

GRADUATE HANDBOOK

BioRenewable Systems (BRS)

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The Program

Developed economies, such as in the U.S. and Europe, are continually transforming as production and processing shifts from non-renewable based materials to more sustainable and renewable biologically-based systems. Toward that end, the agricultural/biological enterprise is uniquely positioned to play a pivotal role as the producer and supplier of resources and personnel to maintain the competitiveness of emerging biobased industries. At the national level, prestigious National Academy of Sciences and major funding agencies such as the U.S. Department of Agriculture, Department of Energy, National Science Foundation and other agencies, envision biobased materials, processes, and energy production as significant components of this biobased economic transformation. Concurrently, research universities across the country are realigning or shifting resources at a rapid pace to develop and offer research-oriented graduate programs in the emerging areas of *biobased education, outreach, and research*.

The BRS graduate program leverages existing science and engineering and wood products expertise of the faculty and allows for expansion into a growing biologically-based area. It also allows students with CAS undergraduate degrees to participate in a graduate program focusing on the science and business sides of the emerging bioeconomy. The new graduate program facilitates economic growth by developing well-educated and well-qualified graduates who, in turn, will help traditional forest- and agriculturally-anchored industries transition into production, processing, and recovery systems based on emerging biobased products. The BRS degree program augments, broadens, and strengthens the ABE Department's and the College's research enterprise through enhanced collaborations in bioproducts, bioenergy, biofuels supply chains, nanotechnology, and green products while adding complementary components in bioproducts packaging and pallets, green adhesives, biobased composites, chemistry and structure of biomaterials, biofuels supply chains, marketing/management, entrepreneurship, etc.

Objectives of the Program

The overall goal of the BRS Graduate Program is to be a world renowned research-oriented graduate program in renewable biologically-based materials, products, and processes that fully integrates the principles of systems technology, science, and management of resilient/sustainable resilient/sustainable biosystems.. Toward that end, the major objectives are:

1. Offer M.S. and Ph.D. graduate degrees that integrate science and technology with business, management, marketing, entrepreneurship, and leadership;
2. Provide advanced educational and research experiences that prepare graduates to lead the development and advancement of the growing biobased economy via industrial, governmental, and academic positions;
3. Develop and maintain a high-quality graduate degree program for students who otherwise might have wanted to apply to the Agricultural and Biological Engineering (ABE) graduate program but who do not have an undergraduate engineering but are qualified for an advanced degree in biorenewable systems;
4. Offer a competitive graduate degree program for students specifically interested in science and business-related aspects of biobased products and materials such as wood and wood-based products, bioenergy, and sustainable/renewable biological systems;
5. Promote advanced, interdisciplinary research addressing the science, technology, and business approaches to sustainable and safe bioenergy, biomaterials, and bioproducts and their supply chains, including the integration of marketing, management, entrepreneurship, and leadership; and

6. Enhance economic development by offering a continuing supply of well-educated and qualified future employees to both existing stakeholders from the agricultural and forest products industries and to an emerging, growing, and broader stream of biorenewable systems stakeholders in companies such as: chemical, pharmaceutical, cosmetics, materials and energy recovery, biobased packaging/processing for food and other products, sustainable systems including safety, and bioenergy.

Graduate BRS Courses

- BRS 500 Research Methods in BioRenewable Systems (3)*: Introduction to research philosophies, methodologies, issues and policies; measures of research quality; research report writing; research ethics.
- BRS 501 Bio-based Polymers (3)*: The chemistry, structure-property relationships, and industrial applications of biobased polymers from plant and agricultural feedstocks.
- BRS 502 Human Behavior in Management and Technology (3)*: Develop an understanding of the relationship between human behavior and professional activities including management, leadership, and ethical decision making.
- BRS 511 Advanced Structural BioComposites (3)**: Manufacture and practices related to the production of engineered biocomposites processed from lignocellulosic materials.
- BRS 550 Applied Bioproducts Marketing(3)**: Bioproduct marketing applications for solid and engineered wood products and biorefinery value chain output including environmental services, energy, fuels, and co-products.
- BRS 551 Sustainable Business Strategies (2)**: Coverage of business strategies that relate to sustainability and environmental issues.
- BRS 590 Colloquium (1-3)**: Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.
- BRS 594 Research Topics (1-9)**: Supervised student activities on research projects identified on an individual or small-group basis.
- BRS 595 Internship (1-6)**: Supervised, research-oriented, off-campus, nongroup instruction, including field experiences, practicums, or internships.
- BRS 596 Individual Studies (1-9)**: Creative projects, including nonthesis research, which are supervised on an individual basis and which fall outside the scope of formal courses.
- BRS 597 Special Topics (1-9)**: Formal courses given on a topical or special interest subject which may be offered infrequently; several different topics may be taught in one year or term.
- BRS 600 Thesis Research (1-15)*: No description.
- BRS 601 Ph.D. Dissertation Full Time (0)**: No description
- BRS 602 Supervised Experience in College Teaching (1-3 per semester/maximum of 6)***: Provides an opportunity for supervised and graded teaching experience in biorenewable systems courses.
- BRS 610 Thesis Research Off Campus (1-15)**: No description.
- BRS 611 Ph.D. Dissertation Part-Time (0)**: No description.

**Required course for students enrolled in BRS graduate program*

***Elective course for students enrolled in BRS graduate program*

****Required course for Ph.D. students enrolled in BRS program*

Program Statement

BRS is positioned to be a world renowned research-oriented graduate program in renewable biologically-based materials, products, and processes that fully integrates the principles of systems technology, science, and management of resilient/sustainable biosystems. Toward that end, the academic and professional requirements for BioRenewable Systems are closely related to the disciplinary focus of agricultural and biological sciences, technological innovation and application, and business, management, and leadership within the continually evolving biobased sectors. This makes BRS unique from other fields of science and management. To promote and fulfill this uniqueness, continuation of courses in science, business, management, and technology at the graduate level is encouraged and expected.

M.S. Program of Study

Each M.S. program of study must meet the following requirements:

	<u>Credits</u>
<u>Required (Core):</u>	
BRS 500 Research Methods*	3
<i>(*To be Joint listed with the current ABE 500 Research Methods)</i>	
BRS 501 Biobased Polymers	3
BRS 502 Human Behavior in Management and Technology	3
<u>Electives:</u>	
Select two courses from the following list:	6 (or 5)*
• BRS 511 Advanced Structural BioComposites	3
• BRS 550 Applied Bioproducts Marketing	3
• BRS 551 Sustainable Business Strategies	2
• ABE 559 Biological Systems Simulation	3
• FOR 880 Bioenergy Feedstock	3
• ABE 888 Conversion Technologies for Bioenergy Production	3
• ABE 884 Biomass Energy Systems	3
• ABE 855 Biomass Harvest and Logistics	3
• ASM 426 Management of Safety and Health Issues in Production Agriculture and Related Businesses	3
<u>or</u>	
• ENVSE 450 Environmental Health and Safety	
• EME 801 Bioenergy Markets, Policy, and Regulation	3
Statistics 4XX or 5XX	3
Additional 4XX or 5XX courses	8 (or 9)*
BRS 600 Thesis Research	6
Total:	31

**Course credits should total at least 24 credits.*

A total of at least 18 credits must be from 500-level or above courses and all courses used to meet course requirements above must be 4XX or 5XX. In addition to the above listed course requirements, every graduate student must fulfill the Scholarship and Research Integrity (SARI) requirement. SARI requirement consists of two parts: (1) completion of BRS 500 with a grade of

B or better and (2) completion of online training program at:

<http://www.research.psu.edu/training/sari/program>, in Physical Sciences and Engineering or Social and Behavioral Sciences. The online SARI requirement must be completed within one year from date of enrollment in the program of study.

A minimum grade point average of 3.00 is required for graduation. Only grades of C or better are accepted for 400-level or above non-remedial courses. All courses must be approved by the student's M.S. Advisory Committee as having significance and value for the degree program. All requirements for the M.S. degree, whether satisfied on University Park campus or elsewhere, must be met within eight years from the first semester of graduate study.

M.S. Advisory Committee: An initial Adviser will be assigned to each entering graduate student by the Department Head, in consultation with the Graduate Program Coordinator and the faculty member agreeing to serve as adviser. To the extent practical and commensurate with potential funding source(s), research interests of the student and assigned Adviser will be compatible. New graduate students are highly encouraged to visit with various faculty members concerning opportunities for thesis research activities. After the student has decided on the preferred research area, s/he should inform the Graduate Program Coordinator or Department Head—by the middle of the first semester of study—of the preferred faculty member to serve as permanent Adviser. Each student should schedule at least a one-hour meeting each week with the permanent adviser to ensure adequate communications.

An M.S. Advisory Committee must consist of at least three faculty, all of whom are members of the Graduate Faculty. The chair (or Co-chair) of the Advisory Committee will be a BRS Graduate Faculty member and will serve as the student's thesis Adviser. Students are encouraged to have one member of the committee from outside the BRS Graduate Program in a field related to the thesis problem. If a student selects a minor, then one member of the committee must be a graduate faculty member of the minor department. As the culminating experience, each M.S. degree student must complete a thesis in their research field of study.

Final Oral Exam: Each M.S. degree student must complete a Final Oral Examination, which consists primarily of presenting and defending their near-final version of thesis draft. However, the examination may cover the entire field of BioRenewable Systems. The M.S. degree student must provide their thesis to their committee no later than two weeks prior to their Final Oral Examination date. The Graduate Program Coordinator must be notified of the exam by a copy of the scheduling letter sent to the Advisory Committee; no scheduling form is required. Otherwise, the guidelines for this examination are basically the same as the guidelines for the Ph.D. Final Oral Examination; see that section for further information.

Schedule for M.S. Requirements: Many of the M.S. degree requirements are listed in approximate chronological order on the following page. It is the student's responsibility to ensure that these and all other requirements are met in a timely manner. It is expected that M.S. students should complete the degree in a timely manner consistent with the research and funding program developed. Table 1 shows coursework for a student enrolled in M.S. program of study in BRS. The proposed schedule in Table 1 allows full-time students to complete the courses in three semesters plus a summer session.

SUGGESTED SCHEDULE FOR M.S. DEGREE

Requirement (responsibility of M.S. student to ensure completion)	Suggested Completion Dates
Recommend permanent Adviser.	Middle of first semester.
Submit to Adviser a list of courses to comprise graduate plan of study.	End of first semester.
Assemble Advisory Committee, in consultation with adviser.	End of first semester.
Transfer credit from undergraduate or post-baccalaureate program, if appropriate.	End of first semester.
Present thesis research proposal to Advisory Committee for approval/feedback.	End of first semester, following BRS 500*.
Complete semiannual progress report form.	Each January and July.
Submit plan of study and thesis project proposal to Advisory Committee for approval (copy to Graduate Program Coordinator).	End of first semester, following BRS 500*.
SARI: Online tutorial and certificate	Must be completed within one year from the date of enrollment in the program of study. Give a copy of the completion certificate to the Graduate Administrative Assistant.
Apply to graduate in LionPATH.	Beginning of semester or summer session in which degree is expected.
Pay thesis fee.	Beginning of semester or summer session in which degree is expected.
Submit draft thesis to Adviser.	Early in last semester.
Schedule Final Oral Examination through the Graduate Program Coordinator, communicate date/time to Graduate Administrative Assistant and distribute copies of thesis to Advisory Committee members and Graduate Program Coordinator.	Distribute thesis only AFTER the thesis has been approved by Advisor and no later than two weeks prior to thesis defense date.
Present departmental seminar based on results of thesis research; schedule through the Seminar Chair	After Final Oral Exam if practical; otherwise, as close to it as is practical.
Submit original copy of thesis to Department Head for signature, then to Graduate School.	After Advisory Committee signs and prior to Graduate School deadline.
Departure meeting with the Director Of Graduate Studies.	Two weeks prior to departure.
Prepare manuscript(s) for publication based on thesis research activity.	Prior to departure.
Disassemble research apparatus and clean as necessary; return equipment and supplies to designated areas. Clean office, desk and file space; empty all drawers and shelves and remove posters.	Prior to departure.
Return departmental keys, books, software, supplies, etc.	Prior to departure.
Provide one electronic copy of thesis to Adviser.	Prior to departure.

*Not all students will be prepared to complete the research proposal for BRS 500 during their first semester; Advisers have the discretion of delaying BRS 500 and completion of the research proposal until the end of the 3rd semester. In these cases, the student (1) should submit a plan of study to their committee at the end of the first semester and (2) work closely with the Adviser to ensure timely completion of the program of study.

Table 1 – Example of a Course Schedule for M.S. Program of Study in BRS

Year 1			
	Course Number	Course Title	Credits
Fall	BRS 500*	Research Methods in BioRenewable Systems	3
	BRS 501*	Bio-Based Polymers	3
	BRS 502*	Human Behavior in Management and Technology	3
		Course from selection list or an elective course	3
Total Credits			12
	Course Number	Course Title	Credits
Spring	BRS 550*	Applied Bioproducts Marketing	3
	BRS 511*	Advanced Structural BioComposites	3
	BRS 551*	Sustainable Business Strategies	2
	Total Credits		
Year 2			
Fall	STAT 500	Applied Statistics	3
	ABE 559	Biological Systems Simulation	3
Total Credits			6
Overall Total Course Credits			26

*New courses

Ph.D. Program of Study

For students holding M.S. degrees, each Ph.D. program of study must meet the following requirements:

<u>Required (Core):</u>	<u>Credits</u>
BRS 500 Research Methods in BioRenewable Systems (Unless previously taken)	3
Communications or International Language/Culture	3
BRS 501 Biobased Polymers	3
BRS 502 Human Behavior in Management and Technology	3
BRS 602 Supervised College Teaching	1
<u>Electives:</u>	
BRS 5XX (excluding BRS 500) or other 400-500 level course as approved by Advisory Committee*	6

**See Graduate Program Coordinator for the most recent list approved by the BRS faculty*

No University-level (Graduate Council) minimum number of courses completed or credits earned are specified for the Ph.D.; the student's dissertation committee will recommend the minimum requirements as appropriate for each individual student's program of study and dissertation research. The candidate is expected to develop a program of study and submit it to the appointed dissertation committee for consideration and approval. All requirements for a

Ph.D. degree, whether satisfied on this campus or elsewhere, must be completed within eight years after passing the Qualifying Examination. Except as specified above, no particular courses, total number of courses or total credits are required by the BRS program. For Ph.D. students that have completed an M.S., the typical coursework load is about 36 credits.

It is recommended that each Ph.D. student not holding an M.S. degree will satisfy the intent of the M.S. degree coursework requirements specified elsewhere in this document. For these students, the typical coursework total is anticipated to be higher than 36 credits.

The student’s Dissertation committee will determine the minimum requirements in such supporting areas as science, technology, and business. The candidate is expected to develop a program of study and submit it to the Dissertation committee for consideration and approval at the qualifying exam.

In addition to the above listed coursework requirements, every graduate student must fulfill the Scholarship and Research integrity (SARI) requirement. The SARI requirement consists of two parts (1) completion of BRS 500 with a grade of B or better, and (2) completion of an online training program at <http://www.research.psu.edu/training/sari/program>, in Physical Sciences and Engineering or Social and Behavioral Sciences. The online SARI requirement must be completed within one year from the date of enrollment in the program of study. Table 2 shows coursework (beyond M.S.) for a student enrolled in Ph.D. program of study in BRS. The proposed schedule in Table 2 allows full-time Ph.D. students to complete the courses in four semesters.

Research credits (BRS 600) are in addition to coursework credits. The Dissertation committee will determine the minimum research credits but typically the total number is 24 credits beyond the M.S. All requirements for a Ph.D. degree, whether satisfied on University Park campus or elsewhere, must be completed within eight years after passing the Qualifying Examination.

Table 2 – Example of a Course Schedule for Ph.D. Program of Study in BRS (Beyond M.S.)

Year 1			
	Course Number	Course Title	Credits
Fall	STAT 501	Regression Methods	3
	BRS 500**	Research Methods in BioRenewable Systems	3
		Technical selection in specialty area(s)	3
Total Credits			9
Year 2			
	Course Number	Course Title	Credits
Spring	STAT 502	Experimental Design	3
		Business/Management elective	3
		Technical selection in specialty area(s)	3
Total Credits			9
	ABE 559**	Biological Systems Simulation	3

Fall		Elective course in communication (from selection list)	3
		Business/Management elective	3
Total Credits			9
Spring		Technical selection in specialty area(s)	3
		Business/Management elective	3
	BRS 602*	Supervised College Teaching	1
Total Credits			7
Overall Total Course Credits			34

*New courses

**If not already completed

Dissertation committee: An initial Adviser will be assigned to each entering graduate student by the Department Head, in consultation with the Graduate Program Coordinator and the faculty member agreeing to serve as adviser. To the extent practical and commensurate with potential funding source(s), research interests of the student and assigned Adviser will be compatible. New graduate students are highly encouraged to visit with various faculty members concerning opportunities for dissertation research activities. After the student has decided on the preferred research area, s/he should inform the Graduate Program Coordinator or Department Head—by the middle of the first semester of study—of the preferred faculty member to serve as permanent Adviser. Each student should schedule at least a one-hour meeting each week with the adviser to ensure adequate communications.

A Dissertation committee must consist of four or more members of the Graduate Faculty and:

- The chairperson and at least one other member must be BRS Graduate Faculty members.
- At least one member must be from a department other than ABE and s/he should be a graduate faculty member of a program other than BRS.
- At least one member must represent any minor department(s) if the student selects a minor(s).
- The Dissertation committee can be appointed only after the Qualifying Examination has been passed.

Communications or International Language/Culture Course Requirements: The purpose of the communications/language requirement is to strengthen the student’s professional communication skills. The candidate must take a 3-credit course in communications. A grade of B or better is required in the course (note: B- does not meet this requirement). The selected course must be approved by the Adviser prior to registration and must meet the expectations of the Dissertation committee. A course used to satisfy this requirement cannot be a course taken

as remedial for the Qualifying Examination and must include the substantial practice of writing and/or speaking. Examples of courses to consider are:

AEE	450	Program Design and Delivery (3)
	530	Teaching and Learning in Agricultural Science (3)
AGCOM	462W	Advanced Agricultural Writing (3)
CAS	450W	Group Communication Theory and Research (3)
	452W	Organizational Communication Theory and Research (3)
	471	Intercultural Communication Theory and Research (3)
ENGL	417	The Editorial Process (3)
	418	Advanced Technical Writing and Editing (3)
	474	Issues in Rhetoric and Composition
	511	Thesis Workshop and Professional Writing (3)
	584	Studies in Rhetoric (3)
HI ED	546	College Teaching (3)

Any 3-credit 4XX foreign language course (Excluding 49X; and must not be candidate's native language).

Qualifying Examination: Ph.D. Qualifying Examination Committee – This committee will consist of four BRS graduate faculty members, including the Adviser, the ABE Department Head (or annually appointed designee), the BRS Graduate Program Coordinator and one faculty member selected by the student. In cases where a member serves two roles on the committee, an additional member will be appointed by the Graduate Program Coordinator.

The Qualifying Examination will consist of developing a Ph.D. research proposal in the semester following the completion of BRS 500, presenting the proposal, and defending/discussing the proposed research with the Committee. The Qualifying Examination will be completed by the student soon after s/he has completed at least 18 credits but before the end of the third semester. Successful completion of the Qualifying Examination does not mean that the student's Ph.D. research proposal is approved. Rather, final approval of the candidate's research proposal will be the responsibility of the Dissertation committee.

Each Ph.D. student will submit to each Qualifying Committee member a detailed proposal for the Ph.D. research a minimum of two weeks prior to the exam. This proposal should contain justification, objectives, related literature, methodology, practical significance, resources required, bibliography, proposed program of study and a statement of possible funding sources to which the proposal could be submitted.

The student will present a 20-minute seminar to the Qualifying Committee. The seminar is open to all in the Department and participants may ask questions of the potential Ph.D. candidate concerning the proposed study, science and technical aspects, business, leadership, and entrepreneurial implications, and other related items. The total seminar time will be limited to approximately 30 minutes. Upon completion of this seminar, the graduate faculty members, and members of the Committee (may) hold a discussion period (no longer than approximately 15 minutes) regarding the student, the

proposed research and the seminar. The student will not be present during this discussion period. Following this discussion, the Qualifying Committee and the student will undertake the remainder of the exam.

The Qualifying Committee will review the written proposal and discuss in detail (up to 2 hours) with the student the proposed research and related topics. The Qualifying Committee will assess the student's understanding of the research process, the student's technical expertise related to biorenewable systems and the proposed research, suitability of the proposed research relative to the BRS graduate program expectations of Ph.D. candidates, the student's understanding of needed resources and other pertinent topics. The Qualifying Committee will also judge the ability of the student to communicate and will complete a "Report on Departmental Assessment of English Competency" (see "English Competency Requirements" section below). The Committee will select, based on the student's performance, one of the following: 1) recommendation that the student become a Ph.D. Candidate, 2) recommendation that the student become a Ph.D. candidate but must undertake additional activities as prescribed by the Qualifying Committee, 3) recommendation that the student undertake additional activities as prescribed by the Qualifying Committee and retake the Qualifying Examination, or 4) rejection of the student as a Ph.D. Candidate. A student will not be allowed to take the Qualifying Examination more than twice.

English Competency Assessment: The Graduate Council and the BRS graduate program of study require candidates for the Ph.D. degree to demonstrate high-level competence in the use of the English language; including reading, writing, listening, and speaking. To fulfill this requirement, the BRS graduate program requires that all Ph.D. students undergo an assessment of English competency. The assessment will include the student's ability to read and comprehend, write, speak, and give presentations so as to effectively participate in scientific and technical discussions. The assessment will be conducted during the Ph.D. Qualifying Examination by the Ph.D. Qualifying Examination Committee and will consist of three parts:

Writing—As part of the Ph.D. Qualifying Examination, the student will prepare a detailed research proposal on the topic chosen for his/her Ph.D. dissertation (see "Qualifying Examination" for further details about proposal). The written document will be judged for its organization, logical arguments in support of the hypotheses, inclusion of relevant details, and appropriate style in the use of language, grammar, punctuation and spelling. The "Literature Section" of the written proposal containing analysis of pertinent literature will be used to evaluate the student's reading comprehension of the technical literature.

Presentation—As part of the Ph.D. Qualifying Examination, the student will present a 20-minute seminar to the Committee. The seminar is open to all in the Department. The presentation will be judged for its organization, clarity, appropriateness to the audience, appropriate use of visual aids, and effectiveness of delivery. The quality of the formal presentation should be comparable to papers presented at technical sessions of professional society meetings.

Oral Discussion—The main purpose of the Oral Discussion part of the English Competency Test is to evaluate the oral skills of the student to participate in scientific and technical discussions with other technical professionals. The Oral Discussion will follow the formal presentation of the research proposal by the student. The examination committee will conduct a discussion with the student on various aspects of the research proposal and on the scientific and technical issues surrounding the research area.

At the end of the Qualifying Examination, each member of the Committee will present an assessment of the student's English competency in the three categories: writing, presentation, and oral discussion. These assessments will be used to certify attainment of English competency or to recommend measures for improving English competency. A "Report on Departmental Assessment of English Competency" form will be completed by the Committee, shared with the student, and placed in the student's Departmental records.

Improving English Competency of Students with Deficiencies—If the expected level of English Competence is not demonstrated, the student must enroll in course(s) to improve English competency. The committee will recommend suitable course(s) which may include selections from the following or additional remedial courses noted in the Report on Departmental Assessment of English Competency (i.e., these courses do not count toward fulfillment of the requirements for the graduate degree):

- Writing Skills
 ESL 116G – ESL/Composition for Academic Disciplines
- Presentational Skills
 CAS 100A – Effective Speech
 CAS 211 – Informative Speaking
- Oral Language Skills
 ESL 114G – American Oral English for Academic Purposes
 ESL 115G – American Oral English for ITAs

If the student completes and passes the recommended course(s) with a B- grade or higher, then the student will be certified as having attained English competency. Otherwise, the student will have to retake the course (or another comparable course). Students judged as not making sufficient progress towards achieving competency in English will have their funding terminated.

Comprehensive Examination: When a Ph.D. candidate has substantially completed the coursework, including the communication requirements, s/he is required to take a Comprehensive Examination covering the major, minor, and related areas of study. The Comprehensive Examination should be scheduled through the Graduate Program Coordinator and the Graduate School at least three weeks prior to the selected date. All candidates are required to have a minimum grade point average of 3.00 for graduate work completed at the University at the time the Comprehensive Examination is given,

and may not have deferred or missing grades. The student must be registered as a full-time or part-time student for the semester in which the Comprehensive Exam is taken. The Comprehensive Examination must be taken at least three months before the Final Oral Examination. If a period of six years has elapsed between the passing of the Comprehensive Examination and the completion of the program, the student is required to pass a second Comprehensive Examination before the Final Oral Examination can be scheduled.

The Comprehensive Examination will be both written and oral. The nature and details of the Comprehensive Examination will be determined by the student's Dissertation committee. In general, the student will be required to demonstrate ability to synthesize information acquired through formal coursework and to use technical literature to find information required for solving biorenewable systems problems. Accordingly, the Comprehensive Examination will consist of 1) The completion of a written examination provided by each of the Dissertation committee members prior to the oral examination; 2) A presentation of the candidate's research; 3) An oral examination that may cover content in the written examination research presentation or relevant subject matter. A favorable vote of at least two-thirds of the committee is required for passing. If a candidate fails, the committee will determine whether another examination may be taken. Results of the examination are reported directly to the Office of Graduate Enrollment Services.

Final Oral Examination: Upon recommendation of the advisor, a Ph.D. candidate who has satisfied all other requirements for the degree will be scheduled by the Dean of the Graduate School to take a Final Oral Examination. The scheduling form can be obtained from the Graduate Administrative Assistant and must be submitted at least two weeks prior to the scheduled exam date. The student must be a registered full-time or part-time degree student for the semester in which the Final Oral Exam is taken. The examination student presentation is open to the public and the student should notify all departmental faculty and graduate students. The examination is related largely to the dissertation but may cover the candidate's entire field of study without regard to courses that have been taken either at Penn State University or elsewhere. Ph.D. candidates enrolled in a dual-title degree program must orally defend a dissertation on a topic that reflects their original research and education in both their BRS graduate program and their dual-title program. The defense of the dissertation should be well prepared including any appropriate visual aids. One of the aims of the preparation should be to synthesize the important conclusions in a time efficient presentation (approximately 20-25 minutes unless otherwise specified), leaving ample time for questions and discussion. A favorable vote of at least two-thirds of the committee is required for passing. If a candidate fails, the committee will determine whether another examination may be taken. Results of the exam are reported directly to the Graduate School.

Criteria for evaluation of the final oral examination:

The following criteria are used to evaluate the final oral examination. The student should be able to demonstrate the ability to 1) understand and communicate potential new short and long-term research hypotheses and/or objectives; 2) create new knowledge and/or develop new solutions/solution methodology(ies); 3) understand and communicate the implications of the new knowledge and findings and their generalization; 4) articulate and defend results to the doctoral committee; and 5) produce a quality dissertation suitable for publication.

Schedule for Ph.D. Requirements: Many of the Ph.D. degree requirements are listed in approximate chronological order on the following page. It is the student's responsibility to ensure that these and all other requirements are met in a timely manner. It is expected that Ph.D. students should complete the degree in a timely manner consistent with the research and funding program developed.

SUGGESTED SCHEDULE FOR Ph.D. DEGREE

Requirement (responsibility of Ph.D. student to ensure completion)	Suggested Completion Dates
Recommend permanent Adviser.	Middle of first semester.
Submit to Adviser a list of courses to comprise graduate plan of study.	End of first semester.
Recommend to Graduate Coordinator faculty members to serve on Qualifying Exam Committee.	End of first semester.
Transfer credit from undergraduate or post-baccalaureate program, if appropriate.	End of first semester.
Prepare dissertation research project proposal for Adviser.	End of first semester, following BRS 500*
Complete semiannual progress report form.	Each January and July.
Schedule and complete Ph.D. Qualifying Examination	Completed immediately following at least 18 credits but before the end of the third semester (target date: first semester following BRS 500)
Form Dissertation advisory committee	After completion of Qualifying Exam
Submit plan of study and dissertation project proposal to Dissertation committee for approval (copy to Graduate Program Coordinator).	End of first semester, following BRS 500*.
Schedule and complete Comprehensive Examination	Upon substantial completion of the coursework and at least 3 months prior to Final Oral Exam
Apply to graduate in LionPATH.	Beginning of semester or summer session in which degree is expected.
Pay dissertation fee	Beginning of semester or summer session in which degree is expected.
Submit draft dissertation to Adviser.	Early in last semester.
Schedule Final Oral Examination and distribute copies of dissertation to Dissertation committee members and Graduate Program Coordinator.	Distribute dissertation only AFTER the dissertation has been approved by Adviser for distribution and at least one week prior to dissertation defense date.
Present departmental seminar based on results of dissertation research; schedule through the Seminar Chair	After Final Oral Exam if practical; otherwise, as close to it as is practical.
Submit original copy of dissertation to Department Head for signature, then to Graduate School.	After Dissertation committee signs and prior to Graduate School deadline.
Departure meeting with Department Head.	Two weeks prior to departure.
Prepare manuscript(s) for publication based on dissertation research activity.	Prior to departure.
Disassemble research apparatus and clean as necessary; return equipment and supplies to designated areas. Clean office, desk and file space; empty all drawers and shelves and remove posters.	Prior to departure.
Return departmental keys, books, software, supplies, etc. to Administrative Assistant.	Prior to departure.
Provide one electronic copy of dissertation to Adviser.	Prior to departure.

*Not all students will be prepared to complete the research proposal for BRS 500 during their first semester; Advisers have the discretion of delaying BRS 500 and completion of the research proposal until the end of the 3rd semester. In these cases, the student (1) should submit a plan of study to their committee at the end of the first semester and (2) work closely with the Adviser to ensure timely completion of the program of study.

Admission Requirements

M.S. Program of Study

In general, for admission to the Graduate School, an applicant must hold either (1) a baccalaureate degree from a regionally accredited U.S. institution or (2) a tertiary (postsecondary) degree that is deemed comparable to a four-year bachelor's degree from a regionally accredited U.S. institution. This degree must be from an officially recognized degree-granting institution in the country in which it operates. Specific to the BRS program, completion of a relevant undergraduate Bachelor degree program is required for admission to the M.*S. degree program; relevant programs span a diverse set of academic disciplines, including but not limited to: Agricultural Sciences, Biology, Chemistry, Business, Engineering, and Environmental Sciences. Students with junior-senior GPA of at least 3.00 (4.00 base) will be competitive in the admission process.

Graduate Record Examination (GRE). All students must submit GRE general aptitude test scores (i.e., verbal, quantitative, and analytical) to be considered for admission.

To qualify for admission, all international applicants must take and submit scores for the TOEFL (*Test of English as a Foreign Language*) or the IELTS (*International English Language Testing System*), with the exceptions noted below. The minimum acceptable score for the TOEFL is 550 for the paper-based test, 213 for the computer-based test, or a total score of 80 with a 19 on the speaking section for the internet-based test. The minimum composite score for the IELTS is 6.5.

International applicants exempt from the TOEFL/IELTS requirement include those who have received a baccalaureate or a graduate degree from a college/university/institution in any of the following: Australia, Belize, British Caribbean and British West Indies, Canada (except Quebec), England, Guyana, Republic of Ireland, Liberia, New Zealand, Northern Ireland, Scotland, the United States, and Wales.

Ph.D. Program of Study

In general, for admission to the Graduate School, an applicant must hold either (1) a baccalaureate degree from a regionally accredited U.S. institution or (2) a tertiary (postsecondary) degree that is deemed comparable to a four-year bachelor's degree from a regionally accredited U.S. institution. This degree must be from an officially recognized degree-granting institution in the country in which it operates.

The program requirement for acceptance to graduate study toward a Ph.D. degree in BRS is typically an M.S. degree with research thesis in BRS or related discipline such as Agricultural Sciences, Biology, Chemistry, Business, Engineering, and Environmental Sciences, or with a B.S. degree in Agricultural Systems Management (ASM) or BRS or equivalent. Outstanding students interested in direct admission from a B.S., B.A., or M.B.A. program to the Ph.D. Program should

contact the Graduate Program Coordinator for further clarification and details. Direct admission will be based on critical evaluation of the student's: potential to conduct publishable research, academic record, an additional language (other than the student's mother tongue), performance on standardized tests, statement of purpose, and reference letters.

Students who apply directly to the Ph.D. program with a BS degree, but are determined to be unqualified, will be considered for admission into the M.S. program or may be admitted on a conditional or provisional basis. The student will remain on a provisional basis until completing the coursework in "C.1 M.S. Program of Study" with a minimum grade point average of 3.00.

Graduate Record Examination (GRE). All students must submit GRE general aptitude test scores (i.e., verbal, quantitative, and analytical) to be considered for admission.

To qualify for admission, all international applicants must take and submit scores for the TOEFL (*Test of English as a Foreign Language*) or the IELTS (*International English Language Testing System*), with the exceptions noted below. The minimum acceptable score for the TOEFL is 550 for the paper-based test, 213 for the computer-based test, or a total score of 80 with a 19 on the speaking section for the internet-based test. The minimum composite score for the IELTS is 6.5.

International applicants exempt from the TOEFL/IELTS requirement include those who have received a baccalaureate or a graduate degree from a college/university/institution in any of the following: Australia, Belize, British Caribbean and British West Indies, Canada (except Quebec), England, Guyana, Republic of Ireland, Liberia, New Zealand, Northern Ireland, Scotland, the United States, and Wales.

Statistical Consulting Services

The Statistical Consulting Center (<http://scc.stat.psu.edu/>) is an educational and service unit in Penn State's Department of Statistics. Faculty, staff and graduate and undergraduate students from Statistics, Computer Science/ Engineering, and Management Science/Information Services provide advice, project management, data management, and statistical analysis for the University and private research community. The Center provides walk-in, short term, and longer term consulting services to graduate students, staff and faculty. Short-term services include two free consultation meetings; whereas longer term services are on an arranged-fee basis.

It is recommended that each student consult with the Statistical Consulting Service during the planning of experiments and prior to data collection, to assure that adequate consideration has been given to statistical analysis.

Thesis Guidelines and Specifications

A degree candidate must demonstrate ability to do independent research and competence in scholarly exposition by the preparation of a thesis on a topic related to the major subject. The thesis should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal an ability on the part of the candidate to do independent research of high quality and indicate considerable experience in using a variety of research techniques. In conformance with the Family Educational Rights and Privacy Act, students are hereby notified that their thesis and other research work may be made publicly available through libraries and other means.

The thesis is to be developed by the student with the supervision, support and criticism of the Advisor. The draft thesis is to be submitted first to the Advisor. The student and the Advisor may agree to prior review of the thesis, either section-by-section or in its entirety, or both. After the thesis has been approved by the Advisor, the student distributes a copy to each member of the Dissertation committee. This draft should be complete in every respect including figures, tables and bibliography; the content and style should be correct and polished.

Graduate students should allow a minimum of five working days before the Final Oral Exam for Dissertation committee members to review the thesis. Some members may require more time. Time for thesis reviews can often be reduced considerably if the graduate student notifies the committee members in advance of the date when copies will be submitted for review.

Acknowledgments. A student is highly encouraged to acknowledge the funding source(s) in the acknowledgments section of the thesis. In all cases, the Penn State College of Agricultural Sciences should be recognized for the contributions it has made to the student's thesis research activities. If the student or the student's research is additionally supported by a contract or grant activity, then it is highly appropriate to acknowledge the source of the external support. An example appropriate statement to acknowledge the support is "Thank you to <Department Head's name> for providing financial support from the Penn State College of Agricultural Sciences throughout my graduate study" or, more simply, "The support received from the Penn State College of Agricultural Sciences is gratefully acknowledged."

Units. All theses must be in SI Units. Customary units may be included in parentheses for special applications.

Thesis Typing. The Information Technology Services (ITS) offers PSTT (Penn State Thesis Template) found at <http://www.gradsch.psu.edu/current/thesis.html>. The thesis is to be completed at the student's expense. Departmental microcomputers may be used for thesis preparation under the following conditions:

- The equipment may be used only by the student.
- The student will readily relinquish the use of the equipment when needed by students or others for extension, research, or teaching purposes.

- The printers are not to be used for multiple copies.

Graduate Seminar

Submission of Thesis. The thesis must meet the Graduate School's format and other requirements. The Office of Theses and Dissertations at: <http://www.gradsch.psu.edu/current/thesis.html> publishes a "Thesis Guide" <http://www.gradschool.psu.edu/current-students/etd/thesisdissertationguidepdf/> and provides thesis writers workshops several times each semester. In addition to Graduate School requirements, the student must provide one CD or an electronic copy to the Thesis Office and his/her Advisor.

(Advisors and the Dissertation committee may require additional copies, perhaps in bound or other formats. The cost of any additional copies required by the sponsor of the research project will be covered by the project funds.)

A graduate student must present a departmental seminar at the termination of each degree program, based on his/her thesis project. Seminars should be scheduled through the Seminar Chair, be during the regular seminar time slot, and be after the Final Exam or at least as close to the end of the degree program as is practical.

Graduate students must attend all department seminars each semester unless they have course conflicts and are encouraged to suggest topics and speakers to the seminar committee. Seminar attendance after passing the Final Oral Exam is optional.

If a student has a regularly scheduled course during the seminar period, then the student must inform the Graduate Program Coordinator at the beginning of the semester prior to the first scheduled seminar. A student may miss up to three seminars per semester without any penalty. If the number of missed seminars exceeds three, this absence will be noted on the student's progress report and the department may withdraw funds for travel to conferences and/or other departmental support. No remedial action will be required if the student provides evidence of attending seminars elsewhere at PSU; equal in number to the missed seminars during the same semester. The substitute seminars must be part of an organized series or a special event and cannot be seminars given as part of a graduate committee event.

Participation in Departmental Activities

All graduate students are invited and encouraged to attend department meetings, retreats, seminars, socials, and all other activities. However, at the discretion of the Department Head, some departmental activities may be for only the faculty.

Graduate students are also invited and encouraged to become involved with departmental committees. Graduate students may not serve on the Graduate Applications Subcommittee to avoid any possible conflict of interests. Graduate student members of committees shall have full voting rights.

Other Degrees

Minors in Agricultural and Biological Engineering

A student pursuing a master's degree in BRS may earn a minor in ABENG by completing at least 9 credits of 4XX or 5XX ABE courses. No more than a total of 3 of the minimum credits may be earned in 49X or 59X courses.

A minor in ABENG for a Ph.D. student must consist of no less than 15 credits of 4XX or 5XX ABE courses. No more than a total of 6 of the minimum credits may be earned in 49X or 59X courses. If the student received a master's minor in the same field as is being proposed for a Ph.D. minor, the 15 credits taken must be above and beyond those used for the master's minor. At least one faculty member from the minor field must be on the candidate's Dissertation committee.

Dual-Title Degree in BRS and INTAD

A student may also pursue a dual title degree in BioRenewable Systems and International Agricultural Development (BRS-INTAD). This program is especially suited to students who are carrying out a research project that has an international agriculture component, and/or those who are interested in pursuing a career in international agricultural development. Students in this program must satisfy the requirements of both the BRS and the INTAD program, which may or may not require additional coursework. Students interested in the dual title degree program should consult the department's INTAD coordinator for information on admission, course selection and degree requirements. Further information on the INTAD program can also be found on the [INTAD](#) website.

Student Organizations

There are several student organizations responding to the needs of graduate students. The largest group is the Graduate Student Association (GSA) which is a university-wide group consisting of representatives from each department. GSA provides a liaison between graduate students and University Administration and acts as both a lobbying group for student issues (such as insurance and taxes) and as a social organization providing such opportunities as happy hours and the summer rental of garden plots. The Engineering Graduate Student Council (EGSC) performs a similar function by providing a communication link to the College of Engineering. EGSC often sponsors panel discussions and brown-bag lunches while also having input on various college advisory committees. Representatives for both of these groups are elected from within the department near the end of each spring semester.

The diversity among graduate students is reflected by the number of ethnic and social groups available to students. Among the many groups are: Friends of India (FOI), Women in Science and Engineering (WISE), and the Black Caucus. The Penn State Outing Club has many divisions including canoeing, hiking, biking, skiing, and equestrian.

Post-Graduation Employment

Assistance finding employment is available at the department, College, and University levels. The Agricultural Sciences Careers Fair is held each fall and attracts about 50 employers. University-wide career fairs are held each September and April in Bryce Jordan Center. Career Services (<http://studentaffairs.psu.edu/career/>) provides assistance in the following areas:

- Drop-In & Career Counseling
- Nittany Lion Career Network
- Job Search and Career Fairs
- Workshops & Events
- Career Information Center
- Education Credentials Services

Student Petitions

A graduate student has the right to submit a petition concerning any academic and/or administrative policy related to the graduate degree program. Generally, a petition needs to be approved by the Advisor and the Dissertation committee and then sent to the Graduate Program Coordinator who will forward the petition as appropriate. The Department Head, in consultation with the Graduate Studies Committee, will make the final decision on petitions relating to policies and requirements promulgated by the department. In all cases, a petition must be submitted as early as possible so that the student has time to develop alternative plans if the petition is denied. Problems that develop between a student and member(s) of the Dissertation committee can be arbitrated on a confidential basis by the Department Head and/or Dean of the Graduate School, as appropriate.

Administrative Policies

Assistantship Responsibilities

A graduate student on a 1/4-time assistantship is expected to work a minimum of 10 hours per week on activities that are in compliance with the overall departmental objectives as determined by the Advisor. Students on 1/2-time or full-time assistantships are expected to work on a similar basis for a minimum of 20 hours or 40 hours per week, respectively. These work requirements may include thesis research activities.

To allow for obtaining a broad base of experiences and professional growth, each graduate student is encouraged to seek involvement with the Advisor and/or Dissertation committee members to gain teaching (classroom or extension) experiences as a part of the graduate education. This experience is expected for all Ph.D. candidates. In addition, each Ph.D. candidate should seek involvement with his/her Advisor to write and submit a research proposal for external funding. Each graduate student should discuss the opportunities for participation in teaching and proposal preparation with his/her Advisor and the Department Head.

The Test of Spoken English (TSE) is required of graduate students whose native language is not English before such students can be appointed to graduate teaching assistantships. Students who score less than 220 on the TSE will not be permitted to hold teaching assistantships.

Work Related Injury

The University covers its employees with Worker's Compensation Insurance as a protection for injuries or illness compensable under the Pennsylvania Worker's Compensation Act.

An employee has an obligation to report any work-related injury, regardless of how minor, to his or her supervisor. The employee will be provided with a "Workers' Compensation Employee Notification" form and a copy of the "Healthcare Provider Panel" list. Any treatment for the first 90 days from first treatment must come from a "Panel" provider in order to ensure that the University will pay for medical treatment. If the injury results in an immediate medical emergency, initial medical assistance may be obtained from a hospital or health care provider of the employee's choice. However, subsequent treatment must be from a "Provider Panel" participant.

Additional information on this topic can be obtained from the Risk Management Office/Privacy Office, 227 West Beaver Avenue, Suite103 Rider Building, State College, PA 16801, phone 814-865-6307.

Health Insurance

The Student Insurance Office is responsible for administering two health insurance plans for graduate students. A graduate student who is on a Graduate Assistantship or Graduate Fellowship is automatically enrolled in the Penn State Graduate Assistant and Graduate Fellow Health Insurance Plan, and the Vision and Dental Plans, which also provides coverage for eligible dependents. Penn State will provide a subsidy of 80% of the annual premium cost for the graduate assistant or fellow and deduct the student's 20% contribution from the monthly paycheck. Health insurance subsidy for eligible dependents is 70% of the annual premium expense. To enroll a spouse and/or dependents for Medical, Dental, and Vision benefits, graduate students must complete the "Online Dependent Enrollment Form within the initial website listed below.

Graduate students not on an assistantship or fellowship may enroll in the Penn State Student Accident and Sickness Insurance Plan. All international students and their accompanying dependents (spouse and/or children) must have health insurance coverage. This may be fulfilled in one of two ways:

- Purchase the Penn State Student Accident and Illness Plan
- Acquire a comparable health insurance plan and provide the University with documentation that provides proof of insurance by submitting a waiver application to the Student Insurance Office.

Further details regarding student health insurance are available at the University Health Services Office, 302 Student Health Center, phone 814-865-7467, or visit: <https://studentaffairs.psu.edu/health-wellness/health-insurance>.

Publication and Presentation

Publication and presentation of knowledge created through research is an essential experience in graduate education. Future employers in academia, government and industry use a student's publication and presentation records as important metrics in evaluating the quality of applicants. The experience and skills developed by preparing and submitting a manuscript, engaging in scholarly debate during the review process, and producing a polished final publication are important for a student's career. Similarly, the ability to provide a clear, accurate and compelling scholarly presentation will be needed throughout one's professional life. In addition, student and faculty productivity in publishing and presenting research results are important to the success of the department. Publication and/or presentation may also be a requirement associated with some sources of student funding.

To prepare graduate students for success in obtaining and excelling in future positions, it is expected that students will prepare and submit publications appropriate for their specific field of study. These may include peer reviewed journal articles, conference papers or extension publications. Students are also expected to present their research at a conference or venue appropriate for their field. Specific expectations for number of publications and presentations will be established by the student, advisor and advisory/doctoral committee. For example, an

M.S. student may be expected to submit 1-2 peer reviewed journal articles and provide 1 technical conference presentation. A Ph.D. student may be expected to submit 3-4 peer reviewed journal articles and provide 1-2 conference presentations. Students should discuss expectations with their advisor at the start of the degree program and, once an advisory/doctoral committee is formed, discuss again so that the expectations are clear. Expectations should be revisited at least yearly during committee meetings and be included in student's progress reports. The student, advisor and committee should establish and follow a research plan that will enable the student to achieve the publication and presentation goals. Students are also expected to support the publication process after graduation. This may include leading the preparation of new publications, aiding in the development of a response to reviewer comments, revising manuscripts and reviewing proofs. In the event that a student graduates having obtained publishable research but does not submit a publication on that research after a period of 6 months, the student's advisor(s) and collaborator(s) may submit a manuscript based on, or that includes, the research. Authorship will be determined based on the level of effort and intellectual contributions of those involved. The student will be notified in writing of the intent to publish and authorship status. Reasonable expenses for publication of manuscripts based on theses (i.e. page charges) are considered legitimate departmental expenses and will be paid by the department. However, expenses for thesis preparation are considered personal expenses and must be paid by the student.

Research Data, Software, Designs, and Manuscripts

All research data, patents, designs, computer software, creations, slides, pictures, reports, etc. obtained by graduate students on assistantship support are the property of the ABE Department. All research data and other requested materials must be submitted to the Advisor before the student leaves Penn State University. The student must also archive all research data using a university archive service such as ScholarSphere available at the university library. If any patents or copyrights are awarded to the inventions or designs of any graduate student's thesis research, then both the student and Advisor are credited. They can receive a percentage of the profits or royalties realized from the patents or copyrights.

Professional Ethics

Penn State policy AD-47 sets forth statements of general standards of professional ethics to serve as a reminder of the variety of obligations assumed by all members of the academic community, including graduate students. The handling of inquiries into questions of ethics is covered in RA-10. RA-13 deals with the co-authorship of scholarly reports, papers, and publications. These policies are available from the departmental administrative assistant.

Academic Integrity

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, students should act with personal integrity, respect other students' dignity, rights and property, and help create and

maintain an environment in which all can succeed through the fruits of their efforts. Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others. Students should read and become familiar with The Pennsylvania State University Policies AC47 *General Standards of Professional Ethics*; AD67 *Disclosure of Wrongful Conduct and Protection From Retaliation*; and AD88 *Code of Responsible Conduct*.

Academic Integrity Guidelines for the College of Agricultural Sciences can be found at <http://agsci.psu.edu/students/resources/academic-integrity> .

A lack of knowledge or understanding of the University's Academic Integrity policy and the types of actions it prohibits and/or requires does not excuse one from complying with the policy. Penn State and the College of Agricultural Sciences take violations of academic integrity very seriously. Faculty, alumni, staff and fellow students expect each student to uphold the University's standards of academic integrity both in and outside of the classroom.

Disability Statement

Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments in this course, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services Web site at <http://equity.psu.edu/ods/> .

In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the documentation guidelines at <http://equity.psu.edu/ods/guidelines>). If the documentation supports the need for academic adjustments, ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.

Travel to Professional Meetings

Graduate students registered full-time will be provided with \$300.00 support plus surface transportation to attend one national ASABE Meeting (or comparable professional meeting) while pursuing a graduate degree. Each full-time graduate student will be encouraged to attend additional ASABE National Meetings with this level of support when he/she is senior author of a paper that he/she is presenting. Surface transportation will be provided, as resources allow, for all graduate students to the ASABE National Meetings regardless of how many times they have attended previously. Support for graduate students to attend other national professional meetings may be provided with the recommendation of the Advisor. This travel support is provided to graduate students from general departmental funds to further

stimulate professional growth and development. Budget constraints may dictate that this travel support be reduced at times.

Office and Key Assignments

Office space is assigned to graduate students on a space-available, priority basis; assignments are made by the Graduate Program Coordinator. Priority of office space is generally given in the order of: 1) graduate students with assistantship support; 2) full-time graduate students without assistantship support; 3) full-time graduate students on provisional admittance; and 4) part-time graduate students.

Nearly every graduate student desk has a desk-top bookshelf. To preserve the high-quality of the desk-top bookshelves, please do not fasten anything to the bookshelves with tape, glue, thumbtacks, staples, nails, etc. These bookcases were made from high-quality, cabinet-grade oak plywood and they will be attractive for many years if they are properly cared for today. Upon request, a small bulletin board will be provided to each graduate student for mounting items rather than fastening them to the bookshelf. Keys are available for most desks.

Door keys will be assigned to graduate students by the Administrative Assistant; assigned keys will unlock exterior doors and doors to graduate student offices and many labs. If a graduate student needs access to other facilities, an appropriate key will be assigned. All door keys require a \$5.00 refundable deposit.

Graduate students must return keys assigned to them upon completion of their graduate program. Keys are not to be loaned to anyone and it is unlawful to duplicate them. GRADUATE OFFICE DOORS ARE TO BE KEPT LOCKED WHENEVER NO ONE IS PRESENT IN THE ROOM.

Recycling

Each graduate student is expected to participate in recycling, per Policy AD34 University Recycling Program. Recycling Guidelines are posted on departmental bulletin boards.

Smoking

For the consideration of health, comfort, and safety of all people in the department, SMOKING IS NOT ALLOWED IN ANY FORM IN ANY AREA of the Agricultural Engineering Building or in any University vehicles.

Regulatory Compliance

Human Research Subjects. University policy requires institutional review and approval of all activities that involve using human subjects in research. A human subject is defined as an individual about whom an investigator (whether professional or student) conducting research obtains (1) data through intervention or interaction with the individual, or (2) identifiable private information. Contact the Office for Research Protections, The 330 Building, Suite 205, University Park, PA, or phone 814-865-1775 or e-mail ORProtections@psu.edu, for more details.

Vertebrate Animals. Approval by the University's Institutional Animal Care and Use Committee (IACUC) is required prior to the involvement of a vertebrate animal in any University activity. This policy applies to non-human vertebrate animals, live or dead, and parts thereof, excluding established cell lines, biological fluids, and conventional foods. Contact the Office for Research Protections, The 330 Building, Suite 205, University Park, PA, or phone 814-865-1775 or e-mail ORProtections@psu.edu, for more details.

Biohazardous Materials. All University research and teaching activities involving biohazardous materials shall be reviewed and approved by the University Biosafety Committee prior to the use of any such reagent. Included are carcinogens, toxins, infectious agents, recombinant DNA, and human body fluids or tissue. Contact the Office for Research Protections, The 330 Building, Suite 205, University Park, PA, 814-865-1775, ORProtections@psu.edu, or Office of Environmental Health and Safety, 6 Eisenhower Parking Deck, 814-865-6391, for more details.

Hazardous Materials. All hazardous materials must be properly handled, including proper waste disposal. Contact the Office of Environmental Health and Safety, 6 Eisenhower Parking Deck, 814-865-6391, for more details.

Purchasing

Materials, supplies, equipment and travel required for conducting research contributing to a departmental research program will be supported by the department with state and federal funds and special grants.

All purchases made for extension, research, and teaching activities, whether related to thesis research or not, must be approved in advance by the Advisor and should be made using a Penn State Purchasing Card whenever practical. The policy of the department with respect to purchases is as follows:

- A graduate student must obtain approval of the Advisor before ordering or picking up material.
- The signed receipt must be attached to a yellow reconciliation form and submitted to the Administrative Assistant.
- These receipts are kept on file by the Administrative Assistant to be checked against the monthly bills.

Supplies and Support Services

Requests for supplies and support services, especially including the assistance of secretaries and technicians, are to be channeled through the Advisor. Supplies and services are restricted to work in support of research activities with approval of the Advisor. However, expenses related to coursework and thesis preparation are considered personal expenses and must be paid by the student.

Graduate students are expected to write manuscripts for publication based on thesis or technical projects and to participate with faculty in the preparation of grant proposals. Related expenses are considered legitimate departmental expenses and, with Advisor approval, necessary supplies and support services will be made available.

Computers and Access Accounts

The department has a microcomputer lab in Room FRL 303 that is available for graduate student use. All lab computers are directly connected to the university network backbone for full Internet capabilities.

All students will be assigned an access account by the university. Account IDs and passwords can be obtained by showing proper identification (student ID or driver's license) at any public computer laboratory on campus, 12 Willard, or Accounts office in 230 Computer Building. The access account provides electronic mail support and Netnews privileges. All microcomputers in the department support electronic mail and Internet access programs.

Microcomputers in rooms FRL 303 are available for coursework, research, and any university-related use. In addition, they can be used for professional development materials such as thesis, resumes, letters, etc. However, use of laser printers for personal use, including professional development items, will cost 10 cents per page, payable to the Administrative Assistant.

No software may be placed on any departmental computer without permission of the computer systems manager and/or Advisor. Commercial software on these computers may not be copied at any time. Grad students can be allocated storage space on a server by requesting it from the systems administrator. Personal files should be kept on a CD or USB drive, since all personal files and unofficial software will be removed periodically.

Occasionally, instructors will reserve the computer lab for a particular class period. During these times, the class has priority on the lab computers. However, in many cases the instructor will allow use of open computers during that time. Please check with the instructor who reserved the lab if you desire to use a computer during that time.

Graduate students have access to the computer lab after regular work hours. It is the student's responsibility to lock the doors in the computer room when leaving during the hours of 5:00 p.m. to 8:00 a.m. and during weekends and holidays.

Fabrication Lab

Students are expected to fabricate experimental equipment needed for their thesis research if the equipment is not otherwise available. Students must follow all guidelines and policies, found at <http://abe.psu.edu/research/facilities/fabrication-lab>. Please note the following:

- The Fabrication Lab is intended only for extension, research and teaching activities.

- All graduate students must attend and satisfactorily complete workshops of instruction on the proper, safe use of facilities and tools. Upon completion of this course, the graduate student will be extended the privilege of Fabrication Lab access. See Fabrication Lab Supervisor for more details. Faculty and staff are expected to complete the workshops as well.
- Eye protection (safety spectacles or cover goggles) and disposable hearing protection are available free of charge to all graduate students upon their initial employment. This equipment is considered the property of the individual student. It is recommended that an individual wearing prescription glasses use the cover goggles on top of prescription glasses.
- Each graduate student shall use the personal protective equipment when working with any of the tools, equipment, and facilities in the Fabrication Lab. Safety instructions, more specialized safety equipment, and reminders are mounted on or near the tools, equipment, and facilities. If there is ever any doubt concerning the safe, proper use of any of the tools, equipment, or facilities, please check with the Fabrication Lab Supervisor.
- A graduate student may not permit people outside the department to use any departmental equipment, facilities, or supplies.
- In cases of extensive or complex fabrication, personnel may help with the work or the work may be contracted out. Use of personnel must be arranged by the Advisor in advance. Graduate students should not use general Lab supplies (steel, plastic, pipe, wood, etc.) without prior approval of the Fabrication Lab Supervisor and Advisor.

Use of University Vehicles

University vehicles are for OFFICIAL USE ONLY. Operators of university vehicles must abide by all highway laws. Special courtesy to other drivers should be exercised at all times, since one is representing the department, University and Commonwealth when driving a university vehicle. Only University students and employees may be passengers in university vehicles unless others have been authorized to participate in official business. An operator should check with the Department Head or the Advisor to determine whether a non-employee has been authorized to ride.

Requirements to operate university vehicles include that the drivers have a driver's license that is valid in Pennsylvania and be an employee of the University. Only those graduate students who are receiving an assistantship, fellowship, or wages from Penn State are employees. Students operating University vehicles must check with the Fabrication Lab Supervisor concerning procedures for signing out vehicles, purchasing fuel, and maintaining vehicle records.

Graduate Faculty

Rachel Brennan (rbrennan@engr.psu.edu)

Ph.D., University of Illinois at Urbana-Champaign, 2003

Associate Professor

Ecological wastewater treatment, bioremediation of soil and groundwater contaminants

Jeffrey M. Catchmark (jmc102@psu.edu)

Ph.D., Lehigh University, 1995

Professor

Cellulose synthesis and organization, nanofabrication and nanocharacterization, molecular and catalytic motors and sensors, plasmonics

Stephen Chmely (sc411@psu.edu)

Ph.D., Vanderbilt University, 2010

Assistant Professor

Biorefining; lignin valorization; new materials and products from biomass; chemical catalysis

Daeun Choi (dxc519@psu.edu)

Ph.D., University of Florida, 2017

Assistant Professor

Robotics/machine vision applications in specialty crop production

Dan Ciolkosz (dec109@psu.edu)

Ph.D., Cornell University, 2000

Assistant Research Professor

Bioenergy

Christine Costello (cxc693@psu.edu)

Ph.D., Carnegie Mellon University, 2010

Assistant Professor

Industrial ecology; ethical decision making; life cycle analysis

Ali Demirci (axd29@psu.edu)

Ph.D., Iowa State University, 1992

Professor

Microbial food safety engineering; industrial microbiology/fermentation

Herschel A. Elliott, P.E. (hae1@psu.edu)

Ph.D., University of Delaware, 1979

Professor

Fate and control of pollutants in soils and water

Eileen E. Fabian (efw2@psu.edu)

Ph.D., Cornell University, 1995

Professor

Environmental biophysics, ventilation systems, air quality

Long He (luh378@psu.edu)

Ph.D., Yanshan University, 2010

Assistant Professor

Mechanization & Automation for Specialty Crops, Precision Agriculture

Paul H. Heinemann (hzh@psu.edu)

Ph.D., University of Florida, 1985

Professor

Systems modeling; mushroom production, odor and air emissions; advanced sensors for food quality evaluation

Jude Liu (jxl79@psu.edu)

Ph.D., University of Manitoba, 2005

Associate Professor

Machine development for biomass harvesting and processing, and bioenergy utilization.

Michael L Mashtare Jr (mmashtare@psu.edu)

Ph.D., Purdue University, 2013

Assistant Professor

Environmental soil chemistry, emerging contaminant fate and transport, SoTL

Lauren McPhillips (lxm500@psu.edu)

Ph.D., Cornell University, 2016

Assistant Professor

Water quality; stormwater management; green infrastructure; urban ecohydrology; biogeochemistry

Judd Michael (jhm104@psu.edu)

Ph.D., Pennsylvania State University, 1994

Professor

Sustainable enterprises, packaging, entrepreneurship, business management

Heather Preisendanz (heg12@psu.edu)

Ph.D., Purdue University, 2011

Associate Professor

Fate and transport of emerging contaminants; water quality; best management practices; green stormwater infrastructure

Cibin Raj (craj@psu.edu)

Ph.D., Purdue University, 2013

Assistant Professor

Storm water management, watershed analysis, application of computational methods in watershed analysis, ecohydrological impacts of climate and land use change

Thomas L. Richard (tlr20@psu.edu)

Ph.D., Cornell University, 1997

Professor

Microbial bioconversion processes; sustainable manure management

C. Alan Rotz (car18@psu.edu)

Ph.D., Penn State University, 1977

Adjunct Professor (USDA-ARS Pasture Systems and Watershed Management Research Unit)

Farm production systems; farm environmental impact

Howard M. Salis (hms17@psu.edu)

Ph.D., University of Minnesota, 2007

Associate Professor

Synthetic Biology, Genetic compiler, Metabolic Engineering

Robert D. Shannon (rds13@psu.edu)

Ph.D., Indiana University, 1993

Associate Professor

Wetland and aquatic biogeochemistry; pollution of aquatic systems

Juliana Vasco-Correa (jpv5237@psu.edu)

Ph.D., Ohio State University, 2017

Assistant Professor

Bioproducts systems analysis; biologically based processing

Yimin Zhu (yuz30@psu.edu)

Ph.D., SUNY at Stony Brook, 2005

Assistant Professor

Lignin chemistry and engineering, organic chemistry, chemical biology

BioRenewable Systems (BRS) Masters Program Assessment Form

M.S. Thesis Proposal Review and Evaluation

Student name: _____

Date: _____

Form to be completed by the student's Thesis committee, as appropriate, and given to the department's Graduate Studies Committee administrative support staff.

Criterion 1: Demonstrated ability to apply knowledge of biorenewable industries and knowledge of a specialized field to the design of an original research proposal.

Criterion 2: Demonstrated a well-defined and sound science and/or experimental methodology to the solution of new problems.

Criterion 3: Demonstrated ability to articulate the proposed methodology and analysis to the advisory committee.

Note: in the table below D-Deficient; A-Acceptable; S-Superior

Faculty name (print above, sign below)	Criterion 1			Criterion 2			Criterion 3		
	D	A	S	D	A	S	D	A	S

Please provide comments or recommendations for any Criterion that received a score of D below or on other side.

Revised: Fall, 2016; Summer, 2017

BioRenewable Systems (BRS) Masters Program Assessment Form

M.S. Thesis Oral Examination

Student name: _____

Date: _____

Form to be completed by the student's Thesis committee, as appropriate, and given to the department's Graduate Studies Committee administrative support staff.

Criterion 1: Demonstrated ability to create new knowledge and solution methodology(ies).

Criterion 2: Demonstrated ability to understand the implications of new findings and their possible generalization.

Criterion 3: Quality of thesis.

Criterion 4: Demonstrated ability to articulate and defend results to the advisory committee.

Note: in the table below D-Deficient; A-Acceptable; S-Superior

Faculty name (print above, sign below)	Criterion 1			Criterion 2			Criterion 3			Criterion 4		
	D	A	S	D	A	S	D	A	S	D	A	S

Please provide comments or recommendations for any Criterion that received a score of D below or on other side.

Revised: Fall, 2016; Summer, 2017

BioRenewable Systems (BRS) Doctoral Program Assessment Form

Qualifying Exam

Student name: _____

Date: _____

Form to be completed by the student's Qualifying committee, as appropriate, and given to the department's Graduate Studies Committee administrative support staff.

Criterion 1: Demonstrated ability to apply knowledge of biorenewable systems and knowledge of a specialized field to the design of an original research proposal.

Criterion 2: Demonstrated a well-defined ability to approach the solution of new problems by the methodical and logical application of sound scientific methods.

Criterion 3: Demonstrated ability to articulate and defend scientific reasoning to the Qualifying committee.

Note: in the table below D-Deficient; A-Acceptable; S-Superior

Faculty name (print above, sign below)	Criterion 1			Criterion 2			Criterion 3		
	D	A	S	D	A	S	D	A	S

Please provide comments or recommendations for any Criterion that received a score of D below or on other side.

Revised: Fall, 2016; Summer, 2017

BioRenewable Systems (BRS) Doctoral Program Assessment Form

Comprehensive Exam

Student name: _____

Date: _____

Form to be completed by the student's Qualifying committee, as appropriate, and given to the department's Graduate Studies Committee administrative support staff.

Criterion 1: Demonstrated ability to apply in-depth knowledge of a specialized field to the design and execution of an original research question.

Criterion 2: Demonstrated well-defined ability to approach the solution of new problems by the methodical and logical application of sound scientific methods.

Criterion 3: Presentation of a set of experimental and/or theoretical results in support of one of more hypotheses and/or objectives

Criterion 4: Presentation of a well thought through research roadmap and timeline for completion of research.

Criterion 5: Demonstrated ability to articulate and defend approach and results to the doctoral committee.

Note: in the table below D-Deficient; A-Acceptable; S-Superior

Faculty name (print above, sign below)	Criterion 1			Criterion 2			Criterion 3			Criterion 4			Criterion 5		
	D	A	S	D	A	S	D	A	S	D	A	S	D	A	S

Please provide comments or recommendations for any Criterion that received a score of D below or on other side.

Revised: Fall, 2016; Summer, 2017

BioRenewable Systems (BRS) Doctoral Program Assessment Form

Dissertation Defense

Student name: _____

Date: _____

Form to be completed by the student's Qualifying committee, as appropriate, and given to the department's Graduate Studies Committee administrative support staff.

Criterion 1: Creation of new knowledge and/or development of new solutions/solution methodology(ies).

Criterion 2: Demonstrated ability to understand and communicate the implications of the new knowledge and findings and their generalization.

Criterion 3: Demonstrated ability to understand and communicate potential new short and long-term research hypotheses and/or objectives.

Criterion 4: Quality of dissertation.

Criterion 5: Demonstrated ability to articulate and defend results to the doctoral committee.

Note: in the table below D-Deficient; A-Acceptable; S-Superior

Faculty name (print above, sign below)	Criterion 1			Criterion 2			Criterion 3			Criterion 4			Criterion 5		
	D	A	S	D	A	S	D	A	S	D	A	S	D	A	S

Please provide comments or recommendations for any Criterion that received a score of D below or on other side.

Revised: Fall, 2016; Summer, 2017