California Avocado Varieties: Past, Present and Future (?)

Mary Lu Arpaia
University of California, Riverside
A member of the Laurel family (Lauraceae) which is mainly tropical evergreen trees composed of ~50 genera and >3000 species

Family includes Cinnamon, Bay Laurel, CA Bay tree, Red Bay Laurel and sassafras and numerous other *Persea* species found in SE USA and throughout Central America
• Seeds found in Archeological Record showing long history of cultivation

• Derived from Spanish Ahaucate (aguacate) which is derived from the Aztec word – Ahuacatl

• Also known as “Palta” in Chile, Alligator Pear in Africa

Aztec man with guacamole; avocados on the tree (Florentine Codex, 1500s AD)
• Relatively “new” crop to domestication
• Highly diverse
• Retains the traits that are adapted to its native neotropical rainforest habitat
• The physiology of the tree is poorly understood
Persea americana Mill.

Family: Lauraceae

3 horticultural races

• Mexican
• Guatemalan
• West Indian (Antillean)
Where is the original home of the avocado?
### GENERAL TRAITS

<table>
<thead>
<tr>
<th></th>
<th>Mexican</th>
<th>Guatemalan</th>
<th>West Indian</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Native Region</strong></td>
<td>Mexican Highlands</td>
<td>Guatemalan Highlands</td>
<td>Tropical lowlands</td>
</tr>
<tr>
<td><strong>Climate Adaptation</strong></td>
<td>Subtropical</td>
<td>Subtropical</td>
<td>Tropical</td>
</tr>
<tr>
<td><strong>Cold Tolerance</strong></td>
<td>Most</td>
<td>Intermediate</td>
<td>Least</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>Least</td>
<td>Intermediate</td>
<td>Most</td>
</tr>
</tbody>
</table>
# LEAF and FLOWER TRAITS

<table>
<thead>
<tr>
<th></th>
<th>Mexican</th>
<th>Guatemalan</th>
<th>West Indian</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flush Color</strong></td>
<td>Greenest</td>
<td>Reddest</td>
<td>Yellowish-green</td>
</tr>
<tr>
<td><strong>Anise Scent</strong></td>
<td>Present (usually)</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Season</strong></td>
<td>Early</td>
<td>Late</td>
<td>Early/Intermediate</td>
</tr>
<tr>
<td><strong>Fruit maturity</strong></td>
<td>5-7 mos.</td>
<td>10-18 mos.</td>
<td>6-8 mons.</td>
</tr>
<tr>
<td>FRUIT TRAITS</td>
<td>Mexican</td>
<td>Guatemalan</td>
<td>West Indian</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Size</td>
<td>Tiny-Medium</td>
<td>Small-Large</td>
<td>Medium-V. Large</td>
</tr>
<tr>
<td>Peel Color</td>
<td>Usually purple</td>
<td>Black or green</td>
<td>Green/maroon</td>
</tr>
<tr>
<td>Peel Thickness</td>
<td>Very thin</td>
<td>Thick</td>
<td>Medium</td>
</tr>
<tr>
<td>Seed Coat</td>
<td>Thin</td>
<td>Usually thin</td>
<td>Thick</td>
</tr>
<tr>
<td>Seed Tightness</td>
<td>Often loose</td>
<td>Tight</td>
<td>Often loose</td>
</tr>
<tr>
<td>Flavor</td>
<td>“Anise”, spicy</td>
<td>Often rich</td>
<td>Sweet, mild</td>
</tr>
<tr>
<td>Oil Content</td>
<td>Highest</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>
• Avocados produced worldwide
• More tropical areas produce West Indian Race varieties
• Most leading avocado producing countries produce Guatemalan/Mexican race avocados
• Leading cultivar worldwide is HASS
1870’s – First trees planted
1911 – First budded trees sold
   – Fuerte introduced to CA from Atlixco Mexico (Carl Schmidt of West India Gardens, Altadena)
1915 – First meeting of the CA Avocado Society
   – W. Popenoe reports on 86 named varieties
The Parent ‘Fuerte’ Tree in Atlixco, MX (1911)

FRUITS FROM THE PARENT FUERTE AVOCADO TREE

Alejandro Le Blanc, Jr., is here shown holding several avocados of the 1918 crop from the parent Fuerte tree. When told of the present importance of Fuerte in California and its probable future value to the avocado industry Senor LeBlanc expressed himself as delighted that he had been able to give to horticulture something of merit.

THE PARENT TREE OF THE FUERTE AVOCADO

At the present time no tree in Atlixco is of greater interest to Californians than the parent Fuerte, which stands in the garden of Alejandro Le Blanc. It is believed to be about 60 years old, and its crown is approximately 25 feet high and 30 feet in spread.

Popenoe, CAS, 1919
FUERTE

• The leading variety from 1920’s to 1970’s
• Adapted to a wide variety of climates
• Known for high fruit quality
• Large spreading tree
• Recognized to have erratic or severe alternate bearing
## Varieties originating before 1940

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seedling Year</th>
<th>Location</th>
<th>C.A.S. Reg. or Introduced</th>
<th>Patented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyon</td>
<td>1908</td>
<td>Hollywood</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fuerte</td>
<td>1911</td>
<td>Atlixco, MX</td>
<td>1915</td>
<td>-</td>
</tr>
<tr>
<td>Hass</td>
<td>1926</td>
<td>La Habra Hts.</td>
<td>1932</td>
<td>1935</td>
</tr>
<tr>
<td>Zutano</td>
<td>1926</td>
<td>Fallbrook</td>
<td>1932</td>
<td>-</td>
</tr>
<tr>
<td>Edranol</td>
<td>1927</td>
<td>Vista</td>
<td>1932</td>
<td>-</td>
</tr>
<tr>
<td>Bacon</td>
<td>1928</td>
<td>Buena Park</td>
<td>1948</td>
<td>-</td>
</tr>
</tbody>
</table>
Rudolph and Elizabeth Hass

The CA Avocado Society visits in the 1960's

‘HASS’
Facts about Hass

- Chance find in La Habra Heights in 1926 and patented in 1935
- Considered interesting but black skin considered a flaw as compared to leading variety, Fuerte
- Did not overtake Fuerte in importance until the planting boom of the mid-1970’s
- Now worldwide leading variety and major variety marketed in US
- High fruit quality when harvested at proper maturity
From the market standpoint the Hass would appear to have everything. Excellent quality, popular size, small seed, good shipper, its leathery skin and long season complimenting the Fuerte. Its single disadvantage is its black color which has been associated in the minds of the public with poor quality fruits. Experience is indicating however that when properly handled this color handicap can be overcome. The Hass variety gives satisfaction and repeat business follows.

The Hass Avocado by H. B. Griswold
California Avocado Society 1945 Yearbook 30
Other varieties originating before 1940

Bacon
"B" flower type
Green when ripe
Thin skin

Edranol
"B" flower type
Green when ripe

Zutano
"B" flower type
Green when ripe
Smooth skin

Bacon
smooth skin
large seed

Edranol
medium skin texture
medium seed

Zutano
thin skin
medium seed
## Varieties originating 1940 - 1980

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seedling Year</th>
<th>Location</th>
<th>C.A.S. Reg. or Introduced</th>
<th>Patented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ettinger</td>
<td>1940</td>
<td>Israel</td>
<td>1954</td>
<td>-</td>
</tr>
<tr>
<td>Reed</td>
<td>1948</td>
<td>Carlsbad</td>
<td>1953</td>
<td>1967</td>
</tr>
<tr>
<td>Sharwil</td>
<td>1951</td>
<td>Qld, Australia</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pinkerton</td>
<td>1960</td>
<td>Saticoy</td>
<td>1974</td>
<td>1975</td>
</tr>
</tbody>
</table>
Other varieties originating between 1940 - 1980

**Ettinger**
- "B" flower type
- Green when ripe
- Pear fruit shape
- Smooth skin
- Large seed

**Reed**
- "A" flower type
- Thick ovate shape
- Green when ripe
- Medium skin thickness

**Kona Sharwil**
- "B" flower type
- Green when ripe
- Pear shape
- Medium skin thickness
- Small seed

**Pinkerton**
- "A" flower type
- Green when ripe
- Necky fruit shape
- Rough pebbly skin
## Varieties originating after 1980

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seedling Year</th>
<th>Location</th>
<th>C.A.S. Reg. or Introduced</th>
<th>Patented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gwen</td>
<td>-</td>
<td>Irvine</td>
<td>1982</td>
<td>1984</td>
</tr>
<tr>
<td>Whitsell</td>
<td>-</td>
<td>Irvine</td>
<td>1982</td>
<td>1984</td>
</tr>
<tr>
<td>Esther</td>
<td>-</td>
<td>Irvine</td>
<td>1982</td>
<td>1984</td>
</tr>
<tr>
<td>Sir Prize</td>
<td>1986</td>
<td>Irvine</td>
<td>1995</td>
<td>1996</td>
</tr>
<tr>
<td>GEM</td>
<td>1985</td>
<td>Camarillo</td>
<td>2003</td>
<td>2003</td>
</tr>
<tr>
<td>Harvest</td>
<td>1985</td>
<td>Camarillo</td>
<td>2003</td>
<td>2003</td>
</tr>
</tbody>
</table>
UC Releases since 1982

Gwen
A flower type
Green when ripe
Ovate fruit shape

Pebbly skin texture
Medium seed size

Lamb Hass
"A" flower type
Black when ripe
Medium skin texture

Flat shoulder
Medium seed

GEM
Flower Type “A”
Black when ripe
Thick skin

Thick skin
Medium seed

Sir Prize
"B" flower type
Black when soft
Thin skin

Ridge
Small seed
Differences between Hass and Lamb Hass

- **Lamb Hass maturity season** – mid to late summer
  
  NOT A SUBSTITUTE BUT SUPPLEMENT TO HASS

- **Fruit shape and size** – more “square” but larger

- **Lamb Hass has more upright growth habit**

- **Flexible wood** – fruit borne interior of tree; tends to set fruit in clusters

- **Lamb Hass is more “tolerant” to Persea mite and other pests (?)**

- **Photosynthetic rate approximately 30% higher than Hass and higher chlorophyll content**
Growth habit differences between Hass and Lamb Hass
Hass

Gem
Differences between Hass and GEM

- Maturity seasons overlap; GEM slightly later - COULD BE A SUBSTITUTE TO HASS
- Can accumulate very high levels of dry matter
- Fruit shape – more “tear drop”
- GEM growth habit more vaselike and compact
- Flexible wood – interior fruiting; tends to set fruit in clusters
- Pest tolerance (?)
- Less Alternate Bearing
- Tends to be more productive under most conditions
Gem is a more compact tree than Hass, very similar to Gwen. Bears fruit on the inside of the tree.
Topwork Trials – Kg/tree

Mixed age trees, seedling rootstock at all sites
Fruit size – All sites, all years

Range across all sites:
- GEM – 170 (Far North) to 294 (North Coastal)
- HASS – 129 (Far North) to 270 (North Coastal)
Alternate bearing – All sites, all years

The lower the number the less alternate bearing

Range across all sites:

GEM – 0.43 (Far North) to 0.71 (North Inland)

HASS – 0.65 (North Coastal) to 0.89 (South Inland)
We had other varieties in these trials.

In all trials the cumulative yield of Gem was ranked either #1 or 2. Alternate bearing was least in GEM at all sites.

We have noted that climate can greatly influence fruit shape (as in all varieties); in very hot climates the fruit can be very elongated.

Anecdotal observations following 2007 Freeze was that GEM did best in return bloom
Bloom time and minimum and maximum temperatures in 2002. Data collected at UC South Coast REC in Irvine, CA.

*GEM* flowers later than *Hass*.
Duration of bloom over 4 years

Irvine, CA
Fruit Maturity - GEM

Similar pattern of DM to Hass; tends to be slightly later

Comparison of dry matter changes over season
What do we know about flavor and postharvest characteristics
Is there life after Hass?

2 perspectives

- Market/Trade considerations
- Limitations of Hass under CA conditions
Percentage of CA Hass Crop Marketed by Month

- CA has US market to itself (1983 - 1992)
- Chile exceeds 20 mill lb/yr (1997- 1998)

Source: CAC
Percentage of CA Hass Crop Marketed by Month

- CA has US market to itself (1983 - 1992)
- Chile exceeds 20 mill lb/yr (1997- 1998)
- Mexico enters market 12 mos/yr all states (2005)

Chile data from 97/98 – 04/05
Mexico data from 05/06 – 09/10

Source: CAC
Percentage of CA Hass Crop Marketed by Month

CA has US market to itself (1983 - 1992)
Chile exceeds 20 mill lb/yr (1997 - 1998)
Mexico enters market 12 mos/yr all states (2005)
Peru enters US market (2010)

Chile data from 1997/98 – 2004/05
Mexico data from 2005/06 – 2009/10
Peru data from 2010/11 – 2015/16

Source: CAC, HAB
What will happen to our marketing window when Columbia, South Africa and the other countries that have petitioned entry finally gain entry? Will we be squeezed even further since 95% of CA’s volume is Hass?
There is a potential silver lining

• 25 countries allowed to ship avocados into the continental US (USDA-FAVIR)

• Most of these are Caribbean countries with limited access to continental US and are shipping mainly West Indian varieties into US

Is there a silver lining?

There is a market in the US for things other than HASS

*Spain allowed to ship Hass in under cold treatment
There is a potential silver lining

• The major importing sources for avocado are currently Mexico, Chile, Peru
• Of these Mexico and Peru are limited to ONLY HASS
• Colombia will be limited to Hass
• The petition from South Africa will likely also only allow HASS

The silver lining?
Does this give us an opportunity to differentiate ourselves and regain a strong 12 month present in US market??????

*Spain allowed to ship Hass in under cold treatment
Our leading cultivar, ‘Hass’ CAN BE improved:

- Tree size and structure
- Bearing habit
- Alternate bearing
- Stress tolerance (Cold, Heat, Salinity)
- Disease and pest tolerance
- Productivity
- Seasonality

It is dangerous to have an industry based on one variety
We need to go from Here to There. To stay competitive.
The challenge of finding new avocado varieties

- Long seasonality
- Fruit must be ripened in order to evaluate; ripening time depends on maturity
- Eating quality changes throughout the season
- Industry standard ‘Hass’ sets a high standard for postharvest and eating quality
Looking for:
• Precocious and low AB varieties with high fruit quality
• Upright, slender tree architecture for HD plantings
Do we have alternatives to Hass?
465418-99
Planted 2007 on Duke 7
465518-99
Planted 2007 on Duke 7
464918-99
Planted 2008 on Duke 7
465202-99
Planted 2008 on Duke 7
Tier 3 Planting Fruit picked, Santa Paula CA, January 2016

Very Early
Very Late
Mid to Late
Early
Mid “B” Flower
Environment influences fruit shape and seasonality

<table>
<thead>
<tr>
<th>GEM</th>
<th>Hass</th>
<th>464918-99</th>
<th>465418-99</th>
<th>465518-99</th>
</tr>
</thead>
</table>

- **Cold and Hot, Inland Valley**
  - Lindcove REC
  - Moderate, Coastal
  - South Coast REC
All planted on Dusa Rootstock
How about eating quality?
Collected data on Visual and Eating Acceptability
Example of monthly rating – 07/16/2014

Visual Acceptability

- Hass: 464034-065418-967352-00
- BL516
- GEM

Eating Acceptability

- Hass: 464034-06465418-99467352-00
- BL516
- GEM

Industry Std → UC Release
Like extremely

Neither like or dislike

Dislike extremely

Avocado Grower Field Day Taste Panel Results - 2014
Visual acceptability across all years
(8 new selections)
Flavor acceptability across all years (8 new selections)
THE BIG PICTURE

Have a range of both dark skin and green skin varieties that are comparable to ‘Hass’ in terms of eating quality

We HAVE material that potentially can

• Provide 12 month market coverage
• Improved tree architecture
• Precocious
• Greater yield efficiency
The road from the grove to the consumer

The most important thing to remember is that there is a *continuum* from the grower to the consumer.
THE ULTIMATE GOAL

Enhanced productivity and production efficiency

Satisfied consumers and increased consumption
Thank you for your attention

Information gathered from
The California Avocado Society Yearbooks
UC Experiment Station and USDA documents

All Archived on www.avocadosource.com
Questions?
Enter Information here