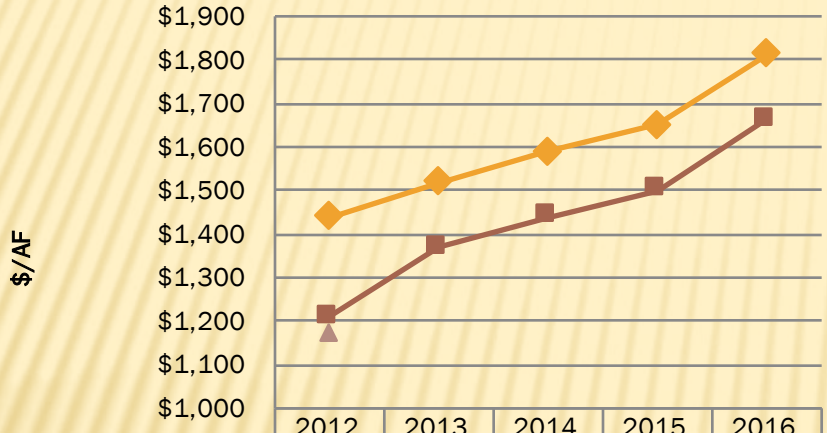
RETHINKING HOW WE GROW AVOCADOS

GARY S BENDER (FARM ADVISOR EMERITUS), GARY TANIZAKI (FIELD TECHNICIAN) AND SONIA RIOS (FARM ADVISOR)
UC COOPERATIVE EXTENSION, SAN DIEGO COUNTY

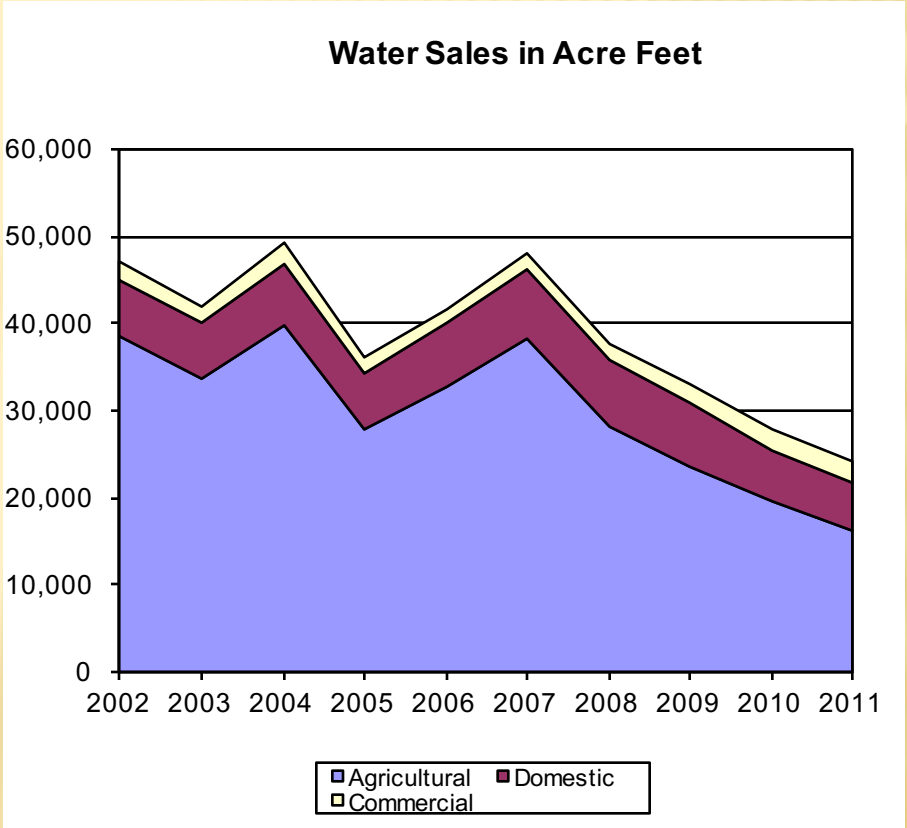
WATER COST PER ACRE FT

VCMWD
SDCWA Low Rate Projections



	2012	2013	2014	2015	2016
M&I - Full Rate	$1,440	$1,518	$1,589	$1,651	$1,811
Percent Increase		5.4%	4.7%	3.9%	9.7%
SDCWA - SAWR	$1,210	$1,368	$1,439	$1,501	$1,661
Percent Increase		13.1%	5.2%	4.3%	10.7%
MWD - IAWP	$1,170	-	-	-	-

DECLINE IN WATER SALES IN VALLEY CENTER 2002 -2011



RAPID DECLINE IN ACREAGE DUE TO HIGH WATER COSTS

IDEAS ON IMPROVING YIELD
SOME GOOD, SOME NOT SO GOOD

- Pruning?
- Changing spacing. High Density? Low Density?
- Pollinizer trees?
- Just a ton of water to leach salts?
- Over fertilization?
- Devices to “inactivate the salts”?
- Microbial solutions?
- Magical Potions? “Doubles the yield with half the water” **“essence of bones” “magical sand” “wax sprays”**(I have heard all of them)

THE OLD AVOCADO GROVE

- Trees grown on a 20’ x 20’ spacing
- Trees were not pruned
- Picking was done often at 30’ off the ground with 10’ picking poles
- The lower leaves were shaded by the upper canopy causing leaf drop in the lower canopy
- This gave a grove a “telephone pole” look
- Yields were low and not sustainable

THE MODERN AVOCADO GROVE

- Higher Density between trees
- Trees maintained at a low height with pruning
- Pollinizers planted so each Hass 'sees' a pollinizer tree (but not sure how many)
- Plenty of bees (3-4 hives per acre)
- Bloom sprays and mulching
- No water stress using tensiometers and CIMIS, leaching salts periodically
- Active scouting and spot treatment for insects and diseases
- But, how do we prune??

CHANGING THE SPACING?
LET'S LOOK AT HIGH DENSITY

HIGH DENSITY GROVE (10' X 10') IN TEMECULA

	Yield lbs/acre
2004 planted	0
2005	0
2006	2,727 (est)
2007	3,636 (est.)
2008	2,727 (est.)
2009	4,545
2010	32,727
2011	
2012	

THEIR PROBLEM

- In 2010 they pruned in the **summer** and pruned most of the fruiting wood off for next Spring
- They pruned all sides and topped

HIGH DENSITY GROVE (10 X 10) – ESCONDIDO

	Yield in lbs/acre
2006 planted	0
2007	0
2008	0
2009	5,080
2010	7,656
2011	24,195
2012	15,144
2013	8,147

THEIR PROBLEM

- **They didn't prune at all** and it turned into a jungle
- Couldn't get through the grove to check the irrigation
- Lower leaves were starting to shade and they were close to falling off

RESEARCH PROJECT INITIATED 2012
COMPARE TWO PRUNING STYLES

- High Density Trial 10’ x 10’ (3m x 3m) spacing
- Each Hass tree facing a Zutano for pollination
- 3-4 hives of bees per acre
- Irrigation and fertilization carefully managed
- Hass and Lamb Hass on Dusa rootstocks
- Planted Summer, 2012

- **Goal: Maximize yield per acre**

HASS

H H H H H H H H H

H Z H H Z H H Z H

H H H H H H H H H

H H H H H H H H H

H Z H H Z H H Z H

H H H H H H H H H

H H H H H H H H H

H Z H H Z H H Z H

H H H H H H H H H

LAMB HASS

L	L	L	L	L	L	L	L	L
L	Z	L	L	Z	L	L	Z	L
L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L
L	Z	L	L	Z	L	L	Z	L
L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	L
L	Z	L	L	Z	L	L	Z	L
L	L	L	L	L	L	L	L	L

Hass/Lamb-Hass High Density Trial Map

Watermonitor Main Water supply valve

		Hass										Lamb Hass									
		H1	**H2**	**H3**	**H4**	**H5**	**H6**	H7	H8	H9	Faucet	L1	L2	L3	**L4**	**L5**	**L6**	**L7**	**L8**	**L9**	Xtra
		H10	**H11**	**H12**	**H13**	**H14**	**H15**	H16	H17	H18	Faucet	L10	L11	L12	**L13**	**L14**	**L15**	**L16**	**L17**	**L18**	Xtra
Road	Xtra	**H19**	**H20**	**H21**	**H22**	**H23**	**H24**	H25	H26	H27	Faucet	L19	L20	L21	**L22**	**L23**	**L24**	**L25**	**L26**	**L27**	Xtra
	Xtra	H28	H29	H30	**H31**	**H32**	**H33**	H34	H35	H36	Faucet	**L28**	**L29**	**L30**	L31	L32	L33	L34	L35	L36	Xtra
	Xtra	H37	H38	H39	**H40**	**H41**	**H42**	H43	H44	H45	Faucet	**L37**	**L38**	**L39**	L40	L41	L42	L43	L44	L45	Xtra
	Xtra	H46	H47	H48	**H49**	**H50**	**H51**	H52	H53	H54	Faucet	**L46**	**L47**	**L48**	L49	L50	L51	L52	L53	L54	Xtra
	Xtra	H55	H56	H57	**H58**	**H59**	**H60**	**H61**	**H62**	**H63**	Faucet	**L55**	**L56**	**L57**	**L58**	**L59**	**L60**	L61	L62	L63	Xtra
	Xtra	H64	H65	H66	**H67**	**H68**	**H69**	**H70**	**H71**	**H72**	Faucet	**L64**	**L65**	**L66**	**L67**	**L68**	**L69**	L70	L71	L72	Xtra
	Xtra	H73	H74	H75	**H76**	**H77**	**H78**	**H79**	**H80**	**H81**	Faucet	**L73**	**L74**	**L75**	**L76**	**L77**	**L78**	L79	L80	L81	Xtra

Hass **Lamb-Hass**

Center tree is Zutano 10'x10' spacing

1-Pink (Shaded)More Traditional Pruning Method-all around. Topped at 7 ft each year.

2-White Alternate Side Pruning Method- Single Side per year. Topped at 7 ft each year

PRUNING TRIAL WITH 2 TREATMENTS ON HIGH DENSITY HASS AND LAMB HASS

1. All sides pruned and topped each year (1/2 of the trees), compared to:

2. Southwest side pruned in first year, Northeast side pruned in second year, Trees topped in third year **(topping changed to every year)**
   - Three year rotation **(changed to two year rotation)**
   - There will always be fruiting wood on the tree
   - This is easy for grove workers

TIMING OF PRUNING

- Harvest early (Feb, March, April)
- Then prune
- Nip back shoots in June so that new fruit is covered by a few leaves for shade
- In the summer, clear the aisles when needed with pruning
- In the spring and late summer top at 7’-8’
- No major pruning in the summer, we don’t want to cut off fruiting wood

ONE YEAR AFTER PLANTING AUGUST, 2013 -TOP TWO ROWS OF THE PLOT

CLEARING THE AISLES, JULY, 2015

CHECKING LIGHT PENETRATION, OCTOBER 2016

SUGGESTIONS FROM CHILE

- We are paying close attention to suggestions by Gardiazabal and Mena (CAS Yearbook 2011)

1. Prune in first year to establish central leader
2. Prune vigorous upright shoots in the subsequent years that compete with the central leader
3. Prune weak branches to create small holes in the canopy for light penetration

VIGOROUS SIDE SHOOTS COMPETING WITH THE CENTRAL LEADER, THESE WILL BE TIPPED

4. In later years prune vigorous side branches to maintain the central leader shape
5. Perhaps use growth regulator NAA to reduce regrowth

APRIL, 2015, AFTER CLEARING THE AISLES

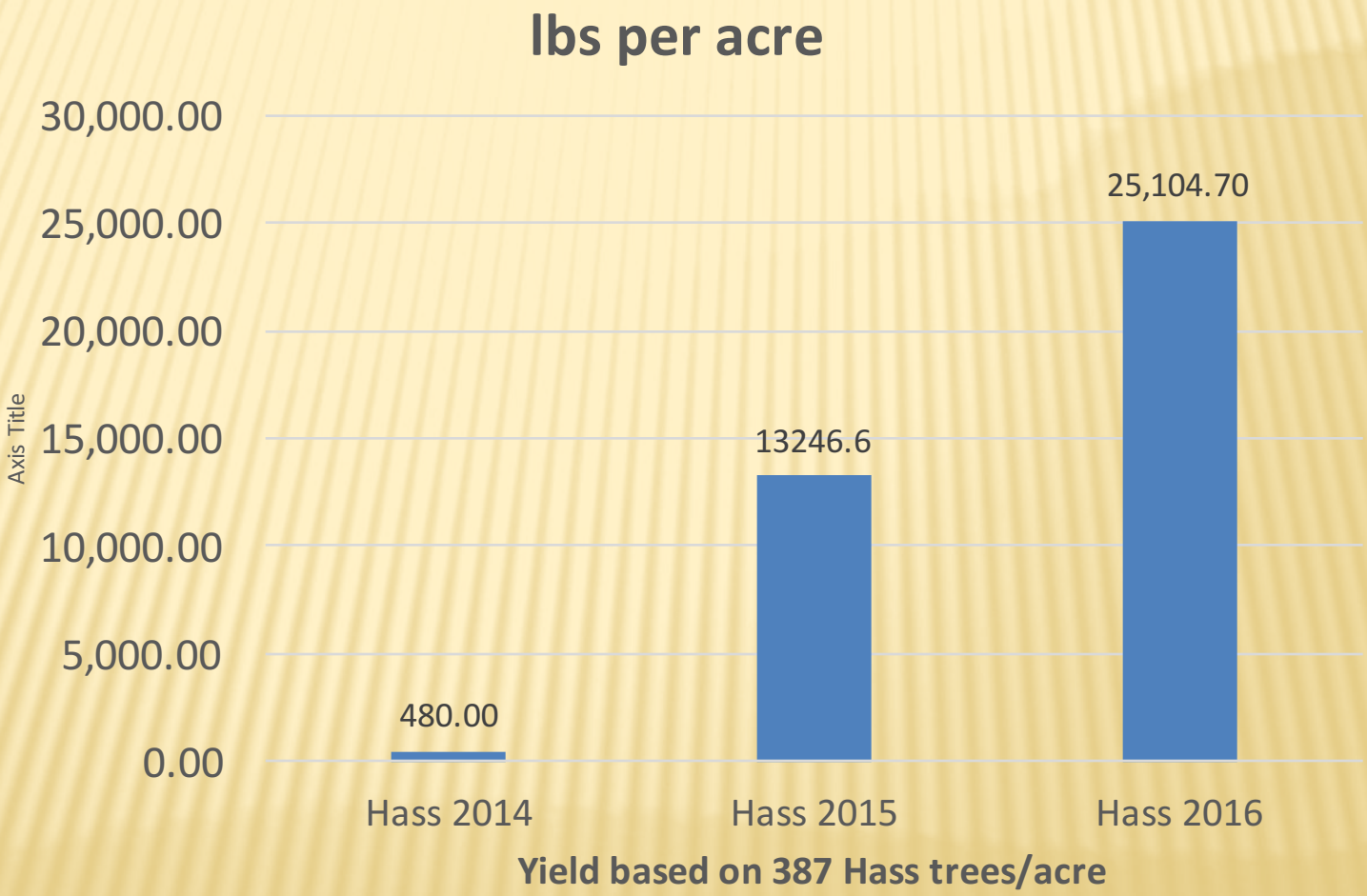
HOW TALL SHOULD THE TREES BE?

- 80% of 10’ (3m) should be about 8’ (2.4m)

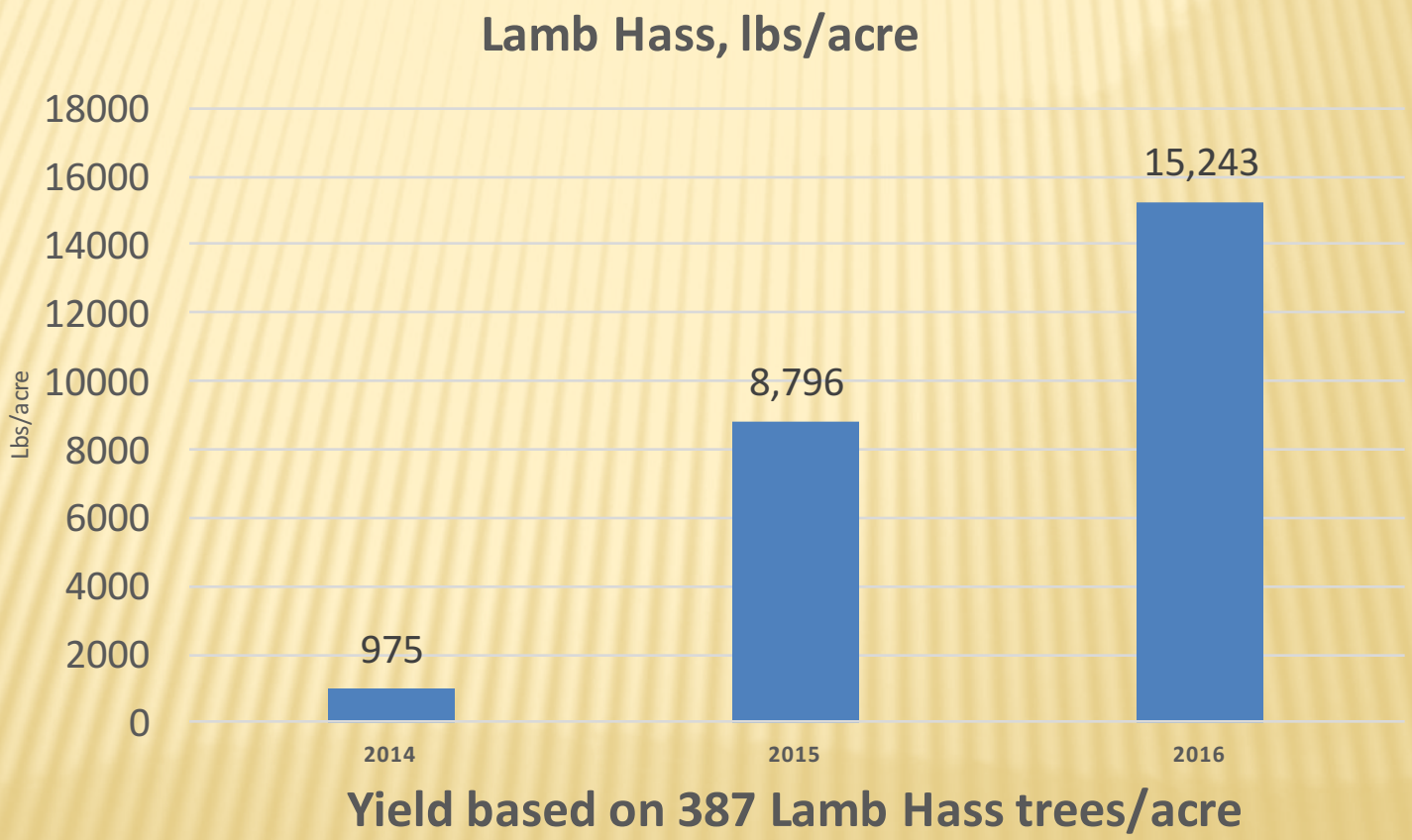
IN OUR HIGH DENSITY TRIAL, 2015

- 2.5 years in the ground:
- Hass harvested March, 2015
- Zutano harvested January, 2015
- Hass at 387 trees/acre, 34.2 lbs/tree =**13,246 lbs/ac**
- Zutano at 48 trees/acre, 33.7 lbs/tree =**1,615 lbs/ac**
- Industry average yield (Hass) for last six years =6,455 lbs/ac
- This caught the attention of radio and TV

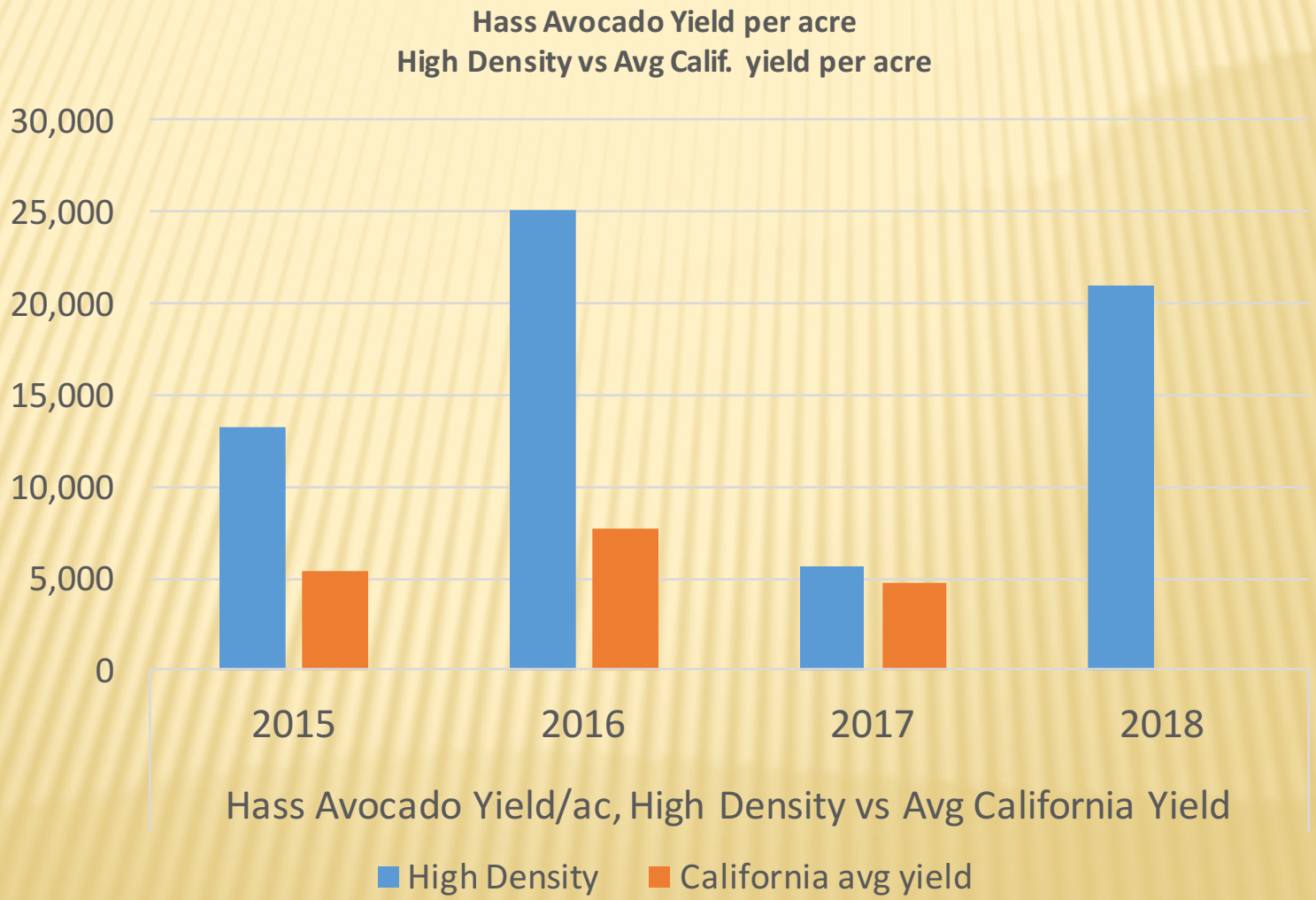
HASS YIELD AS OF MARCH, 2016 3 ½ YRS OLD



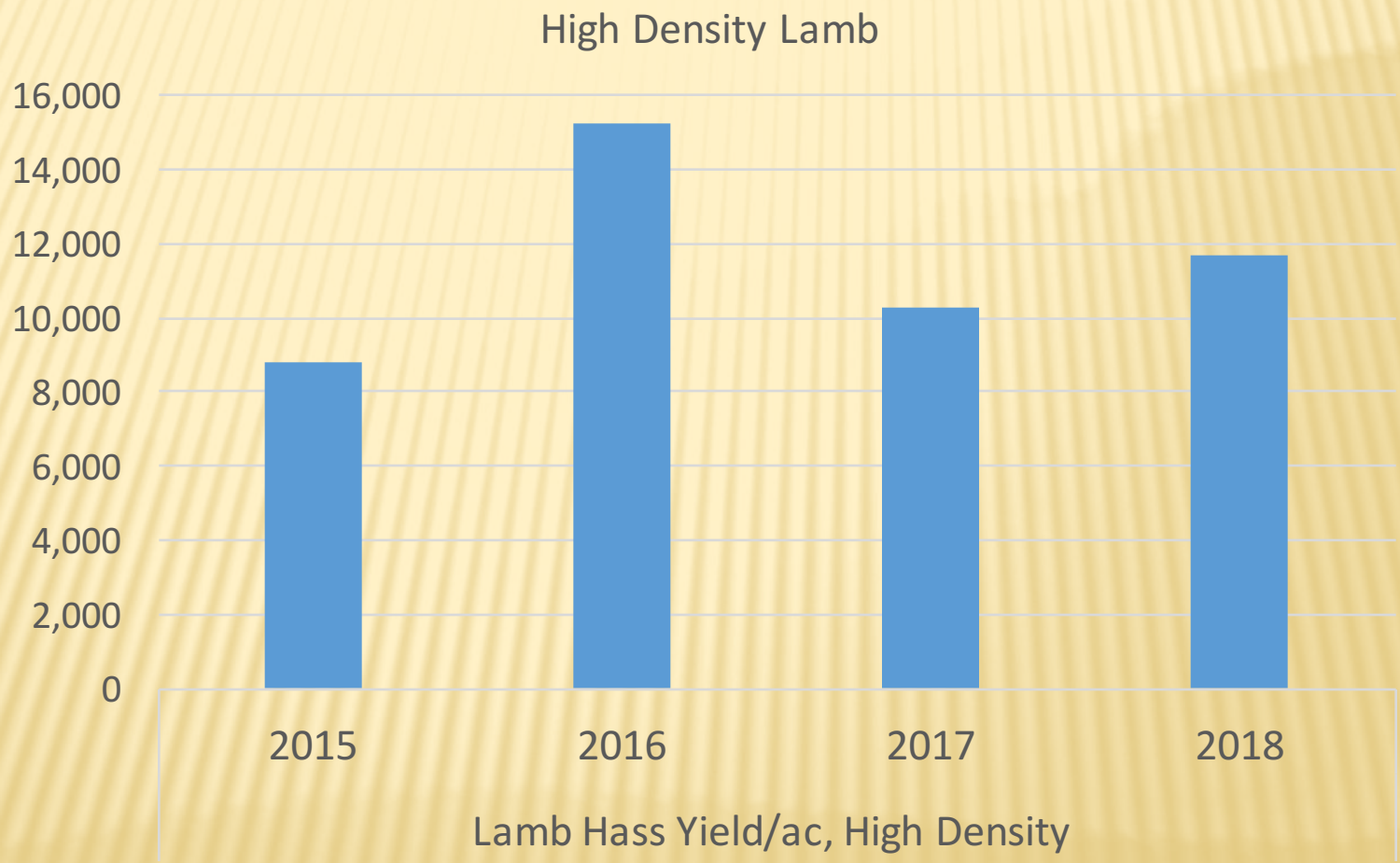
LAMB HASS YIELD AS OF JULY, 2016, 4 YEARS OLD



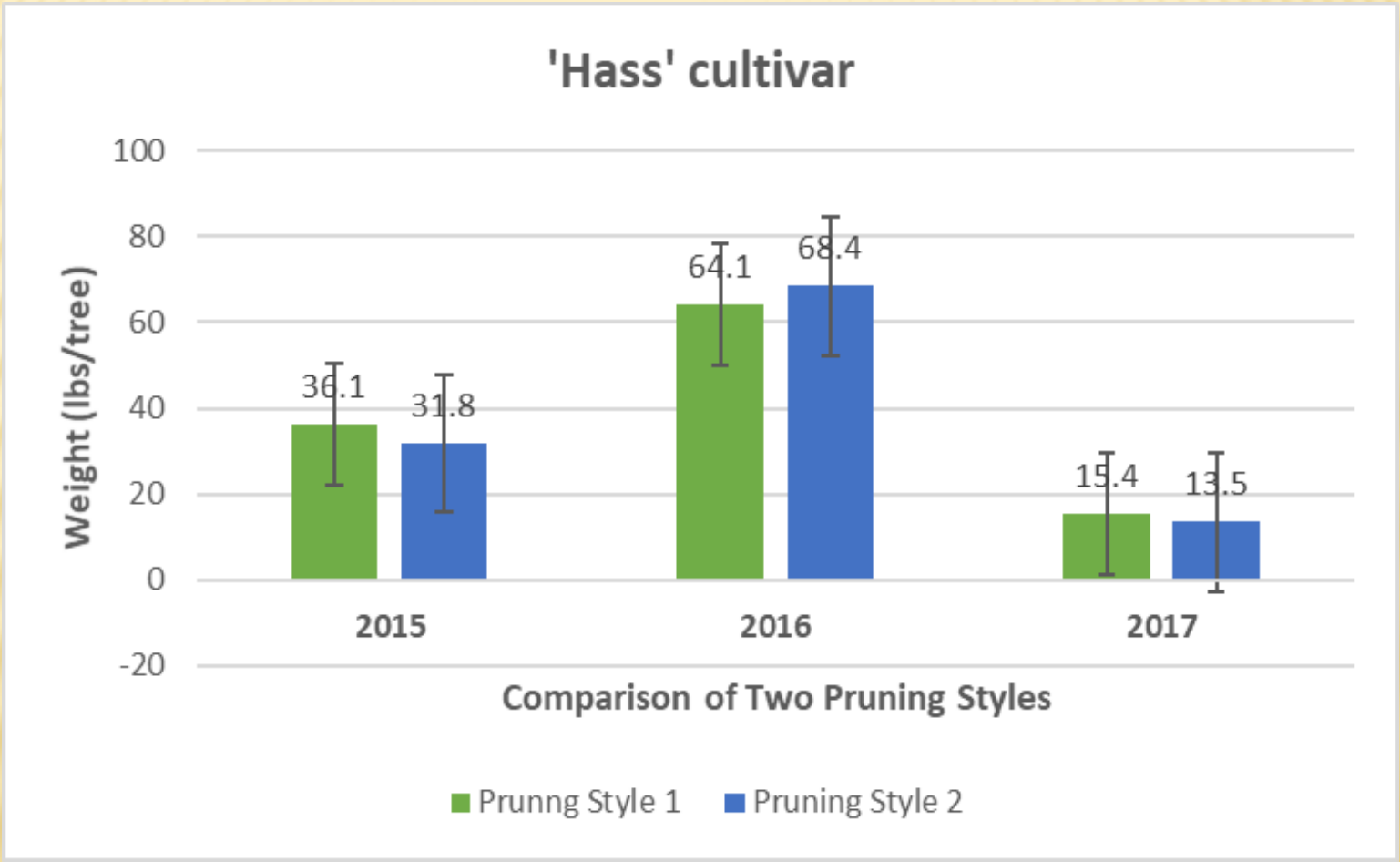
HASS YIELD PER ACRE (TRIAL) AS OF 2018 VS CALIF. AVG YIELD



HIGH DENSITY, LAMB HASS



COMPARISON TO TWO PRUNING STYLES



WHAT ABOUT WATER? WHAT ABOUT LABOR? DOES THIS MAKE A PROFIT?

WATER, BASED ON 430 TREES/ACRE

Time period	Gallons applied per 162 trees	Gallons/acre	Acre feet/acre
2/15/2013-10/31/2013	14388	381926	1.17
11/1/2013-10/31/2014	405232	1075615	3.30
11/1/2014-10/31/2015	353610.5	938595	2.88
11/1/2015-10/31/2016	591991.7	1571336	4.82
11/1/2016-10/31/2017	46501.8	1234293.3	3.79

LABOR IN OUR PLOT, 18 ZUTANO, 72 HASS AND 72 LAMB HASS

Year	Topping Zutanos	Alternate side pruning-Hass	All sides pruned-Hass	Alternate side pruning-Lamb Hass	All sides pruned-Lamb Hass	Skirt pruning and aisle clearing, both Hass and Lamb Hass
2012*	0	0	0	0	0	0
2013	0.75	0.75	0.75	0.75	0.75	0
2014	1	4	6	0	0	3
2015	2	6	7	3	6.75	11
2016	2	8.25	5.5	3.75	8.25	13
2017	(2)**	7	11.75	0	0	14

LABOR, 430 TREES PER ACRE

Year	Topping Zutanos	Alternate-side pruning-Hass	All sides pruned-Hass	Alternate side pruning-Lamb Hass	All sides pruned – Lamb Hass	Skirt pruning and aisle clearing both Hass and Lamb Hass
2015-2017	6	21.25	24.25	6.75	15	38
Average per year in the trial plot (last three years)	2	7.1 for 40 trees	8.1 for 32 trees	2.25 for 40 trees	5 for 32 trees	12.7 for 162 trees
Average per acre	5.3	68.7	98.0	21.8	60.5	30.3
Cost per acre @ $15/hr	**$79.50**	**$1,030.50**	**$1,470.00**	**$327.00**	**$907.50**	**$455.08**

HARVESTING LABOR

- Because trees are being kept below 8 ft, ladders are not required and harvesting is much less expensive
- But our hours for harvesting are not reliable because fruit from each tree had to come up to the scale.

INCREASE IN HASS YIELD IN HIGH DENSITY

Year	Hass yield/ac (Calif.avg) *	High density yield/ac	Increase in yield/ac	$/lb (Calif. avg for March of each year)*	**Increase in $/ac due to high density**
2015	5,240	13,246	8,006	$1.12	**$8,967**
2016	7,733	25,100	17,367	$0.70	**$12,157**
2017	4,801	5,641	840	$1.53	**$1,285**

INCREASE IN $/AC MINUS PRUNING COSTS IN A HIGH DENSITY GROVE

Year	Increase in $/ac due to high density compared to Calif. average (Table 6)	Pruning costs/ac (Zutano pollinizer trees and Hass all sides pruned and topped with aisle clearing)*	**Increase (decrease) in $/ac minus pruning costs/ac**
2015	$8,967	$2,004.58	**$6,962**
2016	$12,157	$2,004.58	**$10,152**
2017	$1,285	$2,004.58	**($720)**

CONCLUSIONS

- Earlier reports showed that growers need to produce 10,000 –11,000 lbs/ac to break even
- We produced 13.246, 25,100, 5,641 and 20,992 lbs/ac for an average of 16,245 lbs/ac
- Alternate side pruning did not differ significantly from all sides pruning
- Water use per acre was 2.88 ac ft/ac, 4.82 ac ft/ac and 3.79 ac ft/ac. Water use for a mature grove in Valley Center is 4.0-4.5 ac ft/ac

GARY TANIZAKI IN THE HIGH DENSITY TRIAL IN OCTOBER 2016

PROBLEMS? OF COURSE!

- Harvesting must be done early (Feb – Mar is best)
- If you harvest too late, then flowering and fruit set has already occurred, and now you have to prune off fruit
- But our industry is set up to harvest through the whole season!
- Trees are expensive! $32-34/tree,
- 430 trees/acre = $13,760-$14,620/acre
- Plus planting costs

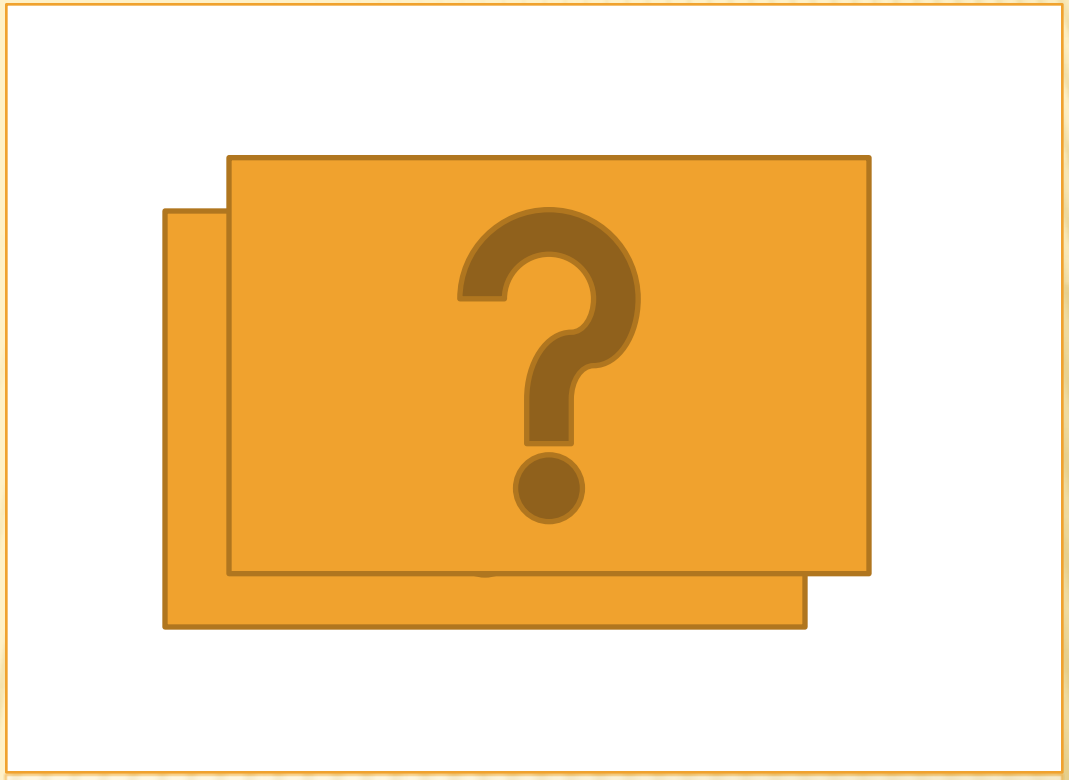
A SOLUTION, MAYBE

- Early harvest outside of tree, then prune, second harvest on inside of tree

THANK YOU!

Gary Bender

gsbender@
ucanr.edu



OTHER SPACING OPTIONS BEING TRIED

7’ X7’ BEING TRIED BY REUBEN HOFSHI AND ALEX GONZALEZ, PERSEA TREE NURSERY

STEVE HOWERZYL, ESCONDIDO

GREG MANGUS AND JULIO TOMAS, FALLBROOK

JIM BROWN, TEMECULA
CREATING A 10 X 10 IN AN OLDER GROVE

ERNESTO VELOZ , FARM MANAGER

JOE ELLIS HIGH DENSITY GROVE IN PAUMA VALLEY

6’ BETWEEN TREES, 14’ BETWEEN ROWS

NICK KRNICH GROVE, BONSALL
7’ X 7’, 888 TREES/ACRE

MICRO-CLONE ON DUSA ROOTSTOCK
PERSEA TREE NURSERY, FALLBROOK

PRUNING IS A MUST!!

POSSIBLE PRUNING STYLES

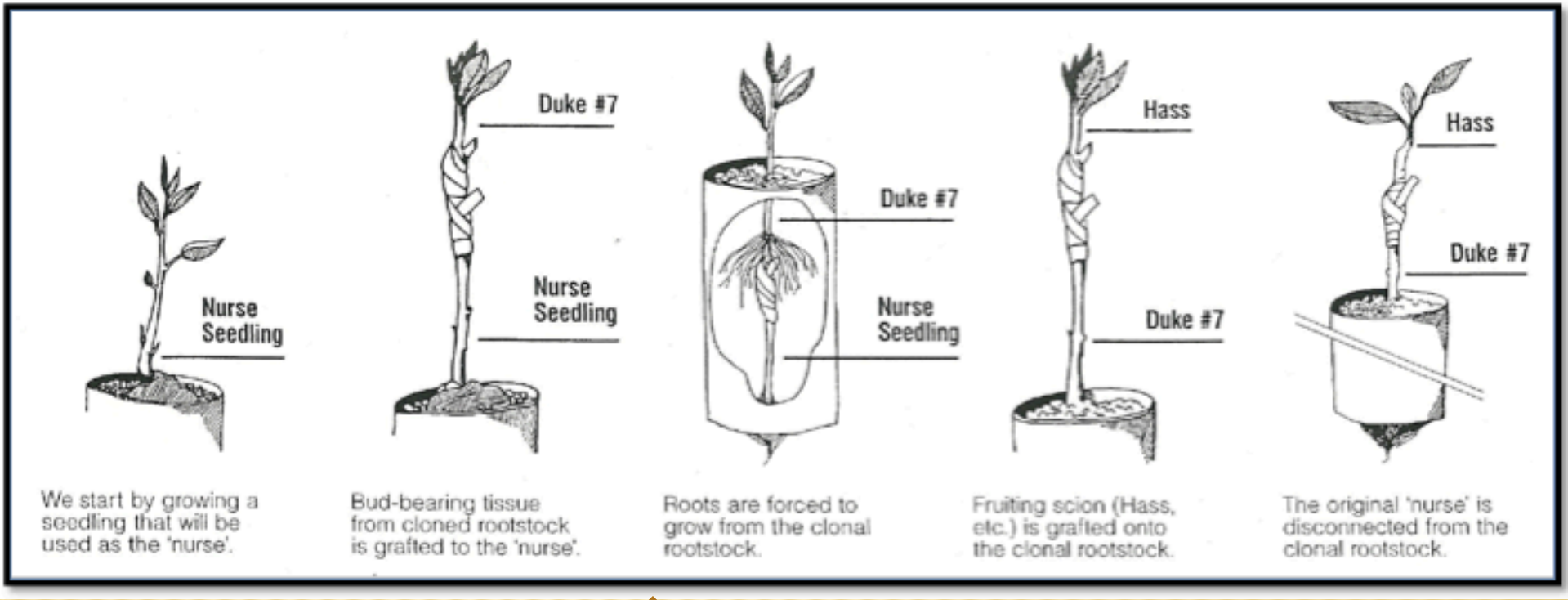
UC TRIAL

- (trial) All sides pruned after early harvest, topped at 7’-8’
- (trial) Alternate sides pruned after early harvest, topped at 7’-8’

OTHER IDEAS BEING TRIED

- One branch removed at chest high each year
- Branch girdled in November, goes into heavy flower, harvested, branch pruned out
- Trees grown as a hedge

LET'S GROW HEALTHY TREES
USE CLONAL ROOTSTOCKS


Nurse Seedling
We start by growing a seedling that will be used as the 'nurse'.
Duke #7
Nurse Seedling
Bud-bearing tissue from cloned rootstock is grafted to the 'nurse'.
Duke #7
Nurse Seedling
Roots are forced to grow from the clonal rootstock.
Hass
Duke #7
Fruiting scion (Hass, etc.) is grafted onto the clonal rootstock.
Hass
Duke #7
The original 'nurse' is disconnected from the clonal rootstock.

Dark 10 days

CREATING A CLONAL ROOTSTOCK

- Zutano seed planted
- Dusa grafted onto Zutano, pot placement
- In the dark for 10 days to etiolate
- Rooting hormone, mix placed around lower Dusa for rooting
- Hass grafted onto Dusa

BROKAW NURSERY, VENTURA

OTHER NURSERIES SELLING CLONAL ROOTSTOCKS

- C and M Nursery, Nipomo
- Maddock Nursery, Fallbrook
- Persea Tree Nursery, Fallbrook

COSTS FOR HIGH DENSITY

PRUNING LABOR

HASS

- 118.25 hrs per acre in 2016
- At $15/hr, pruning cost is $1774/ac

Pruning includes skirt pruning, topping and side pruning. Plus clearing the aisles twice a year. 387 trees per acre

LAMB HASS

- 71.23 hrs per acre in 2016
- At $15/hr, pruning cost is $1391/ac

HARVEST LABOR

HASS

- 96.75 hrs/acre (387 trees)
- 25,100 lbs/acre
- At $15/hr, it cost $0.06/lb to pick
  - $1506/ac to harvest
- At $10/hr, it cost $0.04/lb to pick
  - $1004/ac to harvest
- All harvest done from the ground without ladders, inexperienced crew **and fruit had to be weighed from each tree**

LAMB HASS

- 92.72 hrs/acre (387 trees)
- 14,668 lbs/acre
- At $15/hr, it cost $0.06/lb to pick
  - $880/ac to harvest
- At $10/hr, it cost $0.04/lb to pick
  - $586/ac to harvest

WATER COST

2014-2015

- 2.88 ac ft/ac
- At $1600 per ac ft, $4609 for water per acre

2015-2016

- 4.82 ac ft/ac
- At $1600 per ac ft, $7716 for water per acre
- Water was left on over-night at least once

BOTTOM LINE, ARE WE MAKING ANY MONEY?

- Hass
- At 25,100 lbs/ac, assume $1 per lb
  - Minus water $7716
  - Minus pruning $1774
  - Minus harvest $1506
  - Equals $14,104

NORMAL FARMING THINGS YOU HAVE TO DO (AND YOU HAVE TO DO ALL OF THEM!)

- Monitor soil moisture, tensiometers, WaterMarks, other devices
- Calculate irrigation requirement, use the Irrigation Calculator on avocadosource.com
- Bees, 3-4 hives/acre
- Leaf analysis
- Fertilize correctly
- Use liquid fertilizer injection into irrigation lines
- Root rot control, use clonal rootstocks
- Leach salts at least once a month in the summer

WHAT HAVE WE LEARNED?

- Avocado production can thrive using high density
- Pruning is a must, early pruning after an early harvest is best
- Try not to prune in the summer or fall, except for topping and aisle clearing
- Bees are a must
- **Pollinizer trees are a must**, not sure how many!

NEGATIVES?

- Trees are expensive:

  $35/Hass on Dusa x 430 trees/ac = $15,050
- You need more labor than normal
- Fruit from Zutano trees don't have a market
- You can't have the entire industry harvesting early in the year

THANK YOU!

- gsbender@ucanr.edu

Thanks to the Nick Stehly Ranch

Thanks to the California Avocado Commission for funding the trial

MORE THINGS YOU HAVE TO DO

- Harvest early
- Prune early
- Phosphorous acid twice a year through the irrigation system 1 gal/acre
- **Don't farm sick trees, cap the sprinklers, replant with root rot-resistant clonal rootstocks**
- If you trunk inject, use 0-28-25 instead of 0-60-0 (due to excessive trunk damage)

SICK TREES


UC Statewide IPM Program
© 2004 Regents, University of California

AND A COUPLE MORE THINGS

- Join the California Avocado Society
- Join the Irrigated Lands Group (if you are in San Diego County). Join the Farm Bureau.
- Attend meetings. **Ask your grove manager to attend meetings.**
- Have a PCA check your grove for persea mites, thrips and shothole borer
- **And Look at your Roots!**

AVOCADO ROOT ROT

- Use clonal rootstocks
- Sanitation! Clean your shovels. Clean your shoes. Check the bottom of incoming bins.
- Phosphorous acid
- Check the roots on new trees **while they are still in the pots.**

Fig 1-A,B,C-Branch canker and bark peeling on avocado after pouring non-buffered Phosphorous acid into an artificially drilled hole.

Fig 2-Callus formation and healed bark after application of buffered Phosphorous acid using an injector.

Wedge Direct
Inject System

(slide by Srdjan Acimovic)

Viper Air-Hydraulic

FERTILIZER ISSUES

- A mature tree on a 20'x20' spacing may need about 1.5 – 2.0 lbs actual N split up about 5-6 applications through the growing season
- Do not run a long irrigation after you have injected, Why?
- Do not apply it all at once! This goes right into the ground water
- **We need to reduce contamination of ground water and local streams**

SOME THOUGHTS FROM DR. CAROL LOVATT

- In California, only a limited number of experiments have been conducted to determine optimal rates of soil applied fertilizers – N,P,K,Fe and Zn
- All other fertilizer recommendations are based on leaf analysis using optimum ranges borrowed from citrus and, though modified over the years, are not related to **any avocado yield parameters**

NITROGEN APPLICATION TIMING
RESEARCH FROM DR CAROL LOVATT, UC RIVERSIDE

- Control trees: nitrogen was applied at 1.50 lb actual N/tree/year, (ammonium nitrate) divided into 0.25 lbs in

late Jan-early Feb,,

mid April,

mid June,

mid July,

late Aug-early Sept,

late Oct-early Nov.

This was considered “a control treatment based on a typical grower application”.

- Five other Treatments: the same as the control, but there was an extra 0.25 lb applied in each of these months: January, February, April, June, November.

- The best yield occurred when the extra 0.25 lb N was applied in April or November

FOUR-YEAR TRIAL BY LOVATT

	N applied	average wt/tree of fruit
Control trees (1.50 lbs/year)		128.7lb
Jan	extra 0.25 lb	123.4
Feb	extra 0.25 lb	123.4
April	extra 0.25 lb	158.0
June	extra 0.25 lb	117.0
Nov	extra 0.25 lb	168.3

SO, WHAT IS HAPPENING IN APRIL AND NOV?

- April is the time of anthesis, fruit set and initiation of of the spring vegetative flush
  - Anthesis means flowers are fully open and functional
- November is the end of fall vegetative flush and beginning of flower initiation within the buds

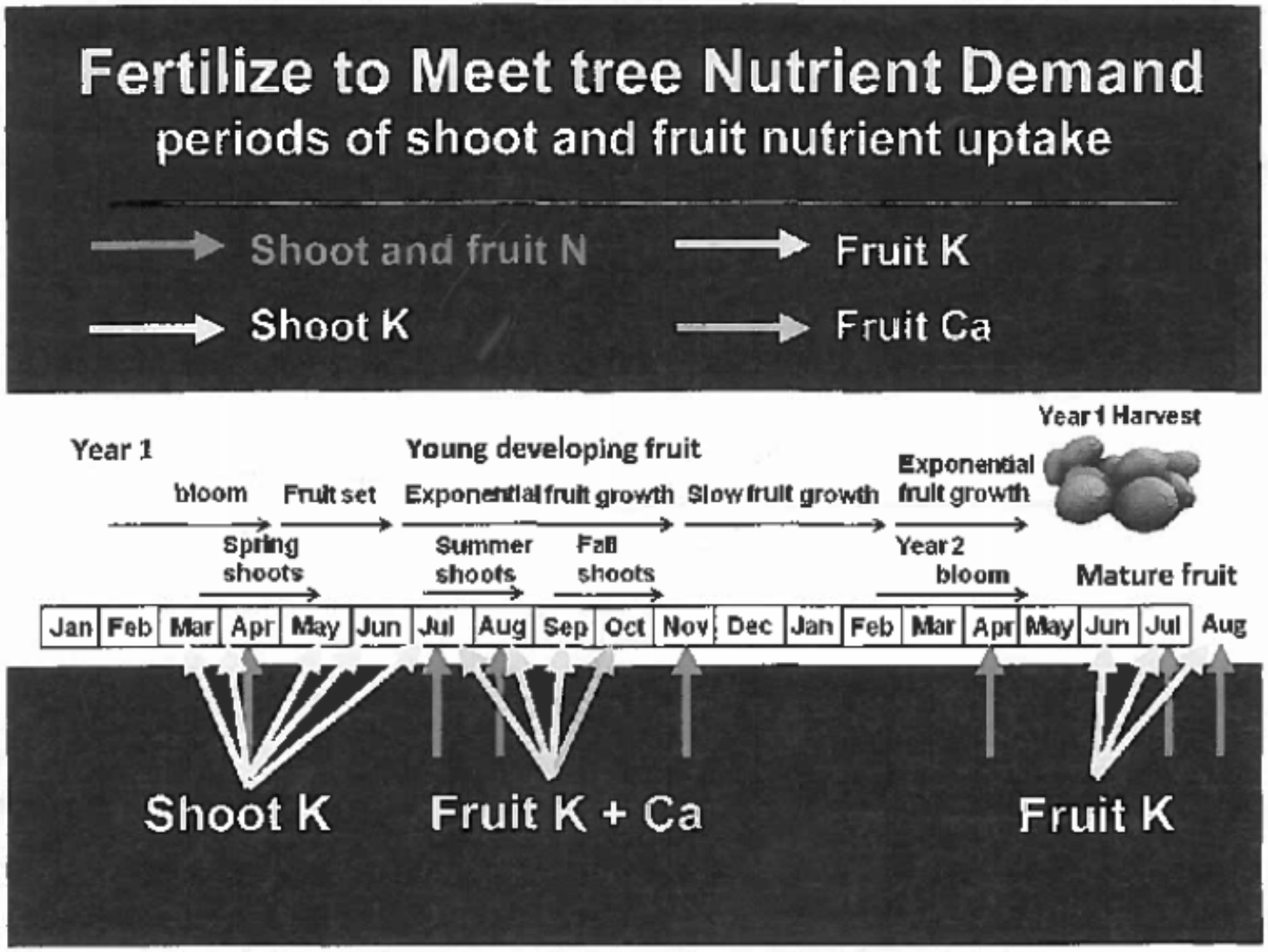
Bottom Line: Double N (in this case 0.50 lb actual N) should be applied in these months

- Lovatt suggested that **"timing of fertilizer application may be more important than previously thought by fertilizer researchers"**

- Google the PowerPoint“Fertilizing the Hass Avocado for Maximum Productivity” by Carol Lovatt

Fertilize to Meet tree Nutrient Demand

periods of shoot and fruit nutrient uptake



POTASSIUM SUGGESTION

- Potassium sulfate KTS (0-0-25) 13 gal/ac applied during each month of June, August, October through irrigation system

- Or, granular Potassium sulfate (0-0-53) 200 lbs/ac applied in June and 200 lbs/ac applied in October

ZINC SUGGESTION

- 10 yr-old tree, 5 lbs zinc sulfate surface banded hand-applied every 3-5 years

Or

- Liquid zinc sulfate 12% 5.1 gal/100 trees every year
- See page 46 in “Avocado Production Book 2, Cultural Care”

ONE LAST THOUGHT

- There is a yield loss of 12% for every 35.5 ppm chloride in irrigation water

- All growers, especially organic growers, should be leaching!
- And, measure your chloride levels in well water (often)

THANK YOU!

- gsbender@ucanr.edu