SOIL SCIENCE

Graduate Program Head	Carrie Laboski
Program Code	SOILS
Campus(es)	University Park (Ph.D., M.S.)
Degrees Conferred	Doctor of Philosophy (Ph.D.) Master of Science (M.S.) Dual-Title Ph.D. in Soil Science and Biogeochemistry Dual-Title Ph.D. and M.S. in Soil Science and International Agriculture and Development Dual-Title Ph.D. and M.S. in Soil Science and Transdisciplinary Research on Environment and Society
The Graduate Faculty	View (https://secure.gradsch.psu.edu/gpms/?searchType=fac&prog=SOILS)

The Soil Science program is administered in the Department of Ecosystem Science and Management, College of Agricultural Sciences. Each student will be associated with an adviser who may provide financial support, research facilities, and/or office space. Applicants are encouraged to explore, study, and research opportunities by contacting faculty who may be prospective advisers.

This program provides opportunities for candidates interested in soil and related water resources to become a professional leader and an independent scholar. Faculty in this program are competent to prepare candidates in the subfields of Soil Science including:

- soil genesis,
- soil classification,
- soil morphology,
- soil mapping,
- soil physics,
- soil chemistry,
- soil health,
- soil mineralogy,
- soil microbiology,
- soil fertility,
- soil conservation,
- geographic information systems,
- computer mapping,
- watershed analysis,
- soil hydrology,
- soil and water management,
- resource inventory and assessment,
- remote sensing,
- land evaluation,
- land waste disposal, and
- land management.

Admission Requirements

Applicants apply for admission to the program via the J. Jeffrey and Ann Marie Fox Graduate School application for admission (https://gradschool.psu.edu/admissions/how-to-apply). Requirements listed here are in addition to Graduate Council policies listed under GCAC-300 Admissions Policies (https://gradschool.psu.edu/graduate-education-policies/).

Prerequisites for major work in Soil Science vary with the area of specialization and the degree sought, but courses in chemistry, mathematics, physics, geology, and basic and applied biological sciences are required.

Applicants for the M.S. degree must have a baccalaureate degree including 76 credits of basic and applied natural sciences. Admission to the Ph.D. program usually requires an M.S. or equivalent degree with a minimum cumulative grade-point average of 3.25 (on a 4.00 scale). Applicants for the Ph.D. program will be evaluated on the quality of work completed in all previous degree programs. Students who lack some of the prerequisite courses may be admitted at the discretion of the faculty member who will serve as the student's adviser. The best-qualified applicants will be accepted up to the number of spaces available for new students. Generally students are not admitted into the program without a faculty member agreeing to serve as the adviser. Credits for prerequisite courses cannot be applied towards requirements for the degree.

Degree Requirements

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (https://gradschool.psu.edu/graduate-education-policies/)

A minimum of 30 credits at the 400, 500, 600, or 800 level is required, with least 18 credits at the 500 and 600 level, combined. The department requires 12 credits of 400- or 500-level formal courses in Soil Science of which 6 must be 500-level, and 6 credits of 400- or 500-level courses in a minor or general studies area. A total of 6 credits, with at least 3 credits at the 500 level, must be taken in statistics. Participation in at least one colloquium course each semester is expected and students must complete at least 1 credit of colloquium (SOILS 590). In addition, M.S. students are required to complete 1 credit of Supervised Experience in College Teaching (SOILS 602); however, this 1 credit cannot be counted towards the degree requirements. Specific courses and requirements will be determined by the faculty adviser and advisory committee.

A thesis based on field or laboratory research is required for the M.S. degree and at least 6 credits in thesis research (SOILS 600 or SOILS 610) must be taken in conjunction with completing the thesis. The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School, and the student must pass a thesis defense.

Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (https://gradschool.psu.edu/graduate-education-policies/)

While a minimum number of courses for the degree is not specified, the Ph.D. committee has the responsibility of specifying courses and credits essential for the education and development of the student. Students are expected to be educated in depth in a specific subfield of Soil Science and to have a perspective of the general field. Normally, students will have 50 to 60 credits in formal course work beyond the B.S. degree. A minimum of 12 credits of 500-level courses beyond the baccalaureate degree are required. Additional requirements include a minimum of 15

credits of 400- or 500-level courses in a minor or general studies area, 6 credits of statistical methods beyond the baccalaureate degree, of which a minimum of 3 will be at the 500 level, and 12 credits of SOILS 600 or SOILS 610.

Doctoral students are required to participate regularly in a departmental colloquium and to register for at least 1 credit of Colloquium (SOILS 590) during the Ph.D. program. Ph.D. students are required to complete two separate semesters of Supervised Experience in College Teaching (SOILS 602) for 2 credits total; however, these 2 credits cannot be counted towards the degree requirements. Doctoral students must pass a qualifying examination, a comprehensive written and oral examination, and a final oral examination (the dissertation defense). To earn the Ph.D. degree, doctoral students must also write a dissertation that is accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Titles

Dual-Title Ph.D. in Soil Science and Biogeochemistry

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/).

Doctoral students with research and educational experiences in soil science may apply to the Soil Science/Biogeochemistry dual-title doctoral degree program. The goal of the dual-title Ph.D. degree in Soil Science and Biogeochemistry is to enable SOILS graduate students to acquire the knowledge and skills of their major area of specialization in SOILS, while at the same time gaining expertise and skills in biogeochemistry. Graduate study in this program seeks to provide students with the intellectual foundation for integrated and mechanistic understanding of interactions between microbes, soils, and plants in diverse environmental systems. Interdisciplinary training that includes biogeochemistry will prepare students for positions in academia, government, non-profit organizations, and the private sector. It will also prepare students for a wide array of research careers in the private sector, including agricultural and environmental sciences, energy industries, and the integrated study of the sustainability of biological systems.

Admission Requirements

For admission to the dual-title doctoral degree in Biogeochemistry, a student must first apply and be admitted to the Soil Science graduate program and The Graduate School. It is preferable but not necessary to discuss the dual-title interest beforehand with a major adviser who has been appointed to the Biogeochemistry program. Refer to the Admission Requirements section of the Biogeochemistry Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/biogeochemistry/). After admission to the Soil Science program, students must apply for admission to the Biogeochemistry dual-title program by submitting an application to the Biogeochemistry Graduate Program Coordinator. The application consists of a written personal statement describing the student's biogeochemistry research interests and career goals that can be met by earning a dual-title SOILS/BGC degree. The statement should be signed by the student's major adviser in support of the student's taking on the academic responsibilities of the dual-title degree. The application will be reviewed by the BGC Program Coordinator, in consultation with the BGC Executive Committee, who will make the admission decision and notify the Graduate School. Students must be admitted into the BGC program prior to taking the qualifying exam.

Degree Requirements

To qualify for the dual-title degree, students must satisfy the Soil Science Ph.D. degree requirements. In addition, students pursuing the dual-title Ph.D. in Soil Science and Biogeochemistry must complete the degree requirements for the dual-title Biogeochemistry Ph.D., listed on the Biogeochemistry Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/biogeochemistry/). Students are required to have two advisers from separate disciplines: one individual serving as a primary adviser in their major degree program and a secondary adviser in an area within a field covered by the dual-title program who is a member of the Biogeochemistry Graduate Faculty. The major program adviser normally will also be a member of the Biogeochemistry Graduate Faculty. The two faculty advisers can represent different academic programs, but this is not required, as faculty from a scientifically diverse department could represent very different areas of expertise.

The qualifying examination committee for the dual-title Ph.D. degree will be composed of Graduate Faculty from Soil Science and must include at least one Graduate Faculty member from the Biogeochemistry program. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. There will be a single qualifying examination, containing elements of both Soil Science and Biogeochemistry. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable.

In addition to the general Graduate Council requirements for Ph.D. committees (http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/), the Ph.D. committee of a Soil Science and Biogeochemistry dual-title doctoral degree student must include at least one member of the Biogeochemistry Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in Biogeochemistry, the member of the committee representing Biogeochemistry must be appointed as co-chair. The Biogeochemistry representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that reflects their original research and education in Soil Science and Biogeochemistry. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Title M.S. and Ph.D. in Soil Science and International Agriculture and Development

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/).

Graduate students with research and educational interests in international education may apply to the Soil Science/INTAD Dual-Title Degree Program. The goal of the dual-title degree in Soil Science and INTAD is to enable graduate students from Soil Science to acquire the knowledge and skills of their primary area of specialization in Soil Science, while at the same time gaining the perspective and methods needed for work in the international agriculture. Graduate study in this program seeks to prepare students to assume leadership roles in science,

science education, outreach, and project management anywhere in the world. Students are required to write research proposals and expected to write grants to support their research activities, reflecting the dual-title degree. As part of their professional development presentations, publication of research articles and active participation in professional societies is expected. Emphasis is placed upon the professional development of the student. Students are able to specialize in the research program areas of soil genesis, classification, morphology, mapping, microbiology, chemistry, physics, mineralogy, fertility, geographic information systems, remote sensing, watershed analysis, hydrology, and land management. At the same time they will acquire a broad perspective about how to apply their research findings in the context of the broader international community. Thus, the dual-title will allow students to master their field of specialization from an international perspective so that they can compare practices and outcomes between countries and regions.

Admission Requirements

For admission to the dual-title graduate degree under this program, a student must first apply and be admitted to the Soil Science graduate program. Once accepted into the Soil Science program, the student can then submit an application to the INTAD Academic Program Committee for the dual-title degree program. Refer to the Admission Requirements section of the INTAD Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/). The application consists of an application form, a written personal statement indicating the career goals that a student hopes to accomplish by earning a dual-title SOILS/INTAD degree, and a letter from the Soil Science academic adviser supporting the student's taking on additional academic responsibilities. The letter also must confirm that the student is in good standing and is capable of taking on the dual-title degree. The application will be reviewed by the INTAD Academic Program Committee, which will make all final admission decisions. Doctoral students must be admitted into the INTAD program prior to taking the qualifying exam.

Degree Requirements for the Dual-title M.S.

To qualify for this dual-title degree, students must satisfy the requirements of the Soil Science Master of Science degree program. In addition, they must satisfy the INTAD program requirements for the dual-title master's degree. Refer to the Master's Degree Requirements section of the INTAD Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/). Some courses may satisfy both the primary graduate program requirements and those of the INTAD program. The double counting of credits must be approved by the student's adviser(s), the head of the SOILS graduate program, and the INTAD Co-Chairs.

For the dual-title M.S. degree in Soil Science and INTAD, the thesis must reflect the student's education and interest in both Soil Science and INTAD. All members of the student's committee must be members of the Graduate Faculty. The master's committee must include at least one Graduate Faculty member from INTAD. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role.

Degree Requirements for the Dual-Title Ph.D.

To qualify for the dual-title degree, students must satisfy the degree requirements for the Ph.D. in Soil Science. In addition, students must complete the degree requirements for the dual-title in INTAD, listed on the INTAD Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/). Some courses may satisfy both Soil Science and INTAD degree requirements. The double counting of credits must be approved by the student's adviser(s), the head of the SOILS graduate program, and the INTAD Co-Chairs.

Graduates of the dual-title INTAD master's degree program who wish to pursue an INTAD doctoral degree must re-apply to the INTAD program for admission. INTAD master's degree credits may be carried over to the doctoral program. Six additional INTAD credits will be required. INTAD master's degree graduates who pursue an INTAD Ph.D. are required to take the INTAD 820 International Agricultural Development Seminar a second time.

Qualifying Examination

Qualifying examination procedures will be based on the procedures of the Soil Science graduate degree program, but will integrate the fields of Soil Science and International Agriculture and Development. Although not encouraged, the dual-title degree student may require an additional semester or more to fulfill requirements for the dual-title degree program. Therefore, under exceptional circumstances, the qualifying exam may be delayed at the discretion of the student's Soil Science adviser in consultation with the INTAD program coordinators. The qualifying examination committee for the dual-title Ph.D. degree will be composed of Graduate Faculty from Soil Science and must include at least one Graduate Faculty member from INTAD.

Committee Composition

In addition to the general Graduate Council requirements for Ph.D. committees (http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/), the Ph.D. committee of a Soil Science and INTAD dual-title Ph.D. student must include at least one member of the INTAD Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in INTAD, the member of the committee representing INTAD must be appointed as co-chair.

Comprehensive Exam

At the end of the course work, students in the dual-title doctoral degree program in Soil Science and INTAD will be required to pass an oral and written comprehensive examination based on their dissertation proposal and area of specialization in Soil Science, while reflecting their dual-title curriculum. A separate comprehensive examination is not required by the INTAD program, but international agriculture must be one of the key areas of the comprehensive exam and the INTAD representative on the student's Ph.D. committee must have input into the development of and participate in the evaluation of the comprehensive examination.

Dissertation and Dissertation Defense

Ph.D. students enrolled in the dual-title degree program are required to write and orally defend a dissertation on a topic that reflects the integration of their original research and education in Soil Science and International Agriculture and Development. In order to satisfy the INTAD dissertation requirement, students may: 1) conduct all or part of their research in an international location, 2) conduct an analysis of a subject in an international context, 3) conduct an analysis of secondary data of international origin, or 4) incorporate another international dimension by approval of the INTAD committee member. Additionally, the dissertation should reflect the student's technical knowledge, knowledge of and sensitivity to a wide diversity of cultures and backgrounds, and the perspective needed to transfer their knowledge in other cultures, particularly in the developing world. The dissertation should contribute to the body of knowledge in soil science and global agricultural development and have potential application in both U.S and international contexts. A public oral presentation of the dissertation is

required. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Title M.S. and Ph.D. in Soil Science and Transdisciplinary Research on Environment and Society

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/).

M.S. and Ph.D. students with research and educational interests in contemporary natural resource and societal changes may apply to the dual-title program in Soil Science (SOILS) and Transdisciplinary Research on Environment and Society (TREES).

The goal of the dual-title graduate program is to enable graduate students from SOILS to acquire the knowledge and skills of their primary area of specialization in SOILS, while at the same time gaining experience in creating engaged approaches to transdisciplinary scholarship. Graduate study in this program seeks to prepare students to draw upon materials from the soil and/or water, sociocultural, and sociodemographic arenas in an integrated, collaborative framework. Graduates of the TREES program are equipped with the ability to communicate effectively with stakeholders affected by natural resource and environmental change issues in public settings. Students are required to write research proposals for collaboration and are expected to write grants to support their transdisciplinary research activities reflecting both research areas of the dual-title degree. As part of their professional development presentations, publication of research articles and active participation in professional societies is expected. Emphasis is placed upon the professional development of the student.

Admission Requirements

Students must apply and be admitted to the graduate program in SOILS and The Graduate School before they can apply for admission to the dual-title degree program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of the TREES dual-title program. Refer to the Admission Requirements section of the TREES Bulletin page (https://bulletins.psu.edu/graduate/programs/majors/transdisciplinary-research-environment-society/). Doctoral students must be admitted into the dual-title degree program in TREES prior to taking the qualifying examination in their primary graduate program.

Degree Requirements for the Dual-Title M.S.

To qualify for this dual-title degree, students must satisfy the requirements of the SOILS Master of Science degree program, listed on the Degree Requirements tab. In addition, they must satisfy the TREES program requirements for the dual-title master's degree. Refer to the Master's Degree Requirements section of the TREES Bulletin page (https://bulletins.psu.edu/graduate/programs/majors/transdisciplinary-research-environment-society/). Some courses may satisfy both the graduate primary program requirements and those of the TREES program. Final course selection is determined by the student after consulting, in advance, with their SOILS and TREES advisers.

For the dual-title M.S. degree in SOILS and TREES, the thesis must reflect the student's education and interest in both SOILS and TREES. All members of the student's committee must be members of the Graduate Faculty. The thesis supervisor and chair of the student's committee shall be a member of SOILS and TREES. Upon selection of the committee members, the committee should be officially appointed via the current outlined process from the Graduate School and must be approved by the TREES Academic Program Committee Co-chair.

Degree Requirements for the Dual-Title Ph.D.

To qualify for the dual-title degree, students must satisfy the degree requirements for the Ph.D. in SOILS, listed on the Degree Requirements tab. In addition, students must complete the degree requirements for the dual-title in TREES, listed on the TREES Bulletin page (https://bulletins.psu.edu/graduate/programs/majors/transdisciplinary-research-environment-society/).

The qualifying examination for SOILS will satisfy the qualifying exam requirement for the dual-title degree program in TREES. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable.

In addition to the general Graduate Council requirements for Ph.D. committees (http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/), the Ph.D. committee of an SOILS and TREES dual-title Ph.D. student must include at least one member of the TREES Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in TREES, the member of the committee representing TREES must be appointed as co-chair. The TREES representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their Ph.D. committee and reflects their original research and education in SOILS and TREES. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Minor

A graduate minor is available in any approved graduate major or dual-title program. The default requirements for a graduate minor are stated in Graduate Council policy GCAC-218 Minors (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-218-minors).

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (https://gradschool.psu.edu/funding/) section of the J. Jeffrey and Ann Marie Fox Graduate School's website. Students on graduate assistantships must adhere to the course load limits (https://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants/) set by the Fox Graduate School.

Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may

be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Soil Science (SOILS) Course List (https://bulletins.psu.edu/university-course-descriptions/graduate/soils/)

Learning Outcomes

Master of Science (M.S.)

1. **KNOW:** Graduates in these three masters programs will have obtained knowledge of core theories and methods as demonstrated by courses completed and grades earned at the bachelor's level. Graduates will exhibit breadth and depth of understanding in their respective disciplines in courses completed at the master's level.
2. **APPLY/CREATE:** Graduates in these three masters programs will be able to clearly synthesize literature and theories in their disciplinary areas and/or in their specialized thesis topics. Such synthesis will help generate new ideas or methods to develop unique solutions to the problems in the three disciplinary programs.
3. **COMMUNICATE:** Graduates in these three masters programs will effectively communicate ideas, arguments, and rationales in clear, concise, well-organized publications (abstracts, papers, proposals) and presentations (conferences, seminars, and research meetings) .
4. **THINK:** Graduates in these three masters programs will be able to critically analyze the work of others in their field of specialty. Such analyses will help graduate students to demonstrate proficiency in designing a research strategy to answer important questions and to improve their own work.
5. **PROF. PRACTICE:** Graduates in these three masters programs will demonstrate the highest ethical standards and core values (including Penn State Core Values) within their discipline and other diverse scientific backgrounds.

Doctor of Philosophy (Ph.D.)

1. **KNOW:** Graduates in these three doctoral programs will have obtained the knowledge of the core theories and methods at the bachelors and/or master's levels. Graduates will exhibit breadth and depth of understanding in their respective disciplines in courses completed at the doctoral level.
2. **APPLY/CREATE:** Graduates in these three doctoral programs will be able to clearly synthesize literature and theories in their disciplinary areas and/or in their specialized thesis/dissertation topics. Such synthesis will help generate new ideas or methods to develop unique solutions to the problems in the three disciplinary doctoral programs.
3. **COMMUNICATE:** Graduates in these three doctoral programs will effectively communicate ideas, arguments, and rationales in clear, concise, well-organized publications (abstracts, papers, proposals) and presentations (conferences, seminars, and research meetings).
4. **THINK:** Graduates in these three doctoral programs will be able to critically analyze the work of others in their field of specialty. Such analyses will help graduate students to demonstrate proficiency in designing a research strategy to answer important questions and to improve their own work.
5. **PROF. PRACTICE:** Graduate students in these three doctoral programs will demonstrate the highest ethical standards and core values (including Penn State Core Values) within their discipline and other diverse scientific backgrounds.

Contact

Campus	University Park
Graduate Program Head	Carrie Laboski
Director of Graduate Studies (DGS) or Professor-in-Charge (PIC)	Frances E Buderman
Program Contact	Rachel Smith 113 Forest Resources Building 466 Bigler Road University Park PA 16802 rdr15@psu.edu (814) 863-7221
Program Website	View (https://ecosystems.psu.edu/)