

AGRON./HORT. 338 SEED SCIENCE & TECHNOLOGY



IOWA STATE UNIVERSITY
Department of Agronomy
Crop, Soil, and Environmental Sciences

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Center Highlights

- Research, education, and training to develop tomorrow's leaders
- Largest public seed testing laboratory in the world (over 100,000 tests for more than 300 species)
- Seed health tests for over 350 pathogens to facilitate movement of seeds (\$800 M) across boundaries
- Development and administration of the new National Seed Health System
- Projects in over 80 countries in 12 years (currently in 30 countries) on seed policies and industry development



Global Seed Program Activities
80 countries in past 12 years



Agronomy/Horticulture 338

Goals

- Prepare the students for jobs in all areas of the seed industry, including seed quality assurance, seed conditioning, seed production and sales representative.



Course objectives

- To gain knowledge of all aspects of seed biology, seed conditioning, quality assurance and production (through lectures and laboratory assignments)
- To integrate the knowledge acquired for problem solving of seed quality and production (through group question and answer sessions)



Class structure

Lectures

- Power Point presentations will be on the web
 - URL: <http://www.agron.iastate.edu/courses/agron338/>
 - Username: ISU e-mail address
 - Password: ISU password

Labs



- Seed Science Center
 - 106 SSC
 - Hands-on
 - Handouts on the web
 - Lab reports
- Seed company tours
 - Meet at back door of Agronomy Hall by the greenhouses
 - Tour reports



Must wear appropriate footwear for labs and tours

Going to the Lab? Dress for the occasion.



Wear appropriate footwear!

IOWA STATE UNIVERSITY
Department of Environmental Health and Safety
319-246-5339 www.ehs.iastate.edu

Progress evaluation

- Weekly quizzes
- Lab and tour reports
- Two mid term and one final exams
- Group question and answer assignment (integrated knowledge)

Grading system

- Mid terms (2 ×200) 400 points*
- Final (comprehensive) 200 points*
- Quizzes 100 points
- Group assignment 300 points
- Laboratory reports 100 points
- Participation in discussion 100 points
- Total possible points= 1000

*Lowest midterm or final score is automatically dropped. If you miss the midterm or final, there is no makeup exam. The exam you miss will be dropped from the grade and your grade will be recalculated based on two exams.

Letter grade



- | | |
|---|--------------------------------------|
| <input type="checkbox"/> A 920 or above | <input type="checkbox"/> D+ 670 |
| <input type="checkbox"/> A- 900 | <input type="checkbox"/> D 620 |
| <input type="checkbox"/> B+ 870 | <input type="checkbox"/> D- 600 |
| <input type="checkbox"/> B 820 | <input type="checkbox"/> F Below 600 |
| <input type="checkbox"/> B- 800 | |
| <input type="checkbox"/> C+ 770 | |
| <input type="checkbox"/> C 720 | |
| <input type="checkbox"/> C- 700 | |

Quizzes



- Multiple choice.
- During lectures.
- Worth 20 points each (total of 5 quizzes).
- About topic covered in previous two classes.
- Two types of quizzes. Individual or individual + group. Class chooses at the beginning of the semester the weight of each part of the exams.

Group assignments



- Groups of approx. 3 to 4 students.
- Each group will be given a case scenario to analyze and find three or four alternative answers.
- Each student in the group will discuss the answer to this scenario.
- Answers are due a week before the presentation in pdf or other electronic form.
- Rest of the class must read the answers and be prepared for discussion (individual or group).

Laboratories



- Must present a summary of each lab session or field trip:
 - Guidance for Lab reports can be found in the Agron 338 course-webpage under the lab handouts tab.
 - Tour reports should include: name of place and people visited, purpose of the visit, and what was learned.
- Summary must be submitted at the next lab session either electronically or hardcopy.
- If you fall behind submitting the summaries, you'll lose 2 points for each week's delay.

Labs and Tours etiquette



- Wear closed-toes shoes. In some tours and labs, safety glasses and ear plugs are **required**.
- Ask questions during the tours and industry lecturers. These visits to/from potential employers give you the opportunity to find out more about their companies and about the work they do.
- Be on time. If at all possible, I would prefer to leave for the tours by 2 pm. But the van will leave at 2:10 pm regardless.
- Please inform Dr. Goggi of conflicts that might prevent you from being on-time.

Attendance

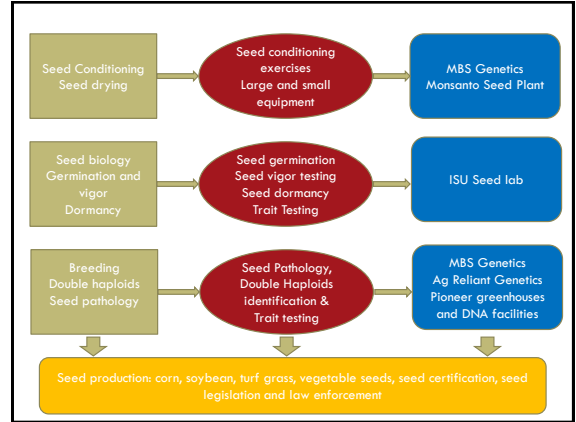


- A minimum of 70% attendance to lectures and laboratories is mandatory for this course.
- Please inform Dr. Goggi of personal or professional conflicts that might prevent you from attending class as your grade depends on attendance. Decisions will be made on a case-by-case basis.

Goals of AGRON 338



1. Better prepared for the job market.
2. Broad knowledge of seed industry.
3. Flexibility.
4. Team work.
5. Capable of solving real case problems affecting the seed industry.
6. Meet with seed industry personnel in a non-stressful environment.



What former students think

- Aaron Strike, Fall 2013 Agron./Hort. 338 graduate, told the Fall 2014 students during our class visit to Ag Reliant breeding facility in Boone "do well in this class so you can get a job in the seed industry upon graduation".
- Kevin Boyer, quality assurance lead for Syngenta who wrote in an e-mail: "My job will involve process simulation lab work, very similar to what we learned in your lab performing small-scale conditioning operations. I'm very glad I took your course."

What former students think

- Fall 2014 Brazilian exchange student, Eduardo Pacheco Bezerra: "I am sending this e-mail to thank you for the opportunity to meet you and have that amazing experience both in class and field tours."

In one of the tour to Monsanto Company's Facility in Boone, IA, I met Nate Cottingham, manager of the site, and because of that tour, during the career fair he asked to interview me and now I am the seed production intern here. They moved me to Constantine, MI, the biggest seed production facility of Monsanto in the World. It is being an amazing experience."

no texting, e-mailing, or cell phone calling

It can wait!



Seed

- “Seeds are the foundation of human and animal life on earth—the foods we eat, the fibers we wear, and most of the products we use in our daily lives are created from a seed. As the delivery mechanism for new plant technologies and varieties, seed is also the crux of agriculture.”
- “There is no substitute for quality seed—a fact of life dating back to the early settlers who knew it as the difference between survival and disaster. Quality seed is essential for growing quality crops.”

<http://www.amseed.com/about.asp>



International seed trade

2013 ISF seed trade statistics

- “In 2013, worldwide seed sales exceeded \$116 billion, of which the United States contributed ~\$16 billion.”



<http://www.worldseed.org/resources/seed-statistics/>

What is a seed?

- Botanically:
 - A fertilized ovule or female gametophyte
 - A small embryonic plant protected by the seed coat, and usually containing some stored food (<http://en.wikipedia.org/wiki/Seed>)
 - A plant part produced by sexual reproduction that contains the embryo and gives rise to a new individual (Encarta dictionary)
 - A propagule containing the next generation plant (The encyclopedia of seeds, Black et al., 2006)

Importance of seeds

- 70 % of all food for human consumption comes from seed
- Feed, fiber, industrial products
- Crop movement
- Crop establishment
- Germplasm preservation
- Weed – unwanted kind of seeds

- Cereals “large-seeded grasses” from family *Poaceae* – *wheat*, *rice*, *corn*, *sorghum*, *oats*, *barley* – rich in carbohydrates, seeds also have some oil and proteins

- Legumes from family *Fabaceae* – *soybeans, lentils, beans, peas, peanuts, etc.* – rich in protein, some species provide oil and carbohydrates
- “Other” oil crops – *sunflower, canola, flax, sesame, safflower*

References:

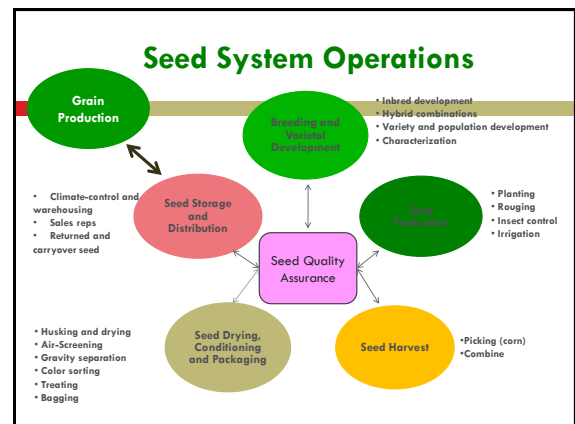
- American Seed Trade Association (ASTA) - <http://www.amseed.com/>
- International Seed Federation (ISF) - <http://www.worldseed.org/>
- The encyclopedia of seeds: science, technology and uses. 2006. Black, M. Bewley, D. and P. Halmer, Ed. CABI North American Office, Cambridge, MA.

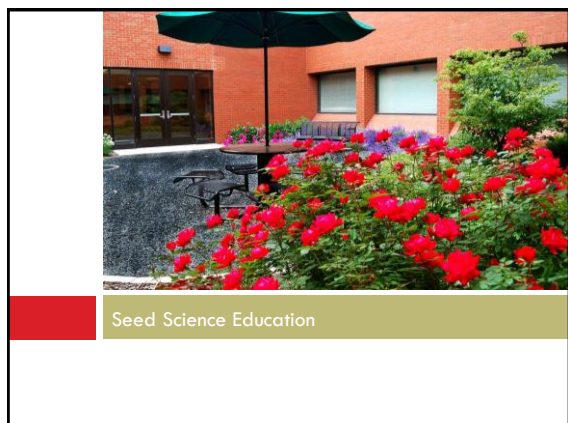
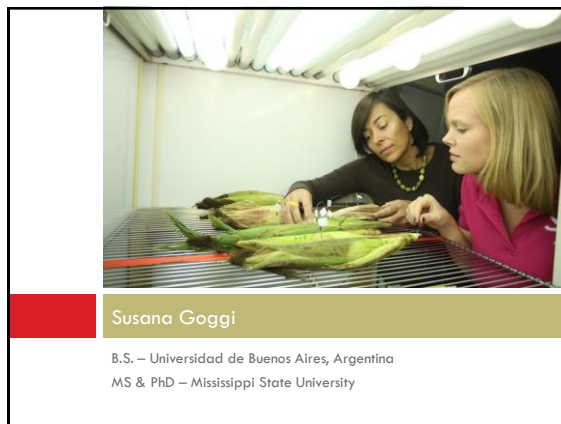
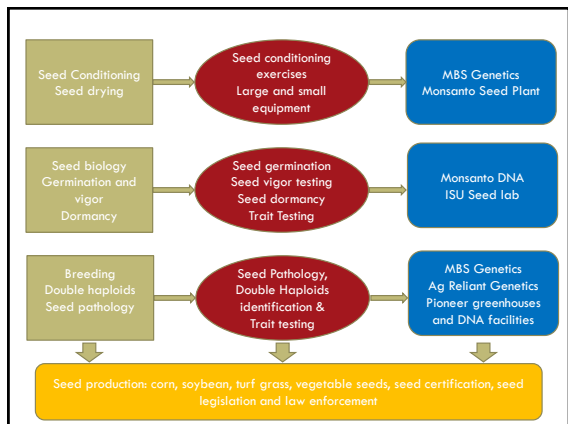
Seed Systems

The activities of a seed system include:

- Breeding and selection of adapted, uniform and consistently high-yielding crop
- Production, multiplication, storage and delivery of adequate quantities of high-quality seeds to farmers in order to fulfill their production needs.
- These systems have very different levels of specialization in different regions of the world.

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Education

- Undergraduate Seed Science and Technology (AGN/HORT 338)
 - Seed science and technology covers all aspects of the seed industry: seed biology, production, and commercialization.
- Graduate Seed Physiology (AGN 538)
 - Seed physiology covers all aspects of seed development, maturation, deterioration, dormancy, germination and vigor. Emphasis is given to current literature.
- Distance education - "Masters" and "Certificate" program in seed science and business

UNDERGRADUATE

GRADUATE

DISTANCE EDUCATION ON-LINE DEGREE IN SEED TECHNOLOGY & BUSINESS



My Seed Physiology Program

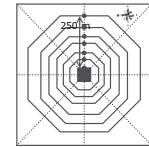
- The seed physiology research and education program focuses on key aspects of seed development, maturation, germination, and deterioration for two crops of vital importance to Iowa's economy: corn and soybeans.

Program Areas

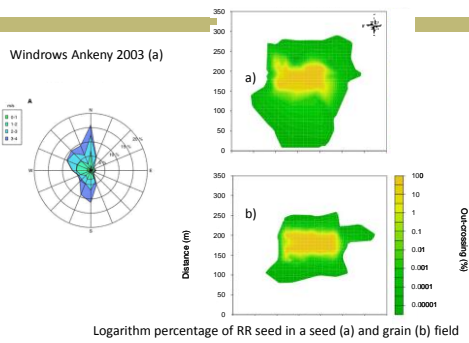
1. Research on minimizing pollen flow and outcrossing in corn production fields.
2. Research on the impact of environmental stress on soybean and corn seed quality.
3. Research on seed quality and storability in corn and soybean cultivars selected for enhanced nutritional properties and value-added traits.

1. Research on minimizing pollen flow and outcrossing in corn production fields.

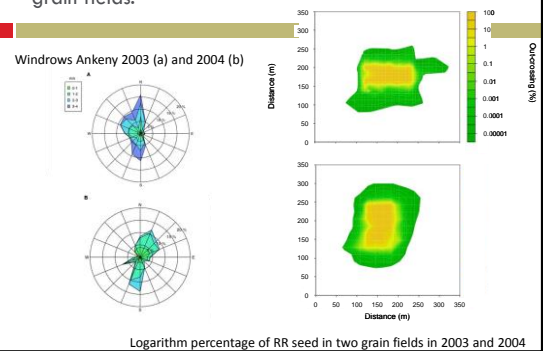
- The objective of this project is to explain pollen dispersal based on pollen biology, actual seed outcrossing patterns, advanced pollen flow modeling, and mathematical weather prediction techniques.



■ Central Plot
● Sample station



- Different outcross distribution between seed fields and grain fields.



2. Research on the impact of environmental stress on soybean and corn seed quality.

□ Genome fluidity in soybean

Genome fluidity, the capacity of the genome to reorganize, has been documented for many plants. These changes are usually the result of biotic or abiotic environmental stress. Many of the genome changes, also known as 'allele-switching' or de novo variation, are stable and heritable.




Genetic Variation Through Seed and Plant Stress


□ Objectives

- To use plant and seed stress to induce changes in the soybean genome
- To determine the effect of these changes on agronomic performance traits and determine if these changes are heritable over multiple years and locations
- To determine if changes in genome sequence


Types of stress:




Seed Stress




Whole plant stress
Photo by Dr. Marianne Hopkins, Canada







Phenotypic Variation




Bruner heritability plot (stress treatment)




MO Valley heritability plot (non-stressed)



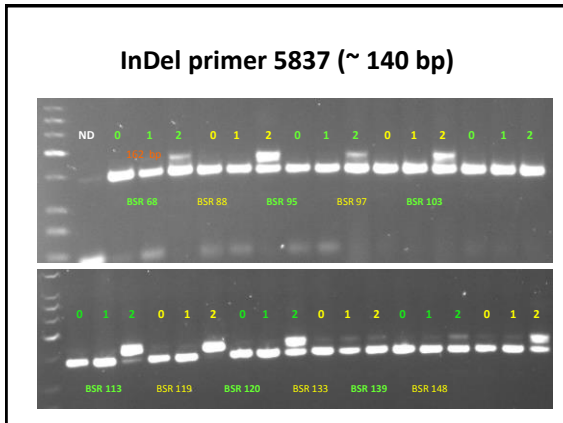
Bruner heritability plot (stress treatment)



Pod color variation
Bruner Farm




MO Valley heritability plot (stress treatment)





2. Research on the impact of environmental stress on soybean and corn seed quality.

- **Frost damage in corn**

The detrimental effects of freezing temperatures at the late stages of seed development and maturation can have a dramatic effect on corn seed quality.



- **Frost damage in corn**
 - The extent of frost damage is strongly influenced by both maternal parent and moisture content at harvest.
 - Frost damage is less severe as seeds mature and dry down.
 - The saturated cold test and soak tests are the best predictors of field emergence of frost damaged seed lots.
 - The low-oil and high-protein hybrid are most severely affected by the artificial frost treatment.

2. Research on the impact of environmental stress on soybean and corn seed quality.

- **Imbibitional injury in soybean**

Imbibitional injury is a phenomenon that occurs during rapid water imbibition by very dry soybean seed. Imbibitional injury can reduce seed germination percentages.


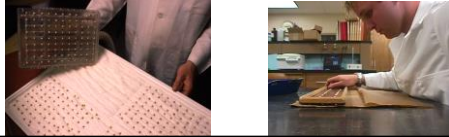


Photo by Cristiano Casini, Argentina

• **Imbibitional injury in soybean**

- Soybean seed germination and emergence in the field were affected by seed composition but not seed moisture.
- The testing medium and seed moisture content influenced germination percentage in the laboratory.
- Seed composition plays an important role in imbibitional injury at low seed moisture content.



3. Research on seed quality and storability in corn and soybean cultivars selected for enhanced nutritional properties and value-added traits.

□ **High oil and protein corn**

Plant breeders developing new inbred lines with improved grain nutritional value are frequently not aware how their selections impact seed quality. Selecting for increased oil and protein content in the grain sometimes comes at the expense of seed quality.



• **High oil and protein corn**

- Seed composition plays an important role in seed quality (high protein vs. high oil seed).
- Genotype and environment where seeds are produced affect seed quality (organic vs. conventional).
- Seed protein content is unaffected by the production environment, but oil content depends on environment (organic vs. conventional).



3. Research on seed quality and storability in corn and soybean cultivars selected for enhanced nutritional properties and value-added traits.

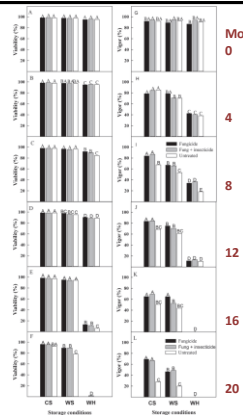
□ **Seed storage in soybean**

Seed treatments are applied to soybean (*Glycine max* L. Merrill) seeds to control early season diseases and insects. Unsold, treated soybean seed must be disposed in a different manner than untreated seed. To minimize treated seed disposal costs, it is necessary to improve seed storage.



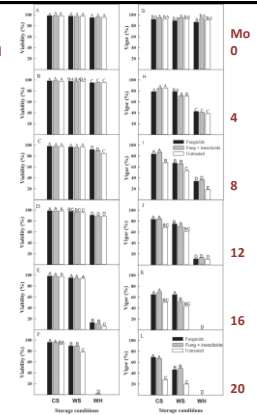
• **Seed storage in soybean**

- Seed viability remains high throughout the study for seeds stored in cold storage (>92%) and moderate in the warm and dry storage (>78%), but decreased to almost 0% after 20 mo in the warehouse.
- Treated seed viability and vigor remains significantly higher than that of untreated seed.



• **Seed storage in soybean**

- Maturity groups and protein content did not affect seed vigor, but seed lipid content did for seeds stored for 12 mo, regardless of storage environment.
- Treated soybean seeds could be carried over for two seasons if the storage temperature is maintained at 10°C and the relative humidity is below 40%.



• Seed storage and seed quality in soybean

- Phosphorus and K fertilization did not improve seed storability, although higher rates of K fertilization increased seed survival in poor storage environments for a short time.
- Excessive levels of P and K fertility decrease seed quality.
- Seed composition changed across sites and treatments, but changes were generally inconsistent.



3. Research on seed quality and storability in corn and soybean cultivars selected for enhanced nutritional properties and value-added traits.

□ Seed biology of *Miscanthus sinensis*

Miscanthus sinensis (Andersson) is an important species for biomass production. In the US, *Miscanthus* is considered as a potential species for biomass-based biofuel production. However, a standardized seed germination protocol is not available.



- Seeds exposed to alternating temperatures showed a higher germination percentage value than those at constant temperatures.
- Seeds harvested in 2011 (fresh seeds) germinated best when subjected to 20/30°C for 16/8 h.
- Seeds reached a maximum moisture content of 74% at 5 d post anthesis (dpa) and maximum dry weight (physiological maturity) at 30 dpa with a moisture content of 33%.

