



# What to Consider: Almond Varieties

December 6, 2016



## What to Consider: Almond Varieties

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California

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**Bob Curtis,  
Almond Board of California**

# Tom Gradziel, UC Davis



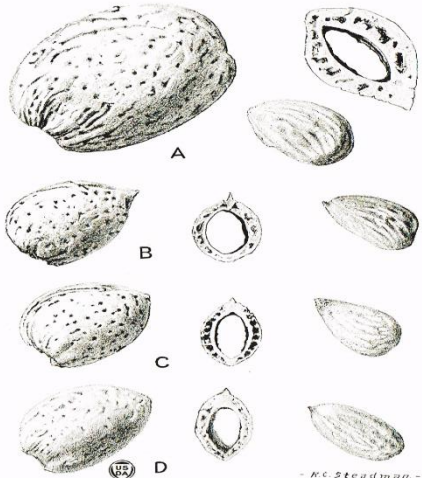


# Almond Varieties for Future Plantings

## Opportunities -and Risks



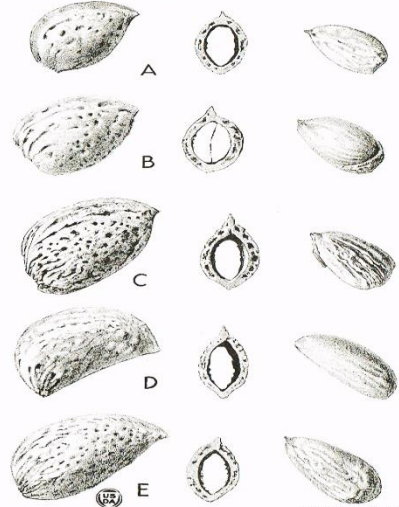
Tom Gradziel  
Dept. of Plant Sciences  
UC Davis



ALMOND VARIETIES.—I

A, Almondo de la F.; B, Ballard; C, Barclay; D, Batham

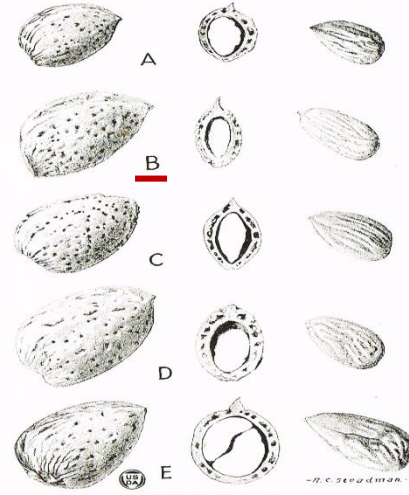
—H.C. Steadman—



ALMOND VARIETIES.—X

A, Karon; B, Lowelling; C, Long L. X.; D, Marie Drouzy; E, No Phi Ultra

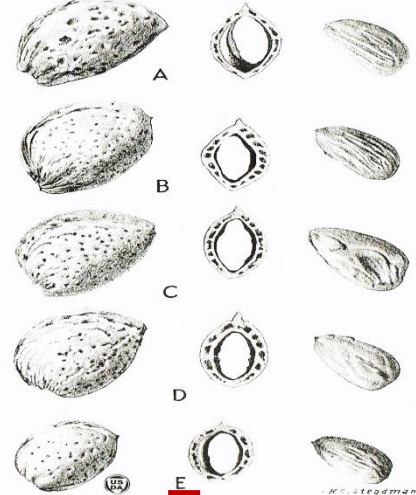
—H.C. Steadman—



ALMOND VARIETIES.—XI

A, Novafall; B, Nusspeckel; C, O'Snell; D, Purling; E, Purlgens

—H.C. Steadman—

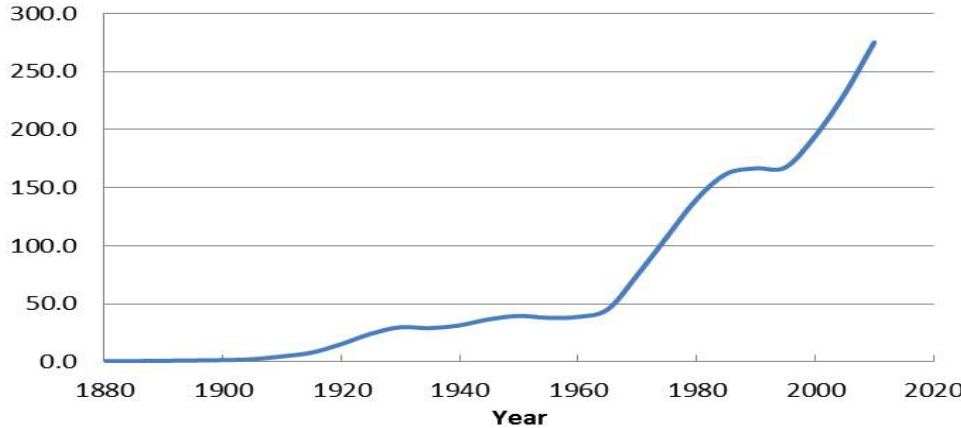


ALMOND VARIETIES.—XIV

A, Bunk; B, Bunker; C, Calhoun; D, Carrascano; E, Fove

—H.C. Steadman—

Production area (ha x 1000)

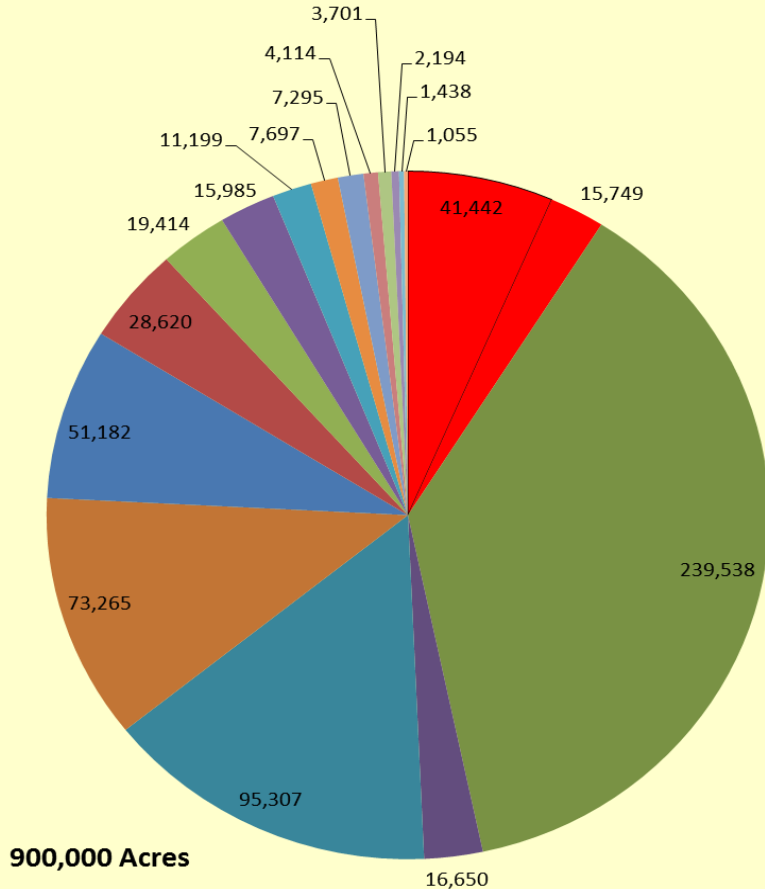


## More than 100 varieties in California



Milo Wood, USDA Bull. # 1282, 1925

# Almond Acreage by Variety



900,000 Acres

- PADRE
- SONORA
- NONPAREIL
- MISSION
- CARMEL
- BUTTE
- MONTEREY
- FRITZ
- PRICE
- OTHERS
- ALDRICH
- WOOD COLONY
- PEERLESS
- RUBY
- NEPLUS
- LIVINGSTON
- THOMPSON
- MERCED

- Aldrich
- Avalon
- Blue Gum
- Dottie Won
- Durango
- Folsom
- Granada
- Harvey
- Jeanette
- Jeffries
- Mono
- Monterey
- Norman
- NPU
- Pearl
- Plateau
- Ripon
- Robson
- Rosetta
- Sano
- Sauret#1
- Sauret#2
- Tioga
- Wassum

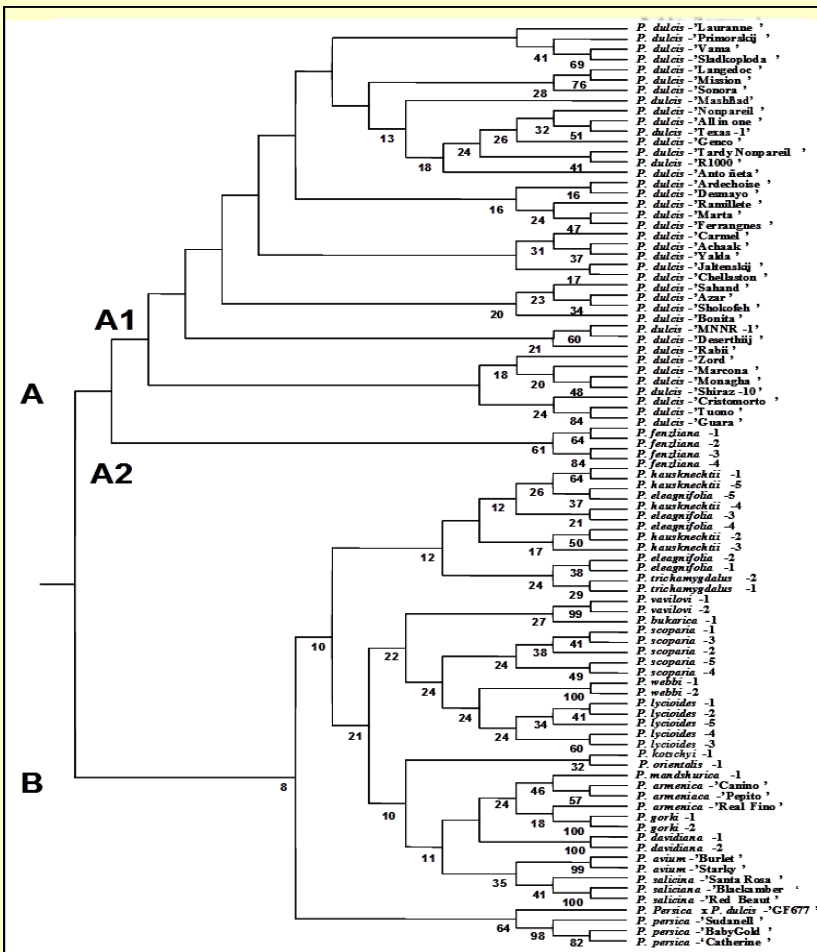
**Winters**

**Sweetheart**

**Kester**

**Independence**

All but a few (green) California varieties are progeny of Mission by Nonpareil cross.



Cultivated almond and wild relatives

Cultivated almond

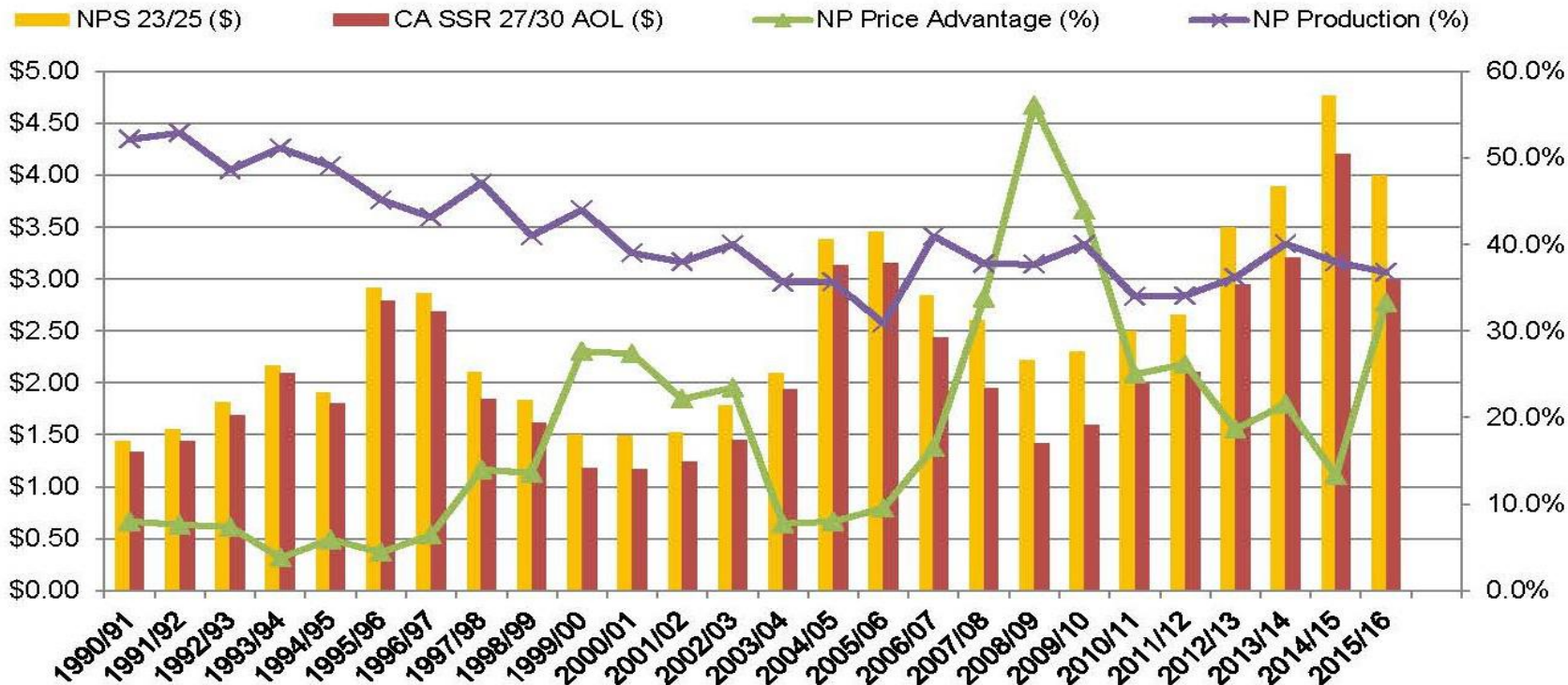
Nonpareil  
Mission

Red box estimates the amount of variability currently utilized within California varieties. Violet box estimates the amount of variability accessible within heirloom cultivars and land races. Yellow box estimates of genetic **diversity** available within closely related species.

Genetic variability in almond & relatives



## Nonpareil vs. Other Varieties (Average Annual Price (USD/lb) & NP Production)



Courtesy N. T. Ryan



**Disease  
resistance**



**High nutrient**



**Large  
Kernel  
size**



**Nonpareil  
Almond**



**Self-  
fruitful**



**Pest  
resistance**



**High flavor**

# New germplasm = New traits = New solutions



*P. webbii* (Iran)



*P. persica* (Korea)



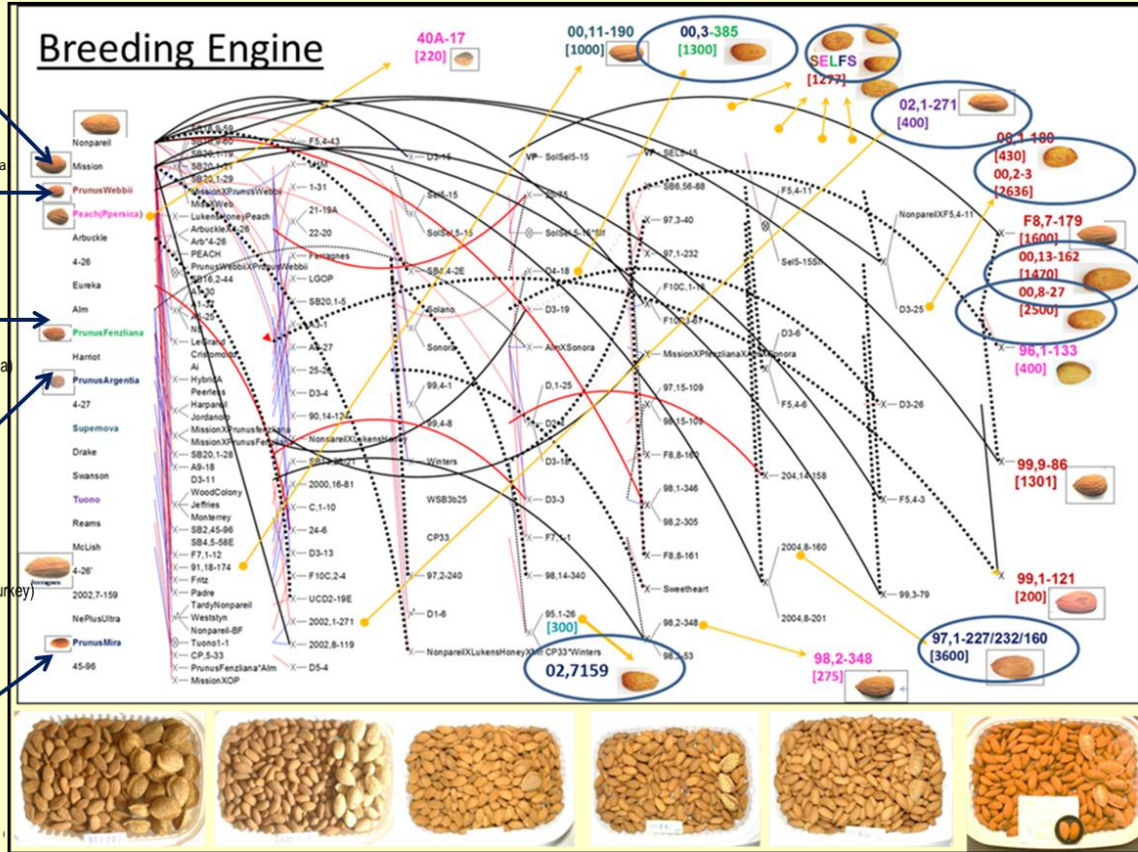
*P. fenziiana* (Syria)



*P. argentea* (Turkey)



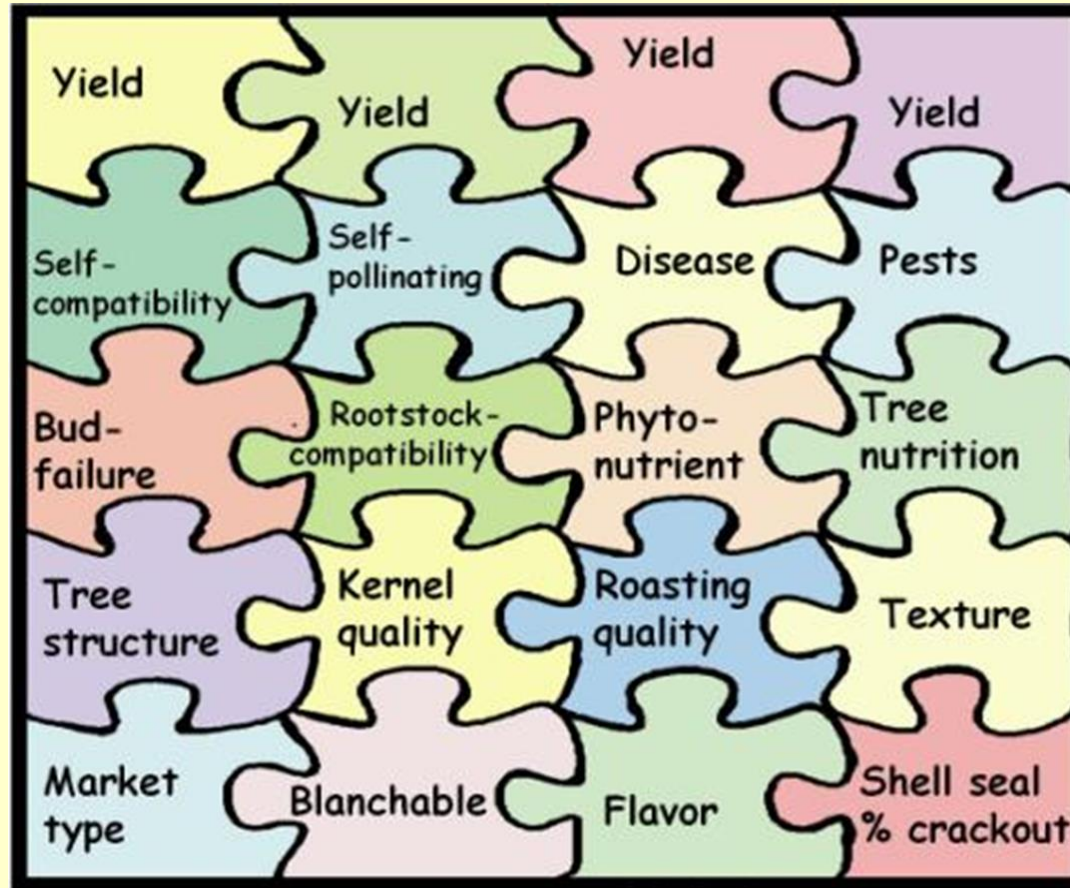
*P. mira*



Plus some old problems

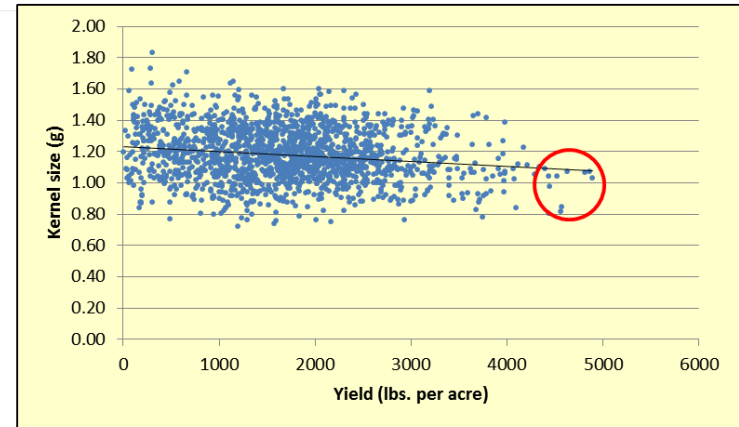
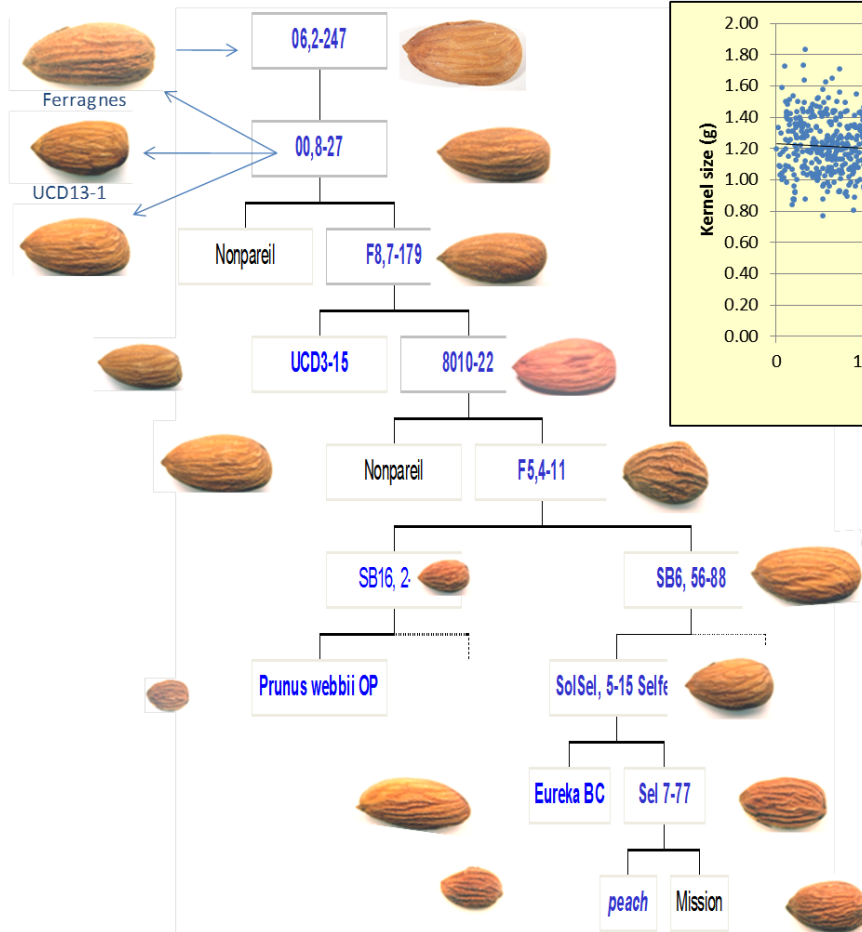
**Multiple  
opportunities  
for crop  
improvement**

**...and failure**



**Anna Karenina principle: Happy families varieties are all alike;  
every unhappy family variety is unhappy in its own way.**

# Breeding: Transfer of self-compatibility to good kernel size/quality



**Maximum  
yield  
at about  
1 gram  
kernel mass**

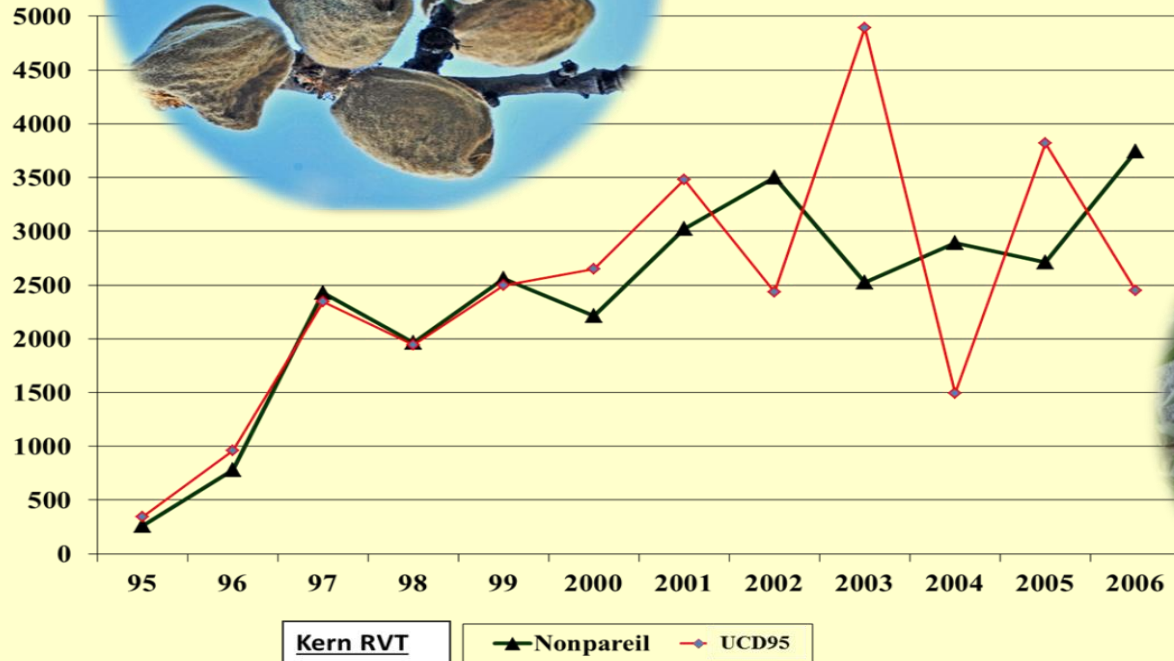
Self-fruitfulness = Self-compatibility + Self-pollination

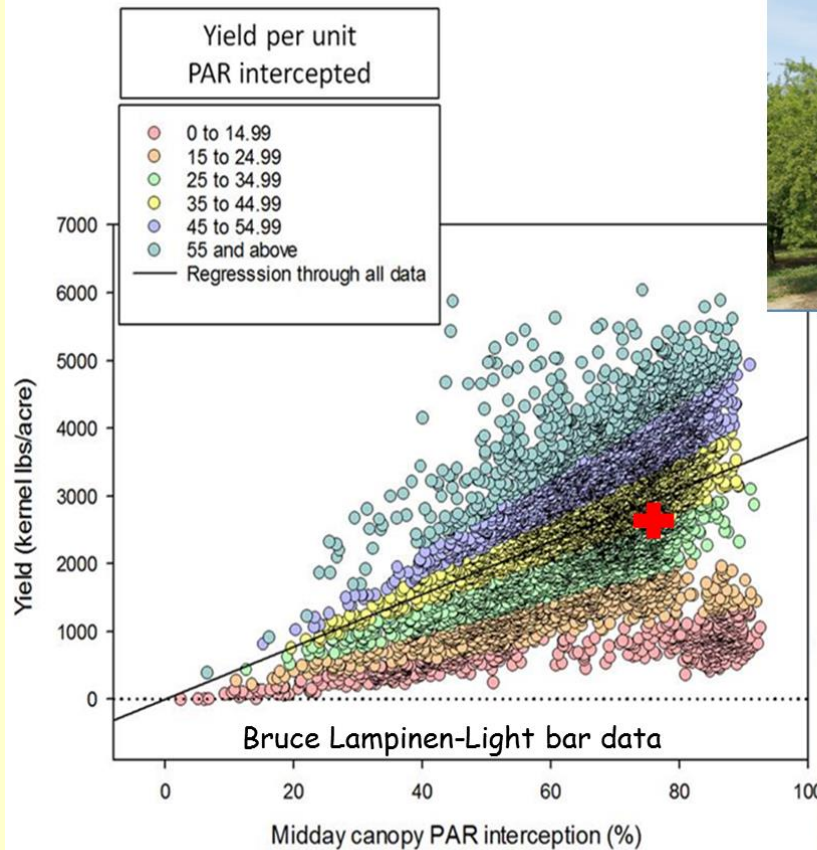
Self-compatibility is  
controlled by a  
Single gene  
and so  
easily transferred



Self-pollination  
is much more complicated

# Alternate bearing





Orchard (life) yield



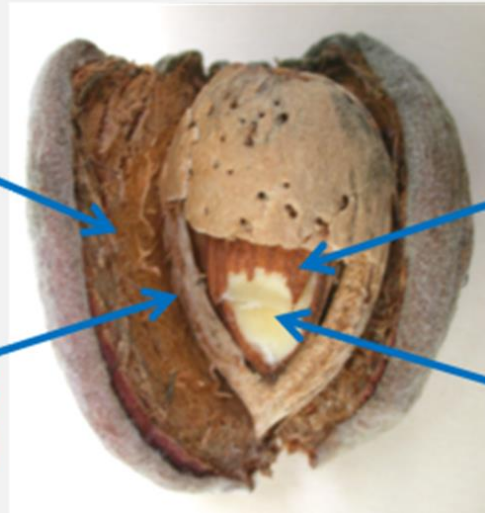
# Kernel quality

<u>Performance</u>	<u>Nonpareil</u>	<u>Sweetheart</u>	<u>Marcona</u>	<u>Heritable</u>
Lipid (%)	38.8 a	43.4 b	42.6 b	No
Oleic Acid (%)	66.8 a	73.0 b	72.2 b	No
Self-compatibility (%)	3.1 a	28.7 b	3.8 a	Yes
Aflatoxin	83.7 a	18.1 b	-	No
NOW (%)	79.5 c	4.1 b	0 a	No
Hull Rot (%)	97.3 c	23.1 a	82.4 b	Partial



Hull  
Resist. Hull rot  
(NOW)

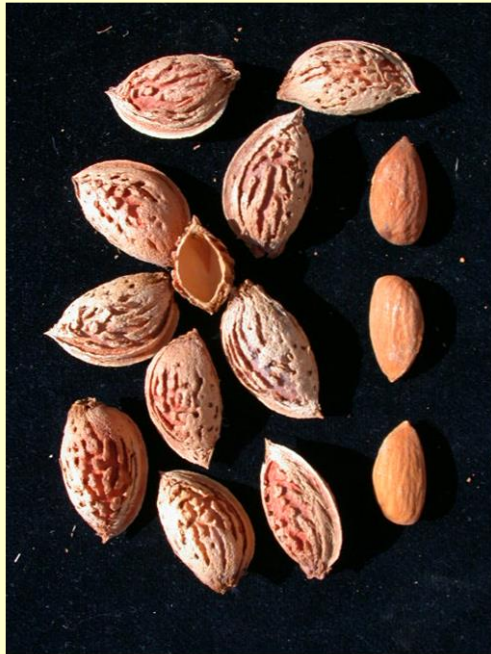
Shell seal  
Resist. NOW  
(Aspergillus)



Seedcoat  
Resist. NOW  
Aspergillus  
Aflatoxin

Kernel meat  
Resist. Aflatoxin

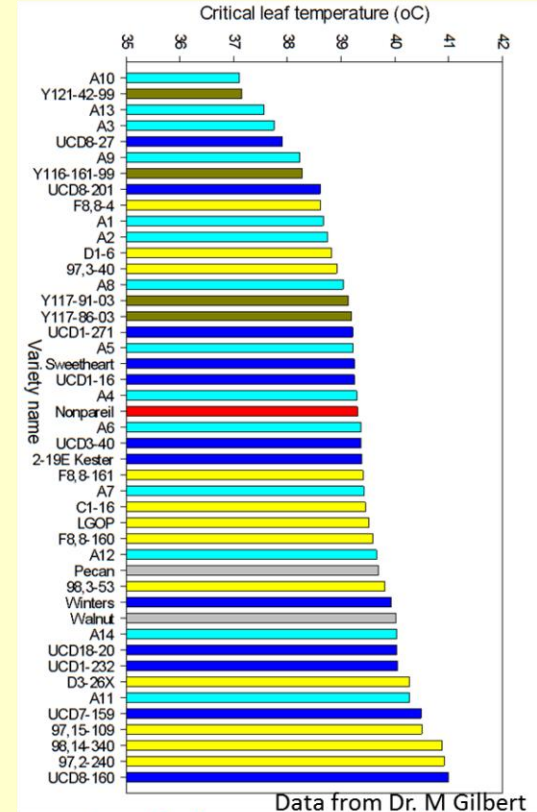
# Kernel allergens & aflatoxin



Origin	R-ELISA
<i>P. argentea</i> (bitter seed)	0.61
<i>P. argentea</i> (BC1)	0.26
(Mission × <i>P. argentea</i> ) F2	0.44
<i>P. bucharica</i> (bitter seed)	0.59
<i>P. persica</i> × <i>P. davidiana</i> (bitter seed)	0.45
<i>P. fenzliana</i> (F2)	1.53
<i>P. fenzliana</i> (F2)	1.66
<i>P. fenzliana</i> (BC1)	2.18
(Mission × <i>P. fenzliana</i> ) BC1 × Sonora	0.61
(Mission × <i>P. fenzliana</i> ) BC1 × Sonora	1.56
(Mission × <i>P. fenzliana</i> ) BC1 × Sonora	0.95
(Mission × <i>P. fenzliana</i> ) BC1 × Sonora	0.92
(Mission × <i>P. fenzliana</i> ) BC1 × Sonora	0.7
<i>P. mira</i> (bitter seed)	0.53
Peach ( <i>P. persica</i> ) (bitter seed)	0.51
Peach ( <i>P. persica</i> ) (bitter seed)	0.39
Almond × <i>P. persica</i>	0.66
Almond × <i>P. persica</i>	0.75
(Nonpareil × <i>P. persica</i> ) F2 (bitter seed)	0.56
( <i>P. persica</i> ) BC4	0.63
<i>P. tangutica</i> (bitter seed)	0.7
<i>P. webbii</i> (bitter seed)	0.88
<i>P. webbii</i> (F2)	0.64
<i>P. webbii</i> (bitter seed)	0.51
<i>P. webbii</i> × (Nonpareil × <i>P. persica</i> ) BC1	0.53
<i>P. webbii</i> (BC1)	1.27
<i>P. webbii</i> (BC1)	0.47
<i>P. webbii</i> (BC1)	0.66
<i>P. webbii</i> (BC1)	0.68
<i>P. webbii</i> (BC1)	0.47
<i>P. webbii</i> (F2BC1)	0.33
<i>P. webbii</i> (BC1)	1.06
Almond × <i>P. webbii</i> × <i>P. persica</i> (BC2)	0.42
Almond × <i>P. webbii</i> × <i>P. persica</i> (BC3)	0.9
<i>P. webbii</i> (BC4)	0.4
Almond × <i>P. webbii</i> × <i>P. persica</i> (BC4)	1.93
Almond × <i>P. webbii</i> × <i>P. persica</i> (BC4)	0.55
Marcona	0.88
Nonpareil	1.02
Chips	1.68
Kahl	1.22
Ferragnes	1.56



# Challenges of Climate Change



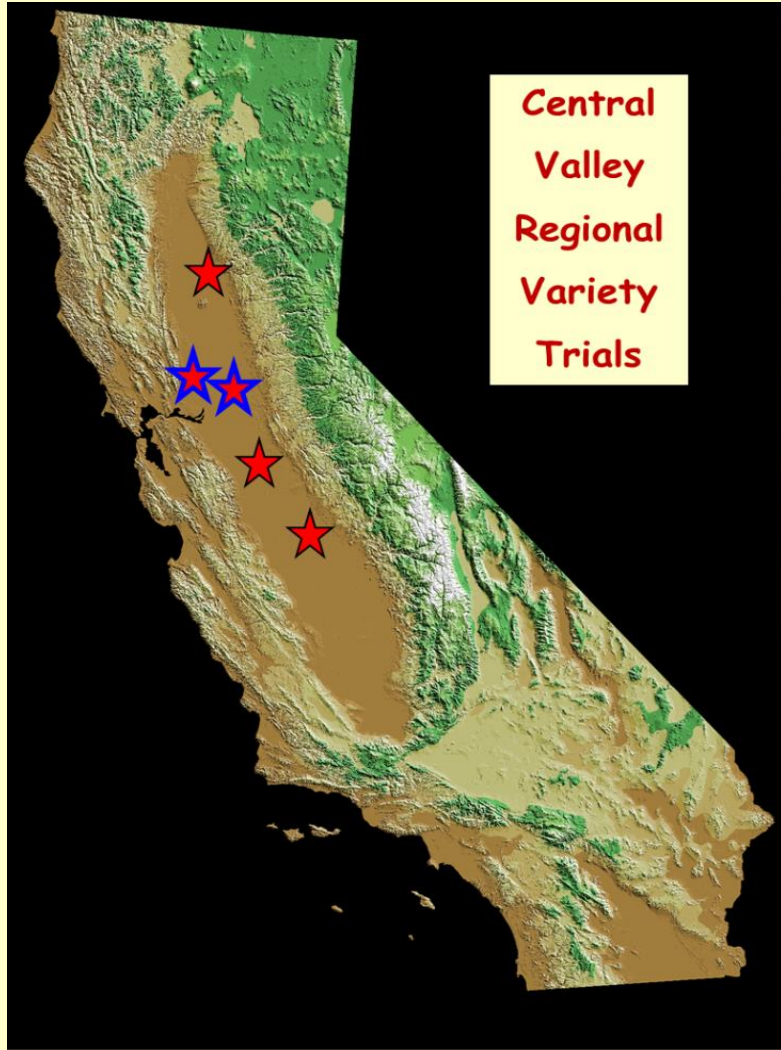
**Almond is a highly adaptable species**

## Rootstock incompatibility



## Noninfectious Bud-failure



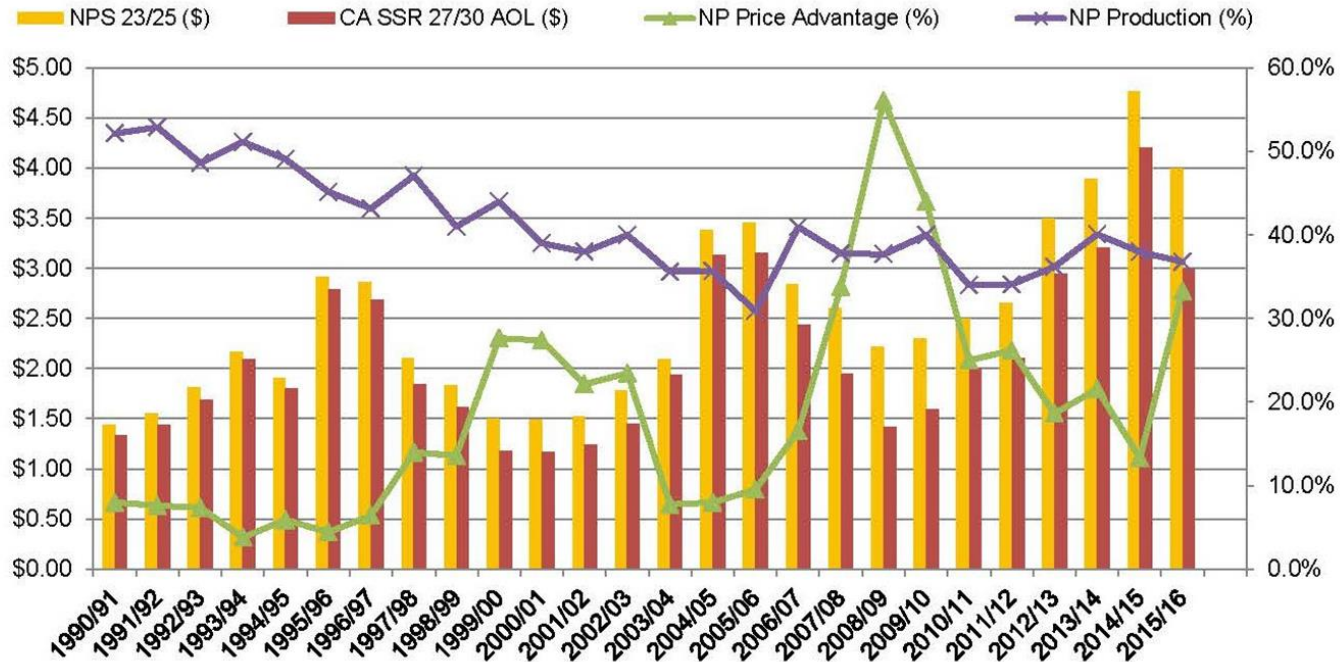


Central  
Valley  
Regional  
Variety  
Trials



Regional Variety  
Trials:  
Identify Problems  
before Widespread  
Plantings

## Nonpareil vs. Other Varieties (Average Annual Price (USD/lb) & NP Production)



Courtesy N. T. Ryan

“While a few of the California varieties, such as Nonpareil, IXL, and Ne Plus Ultra, have proved valuable, most of them are relatively worthless, and their dissemination and cultivation have resulted in much disappointment and loss” (Milo Wood, 1925)

‘where almonds go on the grocery shelf is also important. Next, to provide context in terms of how almonds are used in snacking and an ingredient, Harbinder will review the US market as a case study’.



Thank you





**Harbinder Maan, Almond  
Board of California**





## Category Usage – US Market

Harbinder Maan

Senior Manager, Global Trade Stewardship,  
Almond Board of California



# Agenda

- Nielsen Sales Data – Key Almond Product Categories
- Why do consumers like almonds?
- Texture and flavor
- Summary



# US Retail Sales

- Where do our Almonds go?



## Nielsen Limitations: Scanner Data – Key Outlets Included



Food



Walmart



Club



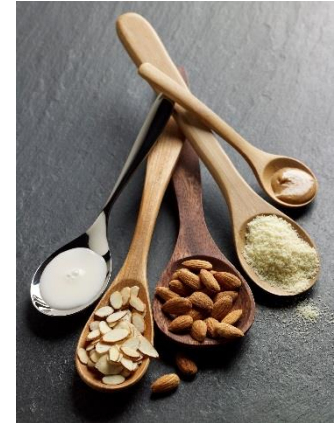
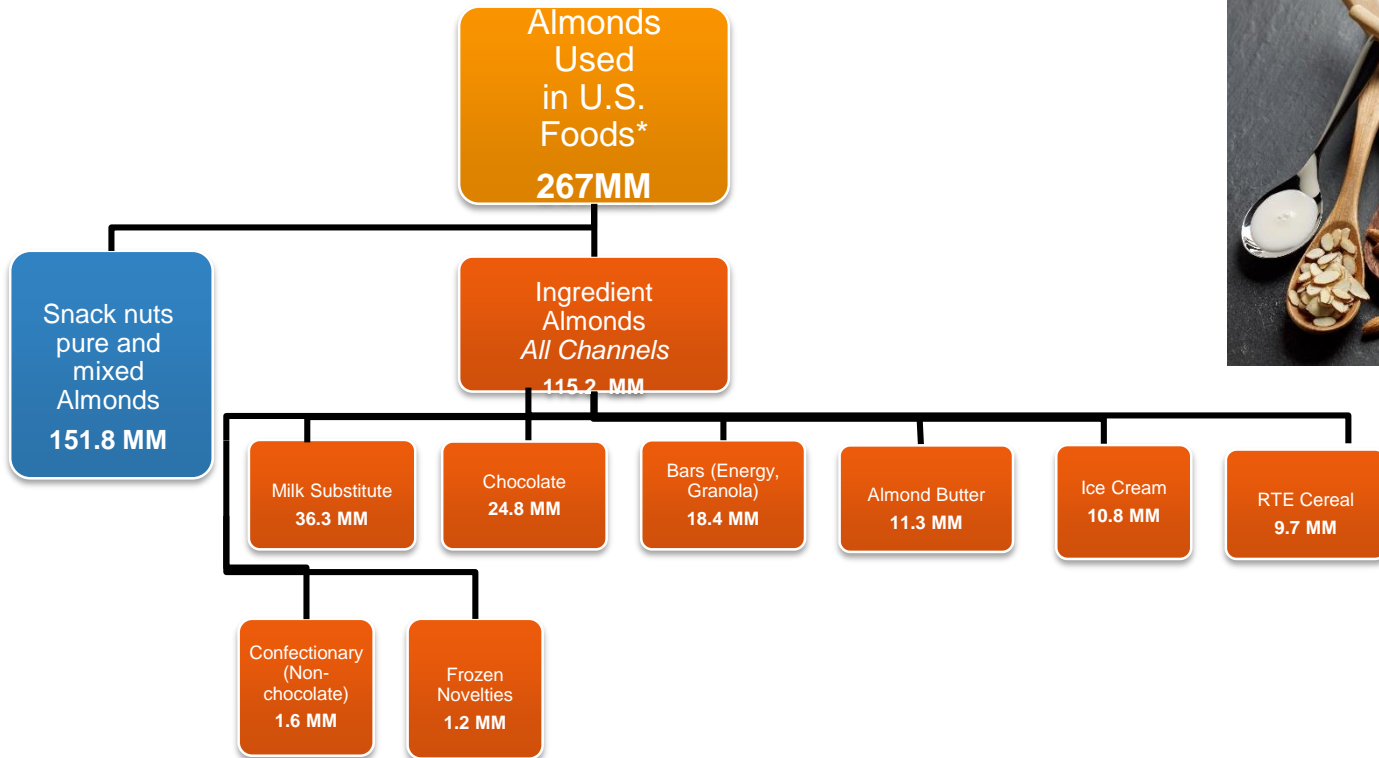
Drug



Mass

# Total Almond Volume Summary (lbs) – US Retail Data – Nielsen, 2015

Note: Volume does not represent all US sales data but those outlets providing scanner data



All numbers are in pounds.  
\*Foods sold in the United States

# Category Performance: Estimated Pure Almond Volume



Category	Est. Pure Almond Volume			
	2012	2013	2014	2015
Total Snack Nuts & Seeds	160.9	163.5	162.9	151.8
Milk Substitutes	14.5	22.3	32.2	38.3
Chocolate	24.0	24.7	25.3	24.8
Bars – Pure & Mixed	15.9	17.0	18.0	18.4
Nut & Seed Butters	5.3	7.6	10.7	11.9
RTE Cereal	7.8	8.1	8.5	9.7
Ice Cream	10.3	10.4	10.4	10.8
Non-Chocolate Candy	1.5	1.6	1.5	1.6
Frozen Novelties	1.0	1.3	1.2	1.2
<b>TOTAL</b>	<b>241</b>	<b>256</b>	<b>271</b>	<b>267</b>

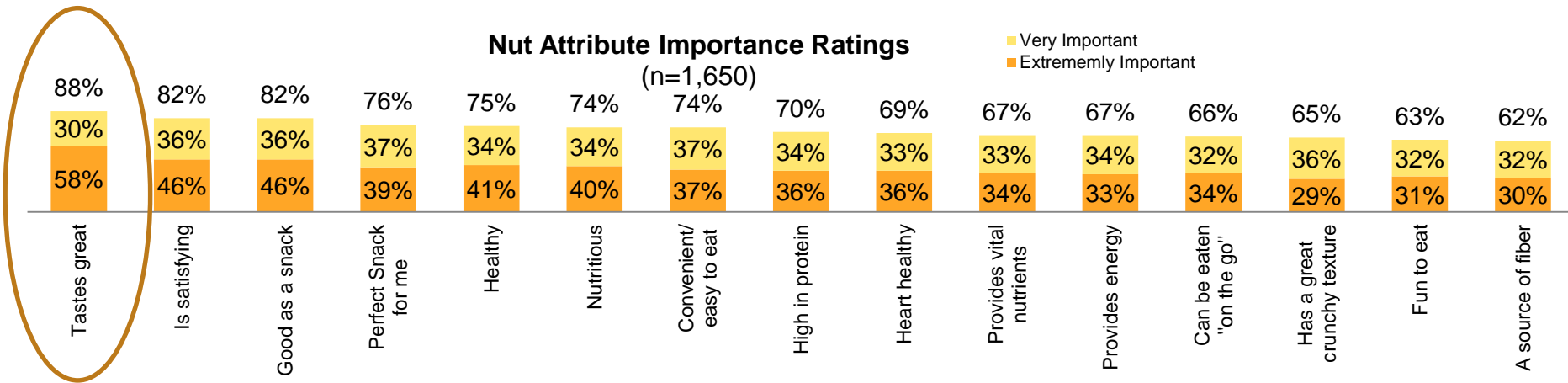




# Attitudes: Attribute Importance Ratings



- “Tastes great” was the most important attribute consumers considered when buying nuts (88% rated as very/somewhat important).
  - “Is satisfying” and “good as a snack” were the top secondary considerations (both at 82%), with many other attributes being very important in consumers’ decisions.



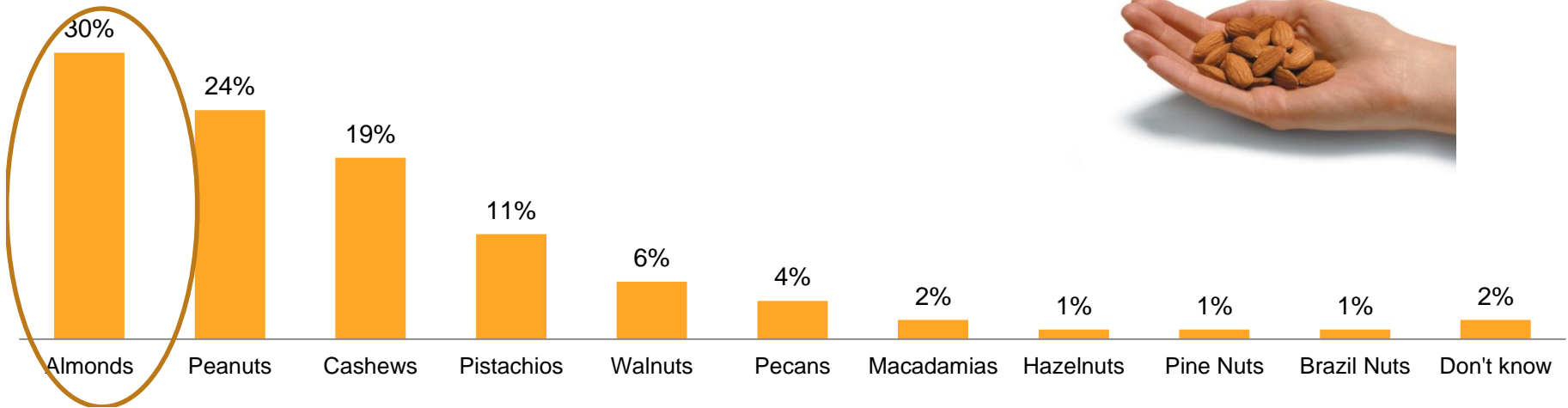
Q15: For each of the following statements, how important is each to you when deciding which type of nut to buy?



## Awareness: Snack Association

- Almonds had the highest association with being a snack (30%) among US respondents, followed by peanuts (24%) and cashews (19%).
  - Pistachios (11%) was the only other nut to have an association as a snack above 10%.

**Snack Association**  
(n=1,650)



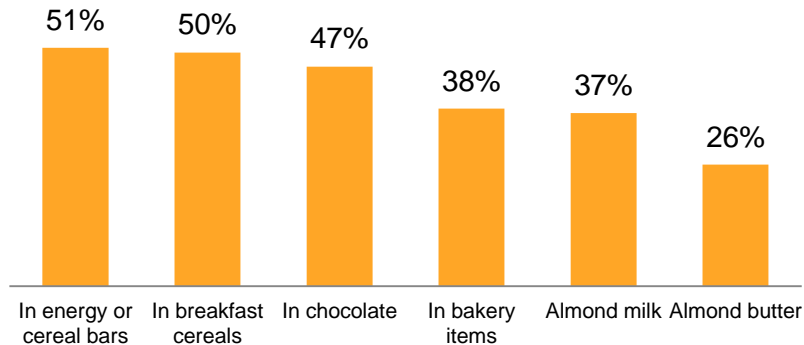
Q2: Now, think for a moment about nuts as a **snack** (*i.e. a food eaten between meals or instead of a meal*), as a whole nut. When you think about eating whole nuts by themselves apart from a meal, what one type of nut **FIRST** comes to mind?

# Almond Consumption: Frequency of Consumption by Form

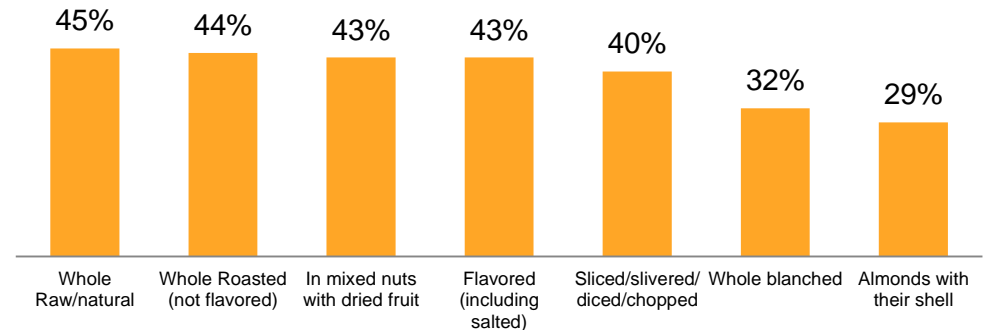
- As an ingredient, almonds were most often consumed in energy/cereal bars, in breakfast cereals, and in chocolate.
- In terms of whole almonds, many forms were very popular, with blanched and in-shell being the least frequently consumed.

**Frequency of Almond Consumption**  
% Selecting “Several times/month” or more often  
(n=1,650)

## Almond as Ingredient



## Whole Almonds



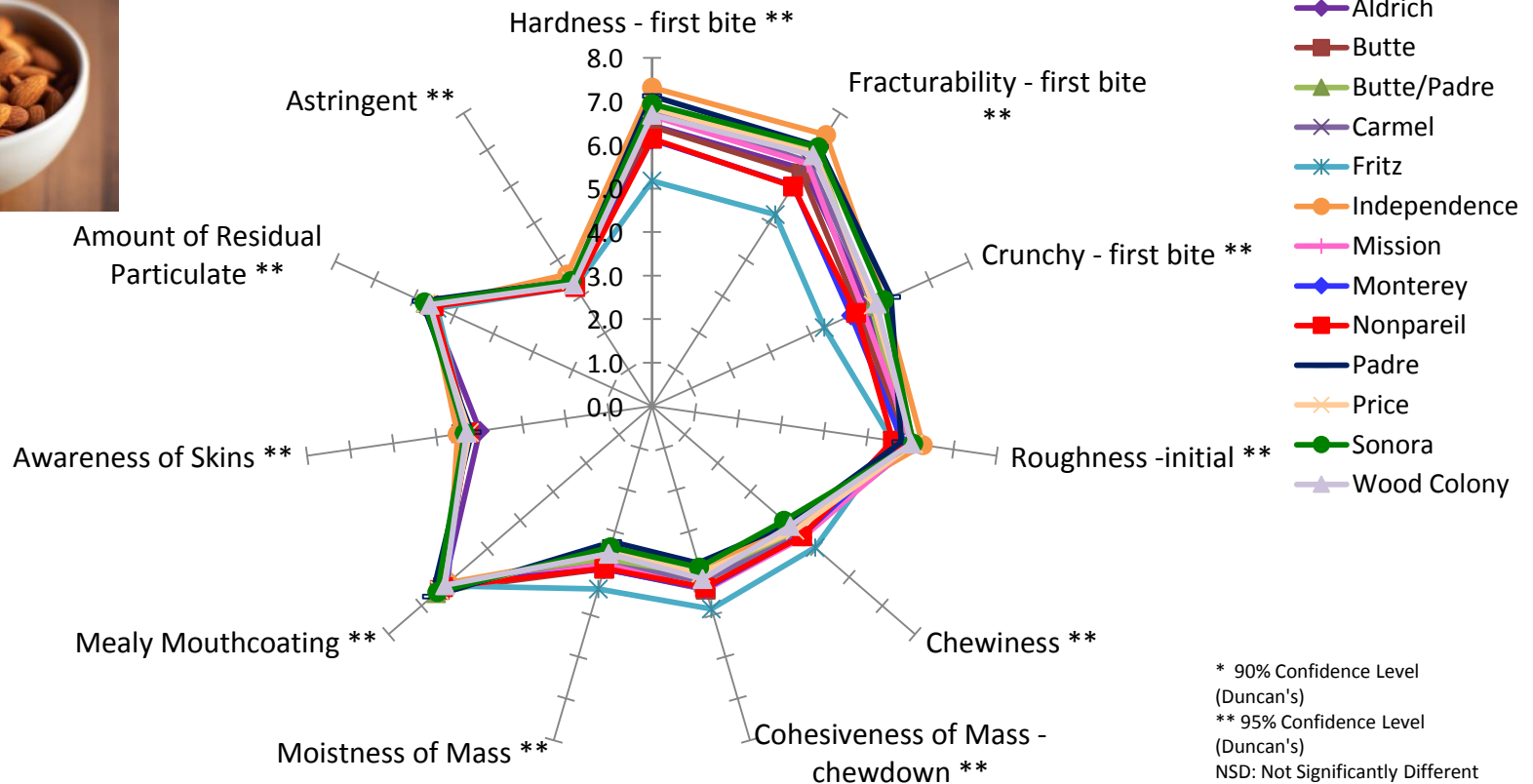
Q21: How often do you consume each of these almond forms or products?

# Flavor

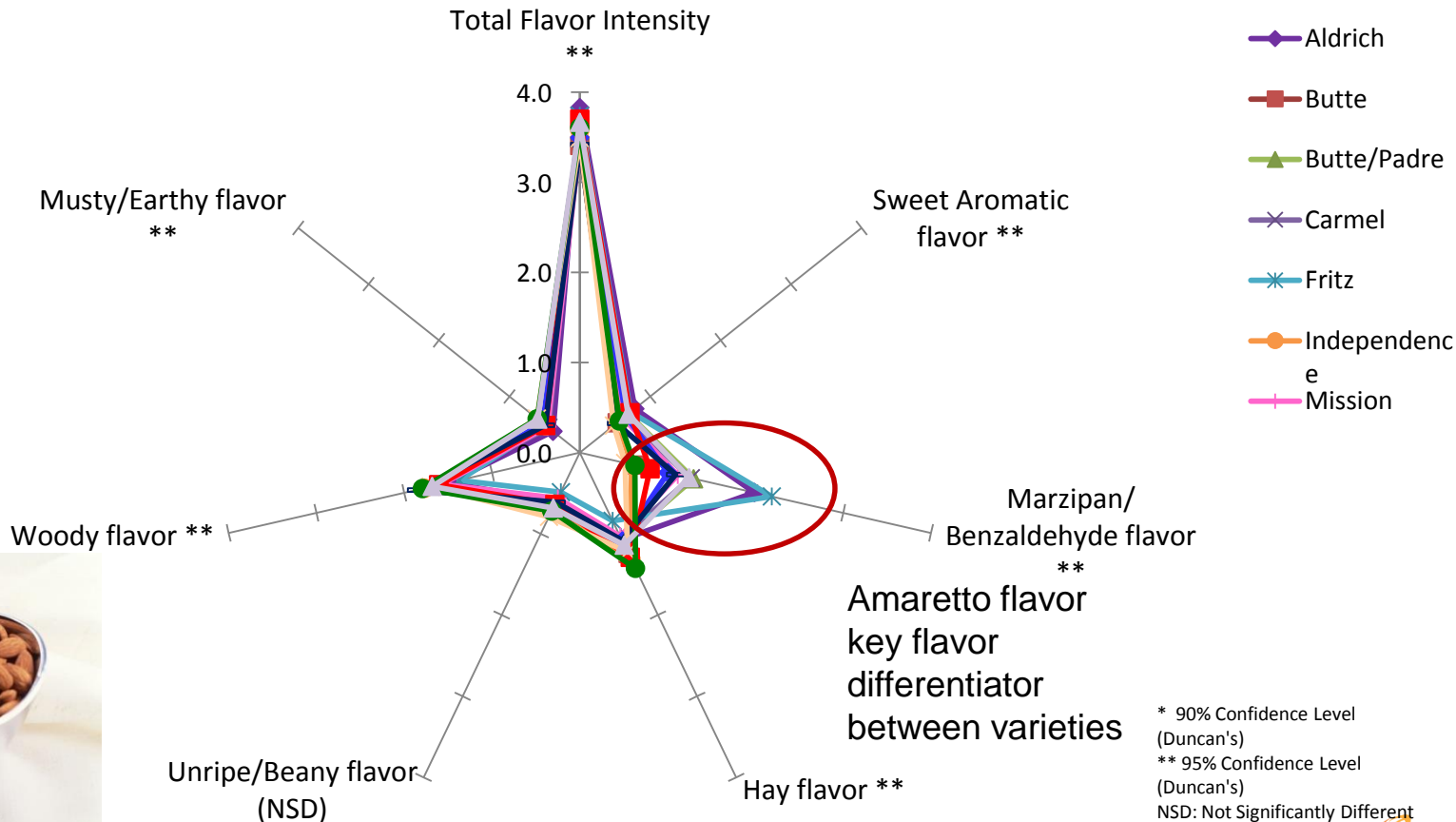
- How different are almond varieties?



# Texture Profile – Key Sensory Attributes of Almonds



# What Differentiates Almonds - Flavor Profile – Key Sensory Attributes for Almonds



# Why and Where is Flavor Important?

Consistent consumer experience is important

## Food Categories

- Low almond flavor desired

1. Almond Milk
2. Almond flour/meal, for baking and gluten free cooking



## Food Categories

- Strong almond flavor/ aroma desired

1. Snacking
2. Chocolate
3. Almond butter
4. Baking

# Case Studies For Flavor – Adding Value Across Grocery Aisles

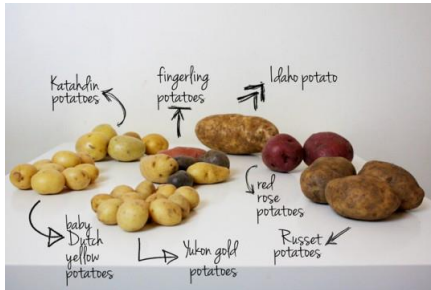
- Tomatoes
  - Garden versus heirloom



- Olive Oil
  - Regular versus Extra Virgin Olive Oil



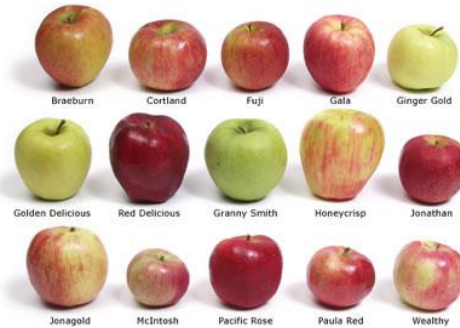
- Potatoes
  - Russet versus Yukon



- Lettuce
  - Iceberg versus Arugala/Kale
- Ancient Grains
  - Wheat versus quinoa



- Apples



# Summary

- Almond versatility is highlighted by the breadth of use as a snack and ingredient
- Consumers rate taste as the number one attribute when selecting nuts
- Almonds have the greatest association with snacking versus any other nut
- Almonds get their distinct flavor from benzaldehyde (Marzipan) flavor and is a key differentiator among varieties
- Almonds can play well across multiple categories and consistency of consumer experience is important





A close-up photograph of several green almonds on a branch, surrounded by vibrant green leaves. The background is softly blurred, showing more of the tree and a hint of a person in the distance. The lighting is bright and natural, highlighting the texture of the almond skins and the veins on the leaves.

**Dani Lightle,  
University of California**

# Almond Varieties: Field Perspective

Dr. Dani Lightle

Orchard Systems Advisor

UC Cooperative Extension, Glenn, Butte & Tehama Cos.



## Today we're talking about:

- What makes the Ideal Variety?
- Considerations for variety selection
- Marketing classification and value
- Current planting trends



# In pursuit of the Ideal Varieties



What makes some varieties better than others?



## Considerations:

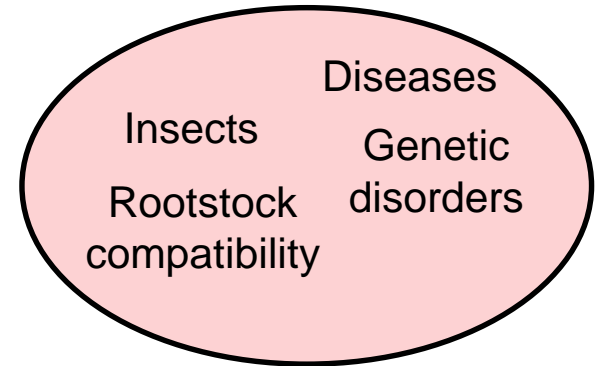
Pollen  
compatibility

Relative bloom  
periods

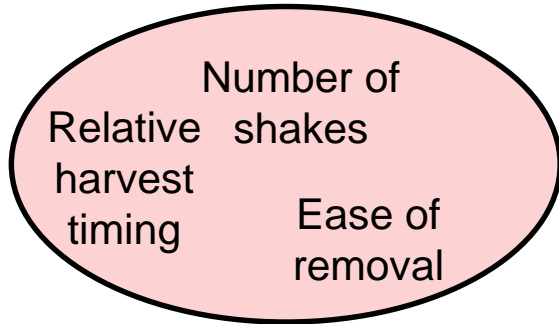
1. Fertilize the nut

## Considerations:

2. Grow the nut (and tree)



## Considerations:

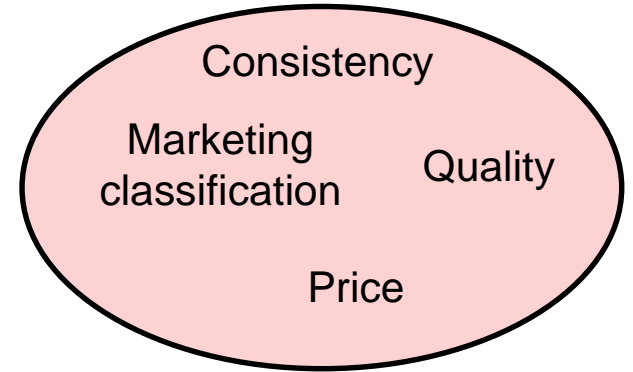


3. Harvest the nut



## Considerations

4. Sell the nut

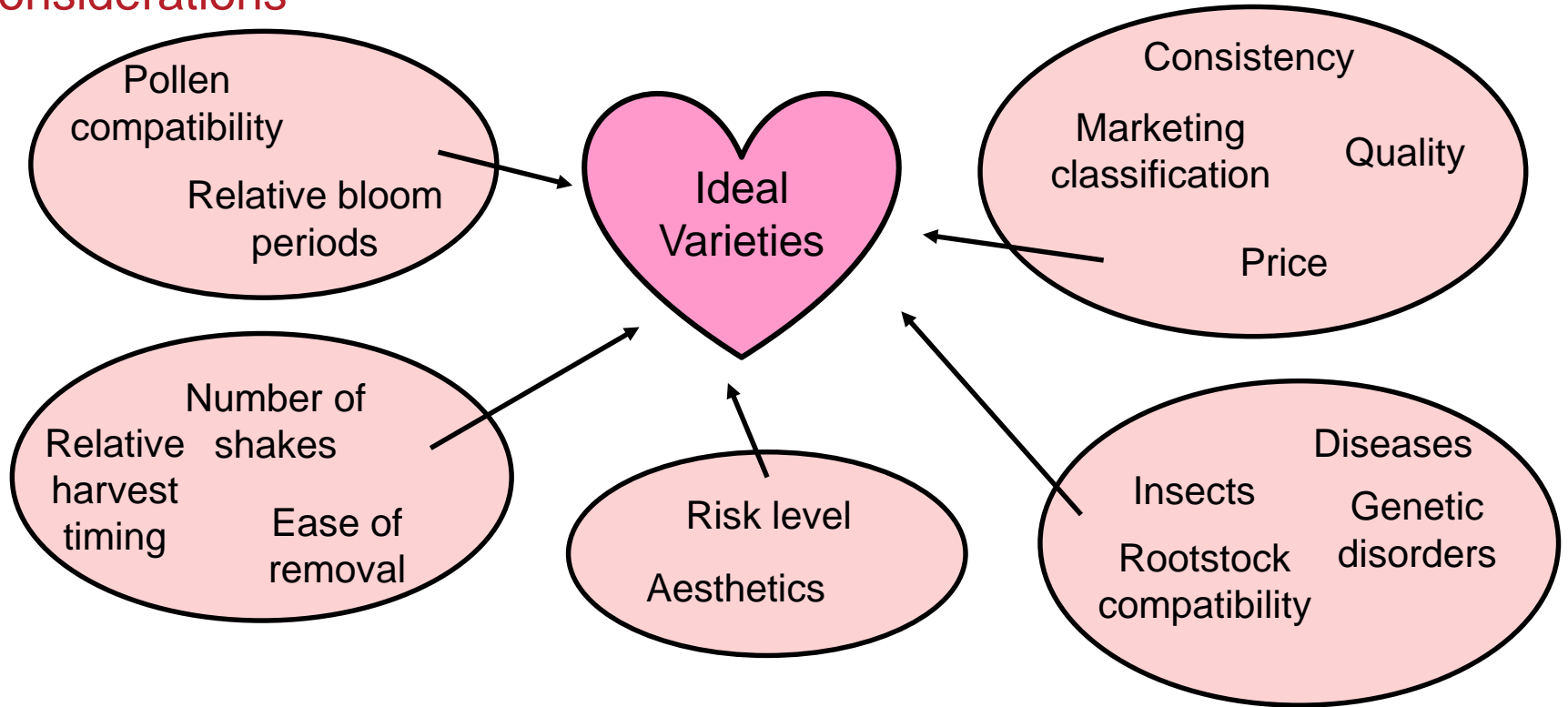


# Considerations



5. Know yourself

# Considerations



# Considerations for Selecting Almond Varieties



## Fertilize the nut



In general, almonds are self-incompatible

Newer varieties may be self-fertile (e.g. Independence; Shasta) or partially self-fertile (e.g. Winters)

Virtually every variety commonly planted is compatible with Nonpareil

Consult a pollen compatibility chart

## Fertilize the nut

Increased frost risk with early blooming varieties (especially northern regions)



Avoid poor overlapping bloom

Consult a chart of approximate bloom periods

## Grow the nut & tree

Compatibility with Marianna 2624	
Intermediate	Incompatible
Butte	Livingston
Monterey	Marcona
	Nonpareil
Compatibility with Krymsk 86	
Monterey - sporadic reports of incompatibility	

### Rootstock Compatibility

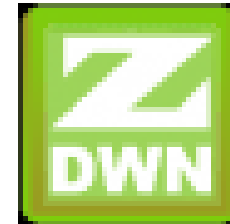
- Historically problematic with Marianna 2624

## Grow the nut & tree

Compatibility with Marianna 2624	
Intermediate	Incompatible
Butte	Livingston
Monterey	Marcona
	Nonpareil
Compatibility with Krymsk 86	
Monterey - sporadic reports of incompatibility	

Variety and rootstock must have compatible licensing.

May depend on nurseries and/or patent holders





## Grow the nut & tree



Avoid known genetic disorders

### Varieties with known Noninfectious Bud Failure potential

Carmel	Peerless
Mission	Price
Nonpareil	Winters

## Grow the nut & tree



Varieties are differentially susceptible to insects and pathogens

Learn site history or talk to neighbors

## Harvest the nut

### Harvest timing

- Your equipment vs contract harvesting?
- Acreage & timing of other harvests in your operation
- Overlap within an orchard & potential for mixed nuts

Consult a harvest timing chart



## Harvest the nut

### Harvest timing

- Your equipment vs contract harvesting?
- Acreage & timing of other harvests in your operation
- Overlap within an orchard & potential for mixed nuts


Consult a harvest timing chart

### Ease of removal

Easy	Difficult
Butte	Fritz (if shaken too early)
Ne Plus Ultra	Mission (young trees)
Peerless	Padre (young trees)
Price	Winters

## Harvest the nut

Fewer passes → 

Mixing incompatible varieties → 

For example<sup>1</sup>:

### **Mix:**

Sonora inshell + Nonpareil inshell

Winters + Carmel

Monterey + Carmel

### **Do Not Mix:**

Sonora meats + Nonpareil meats

Wood Colony with anything

Independence with anything

<sup>1</sup>From: Variety Separations at Harvest. Blue Diamond 2016

# Know yourself

Aldrich

Nonpareil



# Know yourself

## Risk Taker or Risk Averse?



# Marketing Classification & Value





## Marketing Classes

Classification	Description	Uses
Nonpareil Type	Thin outer shell, smooth kernel	Blanched, sliced, cut
California Type	Wide range of shapes & characteristics; blanchable	Manufactured products
Mission Type	Hard shells; small, wide, plump kernels, wrinkled	Salted and/or other seasonings; ice cream
Carmel Type	Long, narrow, light colored	Roasting
Inshell – Hard Shell	Closed, hard, corky shell	Hand crack

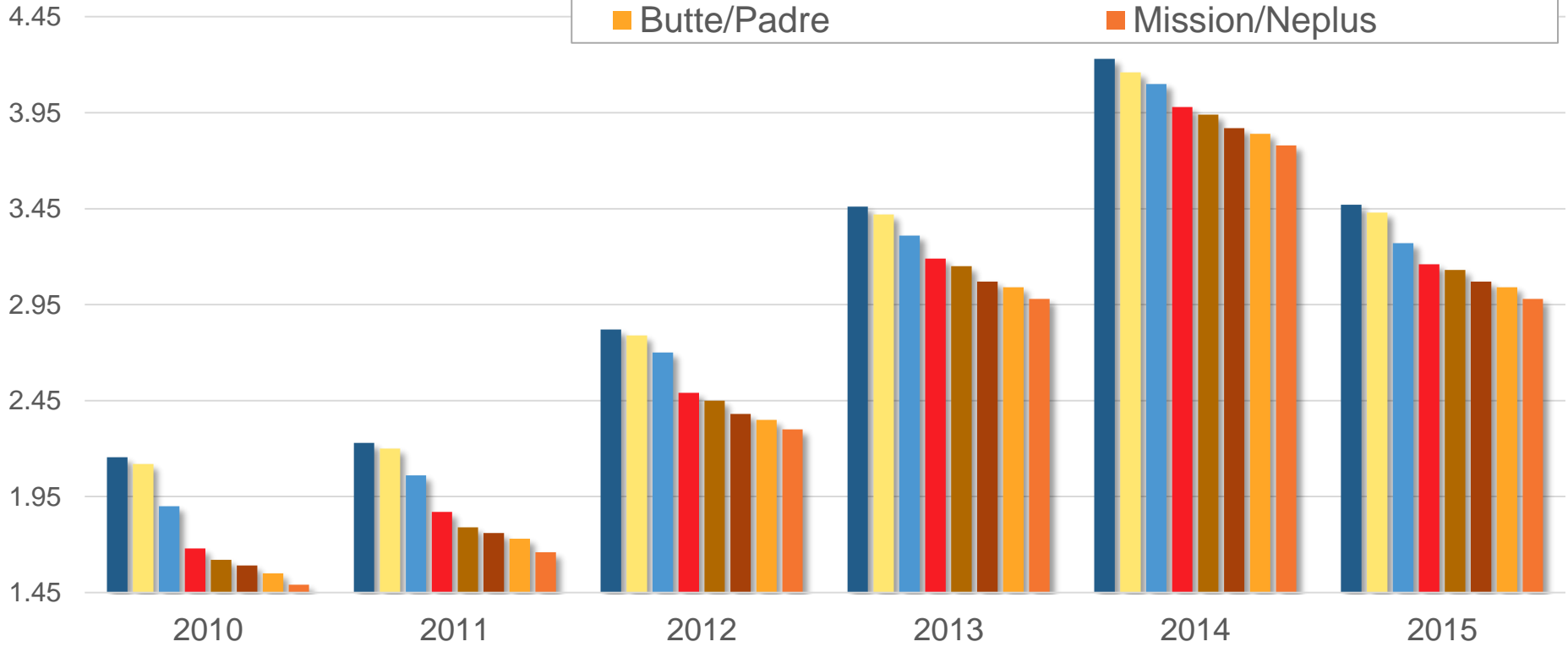
# Marketing Classes

Variety	Nonpareil	California	Carmel	Mission
Aldrich		✘	✘	
Butte		✘		✘
Carmel		✘	✘	
Fritz		✘		✘
Independence	✘	✘		
Mission				✘
Monterey		✘	✘	

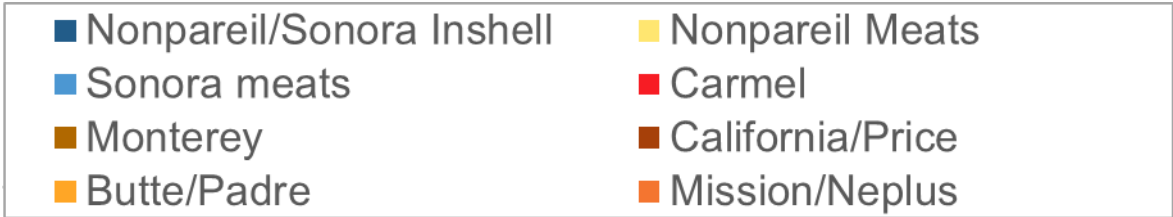
Variety	Nonpareil	California	Carmel	Mission
Nonpareil	✘	✘		
Padre		✘		✘
Peerless		✘		
Price		✘	✘	
Sonora	✘	✘		
Winters		✘		
Wood Colony		✘	✘	

# Crop Payout History

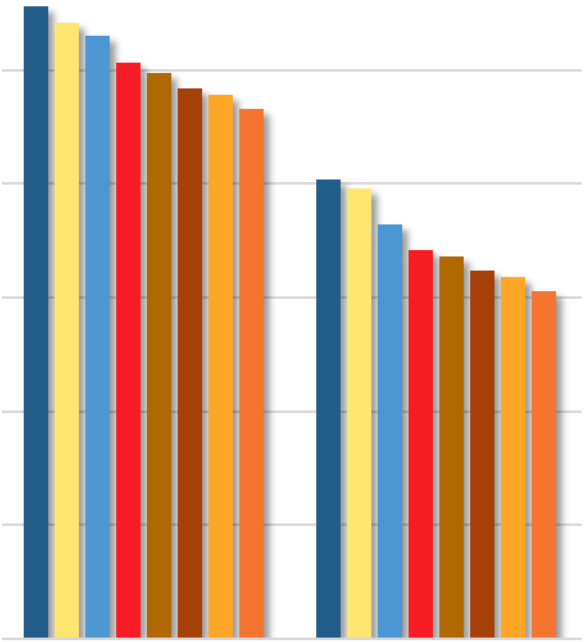
- Nonpareil/Sonora Inshell
- Sonora meats
- Monterey
- Butte/Padre
- Nonpareil Meats
- Carmel
- California/Price
- Mission/Neplus



# Crop Payout History



Relative value of marketing classifications:  
 Nonpareil type  
 Carmel type  
 California type  
 Mission type



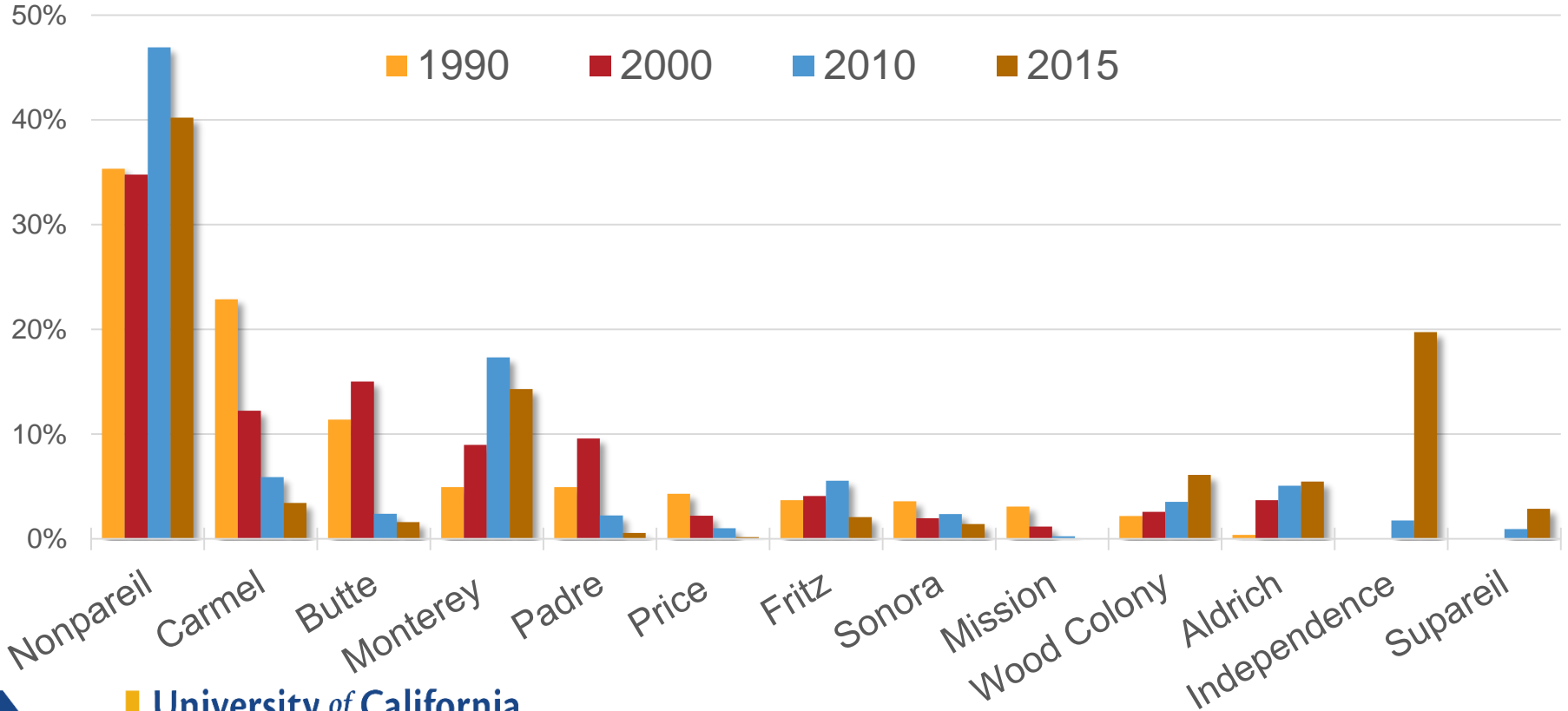
2014 2015

Data from the Blue Diamond Growers payment history.

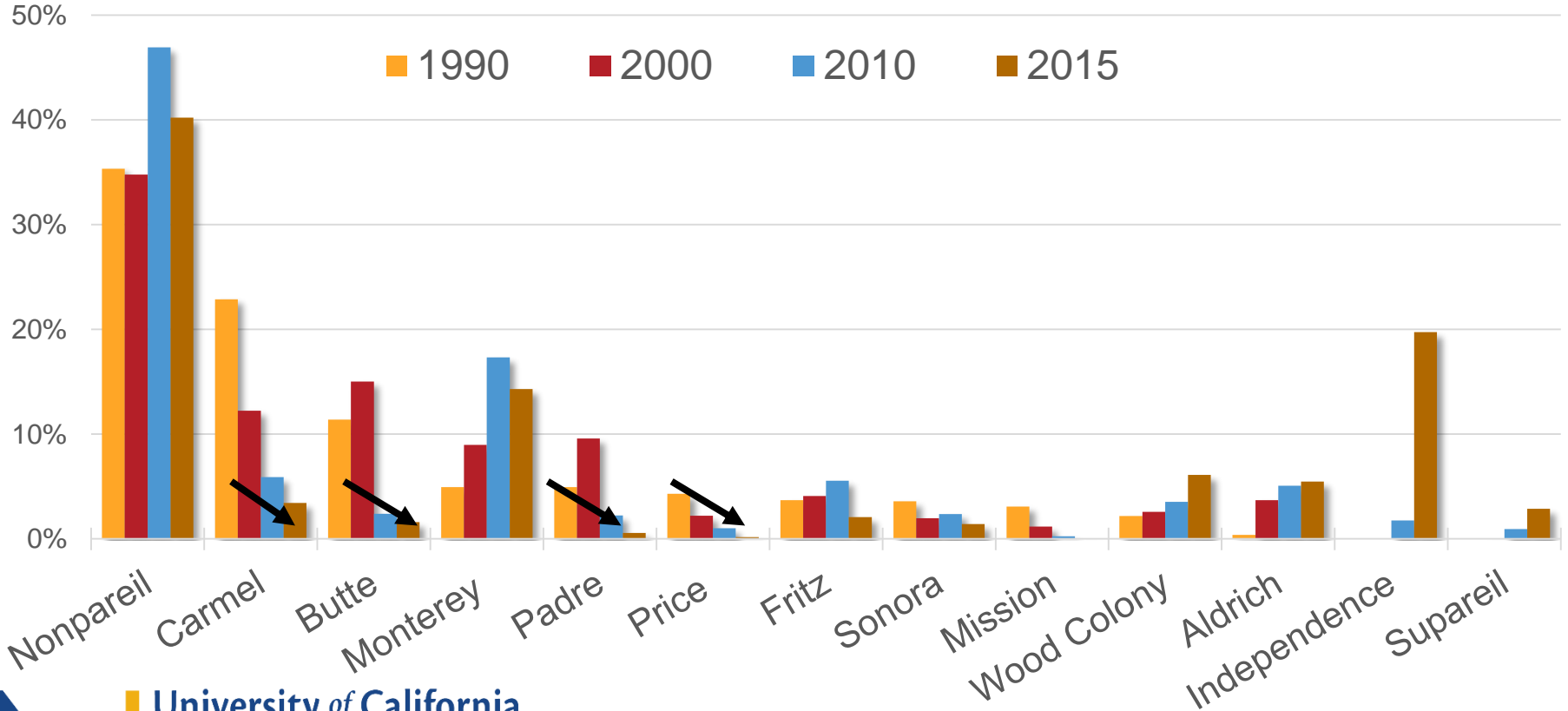
# Current Planting Trends



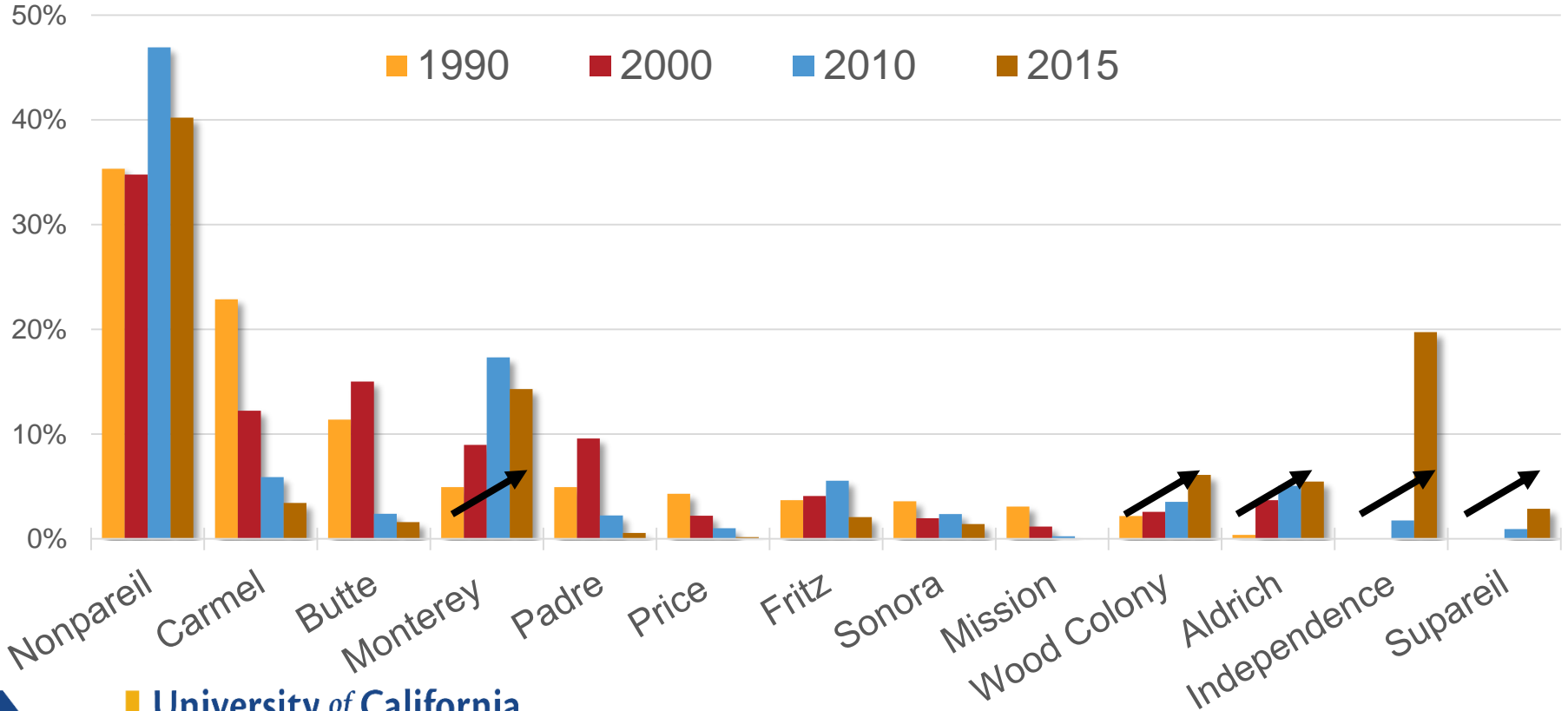
## % of Acreage Planted by Variety



# % of Acreage Planted by Variety



# % of Acreage Planted by Variety





## Final thoughts



- Many factors play into the success of any given variety *in your operation*
- What works for your neighbor may not work for you!
- Seek out resources
  - Almond Production Manual
  - [thealmonddoctor.com](http://thealmonddoctor.com)
  - [sacvalleyorchards.com](http://sacvalleyorchards.com)
  - Your local CE advisor



Thank you for your attention!

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