Breeding fruit crops in the USA using socio-economic and DNA information

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S11 ISAFRUIT
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Outline

RosBREED background

Preliminary results

Breeder survey

Target traits

Marker assisted technology

Relative importance of traits for five crops

Conclusions
RosBREED Background
The **Rosaceae** family of horticultural crops.

- **POME FRUIT**
- **STONE FRUIT**
- **BERRIES (some)**
- **ROSE**
OUR DREAM

Ultra-crisp tasty apples
sweet juicy peaches
flavorful cherries
luscious strawberries

Consistent quality, available & affordable

Enjoyed by consumers, regularly

Sustainably produced throughout the U.S.
IMPACT
increase new cultivar adoption
enlarge market potential
increase consumption

Focus on fruit quality
Honeycrisp: a breakthrough cultivar

- Introduced 1991, Univ of Minn.
- Dramatic impact in U.S. market
- Unique ultra-crisp juicy texture and pleasing flavor
- Required 30 years from crossing to commercialization
- RosBREED can help develop such cvs using DNA and Socio-economic information
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.

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

4 yrs
$7.2M federal
$7.2M matching

This project is supported by the Specialty Crops Research Initiative of USDA’s National Institute of Food and Agriculture
RosBREED OBJECTIVES

1) Use knowledge of trait values to enhance new cultivar adoption, enlarge market potential, and increase consumption.

2) Establish sustainable infrastructure for marker-assisted breeding (MAB).

3) Integrate breeding and genomics information.

4) Conduct MAB in demonstration breeding programs.

5) Enhance sustainability of cultivar development through stakeholder outreach and education.
RosBREED Participants

Supported by the Specialty Crops Research Initiative of USDA's National Institute of Food and Agriculture
RosBREED International Partners

Plant Research Intl
East Malling Research
INRA - Bordeaux, Avignon & Angers
CRA-FRU Rome

Andres Bello University
University of the Western Cape
Plant & Food Research
FruitBreedomics
RosBREED DEMONSTRATION BREEDING PROGRAMS

Rosaceae

WSU
U Minn
Cornell U
MSU
Driscoll’s
USDA-ARS Corvallis

Clemson U
Texas A&M
U Arkansas
WSU
MSU
Trait and Market Class Breeding Targets

Use knowledge of trait values & preferences from producers, processors, & consumers to prioritize breeder targets so new cultivars will be more quickly accepted and have enhanced commercial and consumer impact.
Trait Impact: Focus on fruit quality

Utilize improved knowledge of industry value & consumer preferences to target traits

Red fleshed peaches & nectarines: high priority breeding targets? Value in the marketplace? Economic weight for this fruit color trait?

Courtesy David Byrne, Texas A&M Univ.)
Initial Socio-economics results
Breeder Web Survey

Rosaceae breeders: USA and Canada  60

Responses  41
Usable responses  39

1. What crop(s) are you currently breeding? Please check all that apply.

☐ Strawberry
☐ Apple Scion
☐ Apple Rootstock
☐ Pear Scion
☐ Pear Rootstock
☐ Tart Cherry Scion
☐ Tart Cherry Rootstock
☐ Sweet Cherry Scion
☐ Sweet Cherry Rootstock
☐ Peach Scion
☐ Peach Rootstock

2. What are the target production region(s)? E.g., U.S. Pacific Northwest

[Qualtrics survey interface]

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www.rosbreed.org
What type of organization are you working at as a breeder?

- **University**: 49%
- **Federal**: 29%
- **Private sector**: 20%
- **Other**: 2%

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[www.rosbreed.org](http://www.rosbreed.org)
Influence of interested parties (1-10 scale, mean value)

- Producers’ needs
- Consumers’ needs/preferences
- Intended use of the crop
- Own experience
- Wholesalers’ needs
- Marketers’ feedback
- Other, please specify:
  - Experiences of colleagues/other breeders
  - Nursery feedback
  - Retailers’ feedback
  - Funding agency
  - Available premiums
Challenges in determining priorities
(1-10 scale, mean value)

- Poor communication with interested parties
- Difficult to find consensus across interested parties
- Separate short-term from long-term needs
- Lack of consistent/standardized information on methods
- Lack of genetic material
- Uncertainty if variety being developed would be commercially viable
- Lack of consistent/standardized information on genetic material
- Other, please specify:
Challenges in implementing priorities
(1-10 scale, mean value)

- Other, please specify: 9.5
- Funding availability: 7.0
- Time of senior investigator/staff: 7.0
- Labor/staff availability: 6.5
- Trait heritability: 6.0
- Genetic material availability: 5.5
- Genetic markers availability: 5.0
- Genetic variation: 4.5
- Growing conditions at research farm: 4.0
- Lack of facilities: 3.5
- Land availability: 3.0
Marker Assisted Technology
Use marker assisted technology

Yes 38%
No 62%
Reason for using marker-assisted technology

- Aiding in selecting parents to use: 60%
- Confirming identity: 70%
- Aiding in selecting among seedlings: 60%
- Increasing efficiency: 50%
- Confirming parentage: 55%
- Intellectual property protection: 45%
- Saving cost: 40%
- Other, please specify: 20%
Reason for NOT using marker-assisted technology

- **Too costly**: 50%
- **Lack of technology**: 45%
- **Other, please specify:** 40%
- **Lack of knowledge**: 35%
- **It does not suit to what I am doing**: 25%
Relative Importance of Genetic Traits for Five Crops
## Highest ranked traits: Apple scion

<table>
<thead>
<tr>
<th>Trait</th>
<th>Rank</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit crispness</td>
<td>5.00</td>
<td>96.40</td>
</tr>
<tr>
<td>Fruit juiciness</td>
<td>5.00</td>
<td>96.00</td>
</tr>
<tr>
<td>Consistent storage quality</td>
<td>5.00</td>
<td>88.00</td>
</tr>
<tr>
<td>Shelf-life</td>
<td>5.00</td>
<td>87.00</td>
</tr>
<tr>
<td>Acid/sugar balance</td>
<td>4.75</td>
<td>84.50</td>
</tr>
<tr>
<td>Flavor</td>
<td>4.75</td>
<td>79.25</td>
</tr>
<tr>
<td>Storage disorders</td>
<td>4.60</td>
<td>89.20</td>
</tr>
<tr>
<td>Fruit firmness</td>
<td>4.60</td>
<td>79.20</td>
</tr>
<tr>
<td>Fire blight</td>
<td>4.60</td>
<td>69.00</td>
</tr>
<tr>
<td>Sweetness</td>
<td>4.40</td>
<td>71.20</td>
</tr>
</tbody>
</table>
Highest ranked traits: Peach scion

<table>
<thead>
<tr>
<th>Trait Name</th>
<th>Rank</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit firmness</td>
<td>4.88</td>
<td>92.25</td>
</tr>
<tr>
<td>Fruit uniformity</td>
<td>4.75</td>
<td>85.88</td>
</tr>
<tr>
<td>Fruit shape</td>
<td>4.71</td>
<td>83.29</td>
</tr>
<tr>
<td>Fruit size</td>
<td>4.63</td>
<td>88.75</td>
</tr>
<tr>
<td>Production consistency</td>
<td>4.63</td>
<td>87.50</td>
</tr>
<tr>
<td>Sweetness</td>
<td>4.63</td>
<td>76.38</td>
</tr>
<tr>
<td>Flavor</td>
<td>4.60</td>
<td>82.60</td>
</tr>
<tr>
<td>Productivity</td>
<td>4.57</td>
<td>89.57</td>
</tr>
<tr>
<td>Heat tolerance</td>
<td>4.57</td>
<td>70.57</td>
</tr>
<tr>
<td>Soluble solids(Brix)</td>
<td>4.50</td>
<td>83.25</td>
</tr>
</tbody>
</table>
## Highest ranked traits: Strawberry

<table>
<thead>
<tr>
<th>Trait Name</th>
<th>Rank</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavor</td>
<td>4.89</td>
<td>94.56</td>
</tr>
<tr>
<td>Productivity</td>
<td>4.75</td>
<td>88.50</td>
</tr>
<tr>
<td>Shelf-life</td>
<td>4.67</td>
<td>83.89</td>
</tr>
<tr>
<td>Fruit size</td>
<td>4.60</td>
<td>88.70</td>
</tr>
<tr>
<td>Skin color</td>
<td>4.56</td>
<td>88.33</td>
</tr>
<tr>
<td>Extended harvest season</td>
<td>4.50</td>
<td>74.00</td>
</tr>
<tr>
<td>Production consistency</td>
<td>4.50</td>
<td>71.60</td>
</tr>
<tr>
<td>Fruit firmness</td>
<td>4.40</td>
<td>86.20</td>
</tr>
<tr>
<td>Shipping ability</td>
<td>4.33</td>
<td>81.78</td>
</tr>
<tr>
<td>Root rot</td>
<td>4.33</td>
<td>76.00</td>
</tr>
</tbody>
</table>
CONCLUSIONS

• It is difficult to develop thorough, sustained collaboration among breeding programs, even with financial and technical incentives.

• Including social scientists adds difficulties.

• Proper surveys are time-consuming, expensive, and essential.

• Breeders consider most traits are important or very important.

• Identification of target traits by economic weighting is difficult.

• The experiment is underway, with great potential to achieve our intended impact.
Thank you
Marker-Assisted Breeding Outcomes

Four year project outcomes

- Increased genetic knowledge flow across taxonomic boundaries in the Rosaceae
- Implementation of MAB by breeding programs
- Increased gain in fruit quality per breeding cycle due to improved parent selection and improved mean progeny value

Long-term outcomes

- More rapid availability of new cultivars with genetically superior fruit quality
- Improved profitability and sustainability of US rosaceous fruit, nut, and floral crops with increased consumption and enjoyment
Highest ranked traits:  
Sweet and Tart Cherry Scion

<table>
<thead>
<tr>
<th>Trait Name</th>
<th>Rank</th>
<th>Likelihood</th>
<th>Trait Name</th>
<th>Rank</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit firmness</td>
<td>5.00</td>
<td>100.00</td>
<td>Fruit firmness</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Fruit size</td>
<td>5.00</td>
<td>100.00</td>
<td>Fruit shape</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Powdery mildew</td>
<td>5.00</td>
<td>96.00</td>
<td>Fruit uniformity</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Extended harvest season</td>
<td>5.00</td>
<td>89.00</td>
<td>Pit shape and size</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Self fertility</td>
<td>5.00</td>
<td>89.00</td>
<td>Pit splitting and fragments</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Skin color</td>
<td>5.00</td>
<td>78.00</td>
<td>Machine harvest ability</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Resistance to frost injury</td>
<td>5.00</td>
<td>73.00</td>
<td>Graft compatibility</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Other disease-viral</td>
<td>5.00</td>
<td>44.00</td>
<td>Production consistency</td>
<td>5.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Flavor</td>
<td>4.00</td>
<td>80.00</td>
<td>Skin color</td>
<td>5.00</td>
<td>56.00</td>
</tr>
<tr>
<td>Fruit juiciness</td>
<td>4.00</td>
<td>50.00</td>
<td>Flesh color</td>
<td>5.00</td>
<td>55.00</td>
</tr>
</tbody>
</table>

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