Review Report of the Undergraduate and Graduate Programs in Soil Science

Colleges of Agriculture and Life Sciences

North Carolina State University

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Review Team

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An external review of the undergraduate and graduate programs in the Department of Soil Science at NC State was conducted on December 2-3, 2010. The reviewers met with the associate deans of the College of Agriculture and Life Sciences, the department head and directors of the programs, students, faculty, and staff, and toured the facilities. The following report is based on information from those meetings and the self-study produced by the program. It consists of strengths of the program and opportunities for improvement and recommendations for improvement.

Strengths

- The department has a history of national and international recognition and, in the opinion of the reviewers, continues to be among the top ten soil science programs in the nation.
- The department seems to have a highly collegial and cooperative environment within and among students, faculty, and staff.
- Undergraduate students are highly complimentary of advising and generally positive regarding their undergraduate experience.
- Graduate students have created a strong community, with an active graduate student association and formal and informal events that create a bond among the students.
- Graduate students rated the mentoring by faculty very high.
- State-supported research assistantships give the department an advantage over similar departments at other universities; having state-supported technicians in the labs to train incoming students is a major benefit to students and faculty.
- Students appreciate the wide array of faculty specializations offered by the department.
- Students report that the faculty are accessible and the general atmosphere in the department is welcoming and supportive.
- The department has made some excellent hires at the assistant professor level in the last several years; these junior faculty members are developing as strong researchers with success in achieving grants.

Opportunities for Improvement and Recommendations

Strategic Planning

The department undertook strategic planning several years ago in the form of a compact plan. That plan proposed, among other things, a series of faculty hires, which has been achieved. The plan is now out of date.

Recommendation: The department should consider producing another strategic plan to guide it over the next 5-10 years. As a part of this discussion, faculty should seek to identify a "brand" for the department, what sets it apart from other departments with a soil science emphasis. One focus of branding would be to extend soil science to include urban as well as agricultural research and teaching. The self-study report and this reviewers’ report may provide a starting point for a new strategic plan. It should identify both input and output measures by which the department can evaluate its success and plan changes to achieve goals.
Undergraduate Education

1. The department has proposed a new undergraduate major, Soils and Land Development, which has been approved on campus but is awaiting final approval by the UNC General Administration. This is, in a way, a risky strategy for the department because history suggests that it will be a struggle to keep enrollment large enough to meet the minimum requirements of UNC GA (the associate dean for academic affairs indicates that this threshold would be about 60-70 majors).

Recommendation: Faculty should design an effective strategy for marketing the program to potential students. One marketing decision is to re-brand the program by reconsidering the title, whose reference to “land management” may be an obstacle to attracting students who may have more of an “environmental” interest. Because students are the primary audience, faculty should consider talking to students about titles they would find more meaningful or attractive. In addition, it is doubtful that targeting high school students will be successful because so few soil science undergraduates enter the program as freshmen. Two more likely audiences are students in community colleges and students on campus in other majors.

A. As for on-campus students, the department has already tried some innovative strategies, including hot dog give-aways and databases of interested students. Faculty could also market the program to students in first-year college by actively recruiting students and offering first-year seminars in soil science. All recruiting strategies should be evaluated for their effectiveness so that the faculty can focus only on what works. A part-time recruiter would be very helpful. Also, reach out to students in other programs that are interested in the program.

B. The community colleges represent another potential audience for recruiting. One approach to recruiting these students is to make a 2 + 2 articulation agreement with several of the top community colleges sending students to CALS. CALS should help with these agreements, but the department would need to take the lead in developing the agreement, determining what courses students would need to take in the colleges, how those courses would transfer here, and what courses they will take in their junior and seniors years. Because N.C. community colleges have unified their courses and course numbers in the last few years, such an agreement for all of them may not be difficult to create. The college already has several articulation agreements, so these could be used as possible models.

2. The Department of Soil Science was at one time notable for its international focus. But today’s students seem not to be considering the possibility of international or cross-cultural study as a part of their educational experience in soil science. In today’s globalized environment, this lack of experience could place them at a considerable disadvantage relative to peer institutions.

Recommendation: The department should encourage an international experience for students. They could look to models of programs already existing on campus, such as the Department of Forestry and Environmental Resources, as well as
programs in soil and/or environmental science programs at peer institutions. Indeed, it may be possible for some soil science students to join a trip organized by other departments. There are other options. A faculty member in soil science could develop a 3-week short course overseas. Students could also join a service project related to soil science or do an internship with an NGO or company with a soils emphasis. There is also the possibility for a semester abroad, but faculty need to identify appropriate international institutions and work to be sure courses are transferable to the curriculum. There are resources on campus to support these efforts.

3. The students mentioned several changes they would like in their curriculum: more hands-on work, a soil chemistry course, and a soil mechanics course that allows them to learn about soils from an engineering perspective. Recommendation: It would be useful for faculty to go through the course syllabi to identify hands-on activities currently available and to determine, if warranted, where more could be included. We suggest that faculty use as a guideline national standards that have been established to define experiential learning. To address the lack of a soil chemistry course, there is now the new Soil and Environmental Biogeochemistry, which had previously been taught as a special topics course. Better advertising of this course to undergraduate students may be sufficient to addressing their needs. Finally, the department could identify an existing course in the university that students could take as an elective for soil mechanics or create such a course in the department, perhaps in collaboration with engineering faculty.

4. Time to graduation for undergraduate students is too long and is costly to students as well as unfavorable for recruiting. This problem could largely be the result of a highly prescriptive curriculum and the fact that so many students transfer from other departments and thus typically must take extra courses. Recommendation: The department should take steps to reduce time to degree. One possible approach is to increase flexibility in the curriculum by increasing free, as opposed to restricted, electives. Some of these electives could include courses typically taken in the general education program. Another approach would be to provide more options for students in the soil science courses they take.

5. In addition to the problem of attracting enough students as discussed above, the new soil science major may have the same problem with high time to degree. Recommendation: Before students officially enter the new major, the department should revisit the curriculum to make sure it doesn’t discourage admissions or encourage delayed graduation. Faculty should carefully consider whether to require students in this applied major to take a full year of calculus and organic chemistry. To market this major effectively, faculty may need to soft-pedal the hard-core mathematics and sciences. One strategy would be to examine the jobs these students would likely enter and determine what is required to be successful and what level of rigor in the coursework is necessary. Viewed from this
perspective, for example, it may be that soil microbiology could be made an elective.

6. The new major does not require an internship. Because employers look so favorably on internships and students in many other soil science programs are required to do internships, this would make students more competitive in the job market.  
   Recommendation: Faculty should consider revising the curriculum to require an internship and, if appropriate, appointing an internship coordinator.

7. There appears to be little ethnic or gender diversity among the undergraduate student population. A more diverse environment is beneficial in many ways to students in the program.  
   Recommendation: The reviewers are aware of efforts the department has already made to increase diversity in its undergraduate program. We urge the department to continue those efforts and perhaps to focus more on students in community colleges. The articulation agreement described above may offer the opportunity to address diversity in the pipeline.

Distance Education

1. The department has two distance education (DE) graduate programs, one leading to a soil science certificate and the other to a non-thesis master’s degree (MX). Both of these programs rely on faculty teaching overloads, a model that may be unsustainable in the long run. No program should depend on faculty overloads. Though the certificate program is designed to prepare students for certification in soil science, it lacks the necessary soil chemistry course. DE also may be draining faculty resources—including time for their research—at a time when the department is launching a new undergraduate program.  
   Recommendation: Faculty in the department should rethink their commitment to DE in light of their other commitments. One of the first considerations is to identify the extent to which financial reward for teaching these courses (for the teachers and the department) outweighs the value to students. If DE is a key component of the department’s offerings, then it should be made a normal part of faculty teaching load. In general, such overloads can be problematic for assistant professors working toward tenure and should probably be avoided. Faculty who prefer teaching DE and have a record of providing a high-quality learning experience for students should be given the opportunity to do so. Faculty who do not prefer teaching DE courses should not be obligated to teach them. However, even if a DE course to be taught within a normal load, tenure track assistant professors should be discouraged from teaching them unless it is included in their statements of mutual expectations. If there are courses integral to the two DE programs that the department cannot find faculty to provide, then it should take advantage of DE courses from other universities rather than relying on faculty who are unwilling, overcommitted, or ineffective.

2. Even though the MX has an enrollment of 14 students, it has produced only one graduate in its first six years. Certainly, one would not expect the time to degree of a
program comprised of part-time professionals to generate rapid times to degree. But this may become a faculty workload issue: is an investment in this program worth faculty time?

**Recommendations**: The MX program should be reevaluated after another two or three years to determine whether it is meeting the needs of the students and the expectations of the faculty.

3. DE in this department does not appear to have any guidelines for faculty to follow or standards for delivery, and some faculty do not seem to be making full use of DE technologies in their courses.

**Recommendation**: The department should consider creating guidelines and standards for faculty teaching DE courses. The goal here is not so much greater consistency but greater effectiveness. The department should also strongly consider requiring faculty who presently teach or plan to teach DE courses to be trained in this mode of teaching and learning, focusing on how to design and deliver effective courses and how to make best use of current DE technology. The reviewers also encourage peer review of DE courses. The department should explore DE technologies currently used by other universities with successful programs.

**Graduate Education**

1. A relatively large proportion of soil science graduate students enter the program with degrees in disciplines other than soil science. Some of these students reported that they feel somewhat disadvantaged in taking some of the core courses.

   **Recommendation**: To provide a bridge to soil science for students who did not major in it as undergraduates, the faculty could create a graduate-level course that introduces students to the field. It could be structured according to the scientific subjects that comprise the current core with a focus on problems in soil science and how these sciences can be used to solve the problems. Or perhaps even better, the structure could be on problems themselves as vehicles for learning the science. There are advantages in restricting enrollment in this course to soil science students (and others with permission of instructor if there is room) so that it can be small enough to run as a participatory workshop. However, if it were to be run as a large course, it would probably be very popular.

2. The graduate curriculum, with its core of subfields within soil science, does not appear to reflect current practice in soil science pedagogy. The curriculum of a program plays a major role in establishing the character of the program. It influences the first impression of prospective students, it shapes the experience of current students, and it defines the reputation of the program among colleagues in other departments.

   **Recommendation**: The faculty should consider alternative models for the graduate curriculum, beginning with an exploration of curricular structures in other top departments in the country. This is an opportunity for faculty to redefine the character of the program. Among the models the department may consider are the following.
A. A model that highlights focus areas that students can choose and courses within those focus areas. Such focus areas could include soil, water, and air quality and sustainable plant productivity; land use and management; carbon sequestration and climate change; soil remediation and public health; and restoration of natural systems. This model has the advantage of emphasizing the concerns of soil science, what attracts students to the discipline, rather than its scientific subfields. One way of conceiving such a curriculum is for students to take the introductory course described above and then to take courses appropriate to a particular focus area. Of course, many courses cross focus areas. This approach would allow faculty to teach soil science in a much more integrative way. It would turn the present model around by focusing on a problem area and use that focus to teach the basic principles of soil science.

B A model that defines soil science as a truly interdisciplinary study. In this model, soil science faculty would work with faculty in other departments to create a program under a rubric such as soil and environmental sciences. This interdisciplinary program would draw on faculty and courses in soil related areas such as geology, biological and agricultural engineering, civil engineering, and forestry. This program could offer an introductory course on “Soils in the Environment” to both soil science students and those in other disciplines. This could provide a better appreciation of soil science’s strengths and linkages with other disciplines.

3. Many of the course titles in the current curriculum fail to capture what is exciting and interesting about the course, why a student would want to take it—e.g. Soil Physics, Soil Chemistry, Soil Fertility, Wetland Soils. It feels as though these titles are from a bygone era. This is not just a matter of marketing a course; rather, it is a matter of finding better ways of describing what a course is about, what students will be able to do upon finishing the course.

    Recommendation: The faculty should rethink the course titles and the content that would attract students interested interdisciplinary programs. Again, it might be helpful to research course titles in other programs. For instance, Soil Fertility could become Environmental Nutrient Management. This title better captures what the course is about and informs students that upon completion they would be better able to manage nutrients environmentally.

4. Faculty would like to increase the proportion of doctoral students to master’s students, which also reflects the university’s goal.

    Recommendation: Faculty should aggressively recruit doctoral students. An effective recruitment should begin with the department’s website, which is the first place most students go to investigate a program. The website should be redesigned so that it is a better marketing tool. For example, it should highlight exciting faculty research and make it searchable by research areas as well as faculty names. It should also emphasize the program’s identity, what sets it apart from others, in other words, its brand (mentioned above under Strategic Planning). The college should provide resources to revise and test the website. The department should promote the current research thrust areas and strengths of
the department. In addition to departmental promotion, each faculty should take responsibility to advertise potential opportunities for prospective graduate students. To compete nationally for doctoral students, the department should work with the college to create departmental and/or college fellowships.

5. Though the departmental seminar was praised by graduate students for both its academic and social benefits, it appears that the colloquium, which is scheduled to run one semester a year, has not been offered in about three years.

   Recommendation: Because the colloquium played such an important role in the professional development of students, it should be reinstated.

6. The present preliminary exam evidently consists of a written portion in which students respond to questions from their advisory committee and an oral portion in which students present their research. The oral exam could be more productive in terms of preparation for the dissertation and for the students’ professional development.

   Recommendation: Faculty should consider revising the oral preliminary examination so that students write a formal proposal for their dissertation projects in the format of a particular granting agency appropriate to their research, and then make an oral presentation of the proposal and respond to related questions. The format of the proposal encourages students to think through their research in a highly structured way, persuasively establishing a need for and the value of the research and describing a method for answering a research question or solving a problem. Students could use what they have written in the proposal as a basis for the dissertation. With a proposal in hand, members of the advisory committee would be able to offer more informed guidance to the student.

7. Students noted that some faculty did not seem open to many newer technologies in the classroom and that, overall, the technology savvy of faculty was very low.

   Recommendation: As a part of their professional development, faculty should consider taking workshops provided by the university on teaching with technology. The department should support faculty in upgrading their teaching materials for the electronic classroom.

8. Faculty with specializations in soil microbiology and molecular biology generally have some difficulty in attracting graduate students to work on their research projects. This limits the effectiveness of these faculty in building a research portfolio.

   Recommendation: Soil microbiology faculty should consider recruiting graduate students from the Department of Microbiology. These faculty should consider seeking affiliate faculty appointments in microbiology or other appropriate departments. The university has established a system whereby both departments get credit for the student.

9. The students indicated that the annual progress reports were not being used as advising tools by which advisors would evaluate the progress of and give feedback to
advisees. It also seemed that there was some inconsistency in students’ adherence to the requirement to turn in progress reports.

*Recommendation:* The reviewers understand that the department has recently shifted to a new form of progress reports. Faculty should determine which method best meets the goal of the annual progress report—which is to provide a formal opportunity for advisees to report on their progress over the last year and for advisors to respond to the students—and choose that method. For the reporting procedure to be effective, the department should inform all students what the department expects of them.

**Research**

1. Most junior faculty have not received their complete start-up packages as promised, the consequences of which can be severe for the faculty member, the department, and the university.

   *Recommendation:* Clearly, this situation is not at all acceptable. If start-up funds were promised in a certain amount and on a certain schedule at the time of hiring, those promises simply must be honored. We urge that this issue be given top priority.

2. In its self-study, the department delineated three domains of research that could be used group current faculty and to guide future hires and research emphases: nutrient management and agroecosystem services, land development and human protection, and foundational soil science. Though the reviewers admire this attempt to reconceive departmental research classifications, we had some concerns with this arrangement. The most important concern was that the basic sciences seemed separated from the other two domains. Another concern was that this classification system limits the way departmental research would be interpreted by prospective and current students and outside audiences. The classes don’t provide a clear conceptual basis for communicating with various audiences, university administrators, faculty in other departments, industry partners, and prospective and current students.

   *Recommendation:* The faculty should discuss revising the research categories to make them more productive for future decisions and more understandable to important external audiences. Faculty should be encouraged to look at the broader applications of soil science using the foundational research as a base for all focus areas and as a foundation for addressing new research problems that arise. For example, faculty could consider specific focus areas that are more descriptive of current faculty research and the future of soil science, such as soil, water, and air quality; land use and management; carbon sequestration and climate change; soil remediation and public health; and restoration of natural systems. In each of these areas soil scientists play pivotal role and the department should be a major player.

**Space**

Williams Hall, the home of the Department of Soil Science, is a lawsuit waiting to happen. Perhaps the worst problem is the mold in the air and on surfaces, which, in addition to the sanitary issues, could trigger allergic reactions. Second is the cramped, crowded labs, which could lead to accidents. At least one faculty office we saw also
seemed unacceptable because of mold, crowding, and the degraded condition of the walls and floor. Also in the labs, tiles fall from the ceilings and pipes leak, making floors slippery. Adding to the safety concerns, there are labs that have not been renovated since the 1950s.

**Recommendation:** There is evidently a three-stage plan for remedying the ills of Williams, consisting of (1) a selective renovation of some of the worst teaching labs, (2) an engineering study of the building’s negative pressure (which sucks outside air into the building causing excessive condensation and mold and mildew), and (3) full renovation of the building. The reviewers urge the university to give priority to implementing this plan.

**Extension**
The department has a very strong extension presence. But it would like to expand that presence to more users.

**Recommendation:** There has been some discussion in the department of having extension faculty create educational modules to be posted on the department’s website for users in the community and for students in the program. The reviewers wholeheartedly endorse this plan. Faculty should be provided time and technical support for creating these modules.