FLORIDA'S COMMODITIES at a glance

LIVESTOCK: beef cattle, dairy cattle, horses, poultry, swine, bees

CITRUS: oranges, lemons, limes, grapefruit, kumquats, tangelos, tangerines

SHELLFISH: Shrimp, lobster, clams, scallops, crab

FIELD CROPS: cotton, corn, peanuts, hay, soybeans, sugarcane, tobacco, wheat, pecans

SEAFOOD: Flounder, grouper, cobia, mahi mahi, amberjack, snapper, tuna

FRUIT: Asian pear, atemoya, avocado, bananas, blackberries, cantaloupe, cantaloupe, canarola, grapes, guava, honeydew, longan, lychee, mango, mamey sapote, monstera, papaya, passion fruit, peaches, persimmons, strawberries, watermelon

FOREST INDUSTRY

VEGETABLES: beans, boniato, broccoli, cabbage, carrots, cauliflower, celery, Chinese cabbage, collard greens, cucumbers, eggplant, endive/escarole, lettuce, mushrooms, okra, onions, parsley, peas, peppers, potatoes, radishes, romaine, spinach, squash, sweet corn, sweet potatoes, tomatoes, turnips, tupin greens, watercress, yuca

ALLIGATOR

ORNAMENTAL FISH

NURSERY: trees, shrubs, potted plants, foliage, cut foliage, landscape plants, woody ornamentals, bedding plants, interior plants, garden centers, turf grass, sod, bulbs, hydroponic plants, mounted plants, plugs, seedlings, topiary trees.

Florida Department of Agriculture and Consumer Services
Water and Fertilizer

Disease and Pests

Labor and Fuel

Competition

Water and Fertilizer
Could Biotechnology Be Part of a Solution?
<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenter/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>Genetically Engineered Crops in 2014: Where are they Used; How Do they Work?</td>
<td>Dr. Kevin Folta, UF/IFAS</td>
</tr>
<tr>
<td>9:30</td>
<td>Risks vs. Benefits: Health, Safety and Environment</td>
<td>Dr. Bruce Chassy, Professor Emeritus, University Illinois</td>
</tr>
<tr>
<td>10:00</td>
<td>Public Policy, Testing, Labeling, Patents</td>
<td>Dr. Val Giddings, Information Technology and Innovation Foundation</td>
</tr>
<tr>
<td>10:45</td>
<td>Science Addresses Popular Myths</td>
<td>Rob Wager, Vancouver Island University</td>
</tr>
<tr>
<td>11:15</td>
<td>The Next Wave of GMOS</td>
<td>Dr. Karl Haro von Mogel; University of Wisconsin, Biofortified.org</td>
</tr>
<tr>
<td>11:45</td>
<td>Academics and Journalists in GMO Communication</td>
<td>Jon Entine, Journalist, Forbes &amp; Genetic Literacy Project</td>
</tr>
<tr>
<td>12:15</td>
<td>Questions and Answers from Audience</td>
<td>Panelists, Jon Entine, moderator</td>
</tr>
</tbody>
</table>
Genetically Engineered Crops in 2014

What are they and how do they work?

Kevin M. Folta
Associate Professor and Chair
Horticultural Sciences Department

kfolta@ufl.edu
kfolta.blogspot.com
@kevinfolta
Facts

Genetic Modification? What is it?

How do scientists genetically modify a plant?

What genes have been added?
Crop Biotechnology

Transgenic – GMO – Genetically Enhanced

All are extensions of Plant Genetic Improvement
Centers of origin of selected crops

Note: The pointer locations indicate general regions where crops are believed to have first been domesticated. In some cases, the center of origin is uncertain. Other geographic regions also harbor important genetic diversity for these crops.

Source: This map was developed by the General Accounting Office using data provided by the National Plant Germplasm System’s Plant Exchange Office.
All due to mutations and genomic alterations

All required human intervention for breeding and/or selection
## GE vs. Traditional Breeding

Wide crosses exchange hundreds or thousands of genes and gene variants; GE moves only one/few.

Traditional breeding frequently uses plants that could never normally cross, GE uses genes from self or any other organism.

GE can monitor the effect of a specific change; breeding seeks to judge the effect on plant productivity and does not address possible effects on individual genes.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Hybrids (cross between two non-clonal plants)</th>
<th>Polyploids (whole genomes duplicated or added)</th>
<th>Mutation breeding (Chemical or radiation induced damage to DNA)</th>
<th>Crossing Species Barriers (interspecific crosses)</th>
<th>Transgenics (rDNA method to add a gene-“GMO”)</th>
<th>Cisgenics (rDNA method to add a gene)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples in common foods</td>
<td>Almost everything</td>
<td>Strawberries, wheat, bananas, brassicas, others</td>
<td>Some bananas, pears, apples, rice, yams, mint, others</td>
<td>Pluots, tangelos, some apples, rice, wheat</td>
<td>Much corn, canola, soybeans, cotton, papaya</td>
<td>Coming soon.</td>
</tr>
<tr>
<td>Transfers genes from one species to another</td>
<td>Yes, sometimes</td>
<td>Yes, often</td>
<td>No</td>
<td>By definition</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Occurs in nature</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, transposon movement, mutation from environment</td>
<td>Yes, rare, seldom fertile</td>
<td>Yes, Agrobacterium, other horiz. trans.</td>
<td>N/A</td>
</tr>
<tr>
<td>Human intervention</td>
<td>Yes, for crop improvement</td>
<td>Can be induced chemically to improve crops</td>
<td>Yes, to introduce variation for crop improvement</td>
<td>Yes, for crop improvement</td>
<td>Yes, for precision crop improvement</td>
<td>Yes, for precision crop improvement</td>
</tr>
<tr>
<td>Number of genes affected</td>
<td>10K to &gt;300K, depending on species</td>
<td>10K to &gt;800K</td>
<td>No way to assess</td>
<td>10-300K</td>
<td>1-3</td>
<td>1-3, usually 1</td>
</tr>
<tr>
<td>Know what genes moved or affected do</td>
<td>No.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Know where affected genes are in genome</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Plant patentable</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Documented adversity</td>
<td>Yes</td>
<td>??</td>
<td>???</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Environmental assessment</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Will see.</td>
</tr>
<tr>
<td>Organic acceptable</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Time for new variety</td>
<td>5-30 years</td>
<td>&gt;5 years</td>
<td>&gt;5 years</td>
<td>5-30 years</td>
<td>&lt;5 years</td>
<td>&lt;5 years</td>
</tr>
<tr>
<td>Demanding label</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Will see.</td>
</tr>
</tbody>
</table>
DNA and Traits
How Do We Add a Gene to a Plant?
How Do We Add a Gene to a Plant?

Agrobacterium tumefaciens
Making a New Plant from a Single Cell
<table>
<thead>
<tr>
<th>Only a Few Crops</th>
<th>Only a Few Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn</strong> (field corn, some sweet corn)</td>
<td>Insect resistance</td>
</tr>
<tr>
<td><strong>Canola</strong></td>
<td>Herbicide resistance</td>
</tr>
<tr>
<td><strong>Cotton</strong></td>
<td>Virus resistance</td>
</tr>
<tr>
<td><strong>Soybean</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sugar beet</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Papaya</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Squash</strong></td>
<td></td>
</tr>
</tbody>
</table>
Bt, a Safe and Natural Insecticide

Crystals and spores are ingested by insect larvae.

Midgut membrane damage leads to starvation or septicemia.

Toxins are activated to active form by gut enzymes.

Activated toxin binds to the receptor, subsequently inserts into the membrane and causes leakage of ions and small molecules.
Advantages of the Bt trait

Before/without Bt gene

With Bt gene

Decrease in insecticide
Beneficials not affected

Some signs of resistance
Glyphosate Resistance
“Roundup Ready” Products

A gene is inserted that allows plants to survive in the presence of the herbicide “glyphosate”. Farmers can spray to kill non-transgenic plants.

Glyphosate is extremely safe to use
How Herbicide Resistance Works

Plants

A → B → C → Amino acids → proteins

epsps

glyphosate

glyphosate

How Herbicide Resistance Works

Plants

A → B → C → Amino acids → proteins

Bacteria

A → B → C → Amino acids → proteins

epsps

glyphosate

glyphosate
How Herbicide Resistance Works

Plants

A → B → C → Amino acids → proteins

Bacteria

A → B → C → Amino acids → proteins
How Herbicide Resistance Works

Plants

A → B → C → Amino acids → proteins

epsps

glyphosate

Resistance!
• Important Limitation
In Conclusion

Humans have always been genetically modifying plants.

We need to make more food, with higher nutrition on fewer acres with fewer inputs.

There are only a few plants that have been genetically modified, with a few traits

Insect resistance and herbicide resistance allow farmers to save money, fuel, and labor, and help limit environmental impacts of food production.
Where do I get good information?

Warm welcome

Cold facts

GMOanswers.com

Biofortified.org

geneticliteracyproject.com

kfolta@ufl.edu

Plant Molecular and Cellular Biology Program

Here at UF!