future potential, and justification basis of each professional position within the department needs to identify how these assets support the overall research mission. Possibly a review by CSREES should again be requested and the request contain specific items to be independently evaluated as departmental initiatives.

Organizational Realignment

Many departments have been combined with others, split off, or split up at NDSU within the last 20 years. Soil Science has not been one of these. There are reasons to approach reorganization that would eliminate soil science as a unified discipline

with a good deal of caution. Wide discussion and agreement on goals that can be accomplished within facilities available preceding reorganization has been found necessary for success (Kellogg and Knapp, 1966, p 74). Institutes or centers can develop funding initiatives for programmatic research by multidisciplinary teams cutting across department and college lines (Fischer and Zuiches, 1994). Then departments remain as groups of peers. "Few consolidated college departments containing unlike disciplines have been highly successful for very long," according to Kellogg and Knapp (1966, p 74). While there are several departments and disciplines in NDAES which have, should, and can usefully interact with soil science, we are quite different from most of them.

Applied Versus Basic Research

The extent to which research at the NDAES has been of a practical nature has been in flux throughout its history. Yet, as Danbom (1990) points out, the state can count on the commitment to service at the NDAES. In 1987 Roald Lund said, "All of the technical expertise in the world can't compensate for a commitment to service. The people in the state tell us how they want us to serve them and we do it." This means neither that basic research is to be shunned nor that we always follow the popular line of thought in our state. Basic research serves North Dakota partly by intertwining us with the thinking of the greater scientific world and thereby attracting new ideas and talented scientists. The scientific knowledge which we possess permits us in some cases to discriminate between what is popularly sought and what is important. We must give serious attention to how we structure our efforts so that we not only continue to serve our state but also do so to the best of our ability. This includes a deliberate presence in the basic research arena.

Research Approach

One type of change that has been suggested for soil science research fundamentally changes the approach to the science. Nielsen (1987) proposed six frontiers of soil science which could emerge based on developing and utilizing the intellectual framework of regionalized variable analysis. The six are 1) stochastic analysis, 2) derivation of scaling factors, 3) transfer functions, 4) statistical analysis not utilizing the assumptions of spatial and temporal independence, 5) analysis of multiple land units for managing regional soil and water resources, and 6)

broadening of the educational base and scope. Nielsen's approach has elements in common with our efforts in the areas of precision agriculture and field-scale chemical transport.

Certainly there are ways other than Nielsen's to shift the research approach and no claim is made that we are aware of even all the most well-structured ideas in this realm. We need to be aware and prepared to alter our thinking. This is the way of progress in science.

An example of a program which is widely admired and held up as an example is the ND-MN sugarbeet extension program. Our department's research on the interaction of sugarbeet canopy greenness and nitrogen carryover to the following small grain crop has been recognized as outstanding work (CSREES, 1997). There is a need for this same type of program to be applied more broadly in the region (Tonneson, 2003).

North Dakota's urban population surpassed its rural population in the 1990 census for the first time, even though the overall population remained fairly constant. The possibility of outreach to the urban dweller should not be ignored.

Mention should be made of some new research directions implemented in recent years. A few of many possible examples follow. One is research into the fate in soil of bioactive chemicals such as hormones (Casey et al., 2004). This is of increasing concern nationally and in North Dakota as livestock feeding operations become more concentrated. Another is precision agriculture wherein detailed information on soil properties at various scales is used to optimize fertilizer use and yield (Franzen et al., 2002). The nutritional value, specifically with respect to iron and zinc, of food crops as influenced by soil conditions and genetics is being investigated (Moraghan et al., 2002). This is important for North Dakota since we are a major food producer. Similarly, the influence of soil on the presence of excess cadmium in our commodities is a concern which we are investigating (Wu et al., 2002). Present research also involves studies on carbon sequestration and storage in North Dakota soils, including observation of sequestration as inorganic carbon (Cihacek and Ulmer, 2002).

An effort which has achieved a high level of importance over a somewhat longer period of time is the North Dakota Agricultural Weather Network (NDAWN) that provides needed data statewide for agricultural production and research use. This network consists of 67 automated weather stations statewide. The NDAWN data serves not only agriculture (Enz and Mahoney, 2002) but also economic development activities in North Dakota

and Minnesota (Fargo-Cass County Economic Development Corporation, for one). Additional climatic data from as early as 1879 is also available for computer retrieval.

Curriculum

The Soil Science Department is currently proposing substantial modification of the set of courses offered. The new selection of courses reduces the number of courses we offer to 13 from 18 while at the same time preserving the essential disciplinary subject matter. The remaining courses will allow an undergraduate student to obtain 15 semester hours in soil science and thereby qualify for USDA NRCS employment as a soil scientist. At the same time, courses traditionally taken by students in other majors will be maintained. The new basic soils course should encourage more students to explore soil science since it will be a 100-level course. It will allow students in various majors who now take a soils course as juniors and seniors to take a basic course earlier. The new curriculum also allows the graduate program to continue with full support of needed courses. The new curriculum focuses on natural resource management (NRM), environmental, and conservation issues and utilizes the teaching resources currently available. Judging from recent trends, students in the NRM program will provide a steady demand for our courses.

Departmental Composition

The department, for planning purposes, has considered itself to have four research areas plus extension responsibilities (Brun, 1997). They are physics and climatology (3), fertility and chemistry (2), Genesis (2), management (2), and extension (2), where the numbers in parentheses are the number of currently occupied faculty positions in the area. Dr. Richardson, current interim chair, is included in genesis. One position, recently vacated by retirement of Dr. Deibert (management), is currently unfunded. The division into the four specific areas is in actuality somewhat artificial since the diversity of responsibilities within each is larger than could be covered by remaining personnel if a position became vacant. The department has been functioning for the last several years at approximately this composition.

Loss of any further positions is viewed by the faculty as endangering maintenance of sufficient mass to continue our mission. Fortunately, financial support is not as critically low, since the faculty generally has to this point secured sufficient funds to

proceed with their desired work. Research funds from grants and awards expended by Soil Science in 2002 were almost \$900,000. This was higher than all but two years since 1987 (Casey, 2004). It is true at the same time that considerable research that would be beneficial for North Dakota is not proceeding because of our constricted condition.

There currently are no personnel at NDSU working in the soil microbiology area. Soil Science has in the past shared a position in microbiology. Lack of a microbiology program has been a long-time and often-mentioned deficiency in the Soil Science Department.

Productivity and Morale

Although declining numbers of our faculty have been clear to all for years, the research output of the Department has remained strong. The proportion of faculty regularly publishing in peer reviewed journals is probably higher now than at most periods in the past. Awards for faculty and staff presented at the February 2004 CAFSNR awards program included two staff and one faculty award to Soil Science personnel. Others within the Department share the commitment to excellent work that was recently recognized in our fellows.

Long Range Plans

Materials prepared for distribution to the 1997 CSREES review team upon their arrival included the September 1994 revision of the Department of Soil Science Long Range Plan, which was first initiated in 1990. This plan contains core vision and mission values which seem still mostly appropriate. It also contains details of research projects and other efforts that are presently out-of-date.

Revision of the Long Range Plan may be appropriate at the current time. The department feels that the position of department chairman, now interim, is key to sustaining a productive direction and focus. The authorized department chair position under which the Department had previously always operated was not continued by the most recent State Assembly. A rotating chair would carry a greater perception of continuity than the interim designation, should it not for some reason be desired or feasible to restore the authorized chair position. A search for a professor to specialize in soil biology or soil fertility and environmental chemistry in the wake of Dr. Deibert's retirement is considered highly desirable. Realizing that these short term actions may not fit with current NDAES budget constraints, we will

work to achieve realistic plans for these positions.

The perception has been evident (Brun, 1997) that Soil Science is a "mature" department. What are the implications of this perception? Some think that those close to potential retirement have reduced interest in or ability to take part in long-range or strategic planning. While some at all stages of life decline to become heavily involved in these activities, a presumption based on chronology is only that. Broad and long-time experience acquired with age as well as youthful energetic searching should have places in guiding our future efforts. We are all on a continuum in this respect. The final report of the 1997 CSREES team may be interpreted to indicate that long-range plans need to evaluate priority areas before retirements occur, not after the fact.

The Long Range Plan needs to be updated to reflect the current realities. It must also provide some flexibility to allow anticipated new hires for several years into the future to express their strengths within the plan. This process of long-range planning must of necessity be interactive with administration. A departmental long-range plan including programs and positions without strategic College and Experiment Station administrative support would have limited value.

CONCLUSIONS

The CSRS review report of 1997 contained what now turns out to be a prophetic statement that, "The Department cannot afford to lose any more positions!" Members of the Soil Science Department understand this statement in its full context. Serving North Dakota in the long tradition of the NDAES and its soil scientists remains a strong motivating factor. At the same time, the current reality is that most support for research operations comes from "out of town" sources (Richardson, 2003), that is, outside much influence directly from North Dakota. Lund (1994) has reminded us that, "While we all believe change should occur for our benefit, rarely is that the case, and we usually must adapt." While Soil Science needs to adapt there are also logical priorities and options as to how to proceed. What we have done here is state some current priorities and options and acknowledge that others not mentioned may be feasible and possibly desirable. Soil Science is committed to a long-term process of adaptively refining our priorities. We have been impacted by changing circumstances and we need to continue to adapt to them.

Constructive internal reexamination of Soil Science programs and direction has recently

accelerated, partly in connection with the question of filling vacant department chair and professor positions. Any changes in our short-to-intermediate-term program direction will substantially depend on actions taken to fill these positions. Herein are proposed some steps toward actively engaging the entire Department in moving forward. One step would be to update and revise the long-range plan. The revision should examine in greater depth the potential changes stated earlier and others which may not yet have emerged but are appropriate. Another would be to seek a targeted CSREES review at an appropriate point in our planning discussions. This could be shortly after the long-range plan is revised. Part of the task assigned to the review team could then be to critique the revised plan. Consideration should also be given to ways to engage state and local participation in such a review.

Currently, a Strategic Planning Committee of the NDAES is working to create a strategic planning document for CAFSNR. This should form a framework that enables all disciplines to contribute effectively and in a timely manner to Station (NDAES) priorities. Soil Science is included in this process and is identifying its specific research activities contributing to the overall station plan. Within Soil Science we believe that the most effective way to execute both the Station plan and our broader long range plan is to maintain our core group in a disciplinary department. Individuals may as needed associate with centers of excellence or institutes outside the department.

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