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A woman with long brown hair, wearing a pink shirt, is smiling and looking down at a young girl with long dark hair. They are standing in front of a large display of fresh fruit, including red apples and yellow lemons. The woman's hand is near the girl's hand as they both look at the fruit.

 **Agricultural  
Outlook  
Forum**

**February 18-19, 2010**  
**Crystal Gateway Marriott Hotel**  
**Arlington, Virginia**

[www.usda.gov/oce/forum](http://www.usda.gov/oce/forum)

# **The Importance of Plant Improvement to Sustainable Specialty Crop Systems**

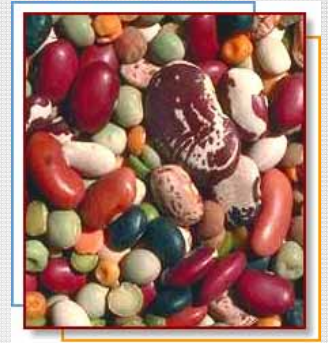
**Jim McFerson**

**Washington Tree  
Fruit Research  
Commission**

# ***Horticulture & Plant Breeding***

***UW-Madison --- BS, PhD***

***Texas A&M --- MS***



***Petoseed: Plant breeder***



***USDA-ARS Geneva: Geneticist***



***WTFRC: Manager, Researcher***

**Born  
Mt.  
Pleasant IA**

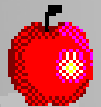
**Cascade  
Garlic**

**small  
farm  
<\$10k**





# WASHINGTON TREE FRUIT RESEARCH COMMISSION



**research focus**



**established by State Legislature in 1969**



**per-ton assessment on Washington producers**



**annual budget \$4M**

**Plant improvement**

**Sustainable**

**Specialty crop**

**Systems**

**Plant improvement**

**Sustainable**

**Specialty crop**

**Systems**

# Plant improvement

Classical plant breeding uses deliberate interbreeding (crossing) of closely or distantly related individuals to produce new crop cultivars with desirable properties.

Modern plant breeding uses techniques of molecular biology to select, or in the case of genetic modification, to insert, desirable traits into plants.

For many specialty crops, plant improvement includes clonal selection, compound plants, and application of exogenous plant growth regulators.



**Plant improvement**

**Sustainable**

**Specialty crop**

**Systems**

# Sustainable Agriculture

An integrated system of plant and animal production practices having site-specific application that will, over the long term:

- Satisfy human food and fiber needs
- Enhance environmental quality and the natural resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls
- Sustain the economic viability of farm operations
- Enhance the quality of life for farmers and society as a whole

-- Public Law 101-624, Title XVI, Subtitle A, Section 1603

*Courtesy Molly Jahn*



COLLEGE OF AGRICULTURAL  
AND LIFE SCIENCES  
University of Wisconsin-Madison

# Stakeholders



# Sustainable Agriculture

“Living in material comfort and peacefully with each other within the means of nature.”

- Wackernagel & Rees

*Courtesy Molly Jahn*



COLLEGE OF AGRICULTURAL  
AND LIFE SCIENCES  
University of Wisconsin-Madison

# Stakeholders



# Sustainable Agriculture

## THE TRIPLE BOTTOM LINE

*People*

*Planet*

*Profits*

*Courtesy Molly Jahn*



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AND LIFE SCIENCES  
University of Wisconsin-Madison

**Plant improvement**

**Sustainable**

**Specialty crop**

**Systems**





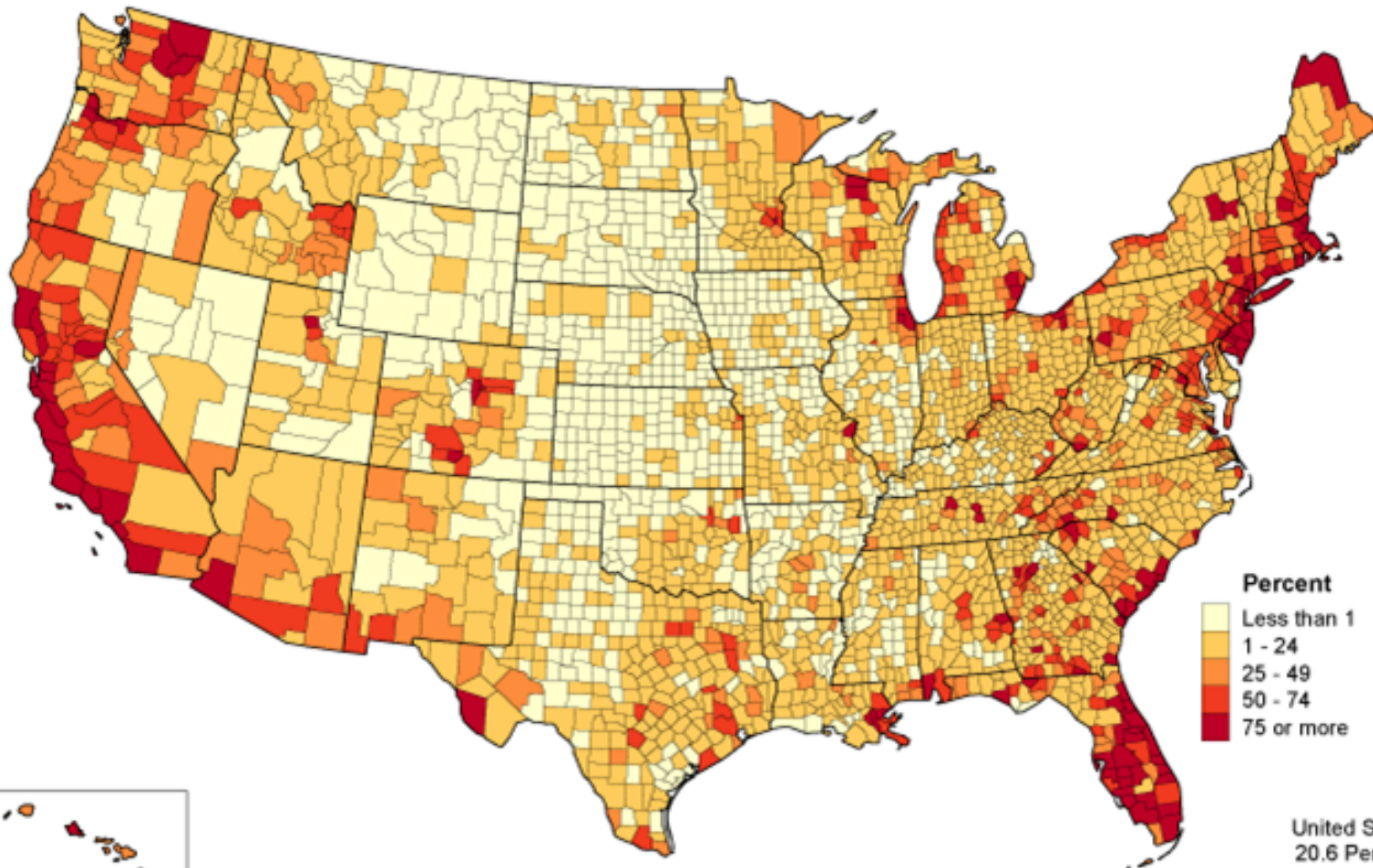
# The Specialty Crop Industry

- Fruits, nuts, vegetables, nursery and landscape crops
- >\$50B annual US production value
- Diverse
  - cropping systems
  - processing systems
  - location
  - everything
- High-value, labor-intensive, high-risk

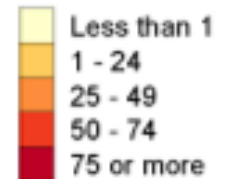
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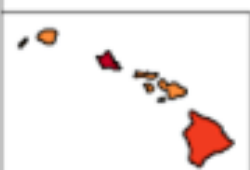
**Value of Vegetables, Melons, Potatoes, Sweet Potatoes, Fruits, Tree Nuts, Berries, Nursery, Greenhouse, Floriculture, and Sod as Percent of Total Market Value of Agricultural Products Sold: 2002**



**Percent**



United States  
20.6 Percent



**Plant improvement**

**Sustainable**

**Specialty crop**

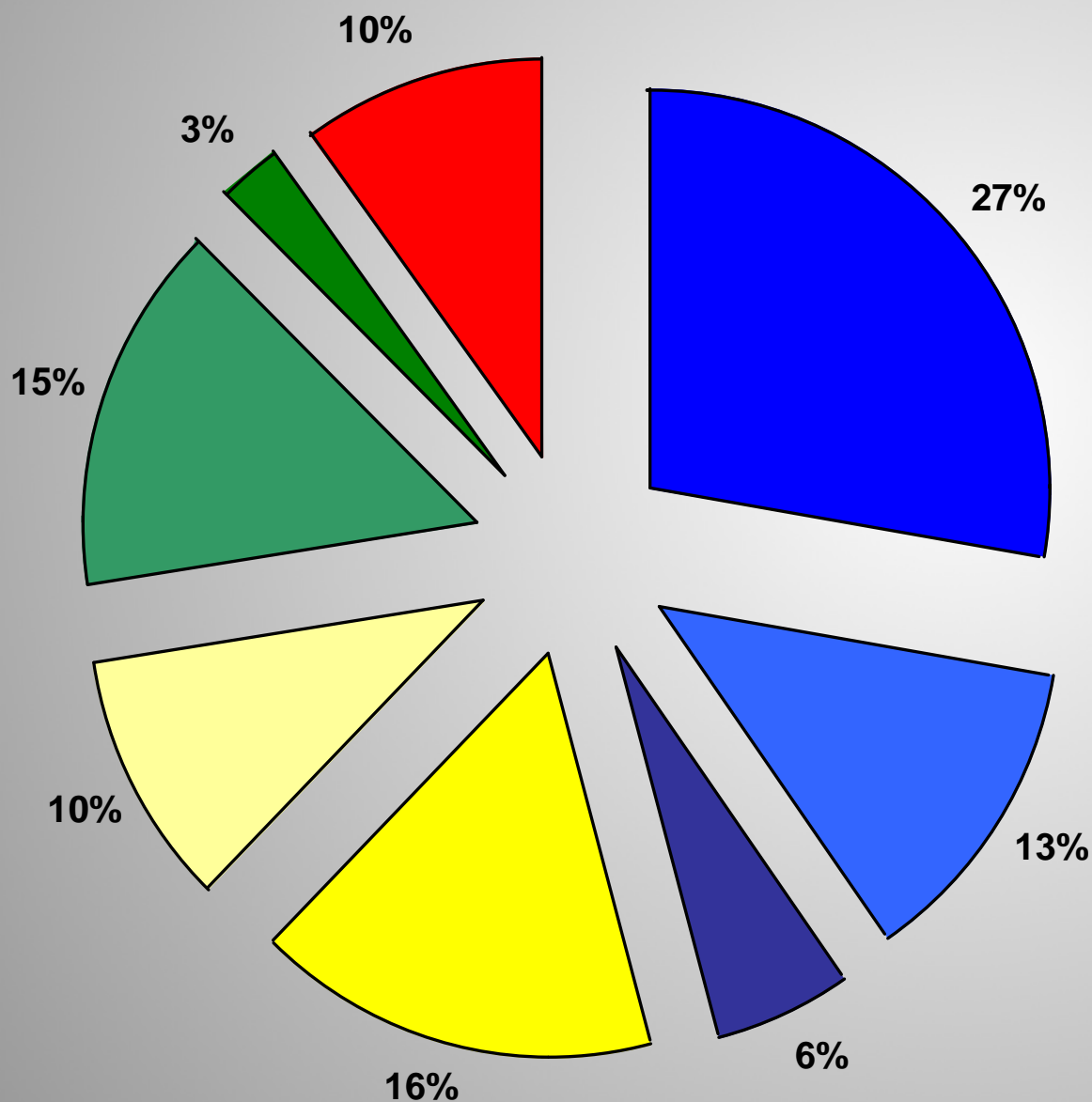
**Systems**

# 4D



# Typical apple production and harvest costs

Clark Seavert, OSU



- Labor: pruning & thinning**
- Labor: harvest**
- Labor: other**
- Machine: fuel & repairs**
- Machine: replacement cost**
- Chemical: general**
- Chemical: fertilizer**
- Other costs**









# Citrus mechanical harvester









**Genetic  
technologies**



**Engineering  
technologies**



# Predictable & accessible systems Genetics and Engineering

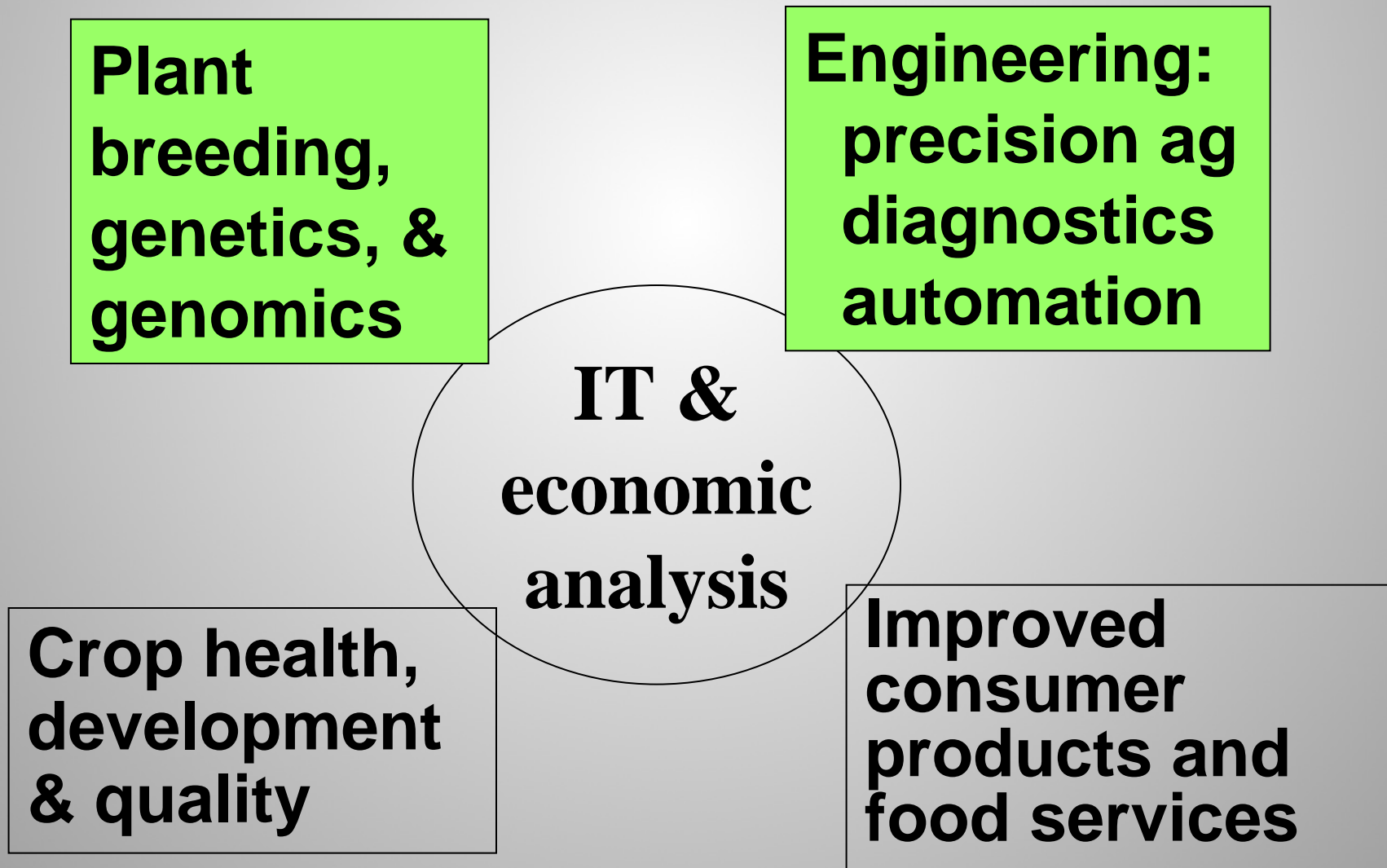


*Measure,  
model,  
and  
manage  
the best  
genetics*



# Technology Roadmap for Tree Fruit Production (2001)

*To be profitable in a globally competitive marketplace, the U.S. tree fruit industry must deliver the highest quality fruit and reduce production costs 30% by 2010*





# Plant Improvement

Fundamental for sustainability by any definition

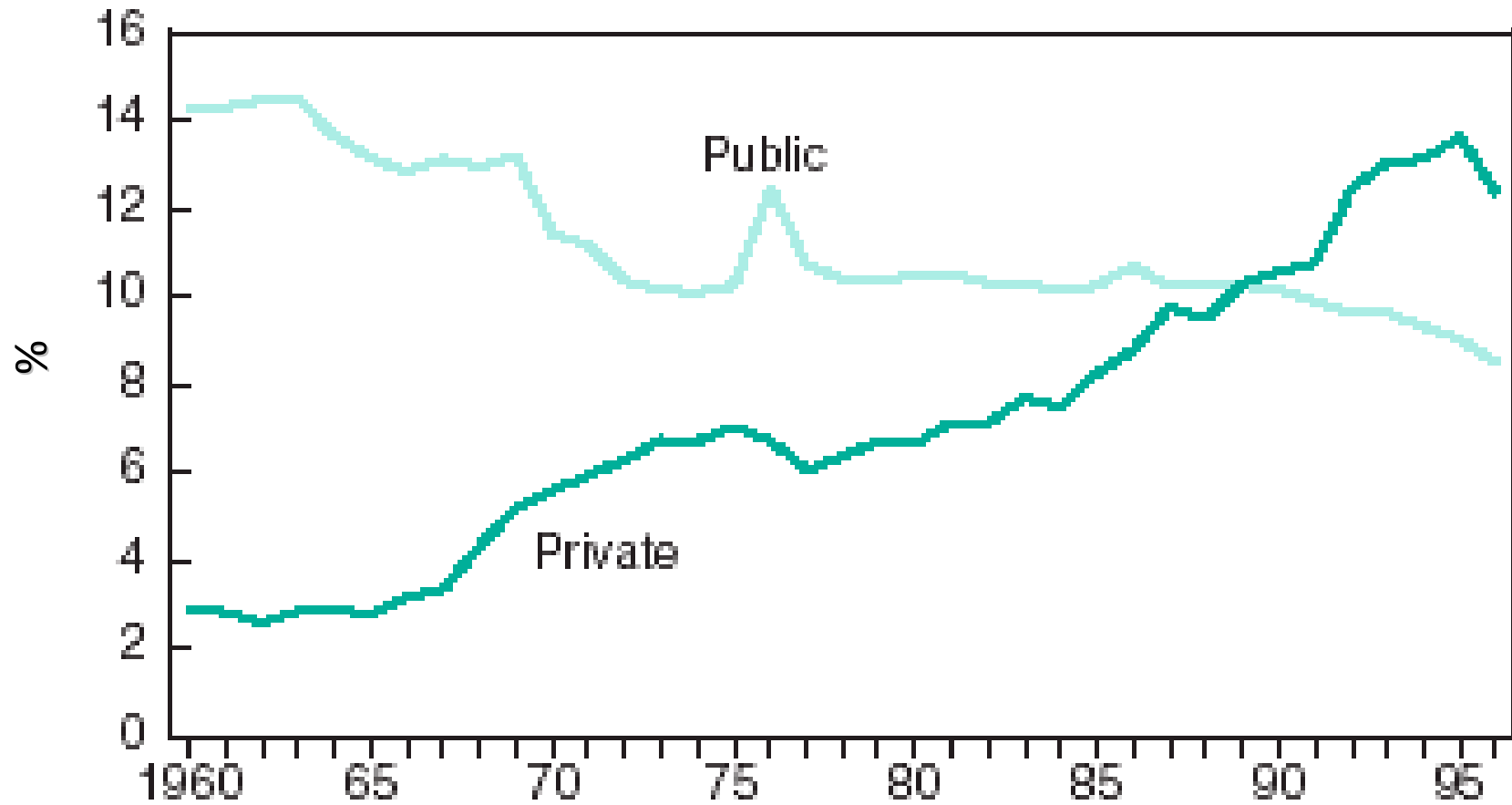
- Utilize natural resources efficiently
- Optimize inputs
- Improve yield, quality, nutrition
- Maximize local adaptation
- Expedite regulatory compliance

*Courtesy Molly Jahn*



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AND LIFE SCIENCES  
University of Wisconsin-Madison

# Plant breeding as a share of total agricultural R&D expenditures



The Seed Industry in U.S.  
Agriculture / AIB-786  
Economic Research Service/USDA

*Courtesy Molly Jahn*



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# Plant Breeding Education Curriculum Development: Delphi Study

Allen Van Deynze, Jamie Miller, Cary Trexler, Fred Bliss

Use of a **Delphi Study** offers a proven mechanism for bringing together a group of experts (breeders) and other stakeholders to develop a comprehensive list of the most important *educational*, *competency*, and *experiential* components for graduate level training in plant breeding. All results from this study will be made publically available for use internationally.

# 2008 Farm Bill

- **International Market Access (\$1.1 billion)**

- ✓ Market Access Program
- ✓ Technical Assistance for Specialty Crops

- **Nutrition Investment (\$1.1 billion)**

- ✓ Expands Fresh Fruit & Vegetable Snack Program to all 50 states
- ✓ Provides a free fresh fruit and vegetable snack to >3M children

- **Specialty Crop Block Grant Program (\$466 million)**

- ✓ State targeted programs addressing infrastructure needs
- ✓ Prioritizes marketing, food safety, quality, handling, labor

- **Pest and Disease Programs (\$377 million)**

- ✓ Prioritize pest and disease threats to production of specialty crops
- ✓ Develop action plans and targets federal resources to emergencies

- **Specialty Crop Research Initiative (\$230 million)**

- ✓ Specialty Crop Research Initiative: Plant breeding, production efficiency, precision ag, product quality

# Specialty Crop Research Initiative

- \$230 million over 5 yrs
- competitive basis
- matching funding
- significant extension component
- transdisciplinary
- Stakeholder priorities
  - plant genomics genetics, and breeding
  - precision agriculture
  - production efficiency
  - product quality



# Carrot breeding stocks with superior resistance to root knot nematodes



Courtesy Phil Simon

# Improving Carotene Content of Carrot in the U.S. Crop

---

- Result of classical plant breeding
- 1950's – 60 ppm
- 1970's – 90 ppm
- 1990's – 130 ppm
- 2010 - 2/3 of typical carrot contains enough provitamin A to fully satisfy daily adult vit A requirements

Courtesy Phil Simon

Beta III  
270 ppm



Progenitor  
140 ppm



HCM  
450 ppm

Courtesy Phil Simon



# Increasing the Farm and Consumer Value of Carrots

---

- Uniform appearance and size
  - Impetus for developing hybrid varieties
- Freedom of defects and disease
  - Leaf blight
  - Nematodes
- Culinary Quality
  - Sweet
  - Not harsh (turpentiney, bitter)
  - Succulent
- Orange Color
- Convenience
  - “cut and peel”
- Nutritional Quality



Courtesy Phil Simon

# RosBREED Mission Statement

We will develop and apply marker-assisted breeding, based on improved knowledge of industry value and consumer preferences, to accelerate and increase the efficiency of rosaceous cultivar release and successful cultivar adoption.

**4 yrs**

**\$7M federal**

**\$7M matching**

Amy Iezzoni, Michigan State Univ  
Cameron Peace, WA State Univ

Specialty Crop Research Initiative



# The Rosaceae family of horticultural crops

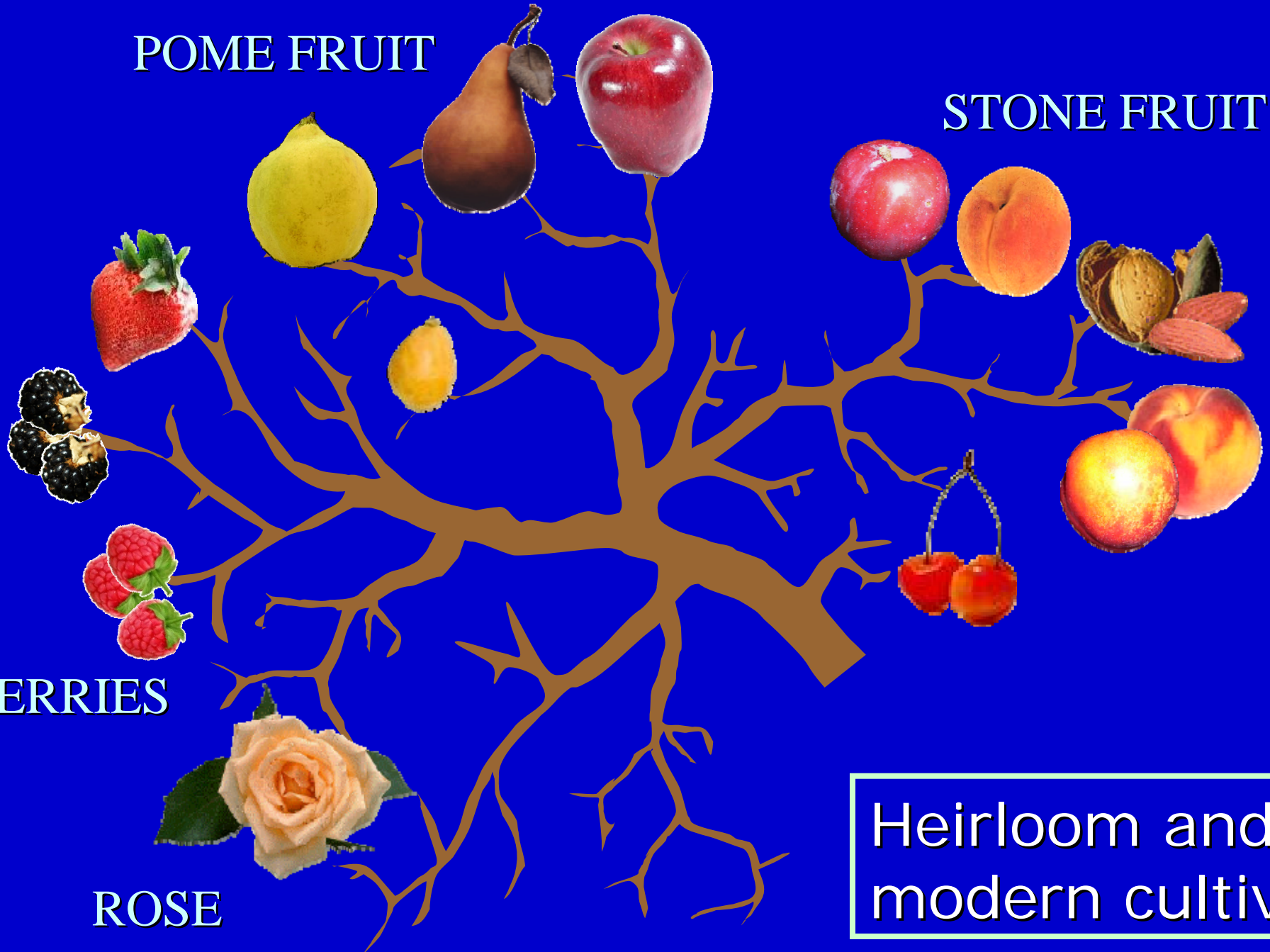
POME FRUIT

STONE FRUIT

BERRIES

ROSE

Heirloom and modern cultivars



# Honeycrisp: a breakthrough cultivar

- Honeycrisp apple - introduced 1991 by the Univ of Minn.
- Dramatic attention and U.S. market share this decade.
- An ultra-crisp juicy texture and pleasing flavor
- 30 years from crossing to commercialization.



*Focus on fruit quality*

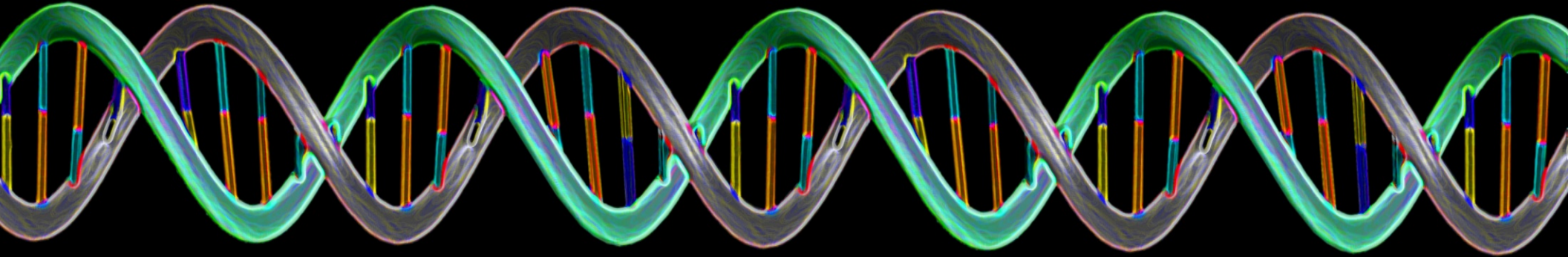


Image courtesy of NSF

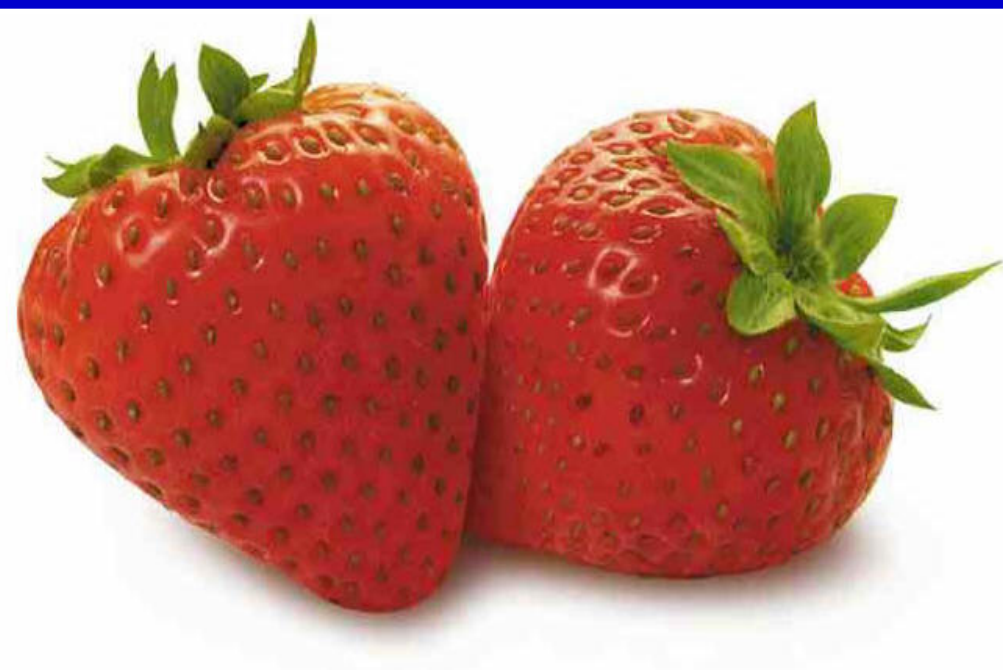
# Apple, peach & diploid strawberry genome sequences will be available in 2010

(Arabidopsis = 157 Mb/C)

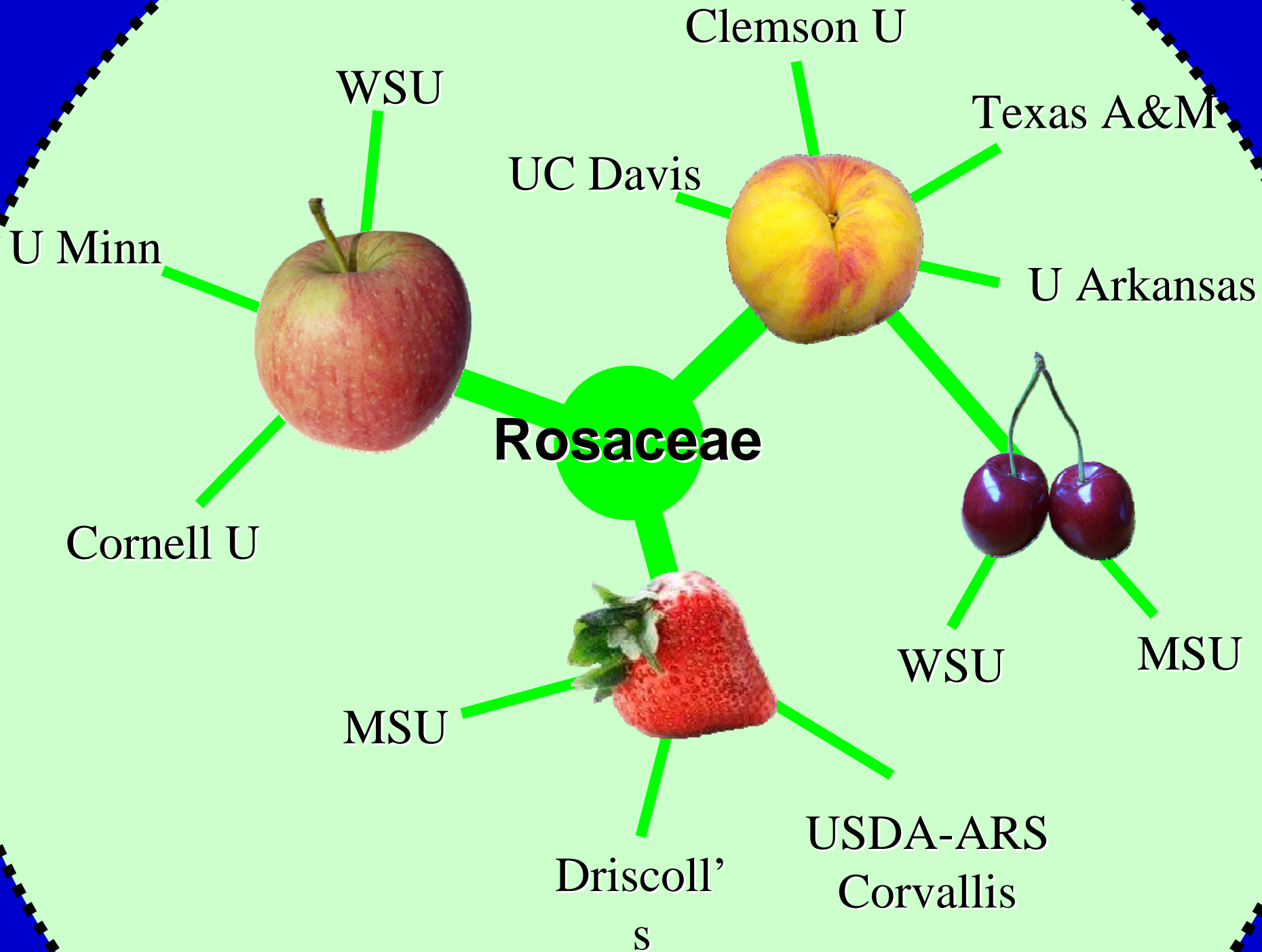
750 Mb/C

280 Mb/C

206 Mb/C



# ROS BREED DEMONSTRATION BREEDING PROGRAMS



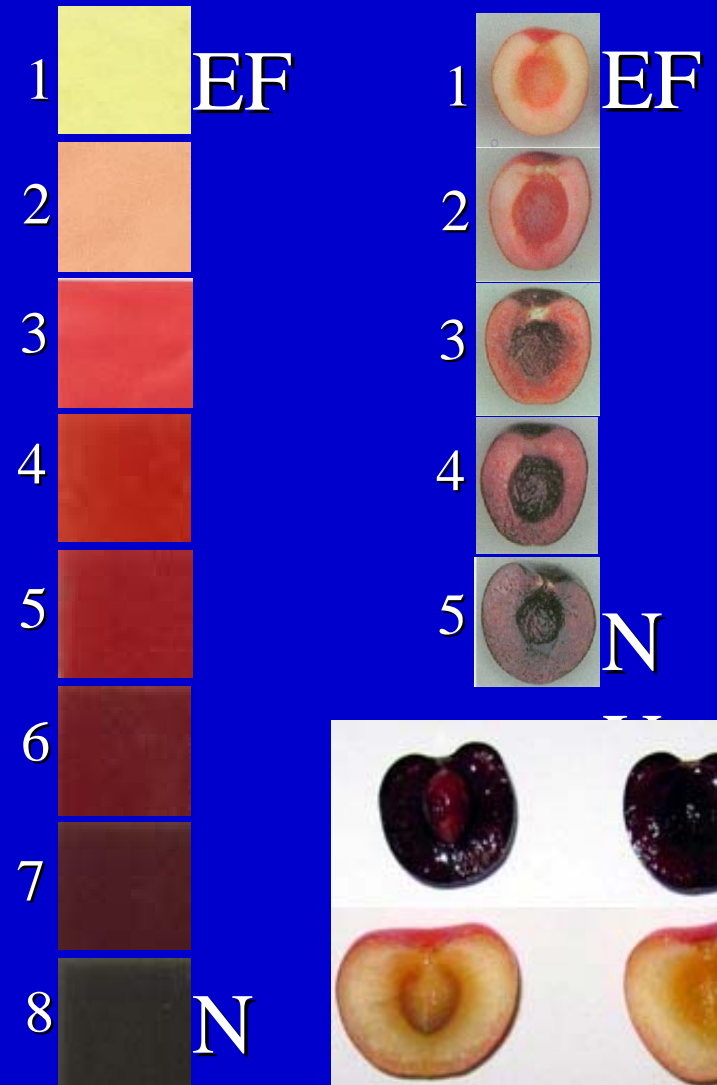
The same major gene is believed to be responsible for red core & foliage in apple, and skin & flesh color in cherry.



Chagne et al. 2007. BMC Genomics 8:212

Skin Color

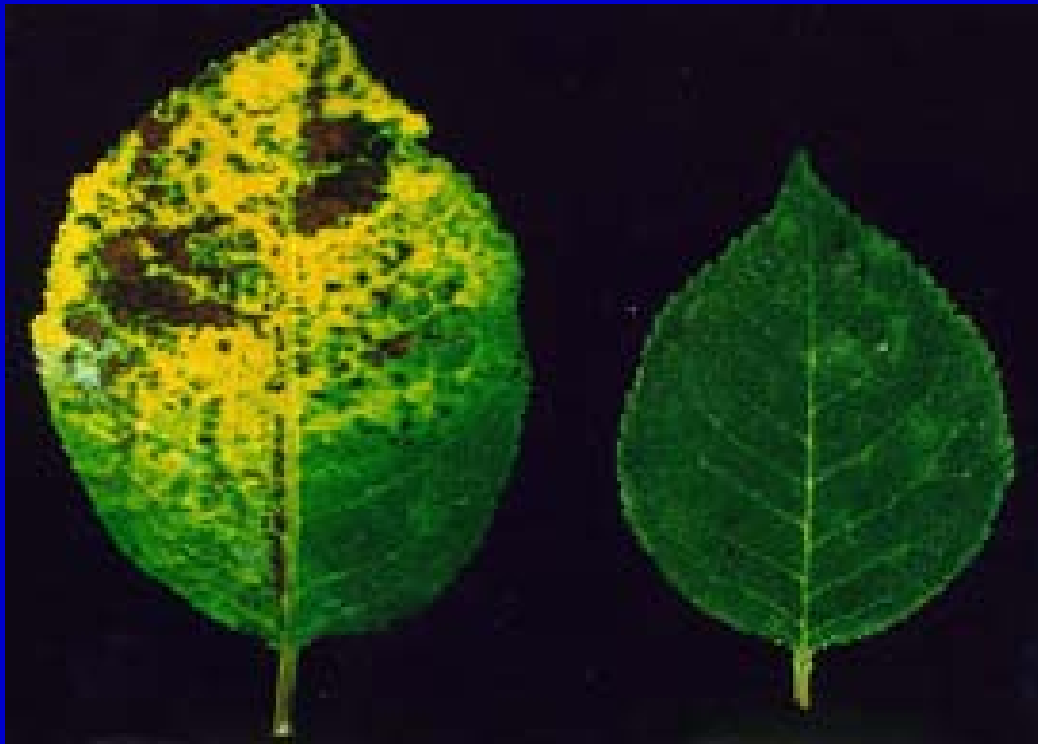
Flesh Color



Y Sooriyapathirana et al. (in review)

# How will RosBREED help breed cherry leaf spot resistant tart cherry cultivars?

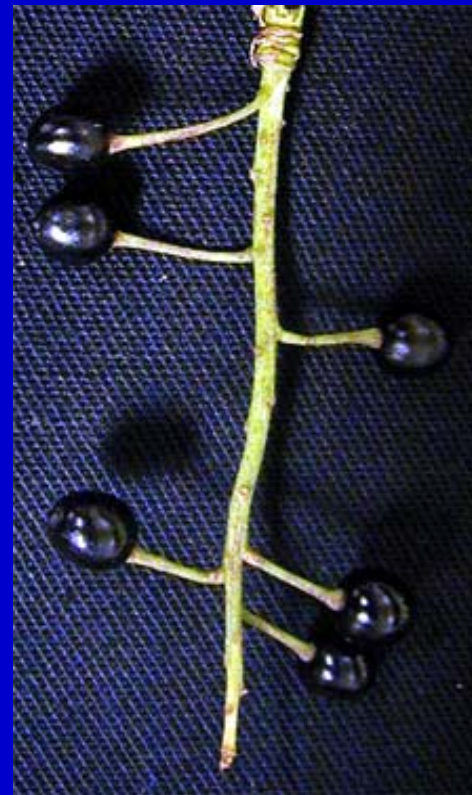
Susceptible



Resistant



Resistant



Susceptible





**RosBREED will generate knowledge of the genetic control of fruit size & enable the use of this information to more efficiently achieve the desired fruit size while retaining the CLS resistance.**

**Sweet cherry cultivar**



**12 grams**



**2 grams**

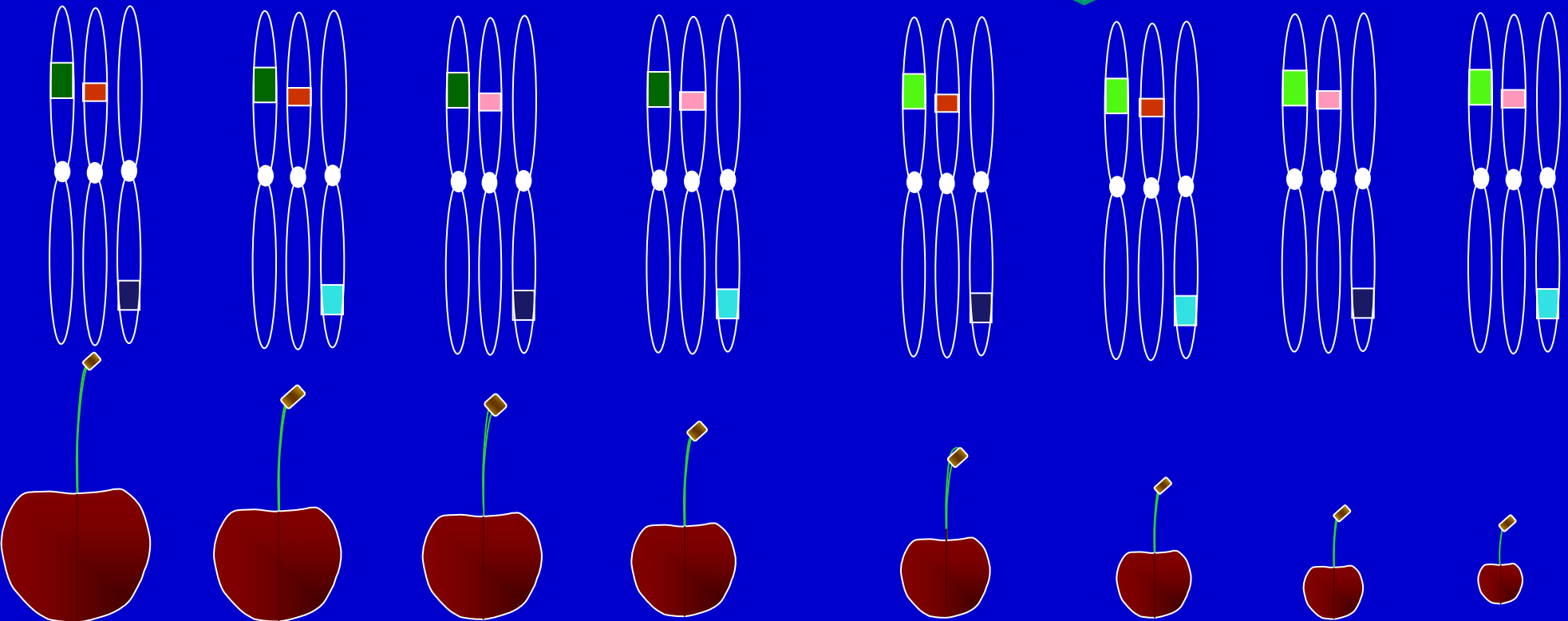
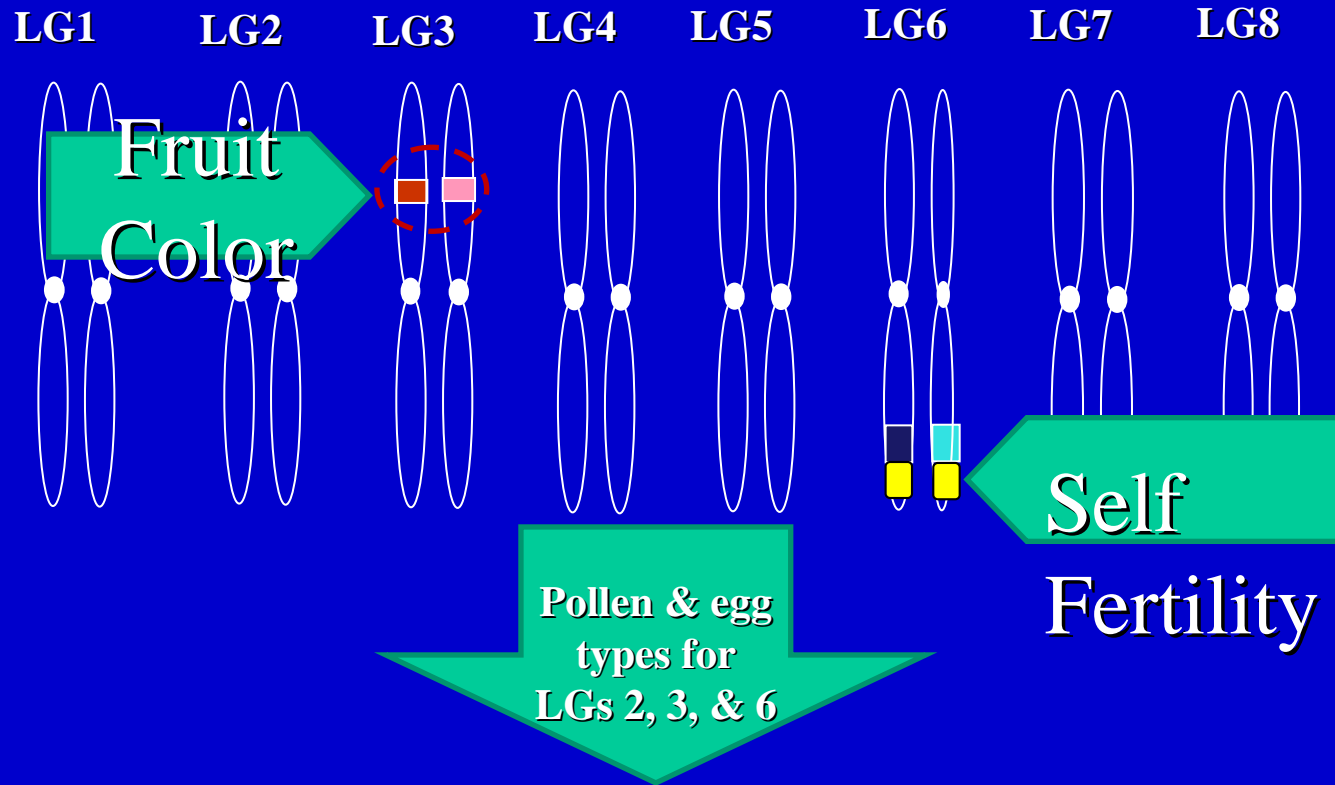


**Wild forest cherry**

**We are identifying the genetic changes that are responsible for this increase in fruit size.**



**In sweet cherry, 3 linkage group regions have been identified that contain genes that control fruit size.**



# RosBREED Stakeholder Advisory Panel

Josefina Alcala  
Jim Allen  
Phil Baugher  
Henry Bierlink  
Chalmers Carr III  
Robert Curtis  
Bill Dodd  
Chrislyn Particka  
Bruce Grim  
Rick Harrison  
Philip Korson  
Kevin Moffitt  
Tom Stokes  
Gary van Sickle



Genetic  
technologies



Engineering  
technologies



# Comprehensive Automation for Specialty Crops (CASC)

[Welcome](#) [Motivation](#) [Partners](#) [Publications](#) [Events](#) [Trip Reports](#) [Commercialization](#) [Advisory Board](#) [Press](#) [Contact](#)



CASC is a multi-institutional initiative led by Carnegie Mellon Robotics Institute to comprehensively address the needs of specialty agriculture focusing on apples and horticultural stock. CASC will develop methods to improve production efficiency, identify threats from pests and diseases, and, detect, monitor and respond to food safety hazards. We expect advances from the integration of robotics technology and plant science.

CASC is funded by the **USDA Cooperative State Research, Education & Extension Service** with matching support from industry and the **Pennsylvania Infrastructure Technology Alliance**.

**4 yrs**

**\$6M federal**

**\$6M matching**

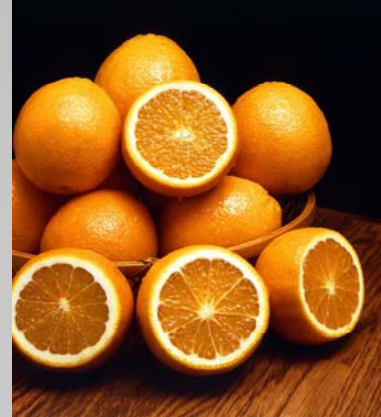
Sanjiv Singh, Carnegie Mellon Univ

Specialty Crop Research Initiative



United States Department of Agriculture  
National Institute of Food and Agriculture

# Thanks



# Stakeholders



# Soil, Water, & Nutrition Management





# Production Systems



# Crop health





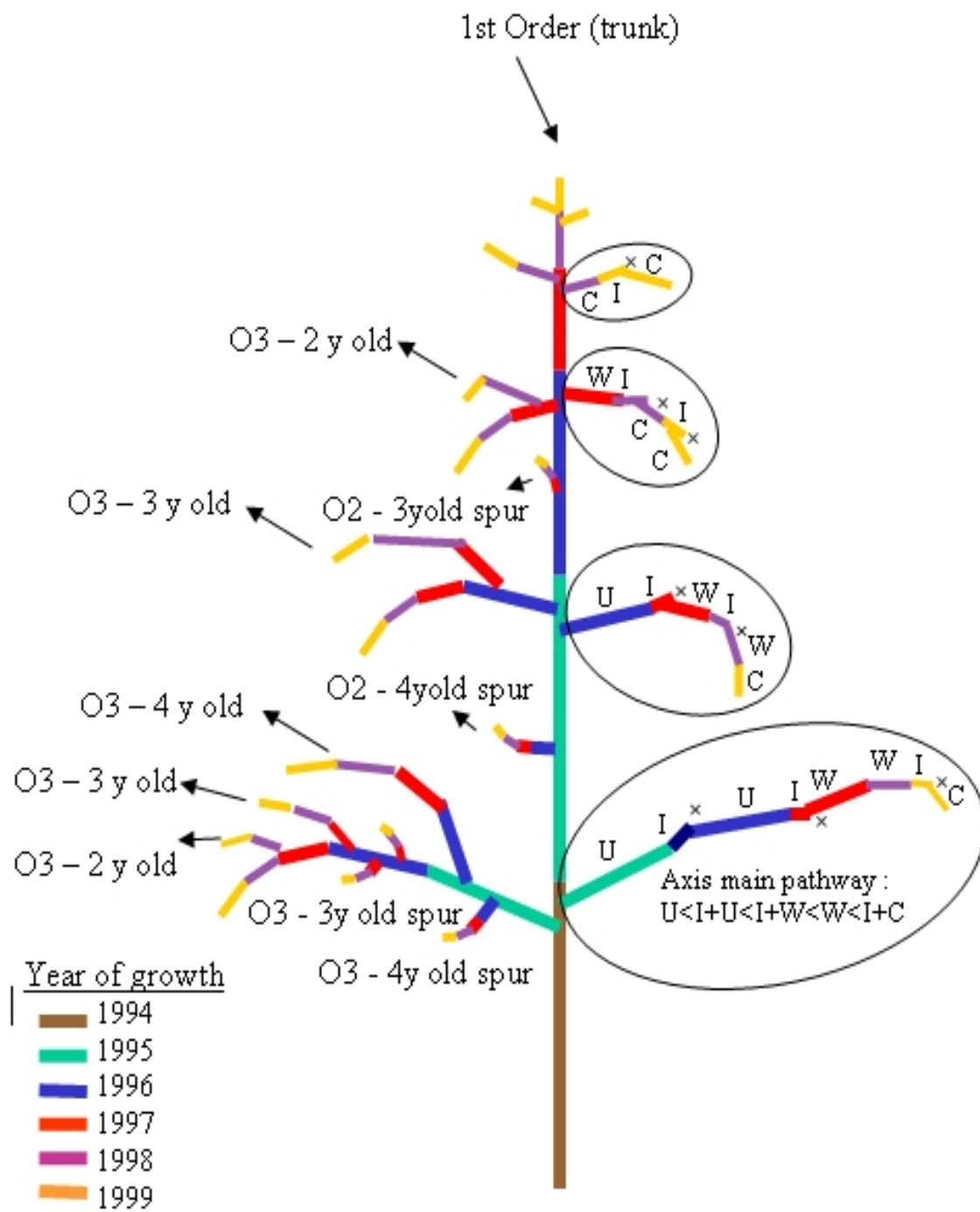
# **Crop Quality Management**

# Vision Robotics orchard scout prototype

Quincy 2008



Picture Courtesy of Geraldine Warner, Good Fruit Grower





# **Oxbo/Picker Technologies mechanical assist prototype**

**August 2009**

**Pasco WA**

# Future Technology

