

# HIGH DENSITY AVOCADO PLANTING: IMPACTS ON PRODUCTIVITY AND WATER COST

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[https://ucanr.edu/sites/Farm\\_Management/](https://ucanr.edu/sites/Farm_Management/)

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# BACKGROUND

## ▪ Declining Acreage in San Diego County:

- San Diego County in 1987/88 as a leading avocado producer had ~ 45,800 acres, ~60% of the 76,307 acres in California
- Now, in 2020 the county has only 14,421 acres (according to the San Diego Agricultural Commissioner report); a 2% per year decline for the last 32 years.

## ▪ Decline due to high cost of production from escalating water prices:

- Reaching to up to \$1,900-\$2,000 per acre foot. Water plays a significant role in the production cost of avocados in this county with ~\$9,000 per acre or ~70% of the production cost.
- On the other hand, yield per acre and prices of avocados remained unchanged or just very little change, causing profit decline leading growers pulling out groves.



In Dr. Gary Bender's ( a California cooperative extension (UCCE) farm advisor in San Diego county, now emeritus seen on the picture) words,

*'how does a grower in California make a profit when the water prices keep increasing and yet, mostly due to foreign competition, market prices remain fairly static?'*

# MANAGEMENT APPROACHES

## Irrigation, fertilization, etc.:

- UCCE (specialists, researchers, advisors) and the industry have over the years investigated various ways of improving production practices with the goal of improving yield and returns to mitigate the increasing price of water in the production of avocados.
- ***Even with the many production improvements achieved, the increase in water prices resulting from heavy dependence of irrigation water from the municipalities was dramatic.***

## Organic Production:

- Some growers also considered organic production in hope of getting higher prices. Though there was some improvement in prices, there was not enough yield to offset the total production cost and bring profit. I did a cost study along with Dr. Gary Bender in 2011, [https://ucanr.edu/sites/Farm\\_Management/files/156257.pdf](https://ucanr.edu/sites/Farm_Management/files/156257.pdf)

## High Density planting

- With many avocado producing countries in recent years experimenting and developing production practices on high density planting; and some growers in San Diego also trying high density;
- **Dr. Gary Bender In 2011** funded by the California Avocado Commission conducted a High Density planting field trial in Valley Center, San Diego, California in cooperation with a grower.
- **The Trial:**
  - Gentle slope landscape (figure A);
  - Planting space of 10' x10' = 430 trees per acre , **almost 3 times the density** of the traditional planting (20'x15'=145 trees per acre in some cases less trees per acre, figure B);
  - Trial varieties were Hass and lamb Hass with a;
  - Zutano variety pollinizer planted in the grove (1 tree per 8 trees of Hass or Lamb Hass).



*High Density Trial, Picture by Dr. Gary Bender, Farm Advisor Emeritus, San Diego County*



*Avocado planting on a hillside*

## TRIAL OBJECTIVE AND EXPERIMENTAL METHOD

- Trial Objective to measure: ***Yield level, irrigation water use*** and develop ***pruning methods***.
- Data collected from 2011-2018.

### Irrigation water use



Monitored and documented using **Watermark soil irrigation Monitors**, irrigated when the Watermarks averaged 35-40 centibars (cb). According to the trial PI, worked perfectly and trees never had any tip-burn.

### Pruning methods:



#### Pruning purpose to

- **Keep trees at 8'**;
- Avoid overcrowding;
- Allow more light shine into the trees, more fruit borne on the lower branches.
- Allow harvesting ease and grove passes; helps keep costs down

2 methods evaluated for yield differences and time/hours required for pruning:

- Alternate side pruning annually vs
- Whole grove pruning annually

*All other production practices, pest and disease management, harvesting, etc. used in the economic analysis were the grower practices.*

The economic analysis was on only Hass variety. In the Trial, Hass variety had more yield, therefore having more economic advantage. So, The data presented here is of Hass Variety.

# I. RESULTS: YIELD-HASS VARIETY

Yield Per Acre, High density trial, Valley Center, 2011-2018				
430 trees per acre				
<i>Year</i>	<i>Trial Year</i>	<i>Yield: lbs./acre</i>	<i>Yield: lbs./tree</i>	
2012	Planting			
2013	Year 1			
2014	Year 2			
2015	Year 3	13,246	31	
2016	Year 4	25,100	58	
2017	Year 5	5,541	13	
2018	Year 6	20,992	49	
<b>Prod. Year (Avg.)</b>	<b>Year 7+</b>	<b>16,220</b>	<b>38</b>	

- Bearing age starts at year 3.
- 4 years Average yield (16,220 lbs.; 38 lbs./tree that is what we used in the production cost analysis

# YIELD COMPARISON

Yield Per Acre from a High density trial, Valley Center, 2011-2018 And Traditional Planting Growers Interview, 2011						
Hass Variety						
Valley Center Field Trial 430 trees per acre				Traditional Planting 145 trees per acre		
Year	Trial Year	Yield: lbs./acre	Yield: lbs./tree	Interview year	Yield: lbs./Acre	Yield: lbs./tree
2012	Planting			2011		
2013	Year 1					
2014	Year 2					
2015	Year 3	13,246	31		700	5
2016	Year 4	25,100	58		2,900	20
2017	Year 5	5,541	13		4,300	30
2018	Year 6	20,992	49		5,300	37
<b>Prod. Year (Avg.)</b>	<b>Year 7+</b>	<b>16,220</b>	<b>38</b>		<b>9,000</b>	<b>62</b>

Comparing yield with traditional planting:

- *More yield per acre as early as year 3;*
- *Average yield ~80% higher than the traditional planting.*

## II. RESULTS: WATER USE/IRRIGATION

Water Use Per Acre, High Density Planting		
HASS VARIETY		
Valley Center Field Trial		
430 trees per acre		
<i>Year</i>	<i>Trial Year</i>	<i>Water Ac. In/acre</i>
2012	Planting	
2013	Year 1	14.04
2014	Year 2	39.60
2015	Year 3	34.56
2016	Year 4	57.84
2017	Year 5	45.48
2018	Year 6	46.00
<b>Prod. Year (Avg.)</b>	<b>Year 7+</b>	<b>~46.00</b>

Water use data ranged from 14 ac.in in year 1 to 46 ac.in in year 6+

Note watering error in year 4

# WATER USE COMPARISON

Water Use Per Acre from a High Density Trial, Valley Center, 2011-2018 And Traditional Planting Growers Interview, 2011				
Hass Variety				
Valley Center Field Trial 430 trees per acre			Traditional Planting 145 trees per acre	
<i>Year</i>	<i>Trial Year</i>	<i>Water Ac. In/acre</i>	<i>Interview year</i>	<i>Water Ac. In/acre</i>
2012	Planting		2011	
2013	Year 1	14.04		6
2014	Year 2	39.60		11
2015	Year 3	34.56		16
2016	Year 4	57.84		21
2017	Year 5	45.48		26
2018	Year 6	~46.00		32
<b>Prod. Year (Avg.)</b>	<b>Year 7+</b>	<b>~46.00</b>		<b>42</b>

Water use in high density showed very little differences from the traditional planting in production year 7+ (46 inches), even though the number of trees ~tripled in high density.

### III. RESULTS: PRUNING

<b>Pruning Hours Per Acre and Per Tree, High Density 2022-2018</b>				
<b>Alternate Side Pruning</b>				
<b>430 trees per acre</b>				
<i>Year</i>	<i>Trial Year</i>	<i>Hours/ Acre</i>	<i>Hours/ Tree</i>	
2012	Planting			
2013	Year 1	26.89	0.06	
2014	Year 2	43.33	0.10	
2015	Year 3	55.08	0.13	
2016	Year 4	48.56	0.11	
2017	Year 5	49.10	0.11	
2018	Year 6	49.50	0.12	
<b>Prod. Year (Avg.)</b>	<b>Year 7+</b>	<b>49.30</b>	<b>0.11</b>	

- The data here for alternate pruning method, because it is more cost effective as there was no significant yield differences between the two methods. Average pruning for annual alternate side method = 0.11 hours per tree

# PRUNING HOURS COMPARISON

Pruning Hours Per Acre and Per Tree, High Density Trial, Valley Center 2022-2018 And Traditional Planting Growers Interview, 2011						
Valley Center Field Trial 430 trees per acre				Traditional Planting 145 trees per acre		
<i>Year</i>	<i>Trial Year</i>	Hours/ Acre	<i>Hours/ Tree</i>	Interview <i>year</i>	<i>Hours/ Acre</i>	<i>Hours/ Tree</i>
2012	Planting			2011		
2013	Year 1	26.89	0.06			
2014	Year 2	43.33	0.10			
2015	Year 3	55.08	0.13			
2016	Year 4	48.56	0.11		14.50	0.10
2017	Year 5	49.10	0.11		16.86	0.12
2018	Year 6	49.50	0.12		21.71	0.15
<b>Prod. Year (Avg.)</b>	<b>Year 7+</b>	<b>49.30</b>	<b>0.11</b>		<b>38.64</b>	<b>0.27</b>
No significant yield differences between the whole grove pruning per year versus alternate side pruning per year. Therefore, alternate side pruning is cost effective						

High density trees pruning lower by ~50% ( due to shorter trees, etc.).

# ECONOMIC ANALYSIS: COST PROFIT ANALYSES

Using the data from the field trial and the grower's production practices for the whole grove, I developed a FULL ENTERPRISE BUDGET:

*Estimated:*

- *Orchard investment costs/establishment costs,*
- *Annual production costs, and*
- *Returns and profit.*
- Wrote a detail whole grove production practices for high density.



*Cooperators: Daniel Sumner and Don Stewart Of Agricultural Economics Dept. Davis, also Gary Bender reviewed the study*

# I. INVESTMENT COSTS/ESTABLISHMENT COSTS

<b>High Density Planting Establishment Costs</b>						
<b>Establishment Years Costs and Returns</b>						
<b>High Density Production (430 Trees Per Acre, 2020 Study)</b>						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Yield (pounds)			13,246	25,100	5,541	20,992
Establishment Costs (year 1-6) (\$)	29,712	9,841	10,969	18,633	14,895	16,804
Returns (\$)			17,187	29,191	9,810	27,069
Establishment cost after returns (\$)	29,712	9,841	6,218	10,558	-5,085	-10,265
<b>Cumulative Establishment Costs (\$)</b>	<b>29,712</b>	<b>39,553</b>	<b>33,335</b>	<b>22,777</b>	<b>27,862</b>	<b>17,597</b>
Production returns after costs (\$)						

Establishment cost of \$17,597/acre reflect that ~83% of establishment costs offset by Returns.

# Investment cost comparison

## High Density and Traditional Planting Establishment Costs

### Establishment Years Costs and Returns Per Acre

#### High Density Production (430 Trees Per Acre, 2020 Study)

Yield (pounds)			13,246	25,100	5,541	20,992
Establishment Costs (year 1-6) (\$)	29,712	9,841	10,969	18,633	14,895	16,804
Returns (\$)			17,187	29,191	9,810	27,069
Establishment cost after returns (\$)	29,712	9,841	6,218	10,558	-5,085	-10,265
<b>Cumulative Establishment Costs (\$)</b>	<b>29,712</b>	<b>39,553</b>	<b>33,335</b>	<b>22,777</b>	<b>27,862</b>	<b>17,597</b>
Production returns after costs (\$)						

### Establishment Years Costs and Returns

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
<b>Traditional Production (140 Trees per acre, 2011 study adjusted for inflation to 2020)</b>						
Yield (pounds)			700	2,900	4,300	5,800
Establishment Costs (year 1-6) (\$)	15,006	6,556	8,505	9,323	11,063	12,525
Returns (\$)			897	3,615	5,515	7,429
Establishment costs after returns (\$)	15,006	6,556	7,608	5,608	5,615	5096
<b>Cumulative Establishment Costs (\$)</b>	<b>15,006</b>	<b>21,562</b>	<b>29,171</b>	<b>34,780</b>	<b>40,228</b>	<b>45,324</b>
Production returns after costs (\$)						

The high density establishment Cost (\$17,597 per acre) was less by ~60% than the traditional planting (\$45,324 per acre).

In traditional planting only 28% of the establishment costs was offset by returns.

## II. PRODUCTION COSTS AND RETURNS PER ACRE:

High Density (430 Trees Per Acre, 2020 Study)	
Yield (pounds—average of 4 years)	16,220
Production costs year 7+ (\$)	16,233
Gross Returns (\$)	22,494
Returns after costs except management (\$)	6,260

In production cost:  
gross returns higher  
than production costs  
by 38% = Profit  
before paying  
management

## HIGH DENSITY AND TRADITIONAL PLANTING PRODUCTION COSTS, AND PROFIT COMPARISON

<b>High Density (430 Trees Per Acre, 2020 Study)</b>	
Yield (pounds)	16,220
Production costs year 7+ (\$)	16,233
Gross Returns (\$)	22,494
Returns after costs except management (\$)	6,260
<b>Traditional Production (140 Trees per acre, 2011 study adjusted to inflation to 2020)</b>	
Yield (pounds)	9,000
Production costs year 7+ (\$)	12,980
Gross Returns (\$)	12,510
Returns after costs except management (\$)	-563

- Notable profit difference between the high density and the traditional planting.
- That shows water cost mitigation achieved through the higher yield of high density planting.
- Looking the impact another way: distributing the cost of water over yield shows a water cost of \$0.54/lb. in high density vs \$1.00/lb. in traditional planting.

## SUMMARY:

## HIGH DENSITY COMPARED TO TRADITIONAL PLANTING

The average yield of 16,620 lbs./acre ~80% Yield increase



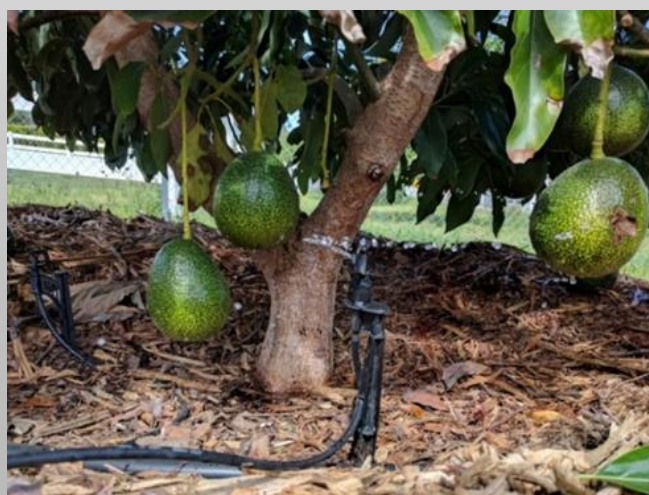
## water use:

- High efficiency ~ same amount of water use (46 acre inches/acre) for 3x times the tree density.

Pruning hours reduced by over 50%, reduces cost



0.11 hours per tree



Overall in the cost study high density planting:

- Significantly lower establishment cost (cumulative of 6 years)=\$17,600/Acre 60% lower than traditional planting; could this be an incentive for investment?
- ~Double gross returns (\$22,500/Acre) and positive net returns: \$6,200/Acre

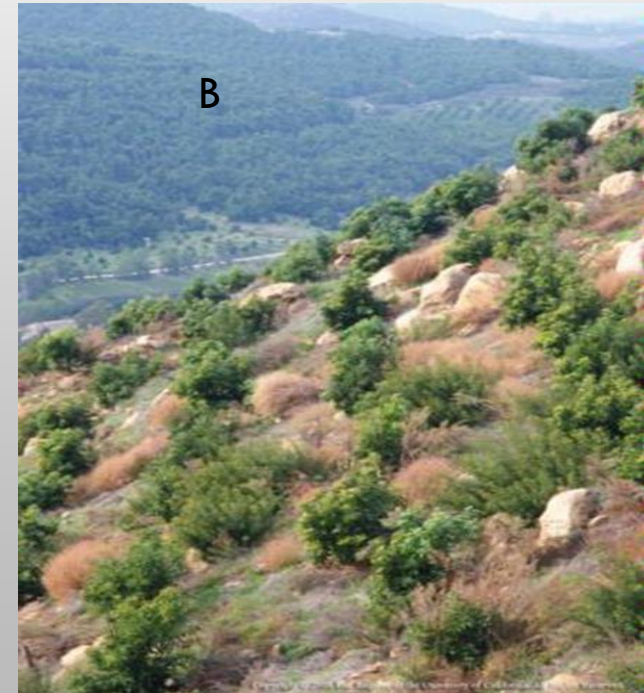
## APPLICATION OF A HIGH DENSITY TO A LARGER SCALE

High density planting in moderately sloped landscape (picture A) shows to be profitable and may be a way to go for maintaining the avocado industry and even may reverse the trend to induce new plantings and revive the industry in San Diego County.



High density in moderately sloped landscape

However, some questions: can high density be done in very steep slope groves as seen in picture B?



Most groves in San Diego County

## APPLICATION OF A HIGH DENSITY TO A LARGER SCALE

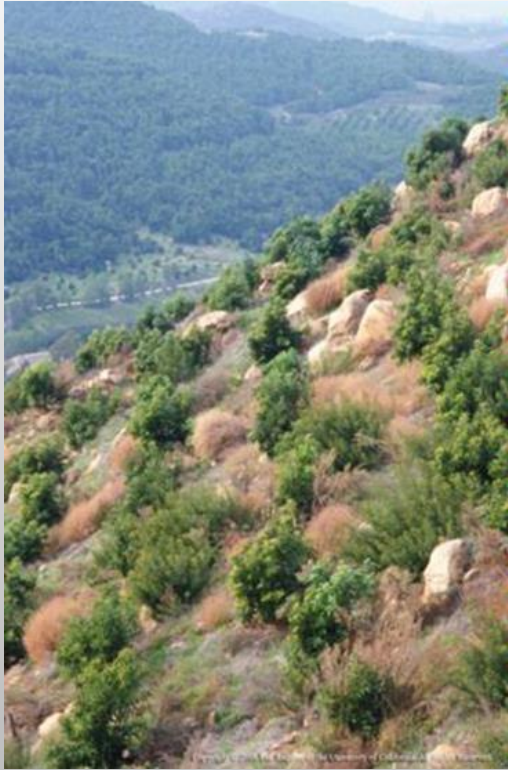
### **Future work must involve to answer the following questions:**

- Is it feasible to assume the same density of planting for steep slope groves as the moderately slope landscape?
- what will be the density that would fit the high slope planting?
- Would planting at a lower density be profitable?
- Would the costs of pruning on a steep slope be as low as the density of moderate slope landscape?
- These and other questions would need further investigation.

# REFERENCES

## For details of the experiment and cost analyses

- Better growing: *Gary Bender*, farm advisor emeritus, UC cooperative extension, San Diego County, High density avocado production, A method to improve yield per acre, winter 2018 / from the grove / 35, [HTTPS://WWW.CALIFORNIAAVOCADOGROWERS.COM/SITES/DEFAULT/FILES/DOCUMENTS/11-HIGH-DENSITY-AVOCADO-PRODUCTION-WINTER-18.PDF](https://www.californiaavocadogrowers.com/sites/default/files/documents/11-high-density-avocado-production-winter-18.pdf).
- Takele Etaferahu, Donald Stewart and Daniel A. Sumner, 2021. 2020 Avocado Establishment And Production Costs And Profitability Analysis In High Density Planting, University Of California Agricultural And Natural Resources Cooperative Extension, Agricultural Issues Center, UC Davis Department Of Agricultural And Resources Economic [HTTPS://COSTSTUDYFILES.UCDAVIS.EDU/UPLOADS/CS\\_PUBLIC/B4/3D/B43D58D9-1E91-4A3E-80F9-A2EDB14958B0/2020AVOCADOHIGHDENSITYSANDIEGOCOUNTY.PDF](https://coststudyfiles.ucdavis.edu/uploads/cs_public/b4/3d/b43d58d9-1e91-4a3e-80f9-a2edb14958b0/2020avocadohighdensitysandiegocounty.pdf)
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Thank  
You