The Applied Plant Sciences graduate program at the University of Minnesota offers M.S. and Ph.D. degrees in the following specializations: Agronomy/Agroecology, Horticultural Science, and Plant Breeding/Molecular Genetics. Our graduates are employed in research, teaching, and management positions in universities, private companies, and agencies around the world.

Process for Developing Learning Outcomes and Assessment

The Applied Plant Sciences Graduate Program underwent a self-study and external review process in 2007. Learning outcomes and assessment procedures were developed and documented at that time with faculty and student input. These learning outcomes were reviewed and amended by our faculty and graduate students in February 2015 to address the 6 domains of Learning Outcomes suggested by the Graduate School. Our assessment process was also amended to better reflect our current practices.

Learning Outcomes

The objective of the APS program is to educate, train, and mentor graduates who:

1. Have a foundational knowledge in plant biological sciences;
2. Have a mastery of principles and concepts and a disciplinary literacy in their chosen area of specialization;
3. Recognize the interrelatedness and complexity of research problems in the applied plant sciences in contexts from local to global;
4. Conduct research responsibly and understand the use of different tools, resources, and research methodologies in the applied plant sciences;
5. Communicate scientific information and ideas in different ways and to diverse audiences; and
6. Effectively use their knowledge and skills to lead and collaborate successfully in teams that produce research-based, innovative solutions and creative thinking to problems in food, agriculture, and the environment.

Components used to assess the achievement of these learning outcomes include the following:

M.S. Degree Requirements

The M.S. degree is offered under Plan A (with thesis) and Plan B (with special project). Plan A requires a minimum of 20 credits that meet the specialization requirements. Plan B has the same course requirements as Plan A, plus 10 additional course credits. A common curriculum comprises a course in statistical analysis, an orientation to Minnesota crop production and research methods, graduate seminar, and research ethics. M.S. students present one graduate seminar and candidates for the M.S. degree need to pass a final oral exam that includes a presentation of the candidate’s research.
**Ph.D. Degree Requirements**

The Ph.D. degree emphasizes original research that contributes significantly to the knowledge base in the student’s field of specialization. Ph.D. students need to complete a minimum of 30 credits that meet specialization requirements and 24 Ph.D. thesis credits. In addition to the common curriculum required for M.S. students, Ph.D. students need to complete a supervised-teaching course, a current-topics course, a thesis proposal seminar, and serve at least one semester as a Teaching Assistant. Ph.D. students need to pass a series of written preliminary exams followed by an oral preliminary exam. Ph.D. candidates need to pass a final oral exam based on the candidate’s Ph.D. dissertation.

**Written Preliminary Exam:** The primary purpose of the written preliminary examination in APS is to measure the students’ capacity to interpret, analyze and make appropriate interconnections with available pieces of information, and then to synthesize those pieces into new information that may be useful in problem solving. The questions are designed to examine the student’s ability to understand scientific principles and to integrate the student's knowledge into a well organized, cohesive answer based on sound scientific principles and thought patterns.

**Oral Preliminary Exam:** The purpose of the preliminary oral examination is to test the student’s ability to synthesize and apply the knowledge in their field of specialization and to understand and present current hypotheses and research methodologies. The exam also includes material from the students minor or supporting program.

**Thesis Proposal Seminar (Agro 8270):** Our graduate program is somewhat distinct from our peer programs in that it integrates multiple disciplines (i.e. Agronomy, Horticultural Science, or Plant Breeding/Genetics). During their thesis proposal, students are required to place their research, whether basic or applied, into the integrative theme of “Sustainable Development of Multifunctional Landscapes-Land, Food, Human Health, and Energy.” Seminar presentation skills are taught and peer mentoring is used in this class. A letter grade is assigned.

**Annual Performance Evaluations:** Graduate Research Assistants and Fellows are formally evaluated by their advisor(s) and the student’s advisory committee in annual meetings of their committees and in formal Annual Performance Evaluation form at least once per year prior to reappointment on July 1. The evaluation includes a review of academic performance, timeliness in meeting departmental and Graduate School guidelines for submitting course programs, thesis proposals, etc., satisfactory progress on thesis research, professional development, and adequate performance of assistantship activities.

**Publications:** The publication of research in peer-reviewed journals is an expectation of all of our graduate students. Publications are tracked during the students’ annual performance evaluation and trends of students within each specialization and by major advisor can be examined. Publication is further encouraged through requirements for latter stage fellowships/awards (DDF and many of our departmental fellowships and awards).

**Placement and Feedback from Employers and Alumni:** Ultimately, the placement and success of our graduates in positions in academia and industry commensurate with their degree level, and their performance in these positions, is a key measure of the effectiveness of our graduate
program. We maintain a database of employment history of our graduates. We take advantage of many opportunities each year to solicit feedback from employers and our alumni regarding the preparation of our graduates for their chosen career. These opportunities arise from attendance at professional meetings, annual on-campus symposia (2-3 per year), and visits to local industry and other employers by our students and faculty. This feedback can come from the students themselves after they have had time to reflect on their careers or from employers when asked about our graduates and what areas of knowledge, skills, and abilities need improvement.

**Achievement and Assessment of Learning Outcomes**

We aim to achieve and assess these learning outcomes in the following manner:

1. **Have a foundational knowledge in plant biological sciences**
2. **Have a mastery of principles and concepts and a disciplinary literacy in their chosen area of specialization**

Achieved by: core curriculum; specialized courses; seminars; interaction with peers, professors, and the student’s advisory committee; the student’s readings of scientific literature; and thesis research. For both M.S. and Ph.D. students, a B average or better (≥3.0 grade point average) is required to graduate. Based on interactions with the faculty advisory committee and class performance, additional coursework may be recommended.

Assessment: grades in coursework; performance in preliminary and final thesis exams; publication of research results; tracking global placement and advancement of graduates, feedback from employers and alumni

3. **Recognize the interrelatedness and complexity of research problems in the applied plant sciences in contexts from local to global**

Achieved by: specialized courses; courses in a minor or supporting field; seminars in APS and other fields; AGRO/HORT 8280: *Current topics in applied plant sciences*; SAGR 8010: *Colloquium in sustainable agriculture*; Ph.D. preliminary written and oral exams; interaction with peers and professors; the student’s own readings of scientific literature; and thesis research, domestic and international travel training and presentation opportunities; interactions with visiting scientists

Assessment: annual performance evaluation and committee review, performance in preliminary and final thesis exams; feedback from employers and alumni.

4. **Conduct research responsibly and understand the use of different tools, resources, and research methodologies in the applied plant sciences**

Achieved by: APSC 8123: *Research ethics in the plant and environmental sciences*; AGRO 5311: *Research methods in crop improvement and production*; specialized courses; seminars; hands-on duties as a research assistant; short-term training at other universities or research institutes; and thesis research.

Assessment: via the advisory committee during the course of the student’s research and during the thesis defense; feedback from employers and alumni.
5. Communicate scientific information and ideas in different ways and to diverse audiences

Achieved by: AGRO 8270: Graduate Seminar; presentations to producers during field days; presentations at meetings; GRAD 8101: Teaching in Higher Education; writing a thesis; publication of extension articles for end-users of applied research, and AGRO/HORT 8900: Publishing in Plant Science Journals (Advanced Discussions). Media training opportunities will be explored in which students will learn skills for communicating with non-scientific audiences, communicating science both orally and in written form.

Assessment: performance in AGRO 8270, final defense presentation and exam: GRAD 8101 (Ph.D. only); performance as Teaching Assistant (Ph.D. only); prolificacy in presenting and publishing research; annual review.

6. Effectively use their knowledge and skills to lead and collaborate successfully in teams that produce research-based, innovative solutions and creative thinking to problems in food, agriculture, and the environment.

Achieved by: completion of an M.S. or Ph.D. thesis; fulfillment of all the requirements for an M.S. or Ph.D. degree, including APSC 8123: Research ethics in the plant and environmental sciences; mentoring by the advisor; committee service (for example department standing and search committees, symposium organizing committees, APS club leadership participation), community service, and, eventually, employment of graduates in universities, government agencies, research institutes, and private companies.

Assessment: via the advisory committee during the course of the student’s research; annual review; job placement and performance in their post-graduate position; feedback from employers and alumni.

Strategy to address problems as they are discovered and use assessment results to improve our curriculum/instruction

During a scheduled meeting of the graduate faculty, learning outcome assessments will be reviewed including quantitative data on student progress (academic performance, degree progress, travel and training opportunities, publications, presentations, and placement) and experiences of faculty will be discussed. A similar meeting with graduate students will review assessments and experiences from the student perspective. The DGS, working with the steering committee, will assimilate output from these discussions and propose changes to curriculum or instruction to the graduate faculty and appropriate instructors and department heads.