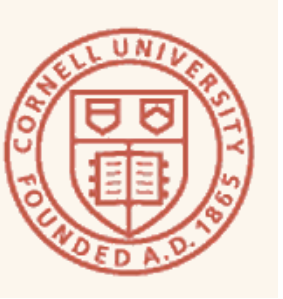
Apple Breeding at Cornell: Fruit Quality and Beyond

IFTA Meeting

February 6, 2013

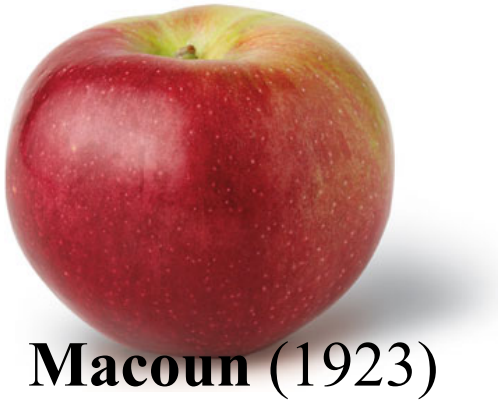


Fast Facts: CU Apple Breeding

- **One of oldest programs**
- **One of largest programs in the world**
- **65 named apple varieties**
- **Integrating breeding, genetics and genomics**
- **Multi-disciplinary, we benefit from collaboration**
- **Cornell Cooperative Extension actively involved (Breth, DeMaree, Sazo, Hoying, Fargione, Iungerman, Kahlke)**

Cornell Varieties

CORTLAND 1915

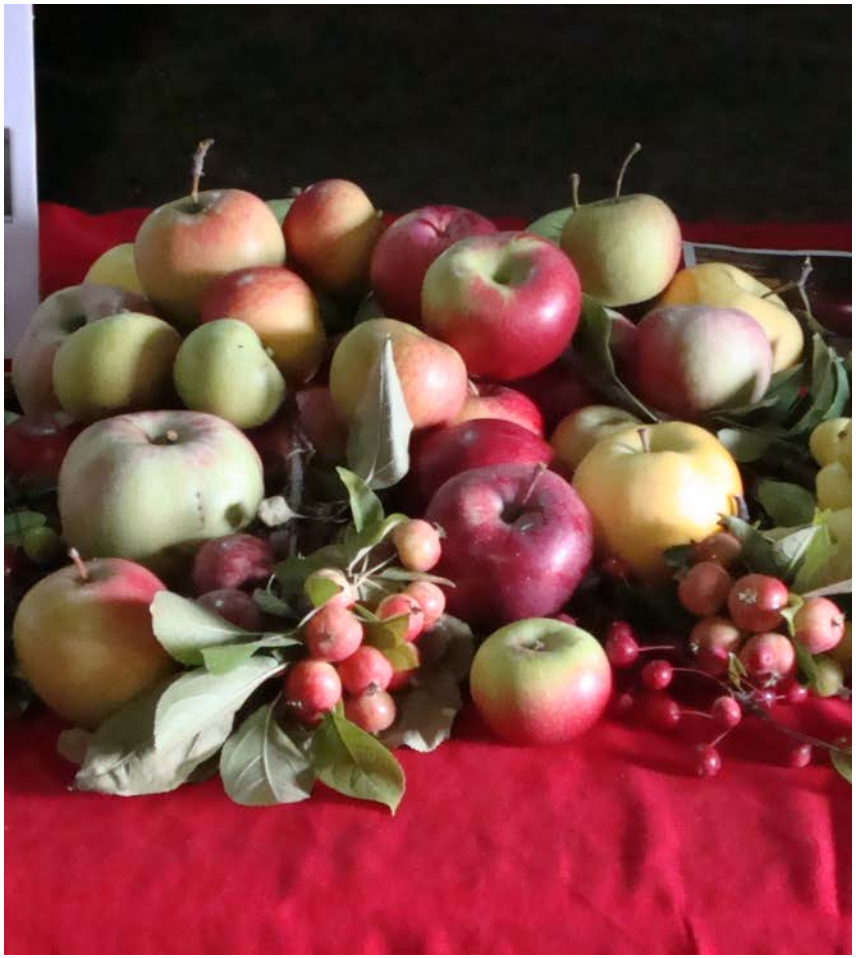


Macoun (1923)

Empire (1968)

Jonagold (1966)

Partnership with USDA: 2012



- **We benefit from access to over 3,000 clones maintained by USDA/ARS at Geneva.**
- **The research leader (Dr. Gan-Yuan Zhong) and I are co-advising a Ph.D. student (Ben Gutierrez) on research on germplasm in the collection**

Partnership: Cornell Apple Breeding and Motts/Dr. Pepper

- Discussed with industry members well in advance of negotiations.
- Gave Motts exclusive rights to advanced selections meeting certain criteria. The selections were not suited to fresh market.
- 10 years of program support.

RosBREED: Enabling Marker-assisted Breeding in the Rosaceae

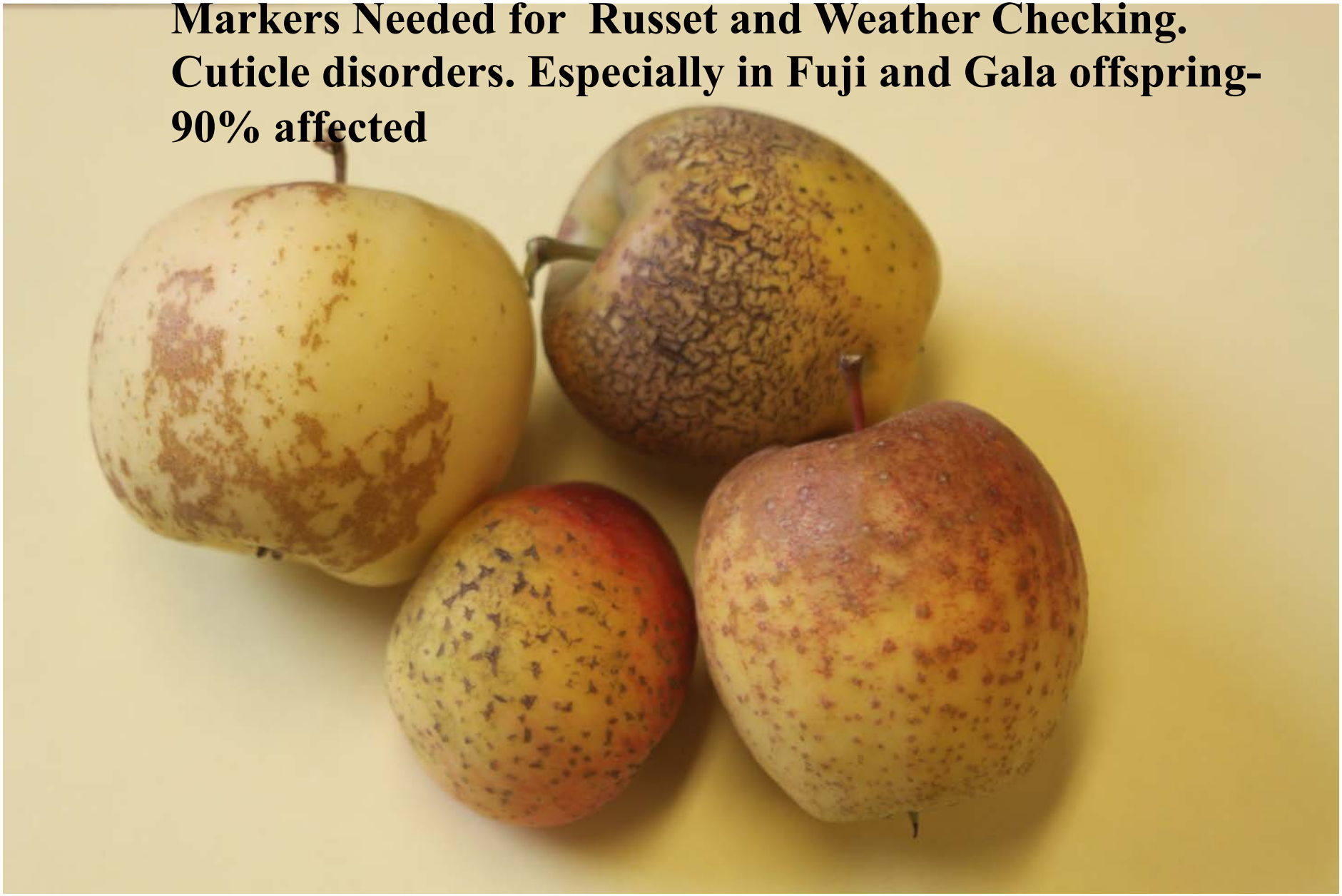
- Looking at markers across 1,000s of seedlings, parents and ancestors
- Partially supports a graduate student
- Resulted in uniform phenotyping across programs

RosBREED 2

- **Good markers have been developed, yet we need more!**
- **RosBREED 2 may be a victim of the “fiscal cliff”.**
- **Markers need to be robust and tested across different populations.**
- **Complex and important problems still need study!**
- **Phenotyping by breeders is crucial to successful markers.**

New markers will prevent such offspring in the future

Markers Needed for Russet and Weather Checking. Cuticle disorders. Especially in Fuji and Gala offspring- 90% affected



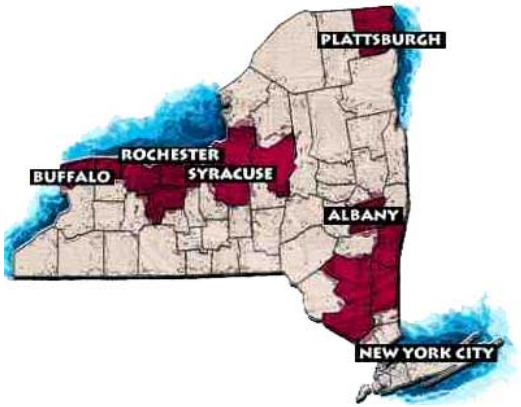
Markers Needed for Open Calyx: Almost every progeny in one cross affected.

CU Apple Breeding: Consumer Satisfaction is Critical

- **Most important attributes: Crispness(crunch), texture, flavor, juiciness, sugar and acid.**
- **Consistency of quality is essential.**
- **Long storage and shelf life.**
- **Free from disorders.**

New CU Apple Selections Generating Interest

NY industry overview



- 674 apple growers
- ‘McIntosh’ #1 variety
- Have and have nots: Not able to grow or join the clubs for ‘Pink Lady’ or the NZ apples ‘Jazz’ or ‘Pacific Rose’
- Only 18 growers members of ‘SweeTango’

How do we capture value for new varieties by developing new models of release?

- **NYSAES Advisory Board: Task Force on Variety Licensing.**
- **Study the past.**
- **Emphasize transparency.**
- **Foster discussions among the industry.**
- **Recognize that we needed an entity that in 2008 did not exist. 674 different growers.**
- **We needed grower buy-in and no one "shut-out".**
- **For long term success we needed funding for a strong marketing program for the new varieties**

Process

- **We gave a call to the New York industry to negotiate for exclusive rights to two New York Selections by:**

- **Editorials (in key grower newsletters and periodicals)**
- **Fruit school presentations**
- **Articles**
- **Emails**
- **Meetings**

NYAG LLC. and Cornell

- **Equal partners**
- **Original officers and members: Roger LaMont, Walt Blackler, Bob Norris, Jeff Crist, Mason Forrence. Chuck Mead and Jim Bittner with Dean Boor and Commissioner Pat Hooker.**

Commercialization

- **Commitment to plant 900 acres (about 60% NY 1 and 40% NY 2)**
- **Names soon**
- **Marketing plans underway**
- **In stores 2014**

New York Selection #1

- **Attractive, productive, crisp, juicy, sweet, mild**
- **‘Honeycrisp’ parentage, without the production problems**
- **High sugar, high firmness, freedom from most storage disorders over many years**

New York #2

- Appeals to consumers who like a tart apple
- Great consumer reaction in tests
- Low flesh browning after cutting

NYAG Members Rating Samples

Postharvest Assessment of Optimum Harvest Date for Regular and CA Storage

Breeding New Varieties, but also Genetic Studies to Make Further Advances

Imagine that fruit quality traits are similar to the diverse plant forms I will show. It is just too hard to show "quality" traits in images. We have similar diversity for quality.

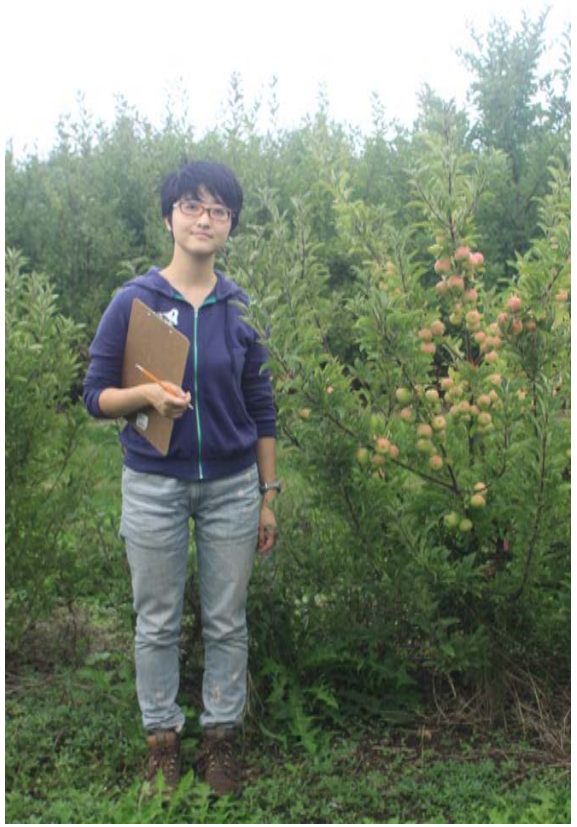
Weeping (W) x Columnar (Co)

Unique Combinations

Plant architecture

Wide branch angles

Unusual Discoveries in Plant Architecture



Variation within Columnar

Scab resistant and strange

Epigenetics: Beyond DNA Sequence. What genes are turned on and off and by what?

How do hybrids stay viable with "wide" crosses?

Interspecific Hybrids: The Parents

A total of four parents will be used for this study: - Two cultivated apples and two Malus species

Maternal Parent

M. x domestica
A columnar selection

'Pinova' Control cross

M. fusca
A species from the Pacific Northwest

M. doumeri
A species from SE

Progeny of Interspecific Cross

TE-Transposable Elements

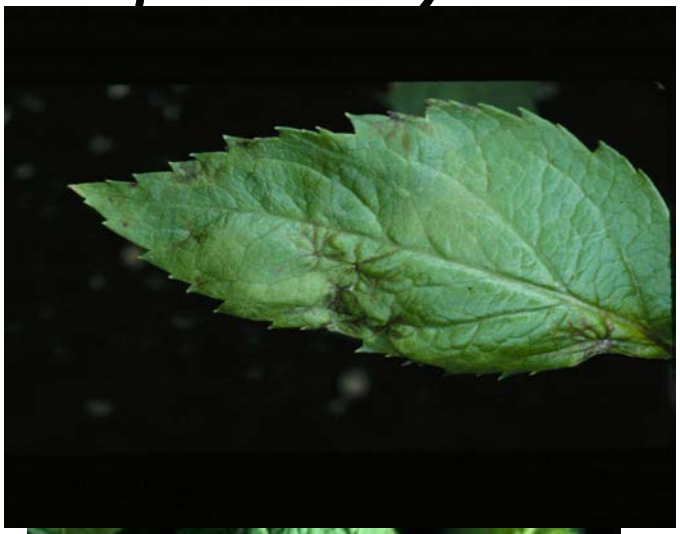
Jumping Genes

- Very common in apple
- Comprise a large % of the genome
- Activated by stress
- We will study their role in new hybrids

Chimeras for apple skin color. Light sectors "turned off".

Diversity in Flowering
New Crabapples for Landscaping

Resistance to Apple Scab
(*Venturia inaequalis*)



‘Honeycrisp’ Genes and Scab Resistance

- We have several “major genes” for resistance.
- ‘Honeycrisp’ (HC) was used as a parent for its “field” resistance at CU.
- A student of Jim Luby identified genes for resistance in HC.
- New hybrids may have multiple genes.

Scab Resistance and……

Resistance to Powdery Mildew

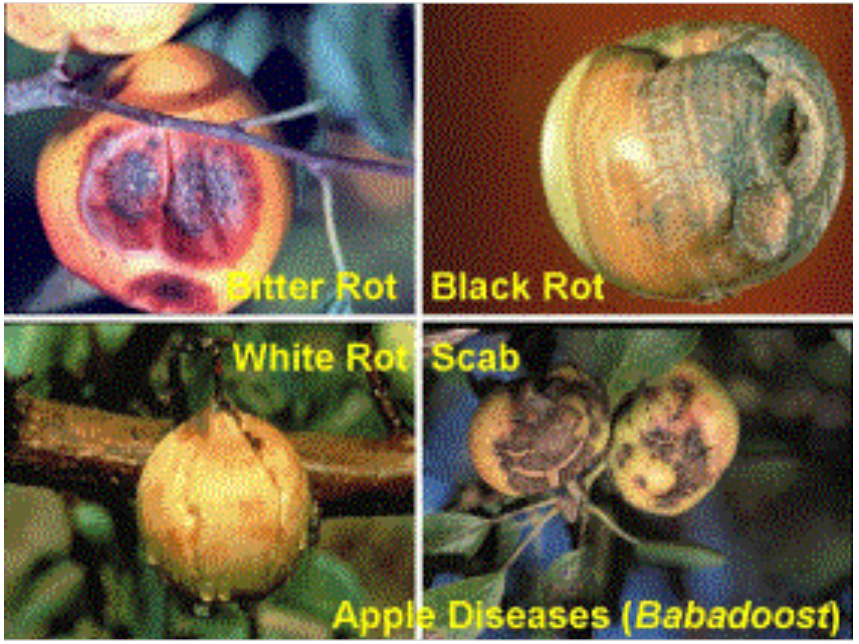
Resistance to Black rot

Resistance to Other Diseases Needed

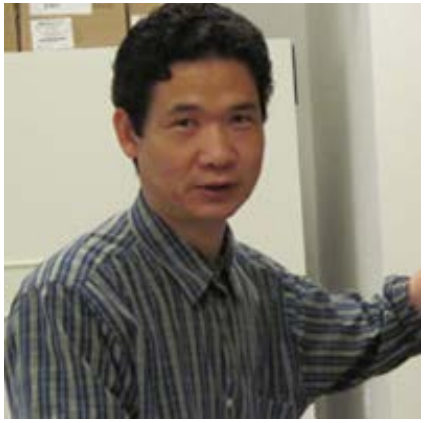
Climate change and new diseases

***Glomerella* leaf spot**

Fruit Rots

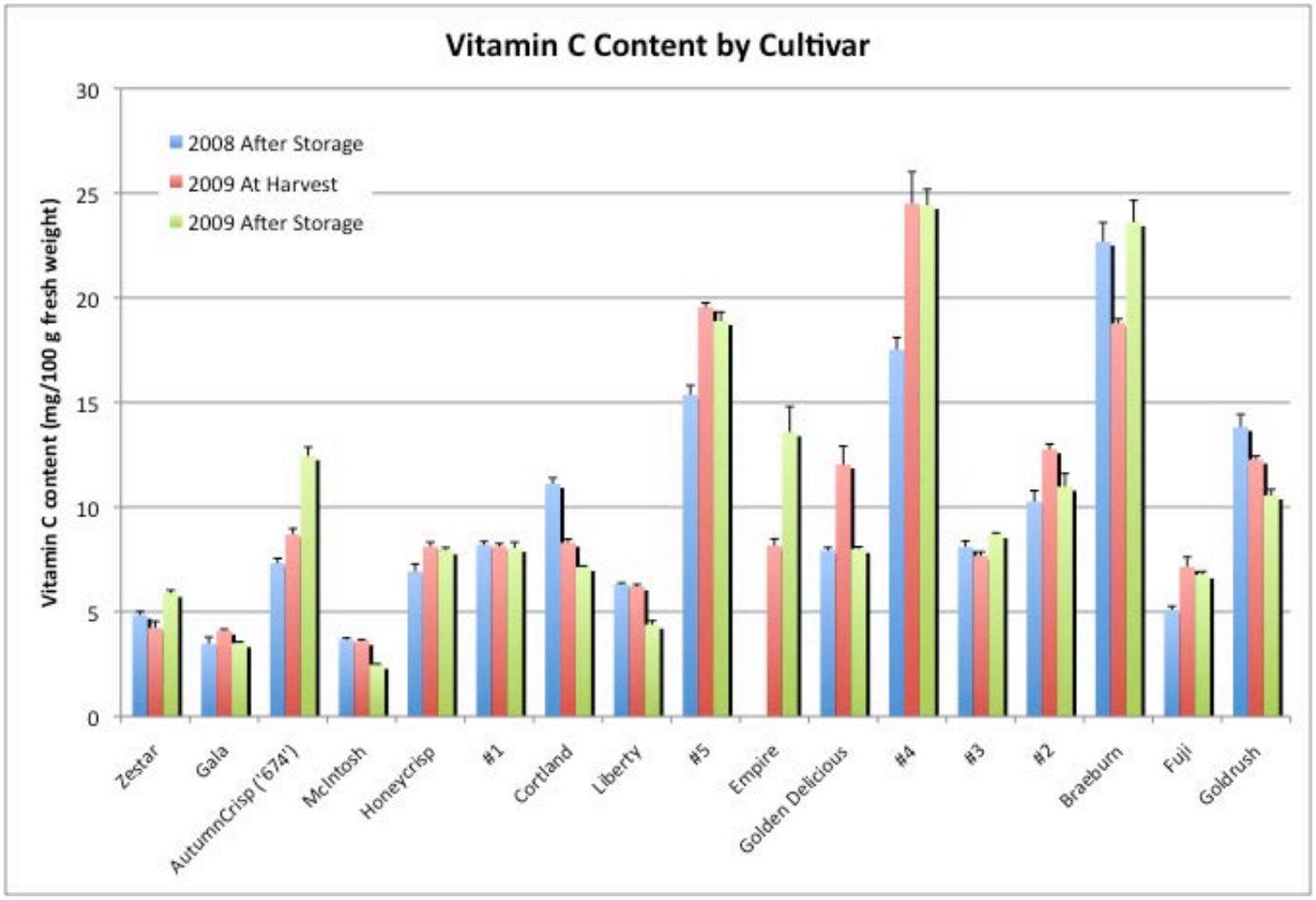


Cornell Researchers



Vitamin C and Antioxidants

- **You do not need to go to heirlooms for genetic diversity in antioxidant. There may be a 10 –to 30 fold variation across apple populations.**
- **You do need to know which ones to target! Which are bioavailable?**
- **While vitamin C is not the most important antioxidant-people understand it. We created higher vitamin C apple selections by crossing (High x High).**


Vitamin C Content by Cultivar
Vitamin C content (mg/100 g fresh weight)
30
25
20
15
10
5
0
2008 After Storage
2009 At Harvest
2009 After Storage
Zestar
Gala
AutumnCrisp ('674')
McIntosh
Honeycrisp
#1
Cortland
Liberty
#5
Empire
Golden Delicious
#4
#3
#2
Braeburn
Fuji
Goldrush

Reduced-Browning

- **Value- added and convenience are important markets.**
- **McDonalds "Apple Dippers"started the trend.**
- **For day care and schools ½ an apple is the serving size.**

Potential for Future Commercialization

There will be Cornell Open Releases

Candid Reasons:

- **Not all releases will be suited to a "managed release".**
- **An open release will bring in royalties to aid in program support and escalating costs.**
- **For long-term viability Cornell must be national/ international in scope. We have the quality to do so.**
- **NYAG will have a seat at the table for managed releases in the US, but open releases will be just that.**
- **Not everyone can pick a winner at the gate. There will be excellent new releases without a champion. Who will be the next innovator? (G. Auvil- 'Granny Smith', J. Frecon-'Gala', growers everywhere- 'Honeycrisp').**
- **Risks and Rewards. Information available.**

Grower Comments this Week

- **“Yeah, you’ll have open releases: New York growers will keep the good ones and the dogs will become open to everyone.”**
- **“At least you are taking care of your industry”.**
- **“Work together as an industry to direct research and communicate to effect the best possible results” (Brad Hollabaugh, IFTA 2013)**

Despite Challenges, There are Great Opportunities Ahead

Thank You For Your Attention!

- **We gratefully acknowledge support from the NY ARDP, NYAG LLC, Motts, Hatch and Federal Formula Funds and SCRI.**
- **Cornell provides a broad base of excellent collaborators and support personnel. I especially thank Kevin Maloney, our field research unit, Faculty in the Department of Horticulture and CC Extension.**
- **Long term support is crucial to the success and viability of our program.**