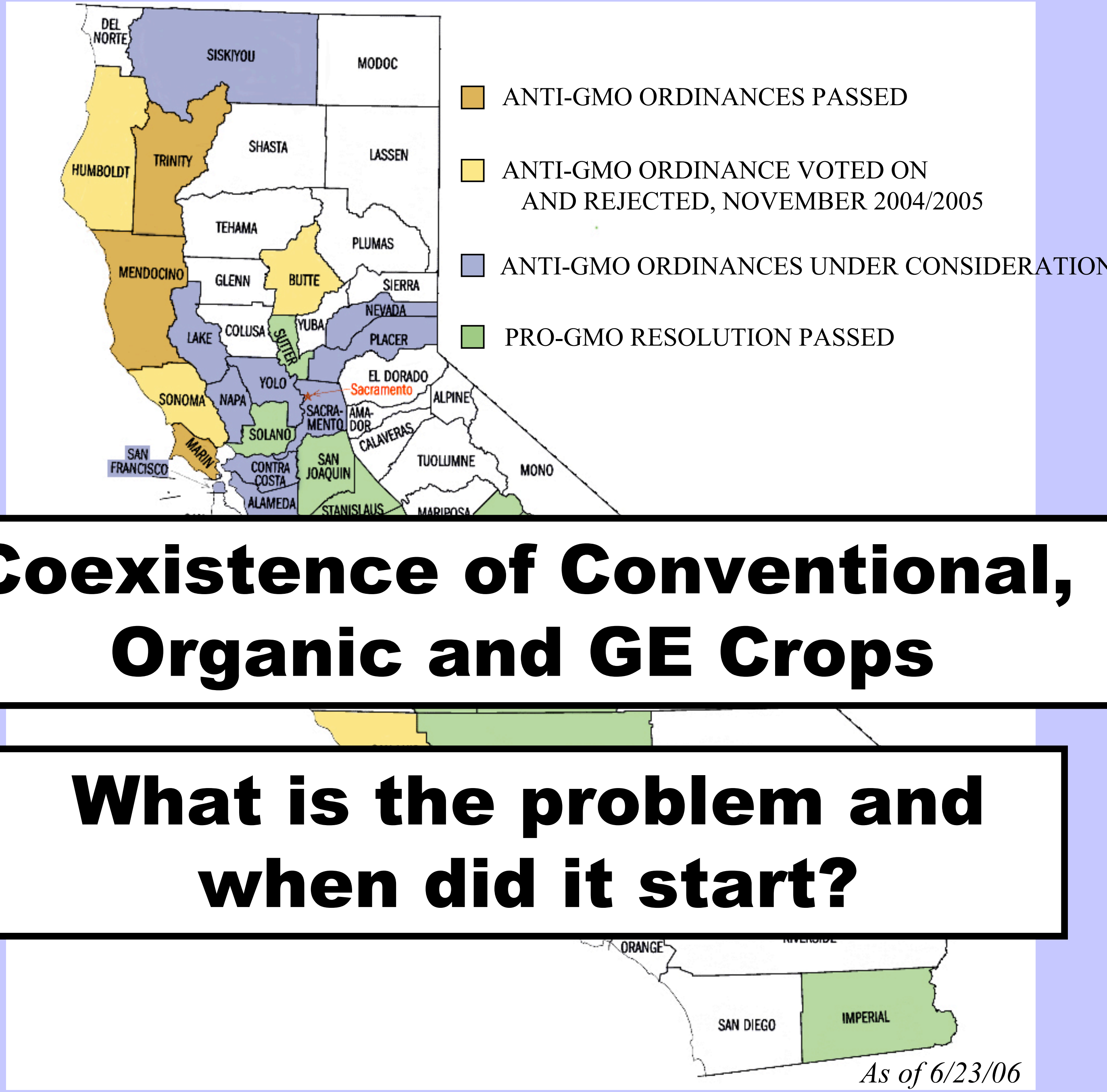
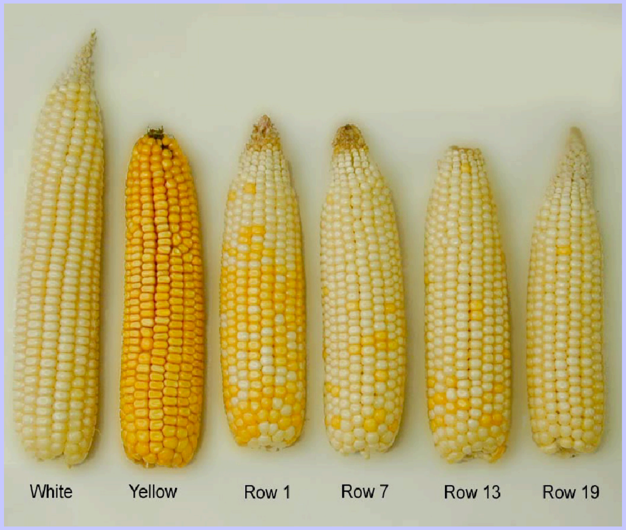
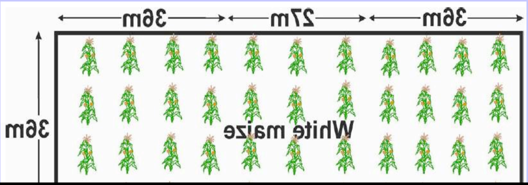
Coexistence of Conventional, Organic and GE Crops

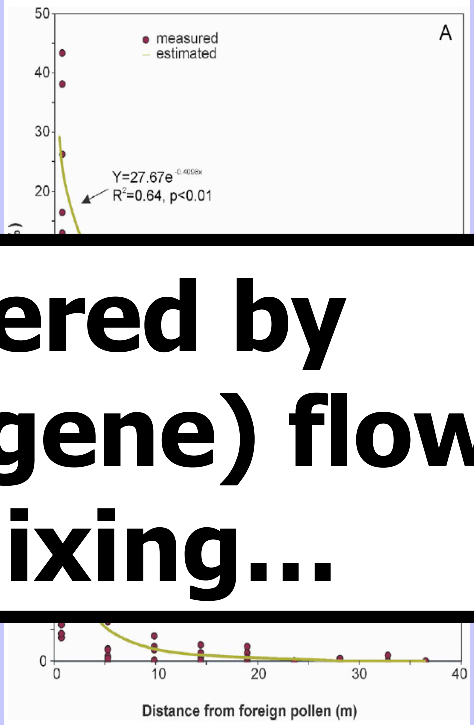
What is the problem and when did it start?



Pollen Drift of GE Corn



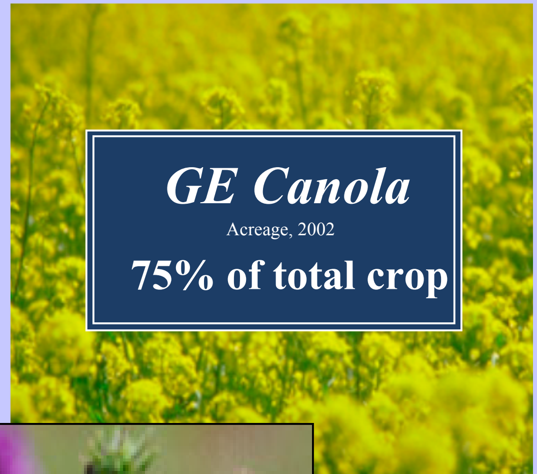


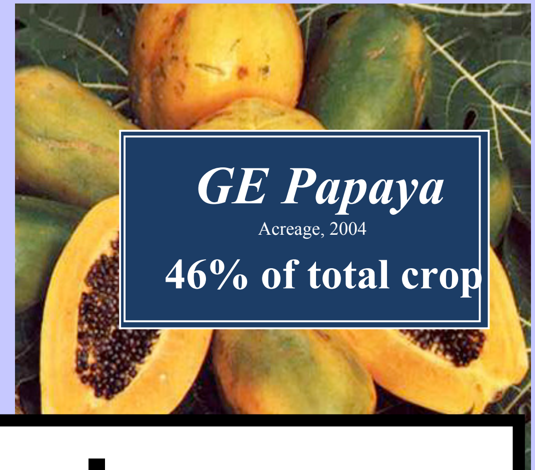


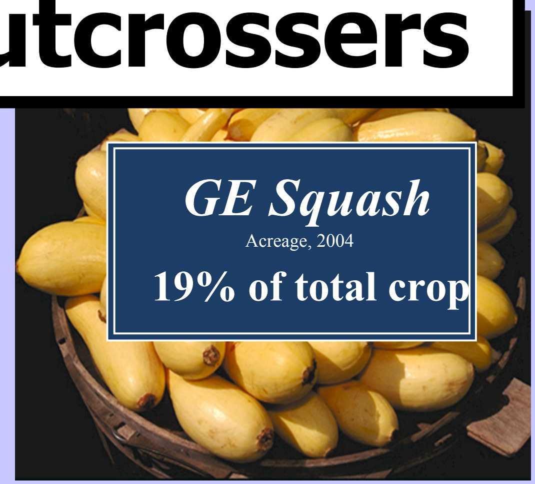
Coexistence is hampered by concerns about pollen (gene) flow and seed and crop mixing…

SOURCE: Ma, B.L. 2005. Frequency of Pollen Drift in Genetically Engineered Corn. ISB News Report, February 2005.

And most GE crops are large acreage and some are outcrossers



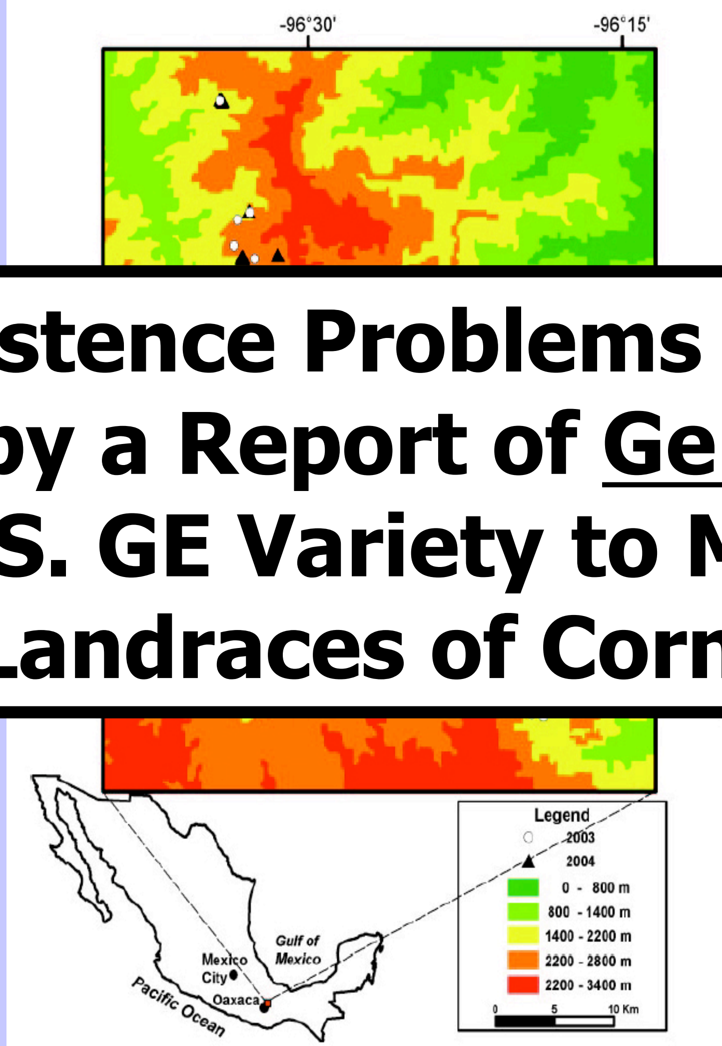




SOURCE: NCFAP; USDA, USA Today

Coexistence is hampered by concerns of organic farmers losing certification and markets?

Map of fields in Oaxaca, Mexico, where seeds were collected from maize landraces in 2003 and 2004.



Coexistence Problems Were Raised by a Report of Gene Flow from U.S. GE Variety to Mexican Landraces of Corn

SOURCE: Ortiz-Garcia et al. (2005) PNAS DOI 10.1073/pnas.0503356101

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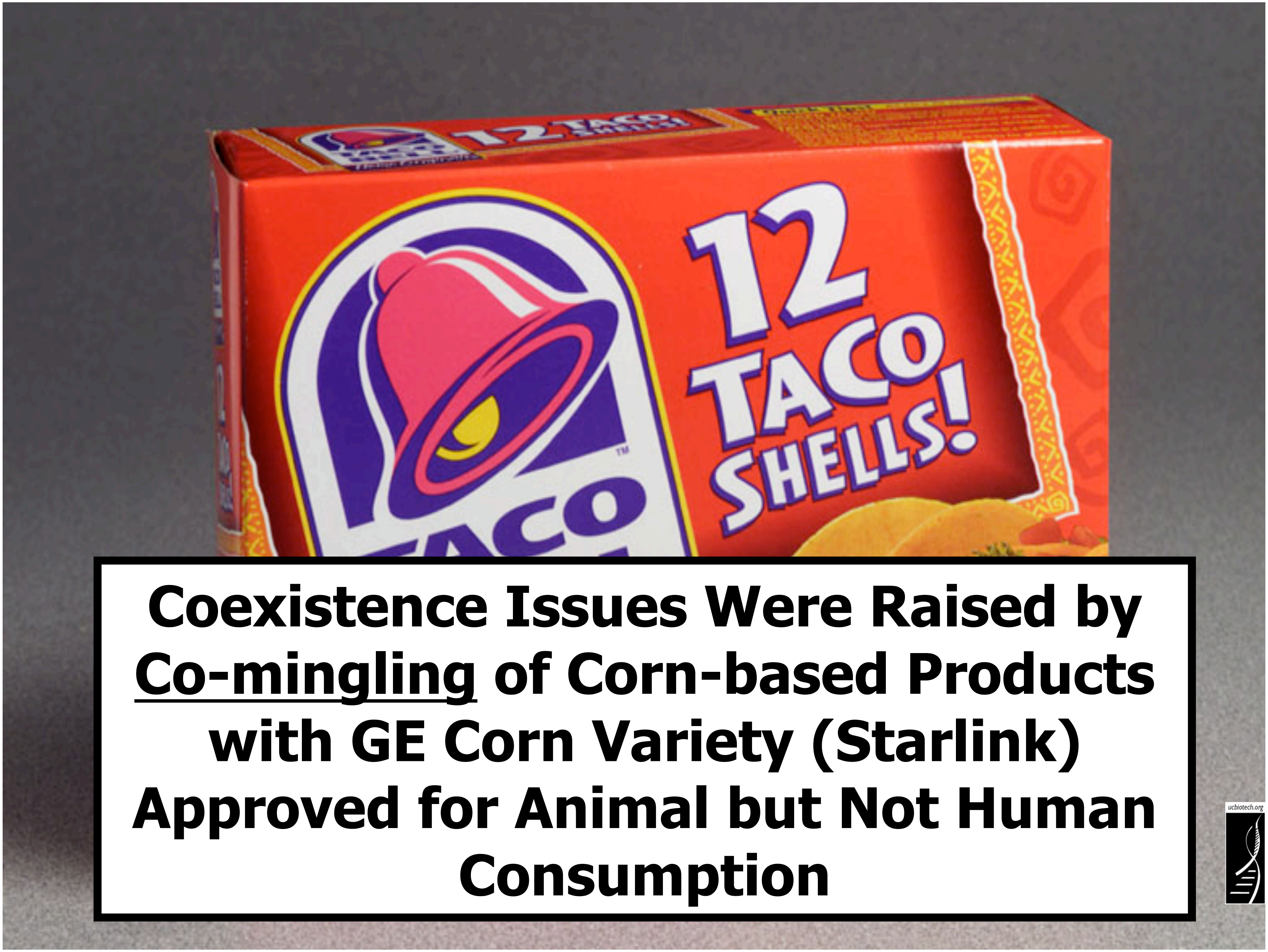

Coexistence Issues Were Raised by Co-mingling of Corn-based Products with GE Corn Variety (Starlink) Approved for Animal but Not Human Consumption

Zimbabwe and Zambia stand united on GM

THE HERALD (Harare) Wisdom Mdzungairi
October 11, 2005

International scientists, including those from the United States, have praised Zimbabwe and Zambia for rejecting genetically-modified food

Fears of Starlink didn't stop in the U.S. – it affected food aid exports to Africa when countries refused corn co-mingled with GE corn

reliable information and guidance available to the groups."

Biotech instills fear and loathing in California rice belt

Growers concerned that U.S. will lose Japanese rice market

By PAUL ELIAS

neered rice anywhere and in any quantity. Biotech-averse consumers in Japan, Europe and elsewhere simply won't buy it, he says, even if the crops are approved for U.S. con-

their sales.

Rice exports are worth $200 million annually to California, which is second only to Arkansas in rice production. Nearly all Japanese imports come from

"It's pretty much economic suicide to let genetic engineered rice

fornia and pose a contamination threat."

SunWest has called for legislation banning genetically engineered rice in California.

So-called "golden rice" was

Recently Issue Moved Close to Home: California, #2 producer of rice, wants to keep E.U. and Japan, industry's largest importer, happy - but gene from unapproved GE variety was found in U.S. rice supplies

ing similar threats because genetically engineered rice continues to turn up on grocery shelves in Europe.

"If that happens, the California industry will evaporate," said Massa as he drove the harvester around his farm about 80 miles north of Sacramento.

He has spent the past three years publicly protesting the growth of genetically engi-

Still, Bayer's blunder has been costly.

Rice futures plummeted by $150 million immediately after the contamination announcement and biotech-hating European retailers pulled U.S. rice from their shelves. Growers in Arkansas, California, Louisiana, Mississippi, Missouri and Texas filed lawsuits against Bayer for hurting

thoroughly rejected by the market.

Japanese and European consumers have a long-standing aversion to biotechnology products and any changes to their food supply, a fear that harkens back to government mishandling of mad cow disease. Those consumers fear that not enough is known about genetic engineering to guarantee that food

Many rice farmers see it as the last step before the country closes its borders to all U.S. rice. "There are political forces in Japan that would very much like to see California rice no longer shipped there," said John Hasbrook of SunWest Foods Inc., California's largest rice miller. "It's pretty much economic suicide to let genetic engineered rice creep into Cali-

the benefits of biotechnology.

"I am not against research with genetically modified materials," said Frank Rehermann, a farmer and chairman of the California Rice Commission. "There will come a day when people will be less apprehensive. But we do have to grow what the market wants and Japan is really particular about this issue."

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SOURCE: Capital Press, October 16, 2006

Is anyone talking about coexistence strategies?

Who? Where?

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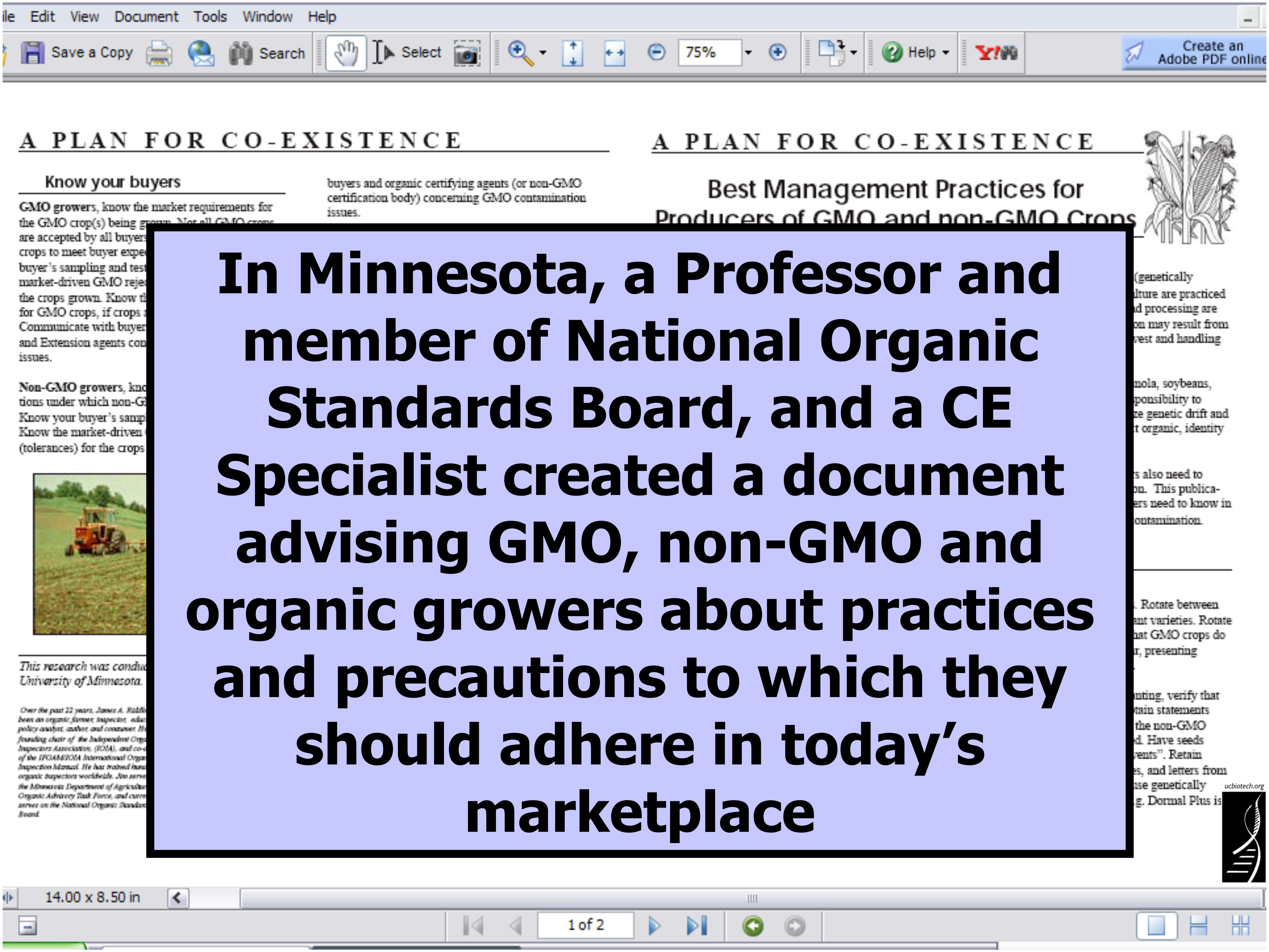

In Minnesota, a Professor and member of National Organic Standards Board, and a CE Specialist created a document advising GMO, non-GMO and organic growers about practices and precautions to which they should adhere in today's marketplace

A PLAN FOR CO-EXISTENCE

Know the regulations

Be informed concerning regulations pertinent to GMO crops. For example, farmers who plant Bt corn are required to plant at least 20% of their corn acreage to non-Bt corn to in order to delay resistance among target pests. Larger refuges are needed when farmers grow both Bt corn and Bt cotton.

Know your farm

Know your fields and determine which have the lowest risk of creating GMO contamination of neighboring crops, or susceptibility to GMO contamination from neighboring crops. Select isolated fields for planting wind and/or insect pollinated crops such as corn and canola. Know the prevailing wind direction. Establish physical buffers, such as windbreaks and hedgerows, to contain/prevent contamination from GMO pollen drift.

Know your neighbors

Establish good lines of communication with neighbors, especially those whose fields directly adjoin fields where GMO or non-GMO crops are to be planted.

GMO growers, notify neighbors that you are planting GMO crops. Let them know which crops are being planted and the steps you are taking to minimize GMO pollen drift.

Non-GMO growers, let your neighbors know where your organic and/or designated non-GMO fields are located. Get to know the farmers who farm adjoining fields, even if they rent the land. Post "Organic Farm" signs along field margins, where needed.

Know neighboring crops

Gather information from neighbors, seed dealers, Extension educators, and input suppliers on the types of crops being grown in the vicinity.

GMO growers, know which neighbors grow organic, IP, and other non-GMO crops. If your neighbor is growing non-GMO corn and you are growing Bt corn, plant your required non-GMO refuge acres next to your neighbors' non-GMO fields. If possible, adjust your planting dates so that your GMO crops do not pollinate at the same time as neighboring non-GMO crops. Be willing to provide your cropping information to neighbors so they can make appropriate adjustments.

Non-GMO growers, know which GMO-related plantings are in the area. If neighbors are growing Bt crops, ask them to plant their "20% non-Bt refuges" in areas that adjoin non-GMO fields to provide some buffer protection. If possible, delay your planting dates so that your non-GMO crops do not pollinate at the same time.

Know your equipment

Know how your equipment is used, calibrated, and cleaned. This includes rented and borrowed equipment and equipment used by custom operators. Know how to clean all pieces of equipment, including planters, combines, wagons, trucks, etc. If the equipment is used for planting, harvesting, or handling any non-GMO crops, make sure to thoroughly clean equipment prior to use. Don't let your equipment contaminate your own or someone else's non-GMO crop. Keep records to document your equipment cleaning activities.

Know your transport

GMO growers, carefully inspect and clean trucks and trailers after your crops have been unloaded. This includes tarps and trailer covers. Keep records to document the cleaning of transport units. By keeping records to document that you clean storage and transport units when you are finished using them, you can verify that your GMO crops did not contaminate someone else's non-GMO crops.

Non-GMO growers carefully inspect and clean trucks and trailers prior to loading with non-GMO grain. Make sure that transport units, including overseas shipping containers, are free of grain, dust, and other foreign material. Keep records to document cleaning activities, including clean transportation affidavits and bills of lading.

Know your crop storage

Carefully inspect and clean storage units prior to use. Make sure that storage units are well segregated and that GMO and non-GMO crops are not stored in the same vicinity. Dust and grain from GMO crops can contaminate non-GMO crops. Thoroughly clean augers, bins, grain dryers, rotary screen cleaners, etc., if they are to be used for both GMO and non-GMO crops. Have proper cleaning equipment, such as air compressors or vacuums, on hand. Document cleaning activities.

Know your harvest

Non-GMO growers, submit crop samples prior to harvest for GMO testing. If contamination is likely, collect samples along a grid pattern, going from areas with the highest risk to areas with low risk. Maintain and submit the samples separately in case part, but not all, of the field is contaminated. Make sure samples are tested for all applicable GMO events. Retain duplicate crop samples and copies of test results.

Know your records

GMO growers keep records of all fields where GMO crops are planted. Maintain field maps or GPS/GIS systems to record GMO and non-GMO crop locations. Document harvest and handling activities. Document your efforts to minimize GMO contamination. With good records, you will have a better chance of identifying causes of problems and determining liability. Valid records of BMPs can help protect you from being held liable, should contamination occur.

Non-GMO growers, you must document efforts to minimize GMO contamination. With good records, you will have a better chance of limiting losses, identifying causes of problems, and determining liability. Valid records of crop yields, test results, cleaning activities, storage, transport, and sales may help establish claims for losses, should contamination occur.

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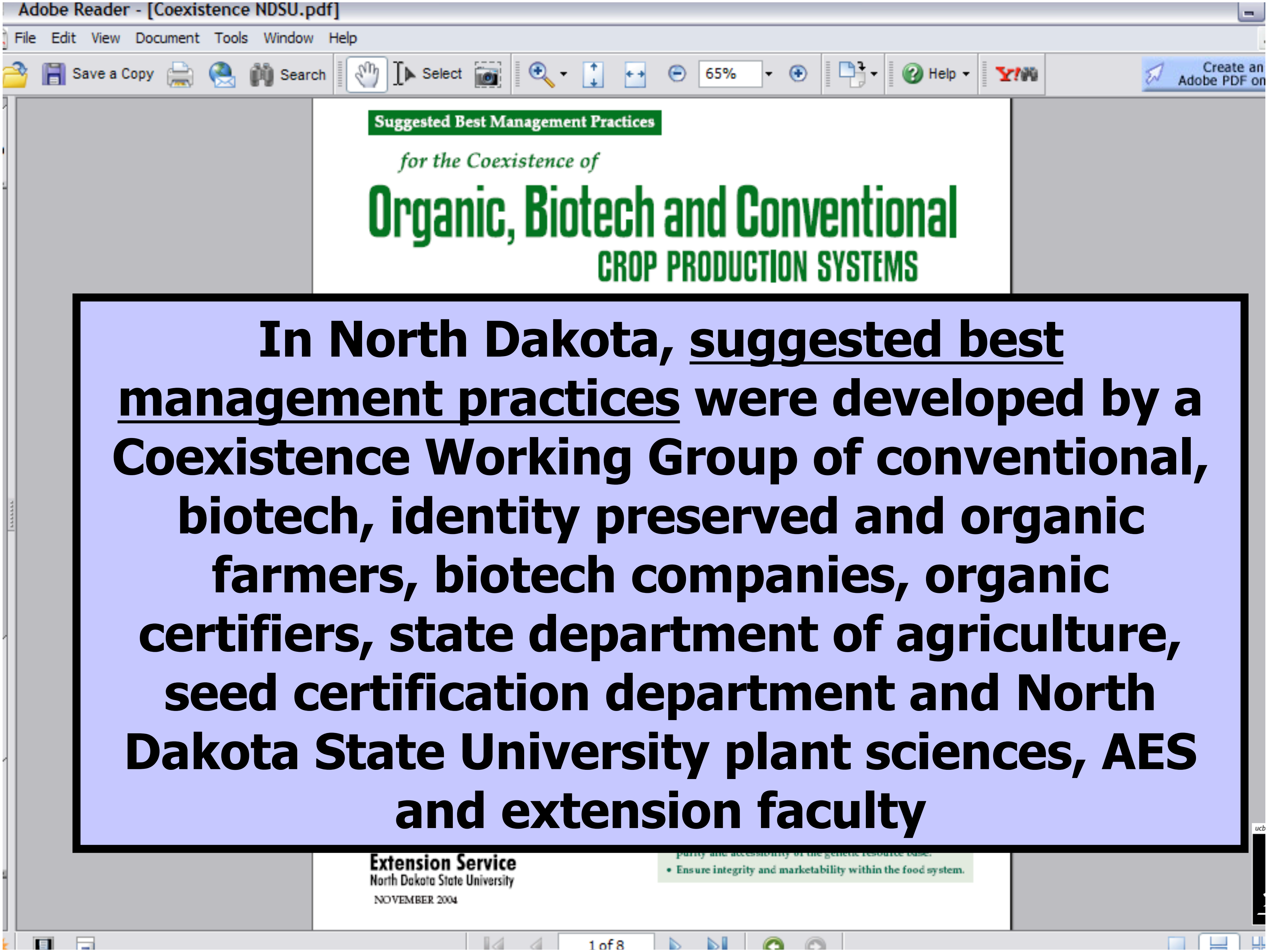
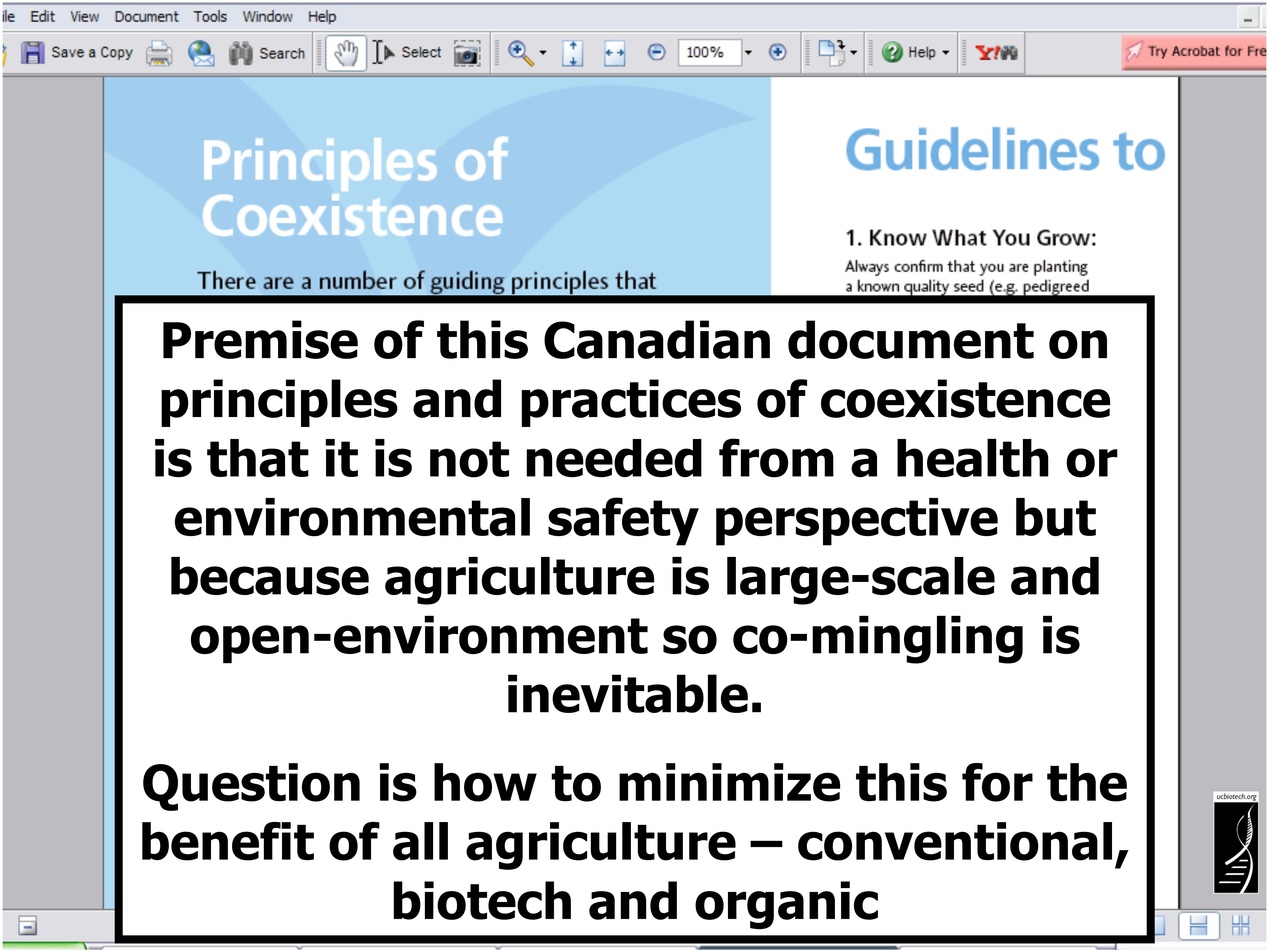


In North Dakota, <u>suggested best management practices</u> were developed by a Coexistence Working Group of conventional, biotech, identity preserved and organic farmers, biotech companies, organic certifiers, state department of agriculture, seed certification department and North Dakota State University plant sciences, AES and extension faculty



Premise of this Canadian document on principles and practices of coexistence is that it is not needed from a health or environmental safety perspective but because agriculture is large-scale and open-environment so co-mingling is inevitable.

Question is how to minimize this for the benefit of all agriculture – conventional, biotech and organic

Genetically Modified Corn Acreage for Selected Countries

COUNTRY	ACRES 2005	ACRES 2006
Germany	988	2,346
Portugal	1,850	3,090
Czech Rep.	370	3,186
France	1,215	12,350
Spain	131,460	148,200
U.S.*	42,500,000	48,400,000

** Figures for years begin Sept. 1*

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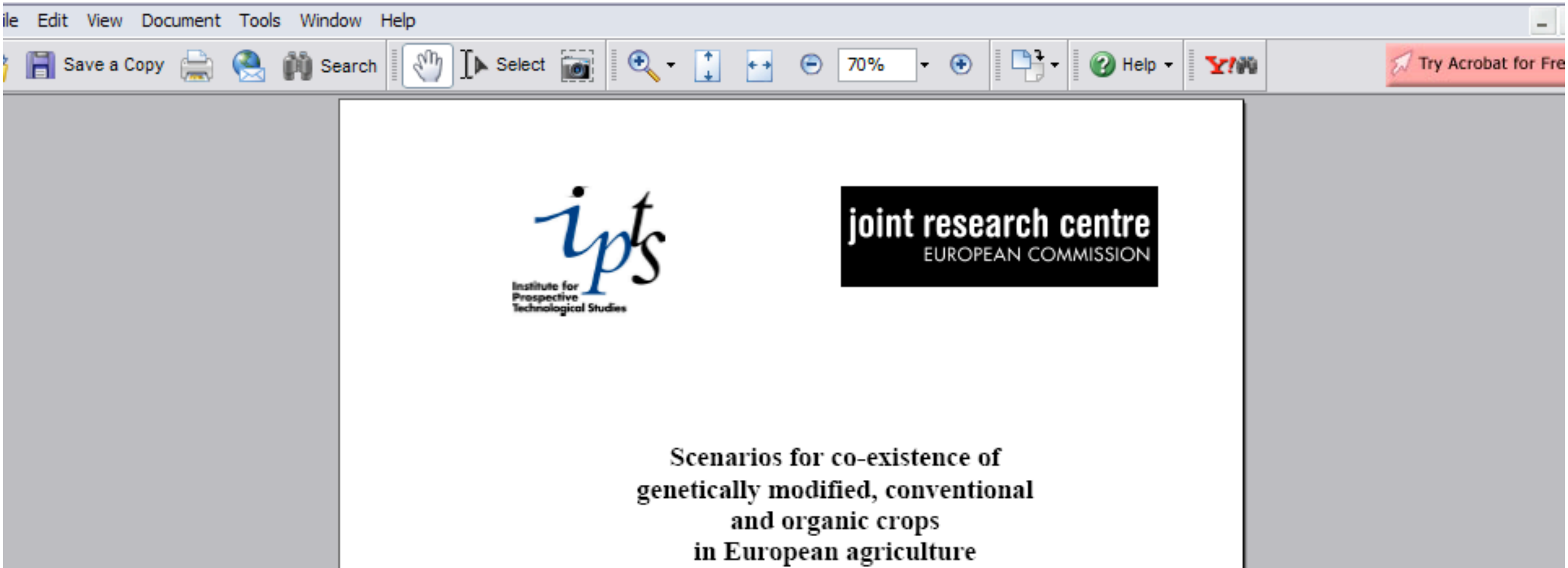
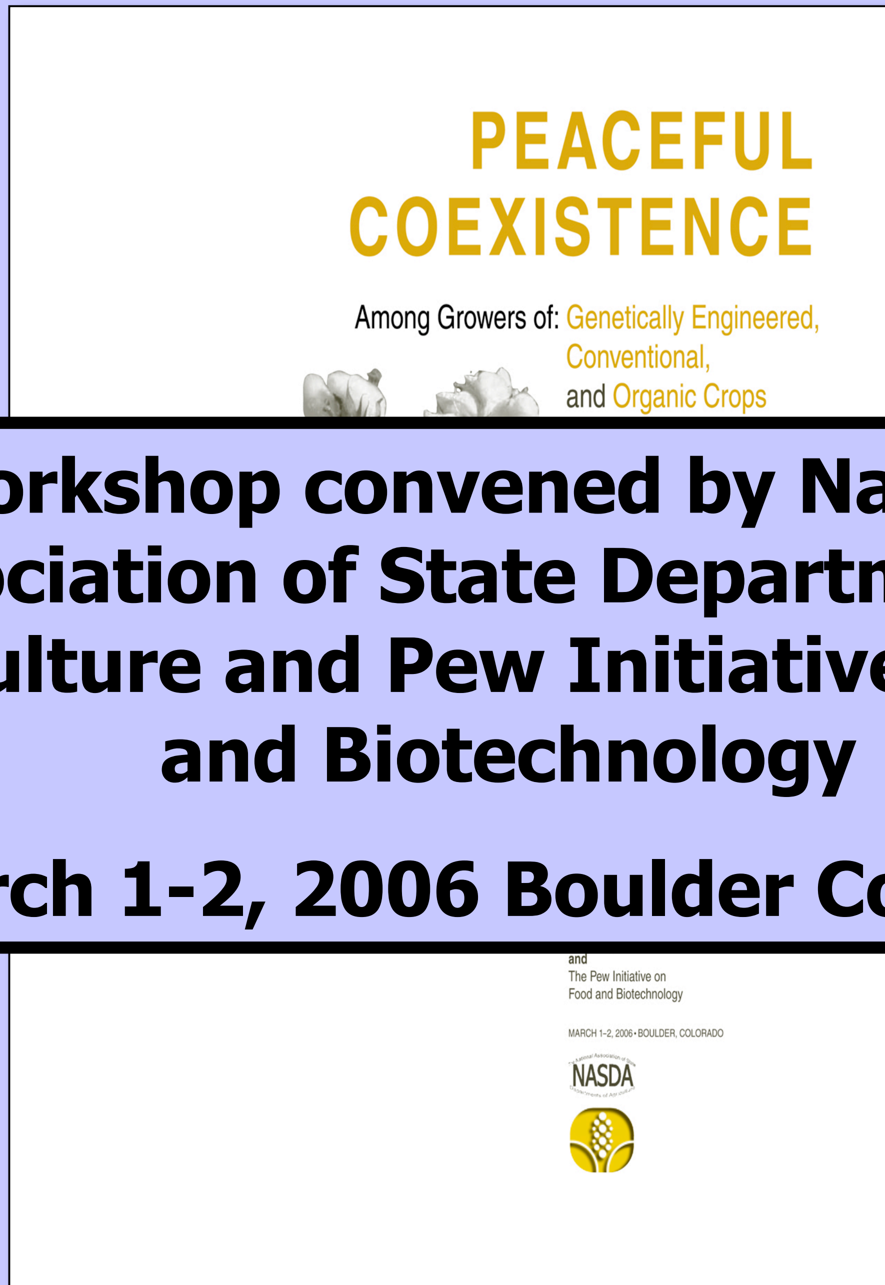
SOURCE: Agricultural Biotechnology in Europe, cited in article published in the Wall Street Journal, 10/12/06.



E.U. studies on coexistence started May 2000 with mandate to Joint Research Centre. Six studies were done at different institutes on: risks of gene flow, adjustments to farming practices, segregation methods, financial losses due to gene flow, monitoring and detection

What Are Some Issues Raised and by Whom?



PEACEFUL COEXISTENCE

Among Growers of: Genetically Engineered, Conventional, and Organic Crops

and
The Pew Initiative on Food and Biotechnology

MARCH 1–2, 2006 • BOULDER, COLORADO

NASDA

Workshop convened by National Association of State Departments of Agriculture and Pew Initiative on Food and Biotechnology

March 1-2, 2006 Boulder Colorado

SOURCE: http://pewagbiotech.org/events/0301/WorkshopReport.pdf

- **One issue is with conventional farmers concerned with export markets**

- **Another is with organic farmers worried about not meeting contract agreements for GE free**

- **Both issues lead to worry about liability - who is responsible for contamination?**

- **Potential liability could result in property damages and nuisance, trespass and negligence claims**

Who’s responsible to ensure coexistence?

- **Is it comparable to the “fence in” and “fence out” situation with cattle?**
- **In Eastern U.S. cattle owner is responsible for fencing in their cattle**
- **In Western U.S. if don’t want cattle on your property it is your responsibility to fence them out**
- **Issue is: must GM growers “fence in” their crops or conventional and organic growers “fence out” GM crops?**

B. Endres, Pew Initiative Workshop on Coexistence

U.S. market has accepted major GE crops; burden for these appears to be on organic and conventional farmers to "fence out" GE at least where GE varieties are ubiquitous

In Germany situation is different; legal burden is on GE growers to "fence in" crops

In some parts of E.U., regional bans on GE crops mean no "fencing" is needed

U.S. regulatory landscape for ag biotech products uses a "layer cake" model: layers of international, federal and state (and in CA county) laws

While some federal laws apply, many states deal directly with international treaties and legal ramifications of other countries

Can CE work toward consensus building – providing a forum for building consensus among parties – working at the local level?

How can states (or counties?) foster coexistence, reduce grower liabilties?

- Form “grower districts” by creating GE-free zones or pharma-free zones (already used for canola/rapeseed separation)
- Missouri passed statute on establishing voluntary grower districts for pharma crops. Can organic districts also be created?
- Are there preemption issues? Do states or counties have latitude to legislate these issues? Generally states take actions for health and safety reasons, not economic ones

Capital Press, September 16, 2005

Communicate to avoid pesticide drift, winemaker says

By MATEUSZ PERKOWSKI
Freelance Writer

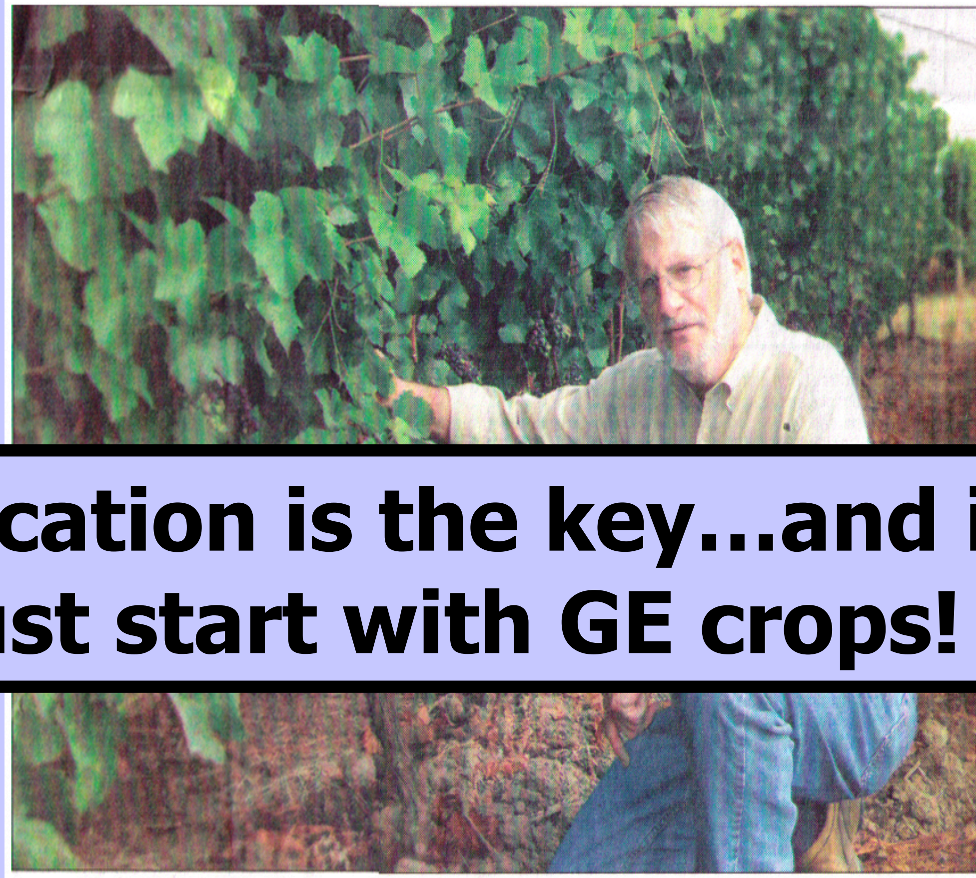
Fifteen years ago, David Adelsheim received some bad news. His vineyard manager had noticed that a section of his vineyard, located near Newberg, Ore., was producing vines with badly distorted leaves.

"Instead of being a full leaf shape, they might have been only half-a-leaf shape, or they were smaller and fanned together," said Adelsheim. All the symptoms pointed to one thing: the plants had been damaged by an herbicide.

Communication is the key…and it didn't just start with GE crops!

Roughly five acres were affected by the drift, which was about a third of Adelsheim Vineyards at the time. The first several rows were the most badly damaged, but even grapevines 30 rows down were showing some deformation. Because the neighbor had sprayed in mid-spring – after the grape bud break but prior to bloom – much of the year's crop had been aborted, and the remaining vines were too damaged to ripen any grapes.

In the decade and a half since then, Adelsheim Vineyards has managed to overcome the injury caused by the incident – the company has expanded to 180 acres, and the five acres ravaged by the herbicide have largely recovered. Nonetheless, Adelsheim said the effects of the



MATEUSZ PERKOWSKI/For the Capital Press

David Adelseheim examines some grapes at his vineyards near Newberg, Ore. Fifteen years ago, herbicide drift damaged several acres of his grapevines, and Adelsheim said the affected plants have never fully recovered.

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ANR CORE ISSUES GRANT: Coexistence of Diverse Production Systems in California Agriculture: Development of Science-based Educational Materials and Outreach Programs.

Objective 1. Development of public educational materials on specific concerns with regard to the use of genetic engineering in California agriculture.

- **Development of an updated set of non-technical, peer-reviewed fact sheets.**

1. ***Introduction to Genetic Modification*** - Peggy Lemaux (UCB)
   http://anrcatalog.ucdavis.edu/pdf/8178.pdf

2. ***Plant Genetic Engineering and Regulation in the United States*** – Alan McHughen (UCR)

To communicate you need information …check the ANR FACT sheets on coexistence and other topics related to GE crops

6. ***Genetic Engineering and Animal Agriculture*** – Alison Van Eenennaam (UCD)
   http://anrcatalog.ucdavis.edu/pdf/8184.pdf

7. ***Genetic Engineering and Fish*** – Alison Van Eenennaam (UCD)
   http://anrcatalog.ucdavis.edu/pdf/8185.pdf

8. ***Plant Genetic Engineering and Intellectual Property Pro***tection - Brian Wright (UCB)
   http://anrcatalog.ucdavis.edu/pdf/8186.pdf

9. ***Some Food and Environmental Safety Issues with GE Products: A Scientific Perspective*** – Peggy Lemaux (UCB)
   http://anrcatalog.ucdavis.edu/pdf/8187.pdf

Still in progress

10. ***Genetic engineering and IPM*** – Rick Roush (UCD)
    http://anrcatalog.ucdavis.edu/pdf/8181.pdf

- **Development of a 30-minute coexistence educational video** – Alison Van Eenennaam and Peggy Lemaux and ANR communication services

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New Fact
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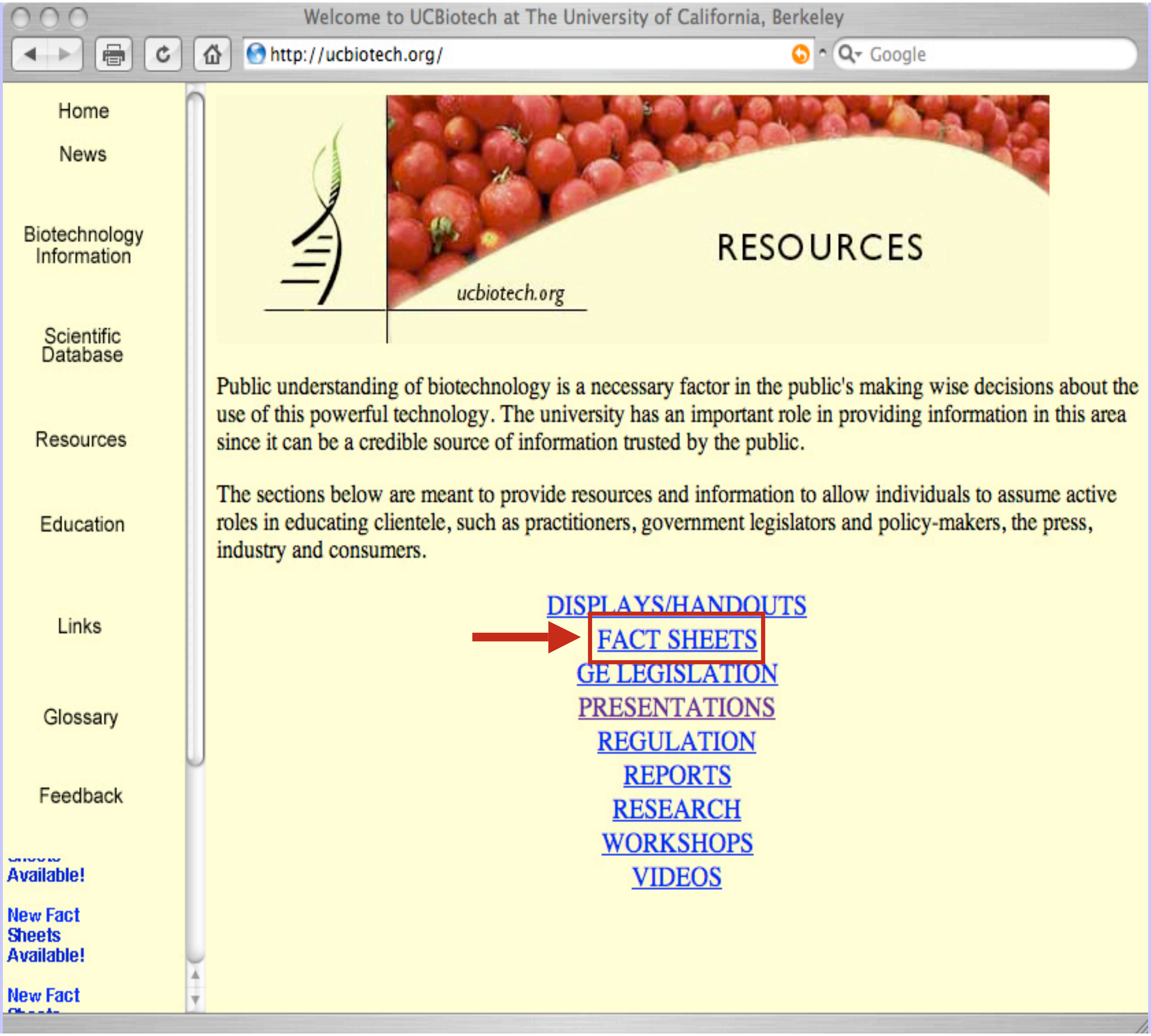
This website, a part of the University of California Division of Agricultural and Natural Resources Statewide Biotechnology Workgroup, provides science-based information to the public on issues relating to the application of biotechnology to crops. For the scientific community, educational tools and an extensive database of pertinent scientific literature are available to promote participation in the dialogue. Teaching aids for students and teachers are provided.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RESOURCES
Public understanding of biotechnology is a necessary factor in the public's making wise decisions about the use of this powerful technology. The university has an important role in providing information in this area since it can be a credible source of information trusted by the public.
The sections below are meant to provide resources and information to allow individuals to assume active roles in educating clientele, such as practitioners, government legislators and policy-makers, the press, industry and consumers.
DISPLAYS/HANDOUTS
FACT SHEETS
GE LEGISLATION
PRESENTATIONS
REGULATION
REPORTS
RESEARCH
WORKSHOPS
VIDEOS

Welcome to UCBiotech at The University of California, Berkeley

http://ucbiotech.org/

FACT SHEETS

Back to Resources page

Introduction to Genetic Modification
Peggy G. Lemaux, publication 8178
PDF

Plant Genetic Engineering and Regulation in the US
Alan McHughen, publication 8179
PDF

Genetic Engineering and Pollen Flow
Norman C. Ellstrand, publication 8182
PDF

Genetic Engineering and Animal Feed
Alison Van Eenennaam, publication 8183
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Genetic Engineering and Animal Agriculture
Alison Van Eenennaam, publication 8184
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Genetic Engineering and Fish
Alison Van Eenennaam, publication 8185
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Plant Genetic Engineering and Intellectual Property Protection
Brian D. Wright, publication 8186
PDF

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AGRICULTURAL BIOTECHNOLOGY IN CALIFORNIA SERIES PUBLICATION 8192

Methods to Enable the Coexistence of Diverse Corn Production Systems

KENT BRITTAN, University of California Cooperative Extension Farm Advisor, Yolo County

UNIVERSITY OF CALIFORNIA
Division of Agriculture and Natural Resources
http://anrcatalog.ucdavis.edu

UC PEER REVIEWED

Corn (*Zea mays*) is produced throughout California as fresh sweet corn, silage corn, and grain. In 2005, California produced 25,000 acres (10,100 ha) of sweet corn, 440,000 acres (178,000 ha) of silage corn, and 100,000 acres (40,500 ha) of grain. The worth of each was $109 million, $300 million, and $52 million, respectively, for an annual total state value of $500 million (NASS 2006). People consume approximately 18% of the total corn produced in California, with the rest being eaten by animals, mainly dairy cows. California is a net importer of corn, with much of this additional grain coming from the midwestern states to feed animals in large poultry houses, cattle feedlots, and to be used in flour mills.

Does cross-pollination occur in corn?

Unlike all other major grain crops such as wheat, rice, and barley, the corn plant has separate male and female flowering parts. The tassel and the ear are the male and female flowering structures, respectively. During the flowering stage, pollen shed and silking are necessary aspects of generating the next generation of seeds. Because of the separation of the male and female parts, cross-pollination of corn plants occurs with high frequencies. Under field conditions, 97% or more of the kernels produced by each plant are pollinated by other plants.

Cross-pollination is achieved by wind and gravity dispersal of the shedding pollen. Pollen is light and can be carried considerable distances by the wind. However, most of pollen settles within 20 to 50 feet (6 to 15 m) of the donor plant. Under favorable conditions, pollen is only viable for 18 to 24 hours, with viability diminishing rapidly from desiccation. Over a 7- to 21-day period, tassels at the top of the plant produce 2 to 5 million pollen grains from the anthers. This translates into 2,000 to 5,000 pollen grains shed for each silk that connects to a single ovule. Pollen shed from the top of the plant facilitates dispersal. Corn pollen (among the largest and heaviest of the angiosperms, the group of plants that produces flowers, fruit, and seed), is approximately 100 microns, compared to most other wind-pollinated plants that have pollen ranging from 17 to 58 microns (Stanley and Linskens 1974).

Pollen drift, which can result in the passage of genes from one corn variety to another, is not limited to genetically engineered (GE) traits and has become an important consideration in non-GE and organic corn production. Producers are concerned that pollen drift from GE hybrids to nearby non-GE varieties will contaminate their corn by cross-pollination. Farmers growing GE hybrids approved for export, as well as those growing non-GE varieties, want to avoid contamination of their crops by the GE corn that has not yet received approval for overseas markets (Nielsen 2003a). Labeling tolerances of major import markets for non-GE corn are: European Union, 0.9%; Japan, 5%; and Mexico, 5%. If the shipment exceeds these levels it must be labeled "May Contain" GE material.

How far does corn pollen travel?

Dispersal of corn pollen has been intensively studied. Some studies measured the distance the pollen traveled from its source as a function of the density of pollen while

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AGRICULTURAL BIOTECHNOLOGY IN CALIFORNIA SERIES PUBLICATION 8191

Methods to Enable the Coexistence of Diverse Cotton Production Systems

UNIVERSITY OF CALIFORNIA
Division of Agriculture and Natural Resources
http://anrcatalog.ucdavis.edu

ROBERT B. HUTMACHER, Extension Agronomist, University of California Shafter Research and Extension Center and University of California, Davis, Department of Plant Science; **RON N. VARGAS,** County Director and Farm Advisor, University of California Cooperative Extension, Madera and Merced Counties; **STEVEN D. WRIGHT,** Farm Advisor, University of California Cooperative Extension, Tulare and Kings Counties

Upland cotton (*Gossypium hirsutum*) and Pima cotton (*G. barbadense*) are the two types of cotton produced commercially in California. In acreage as well as crop value, over the past 5 years cotton has typically ranked in the top three in agronomic field crops grown in California. During that period, plantings of upland cotton in California have ranged from about 400,000 to over 650,000 acres (160,000 to 260,000 ha), while Pima plantings have ranged from about 140,000 to over 250,000 acres (56,000 to 101,000 ha).

Does cross-pollination occur in cotton?

Both upland and Pima cotton are variously referred to as "largely self-pollinated" or "partially cross-pollinated." These descriptions acknowledge that these types of cotton are mostly self-pollinated but some cross-pollination can occur, albeit at relatively low incidence rates, through activity of pollinating insects or by wind dispersion. The pollen of both wild and cultivated *Gossypium* species is large in size and among the heaviest among angiosperms, the group of plants that produces flowers, fruit, and seeds. Individual flowers of Pima and upland types are open only for part of a single day, typically opening in the morning, changing color, and withering late in the same day. The pollen of cultivated *Gossypium* species has been described as being sticky and having pronounced spines, with a marked tendency for groups of pollen grains to clump together. In combination with the location of pollen-bearing organs, or anthers, within the flowers, these pollen characteristics greatly reduce the opportunity for cotton pollen to be easily windborne. The duration of pollen viability has also been found to be affected by environmental conditions as well as some characteristics of pollinator species (Richards et al. 2005). In that study, most cotton pollen carried on mouthparts of moths was nonviable within 8 hours after removal from flowers as

AGRICULTURAL BIOTECHNOLOGY IN CALIFORNIA SERIES PUBLICATION 8193

Methods to Enable Coexistence of Diverse Production Systems Involving Genetically Engineered Alfalfa

DANIEL H. PUTNAM, Extension Agronomist, Department of Plant Sciences, University of California, Davis

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Division of Agriculture and Natural Resources
http://anrcatalog.ucdavis.edu

During the past decade, genetically engineered (GE) traits have been successfully commercialized in corn, cotton, canola, papaya, squash, and soybean, particularly the Roundup Ready (RR) trait that allows the herbicide glyphosate (Roundup) to be applied to kill weeds without damaging the crop. In June 2005, alfalfa (*Medicago sativa*) varieties with the RR trait were deregulated (APHIS 2005), allowing GE alfalfa varieties to be sold commercially.

In recent years, alfalfa has overtaken wheat as the third most important crop economically in the United States, exceeded only by corn and soybeans. Over 22 million acres (8.9 million ha) are harvested each year, with the largest alfalfa-producing states in the Midwest and West, particularly California, South Dakota, Wisconsin, Idaho, Minnesota, and Iowa (NASS 2005). Alfalfa is California's largest crop by area at 1.05 million acres (425,000 ha), with a value of $800 million to $1 billion. California produces more alfalfa hay than any other state.

When fully commercialized and if adapted by growers, the RR technology may cause profound changes in the way alfalfa growers approach weed control as well as in the varieties that they grow (Van Deynze et al. 2004). However, the introduction of GE alfalfa varieties may also pose challenges to their coexistence with non-GE and organic production and marketing systems (Pridham 2004).

What are the sensitivities of alfalfa markets and consumers?

Crops with GE traits such as the RR trait or resistance to insects using *Bacillus thuringiensis* (Bt) have been used in animal feeding systems for more than a decade, and a number of studies have shown that DNA or proteins from GE crops have not been detected in milk, meat, eggs, or other products from animals that consume these crops (FASS 2005). Government agencies, using the concept of "substantial equiva

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Genetic Engineering and Organic Production Systems

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What is organic agriculture?

Organic farming is an agricultural production system that eliminates the use of synthetically produced fertilizers, pesticides, growth regulators, and livestock feed additives. To maintain soil productivity and fertility and to control weeds and pests, organic farming relies primarily on crop rotations, crop residues, animal manure, legumes or other green manures (crops planted specifically to be returned to the soil as enhancements), and biological pest control. Several different terms are used for organic farming, such as biological farming, regenerative farming, and sustainable farming. However, these terms are not synonymous. In the United States, only products produced using specific methods and certified under the USDA's National Organic Program (NOP) can be marketed and labeled as "organic."

Organic agriculture strives to enhance the abundance of beneficial insects and organisms and places high value on reducing pesticide use in order to maintain a more diverse community of plants and associated organisms. Organic farming can be more energy efficient than conventional agriculture, due in part to the goal of recycling animal fertilizers and organic matter produced on the farm (Mader et al. 2003). Although yields on organic farms are sometimes less than those of conventional systems, price premiums make it an attractive option for growers looking for specialized markets and a higher-value product. Organic production practices can reduce pesticide use by as much as 97% relative to conventional farming practices (Mader et al. 2003), although biological pesticides and naturally occurring pesticides can be used. While many organic growers depend on improved genetic varieties, others specialize in heirloom vine-ripe commodities that produce reliable crops under their unique conditions. The demand for organically produced fruits, nuts, and vegetables is increasing. In 2004, California gross sales of organically produced crops generated about $752 million, or approximately 2% of California's $31.8 billion agricultural markets (California Organic Program 2005).

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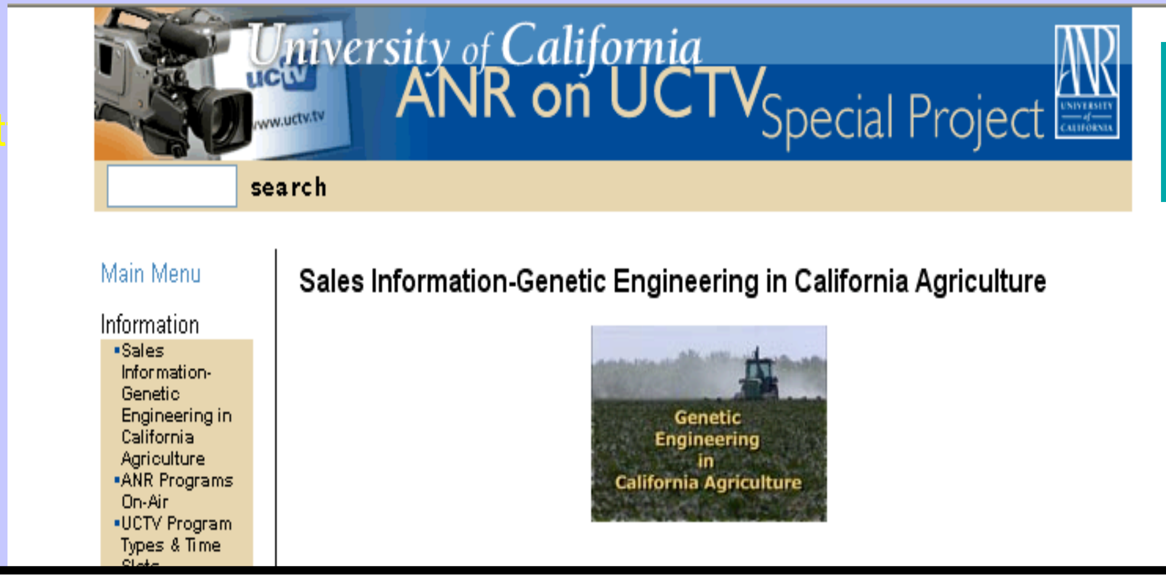

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