Biotechnologies: Agriculture, Food, Natural Resource Issues

- BIOLOGY 430-430H/530 & FOREST SCIENCE 430-430H/530 - 3 credits
- http://oregonstate.edu/instruct/bi430-fs430/
- Welcome
- Strauss introduction
  - My CV, publications
- Student introductions
  - Name and reason for interest in class?
  - What do you expect class to be about?
- Define biotechnology and GE
- I will generally use interchangeably—assume biotech=GE unless otherwise stated
We have seen miracle products.

- Golden rice
- Virus-resistant papaya
- BT cotton
Major humanitarian, developing country benefits

Percent of Chinese cotton farmers with pesticide poisoning symptoms

Pray et al., 2002. Plant J. 31:423-430
Animal/human health benefits

Bt corn with lower levels of fungal toxins

National Center for Food & Agricultural Policy, 2001
Major farmer benefits
Area of GE crops planted in USA has grown rapidly

![Biotech % of Total U.S. Crop Acreage Graph]

- Soybeans
  - 1996: 2%
  - 1997: 13%
  - 1998: 37%
  - 1999: 54%
  - 2000: 68%
  - 2001: 74%
  - 2002: 68%

- Cotton
  - 1996: 45%
  - 1997: 48%
  - 1998: 61%
  - 1999: 71%
  - 2000: 71%

- Corn
  - 1996: 25%
  - 1997: 25%
  - 1998: 26%
  - 1999: 37%
  - 2000: 32%
Ecological “Endorsement”
Ecological Society of America 2004 report

• “GEOs have the potential to play a positive role in sustainable agriculture, forestry, aquaculture, bioremediation, and environmental management, both in developed and developing countries.”

• “We reaffirm that risk evaluations of GEOs should focus on the phenotype or product rather than the process.”
But the reception has been decidedly cold in many quarters EU and world trade
Major public relations campaigns are underway
How many European consumers feel about food biotechnology
Is Zambia right to refuse GM food? BBC Poll Results

http://newsvote.bbc.co.uk/1/hi/world/africa/2412603.stm?dynamic_v vote=ON
1 February 2003, n = 5108
Half-truths, distortions, make it hard to tell what is going on and who is deceiving who.
While industry paints a warm, fuzzy PR image
But the “revolution” is over?

No major companies plan new biotech crop projects for ~10 years

International: OECD field trial data, 1986 through 2000

USA fruits and vegetables (California Agriculture 2004, Redenbaugh & McHughen)
Crossing of existing approved plant varieties*
*includes all methods of breeding

Conventional pollen based crossing of closely related species
Selection from a heterogenous population
rDNA via Agrobacterium, transfer of genes from closely related species
Conventional pollen based crossing of closely related species
Conventional pollen based crossing of distantly related species or embryo rescue
Somatic hybridization
Somaclonal variation (SCV)
rDNA biolistic, transfer of genes from closely related species
rDNA via Agrobacterium, transfer of genes from distantly related species
rDNA biolistic, transfer of genes from distantly related species
Mutation breeding, chemical mutagenesis, ionizing radiation

Likelihood of unintended effects (arbitrary scale)

*includes all methods of breeding

Risks of unintended effects on food from genetic engineering familiar: NRC/IOM 2004
What is going on?

• How can science and society be so out of whack?
• Is the *system* so corrupt we cannot risk biotechnology despite its scientific promise?
• Is biotechnology the *final straw* that requires reorganization of our agriculture and food system to meet environmental and consumer demands for quality assurance before it will be widely accepted?
• Do consumers really demand it or is it being *imposed* by an elite that will not bear the costs of their good intentions gone astray?
Why am I teaching this class?

• My history a microcosm of the polarized debate about biotechnology
  – Suspicious young environmentalist, distrusted genetics and geneticists

• Then grew up, learned the materials, and became interested in guiding intelligent use and innovation
  – Lab focus on tree biosafety/containment

• Incredible well-spring of new ideas and possibilities from biotech (recent articles)
Why am I teaching this class?

• Extraordinary public opposition, led and funded by many of the same environmental groups I used to support

• Incredible divergence of science vs. public policy: Method based regulations vs. “Product not process” conclusion of scientists everywhere

• The problem is differing ideologies, systems, philosophies
  – Organic with complete GE exclusion, not matter what needs or goals.
  – Is modifying genes from one species less natural than movement of exotic organisms around the globe?
  – Than making radical changes to productivity and quality via hybridization, irradiation, or inbreeding to expose rare mutations?
Why am I teaching this class?

- Biotech controversy has caused me to re-examine, re-define, re-defend who I am and what I do...continuously...as a scientist and a citizen...it is that process that fascinates and stimulates me

- A large part of the noise is based on bad facts and distorted ("pseudo-scientific") information (e.g., Gould article on Rifkin on web site)

- The main goal of this class is to make sure you have accurate information and understand the diverse perspectives that are out there
Why am I teaching this class?

• You may reach different conclusions about the desirability of all, or specific, GE crops based on the material you hear, and accept, depending on your perspective

• Hopefully, your science based views are not based on an “all GE is good or all GE is bad” level of analysis
  – Against large preponderance of scientific opinion
Education objectives

- **Objectives from web site**
- The key goal of this class is to examine high technology production, particularly the use of modern genetics and chemistry, with respect to its benefits and damages to societies and the environment. The classes uses biotechnologies, broadly defined to include genetics and chemistry, as a **prism** with which to look at the big issues of how we produce natural resources and where technology is taking us.
What do we mean by a prism?

• Biotechnology raises nearly all of the same issues as other forms of agriculture, but its precision and specificity helps to refine and focus those issues for more detailed analysis, and for more holistic consideration
The prism
Environmental impacts

• What are best methods? Intensive vs. extensive production? We must have both, defined in various ways, and all must be sustainable

• What kinds of impacts are most important and should be weighed most heavily? Energy use? Soil loss? Pesticide ecotoxicity? Hybridization/invasiveness? Gene movement? Maximizing one reduces delivery of others: Tradeoffs everywhere

• How to weigh environmental vs. humanitarian benefits? Environmental regulation vs. human health/nutrition benefits? Vit A rice vs. genetic pollution?
The prism
Social/economic issues

• Who should own and control germplasm? Should there be ownership or patents of any kind for living things?
• What kinds of patents promote most public good via balance of economic stimulus for innovation/companies vs. promotion of monopoly/anti-commons?
• Do we need GMOs? How can we decide ahead of time what the world needs or does not to alleviate poverty, improve nutrition, and to improve economic well being? What about breeding? Top down vs. bottom up? Paradox of socialist vs. capitalist approaches
• Should opinion polls dictate regulation or should science? Product vs. process? Labeling costs and political implications are great. Paradox of right to know vs. right to be protected from costs and imposition of one ideology on another
The prism
Human health/well-being

- Enhanced nutrition, vitamins, reduced allergens, reduced pesticide exposure products out there or nearly so
- Why is there no pressing call to regulate plant breeding despite clear and ongoing risks? Paradox of under vs. over-regulation
- What are opportunity costs of not going forward or retarding progress to a snail’s pace, or limiting players to only big companies, by strong regulation? When is being precautionary actually reckless or dangerous?
The prism
Communication/legal “ecology”

• The issue is how any new environmental technology, genetic or otherwise, should be used in a system context
  – GE as many technologies!
• For this it must be developed via basic and applied research
• Communicated, understood, interpreted
• Controlled socially via regulations & laws
• Ownership/commercial use/trade rights defined
• Analyzed for both short and long term benefit
• Decisions reached via expert or political process
Interdisciplinary

• All of this is too much, too big, for any one teacher or scientist.
• Intelligent perspectives too diverse for one human to present all fairly.
• Thus interdisciplinary approach to class.
• **Key filter**
  – I have tried to impose is good scientific foundation, open mind, decent teacher.
  – Mostly avoid pro or anti GE diatribes, except to expose you to diversity of opinions.
Faculty involved

- *From 8 Departments on campus*
- Ethics, veterinary medicine, animal production, organic food certification, plant genetics, environmental toxicology, pesticides, sustainable agriculture, food technology/industry, crop breeding, organic agriculture methods, MD, human toxics/allergens
Interactive

- **Interacting, questioning** faculty and each other a key part of class: 60/20 minute class arrangement, grading based on participation
- **Respect all views**
- **Class structure** - Each lecture followed by a 20 minute discussion where students will first form small groups to (5-10 min), then students will question the speaker and interact with each other (10-15 min). In the small groups students will 1) summarize 3-4 main points made in lecture and readings; 2) identify 3-4 areas where they desire more information; and 3) identify 3-4 issues where they agree/disagree with views of the lecturer or the readings
Logic of class sequence

- **Schedule**: Intro and basics, then case studies and specific issues
- Intro to controversies
- History/practice of plant breeding
- Basics of genes and biotech methods (plant focus)
- Basic of toxicology/chemicals in environment
- Ethics, general and animals

- Case/issues: DDT, Bt crops, no-till ag, dietary supplements, animal biotech
- Organic/sustainable ag: Perspectives and view to GE
- Future/emerging issues (pharma crops)
- Implication for developing world/poor
Readings a critical part of class

- Great stuff out there as well as lots of non-sense.
- General knowledge of required readings tested comprehensively on final exam.
- Also via four essays and term paper.
- Background readings give added facts, views, opinions, recent/local news.
- Text (Pringle) with focus on human/business (fast read).
- Other readings focus on science.
- All but text available via web site.
- Readings for first two lectures
Grading

- Web site info
- 40% of grade, four summary-critique essays of lectures and their associated readings
- 25% of grade, term paper
- 10% of grade, oral presentation and participation
- 25% of grade, final exam
- Honors students (optional for others), two 1 hour discussion/debates
Other stuff on web site

• **Lecture notes.** May be available after lectures, rarely before. Faculty vary!

• **Other readings.** Some of the great stuff out there, listserves, and best web sources of information.
  – Can use to supplement/replace that of assigned readings on occasion for essays.
  – Sign on to one or more? Agnet?

• **Web resources.** Many useful links to eduction/outreach/activist/anti-biotech/company pages
IT Came from the Grocery Store

The HORROR of Genetic Engineering

Do YOU Know What's in the Food You're Buying?