



Biotechnology for California: Science, Policy and Marketing

Kent J. Bradford
Seed Biotechnology Center
University of California, Davis
kjbradford@ucdavis.edu



Crop Biotechnology in California

- Current status of agricultural biotechnology.
- What about specialty crops?
- Regulatory issues with agricultural biotechnology.
- Political issues with biotechnology in California.

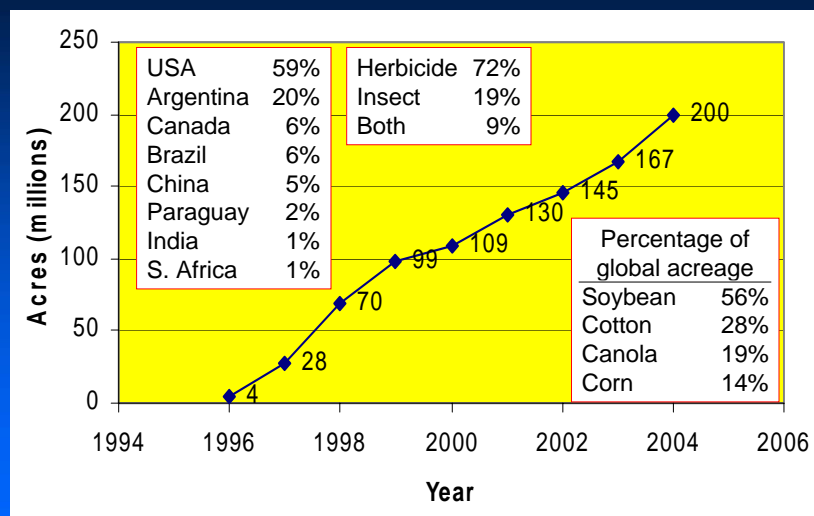


Current Status of Ag Biotechnology

- Market status of biotech field crops
 - Field crops with GM traits already in the market continue to expand (corn, cotton, soybean, canola).
 - In California, herbicide-tolerant cotton is the major biotech crop.



Global Acreage of Biotech Crops



C. James (2004) Preview: Global Status of Commercialized Biotech/GM Crops: 2004. ISAAA Briefs No. 32. www.isaaa.org



Benefits of Biotech Crops

A study released in October 2004 by the National Center for Food and Agricultural Policy found the following impacts in the US for 11 biotech traits in six crops (soybeans, corn, cotton, papaya, squash and canola):

Year	Planted acreage	Yield increase	Reduction in production costs	Net economic impact	Pesticide use reduction ¹
	Million acres	Billion pounds	Billion dollars	Billion dollars	Million lbs.
2003	106	5.34	1.5	1.9	46.4
2001	80	3.79	1.2	1.5	45.7

¹Refers to active ingredients.



www.ncfap.org



UCDAVIS



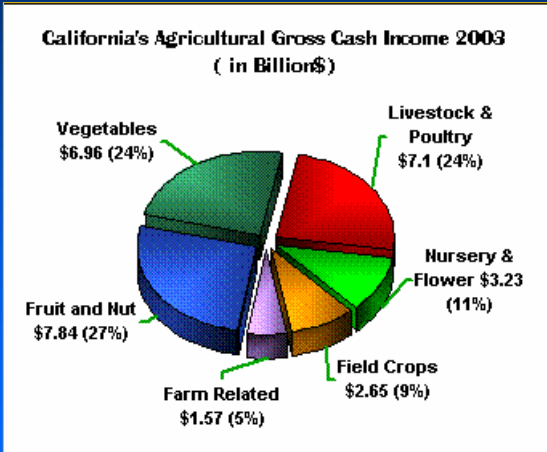
Current Status of Ag Biotechnology

- **Market status of biotech field crops**
 - **Additional input traits are being introduced (e.g., rootworm-resistant corn)**
 - **Some new crops are being introduced (e.g., Roundup Ready alfalfa in 2005)**
 - **Output traits are coming (e.g., modified oils)**



What About Specialty Crops?

- 85% of California's crop production is in vegetables, fruits, nuts, nursery and flower crops.



www.cdfa.ca.gov



Specialty Crops Account for 47% of US Crop Value

Crop	Farm cash receipts (\$ Billions)	Share (Percent)	Crop Area (Million Acres)	Share (Percent)
All crops	106.2	100.0	409.2	100.0
Horticultural crops	50.0	47.1	10.6	2.6
Vegetables	16.0	15.1		
Nursery and greenhouse	15.2	14.3		
Fruits and melons	11.5	10.8		
Tree nuts	2.4	2.3		
Other (mushrooms, seeds)	4.9	4.6		
Field crops	56.1	52.9	398.6	97.4
Oil crops (incl. soybeans)	17.3	16.3		
Feed crops (incl. corn)	24.3	22.9		
Food grains (wheat, rice)	8.0	7.5		
Cotton	5.0	4.7		
Tobacco	1.6	1.5		

compiled by A. Jerardo, USDA Economic Research Service,
http://www.ers.usda.gov/briefing/farmincome/data/cr_t3.htm;
 acreage data from National Agricultural Statistical Service, www.nass.usda.gov.



Biotech Crops Formerly in the Market

- Flavr Savr tomato – long shelf life
 - Initial marketing success
 - Poor varieties
 - Business failure
 - Led to seed and genetics consolidations

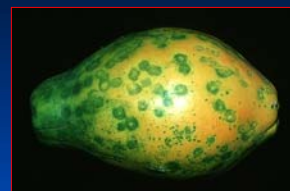


- Potatoes – insect and virus resistant
 - 4% of national acreage in 1999
 - Withdrawn due to marketing issues



Horticultural Biotech Crops in the Market

- Papaya – virus resistant
- Squash – virus resistant
- Sweet corn – insect resistant
- Blue carnations - color



Trevor Suslow

1999: Commercial Planting
Courtesy of D. Gonsalves



Biotech Crops Potentially in the Market

- Herbicide resistance

- Lettuce
- Tomato
- Strawberries
- Sugar beets
- Rice
- Wheat



Biotech Crops Potentially in the Market

- Insect resistance

- Broccoli
- Alfalfa
- Apples
- Walnut



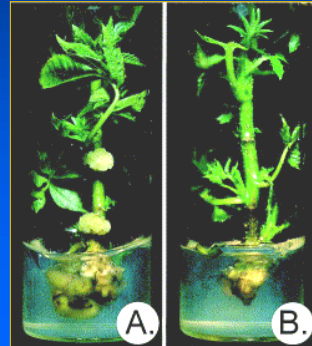
Interplanting Bt-apples with walnuts controls codling moth without insecticides.

--Dry Creek Laboratories



Biotech Crops Potentially in the Market

- Virus resistance
 - Pumpkin, watermelon, tomato, pepper
 - Stone fruits – plum pox virus
 - Raspberries – bushy dwarf virus
 - Citrus – tristeza virus
- Bacteria resistance
 - Grapes – Pierce's disease
 - Citrus – Bacterial canker
 - Apples – Fire blight
 - Walnut - Crown gall
- Fungi, nematodes
 - Various crops



Escobar et al. (2002) Plant Science 163:591-597.



Potential Impact of Biotech Crops

A study on pest control released by the National Center for Food and Agricultural Policy in June 2002 found that:

- Case studies of 32 biotech crops “in the pipeline” could reduce grower costs by \$400 million and reduce pesticide use by 117 million lbs/year.
- California would potentially benefit the most, with estimated economic benefits of \$206 million and 66 million fewer lbs of pesticides applied per year.

www.ncfap.org





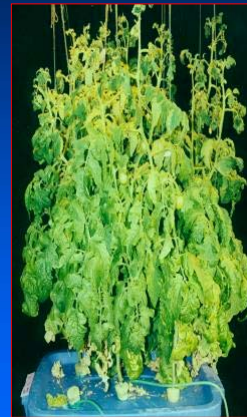
Biotech Crops Potentially in the Market

- Stress resistance
 - Salt tolerance
 - Drought tolerance
 - Cold tolerance

Transgenic tomato plants expressing the Na⁺/H⁺ antiporter grow well at 200 mM NaCl.



Wild-type at 200 mM NaCl

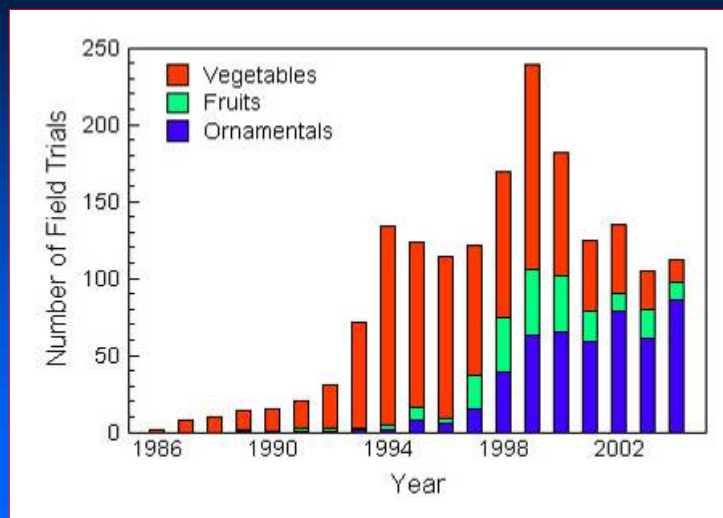


X1OE at 200 mM NaCl

Zhang and Blumwald (2001) *Nature Biotechnology* 19: 765-768.



US Field Trials of Biotech Specialty Crops



<http://www.nbiap.vt.edu/cfdocs/fieldtests1.cfm>

Bradford and Alston (2004) *Chronica Horticulturae* 44: 4-8



Why Aren't Biotech Crops in the Market?



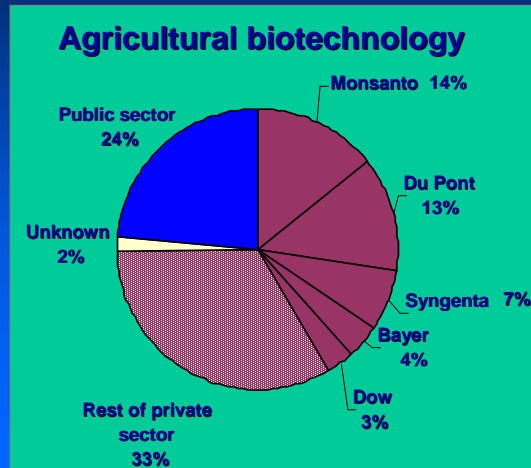
Why Aren't Biotech Crops in the Market?

- Market resistance
 - US consumers relatively unconcerned
 - Marketers/retailers very concerned
 - Why risk being picketed?
 - Brand name protection
 - Regardless of production benefits, they don't outweigh the potential negatives in the market
 - Waiting for "consumer traits" to pull products through the market
 - More difficult to engineer
 - Value uncertain in the market
 - Foregoes benefits from input traits



Why Aren't Biotech Crops in the Market?

- Access to intellectual property



Public Intellectual Property Initiatives



- Housed at UC Davis
- 25 Member institutions
- www.pipra.org

THE ROCKEFELLER FOUNDATION



www.cambia.org



Why Aren't Biotech Crops in the Market?

- Market size
 - Many minor crops serve niche markets and require multiple varieties to match production and marketing needs.
 - Individual varieties can only command a small fraction of the total market.
 - Small markets cannot recoup development and registration costs on seed sales alone.
 - Similar to the situation for maintaining registrations for agricultural chemicals for small market applications or drugs for minor uses.
 - IR-4 program - USDA
 - Orphan drug program - FDA



Why Aren't Biotech Crops in the Market?

- Regulatory issues
 - Current regulatory data requirements are not economical for small market crops.
 - Regulatory hurdles are a key factor limiting commercialization of biotech small market crops, particularly for public institutions and smaller private companies.
 - Efforts are underway to establish a program analogous to the IR-4 program to assist with regulatory approvals for small market crops.



Special Issue of California Agriculture

Workshop on
Biotechnology for Horticultural Crops



Challenges & Opportunities
Monterey Plaza Hotel & Spa
Monterey, California
March 7-9, 2002



Papers from the Workshop were published as a special issue of *California Agriculture* in April 2004. It is available online at <http://californiaagriculture.ucop.edu>.



Local Regulatory and Policy Issues

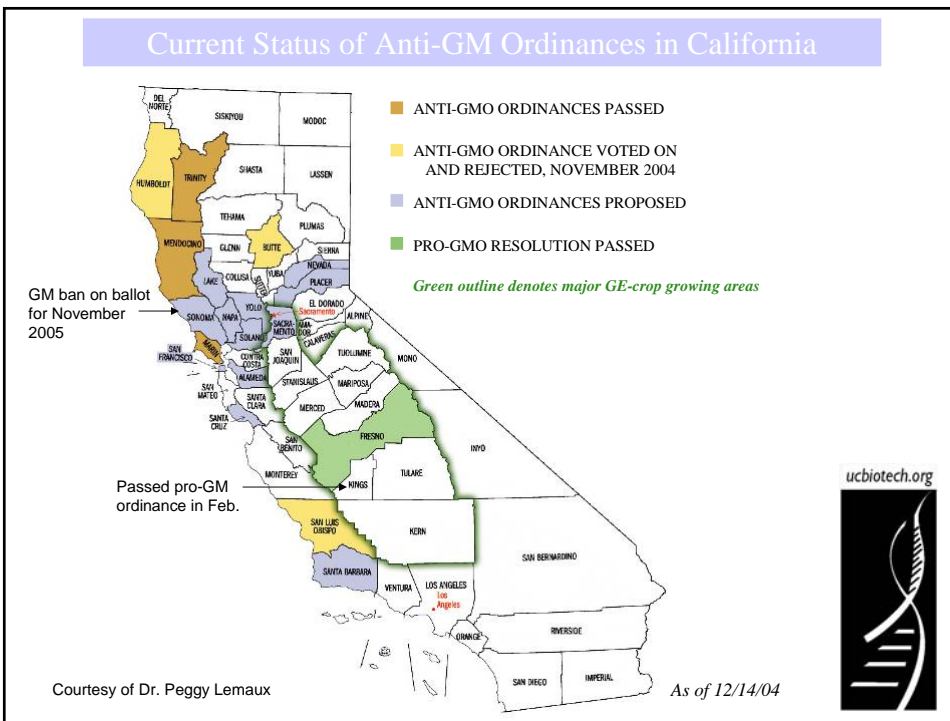
- Rice Certification Act -- 2002
 - Established a procedure for evaluation of new varieties having “market impact.”
 - Rice engineered to produce two human proteins for use in hydration fluids for infants was evaluated under this act.
 - Was approved, but with restrictions that it not be grown near existing rice production.
 - Company has moved to Missouri.



Local Anti-GM Ordinances



Local ordinances are being circulated or enacted to ban the production of GM crops.





International Development of Biotech Crops

- At least 15 developing countries are supporting public research on biotech traits in 45 species, most of which are specialty crops.
- China is second only to the US in expenditures on crop biotechnology.
- Some countries are moving forward, while our industry is stymied by regulatory and market constraints.
- Just as European biotech companies moved operations to the US, some US specialty crop breeding companies are opening research and production facilities in China.

Cohen, J.I., 2005. Poorer Nations turn to Publicly Developed GM Crops. *Nature Biotechnology* 23: 27-33.

Runge, C.F., and B. Ryan. 2004. The Global Diffusion of Plant Biotechnology: International Adoption and Research in 2004. www.apec.umn.edu/faculty/frunge/globalbiotech04.pdf.



Summary

- Some biotech crops are expanding in acreage while others are excluded from the market.
- Market acceptance and regulatory issues, not science, are limiting what products are in the market.
- Many types of agriculture can co-exist in California.
- California's ability to compete in local and global markets will be hampered if our agricultural industry is not able to use the most efficient production methods.