Planting systems on hillsides – a holistic approach




Planting Design

A regular planting from CA

The external wall appears productive….. But walk inside and one sees empty non-productive space

A California Hedgerow

High Density in California

Trees per Hectare

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Least	Medium	Most
277	463	1,110

Planting Orientation

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Contour	North/South preferred	No specific orientation since trees are equidistant

Ability to develop a planting system for hillsides

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Medium	Worst	Best

Tree Height

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Highest	Medium	Lowest
Unpruned	Depends on distance between rows	Depends on distance between trees

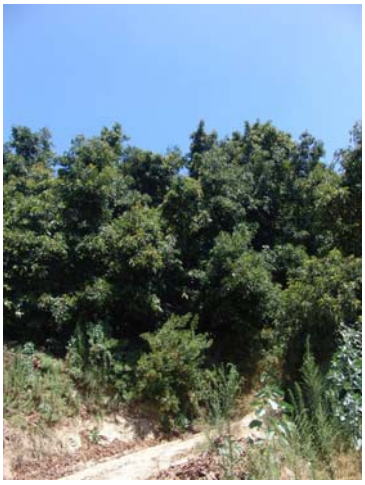
Tree Dimension

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
4 sides plus top (until trees grow into a solid canopy)	2 sides plus top	4 sides plus top

Exposed canopy surface area

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Good only until trees touch; then only top of tree and sides of the block	Acceptable if N/S planting is achievable	Best since all sides exposed

Standard planting



California Hedgerow

High Density

Half-tree contour of light penetration – Hedge Row

Extent of effective light penetration

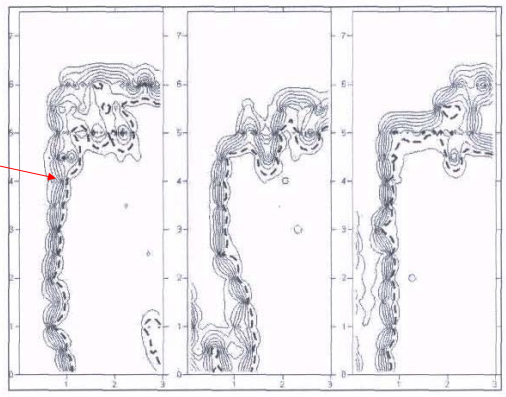


Figure 51– Contours of half-tree cross sections based on measurements done on the 7/9/2003 in 'Shomrat' orchard; CV. Hass; pruned hedgerow; three different cross sections from the same row.

Matan Hadari. 2005. MSc Thesis. A Three Dimensional Model of the Light Regime in an Avocado Orchard. Technion. Haifa. Israel.

Light penetration into the tree

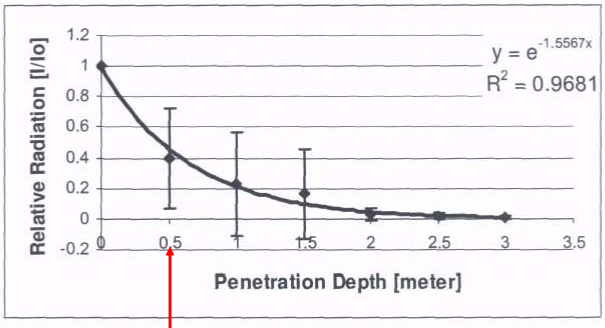


Figure 53- Relative irradiance in different depth of the canopy as measured on the 3/9/2003; "Shomrat orchard", CV. 'Hass'.

60% reduction of light penetration within 0.5 m (20 inches)

Matan Hadari. 2005. MSc Thesis. A Three Dimensional Model of the Light Regime in an Avocado Orchard. Technion. Haifa. Israel.

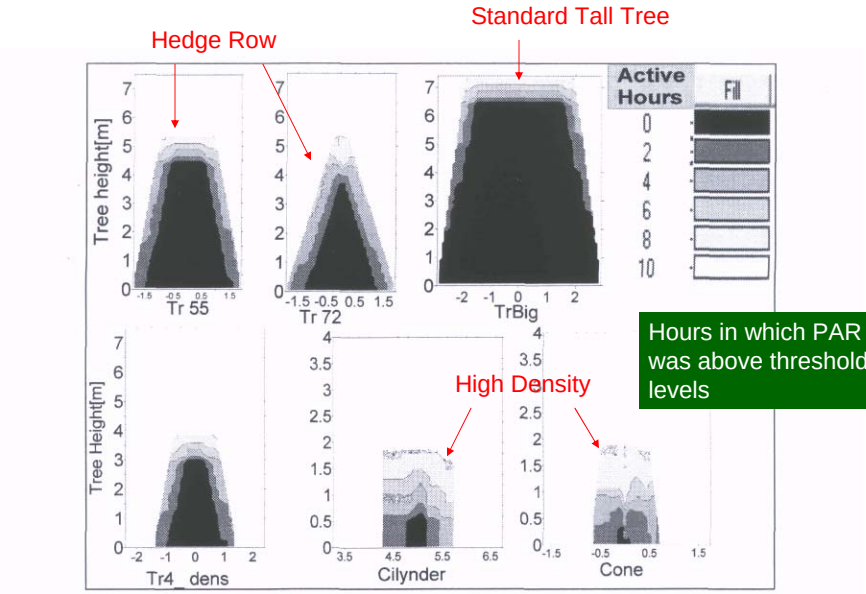


Figure 50 - Seasonal averaged daily exposure hours with PAR above the threshold level in selected models.

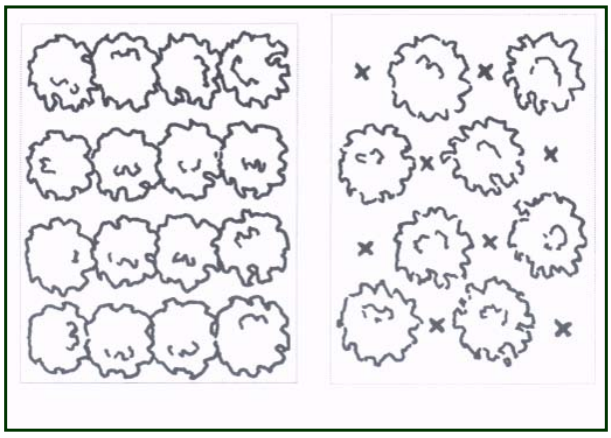
Matan Hadari. 2005. MSc Thesis. A Three Dimensional Model of the Light Regime in an Avocado Orchard. Technion. Haifa. Israel.

Management Strategies

Tree Removal

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Yes	No	No

Tree removal when crowded



Rejuvenation Strategy

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Stump trees; keep same trees forever	Side replacement every 3 years	Tree replacement every 10+ years

Hedgerows require severe pruning every 2 to 3 years

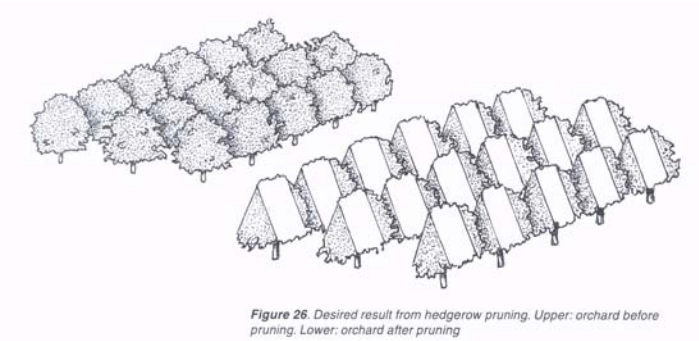


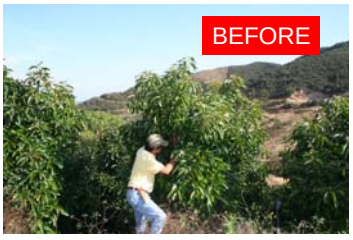
Figure 26. Desired result from hedgerow pruning. Upper: orchard before pruning. Lower: orchard after pruning

Mechanical Pruning of Hedgerows on Flat Ground

Pruning Costs

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Least	Intermediate	Highest
Low branches only	Some annual pruning with aggressive pruning every 3 years	On-going

High Density Maintenance
Light pruning 2 to 3 times/year

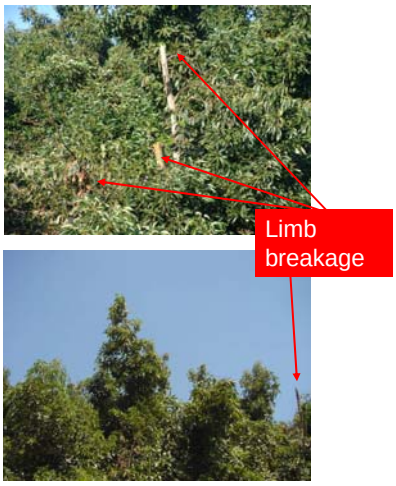


Branch support (staking) and probability of branch breakage

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
High	None	None

Staking and limb breakage

Limb breakage



Cost and ease of spraying for pests and foliar nutrition

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
High	Medium	Low
Requires helicopter in most cases when trees are mature	Helicopter and some ground application depending on slope and accessibility	Ground application feasible

Pathway for honeybees

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Good in early years	Medium	Always

Productivity considerations

Early production (on per hectare basis)

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Least	Medium	Most

Kilograms of fruit needed per tree to achieve production goal

Tree spacing (m)	Target Production (Kg/HA)		
	10,000	15,000	20,000
3 x 3	9.0	13.5	18.0
6 x 6	36.0	54.0	72.0

Productivity loss as trees mature and crowd

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Low until shading occurs	Loss occurs every 3rd year when one side is severely pruned	Least

Harvesting considerations

Cost of harvesting

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Highest	Medium	Least

Size picking accuracy in mature trees

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Low	Medium	Best

Impact of planting density on ease of harvesting

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Good as long as trees are relatively small	Depends on orientation of hedge row relative to the slope	Always easier to pick

Harvest equipment required (ladders and picking poles)

Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Most	Medium	None

Worker environment

	Low Density (6 x 6)	Hedge Row (3.6 x 6)	High Density (3 x 3)
Worker Efficiency	Low	Medium	High
Worker Friendly	Least	Some	Most

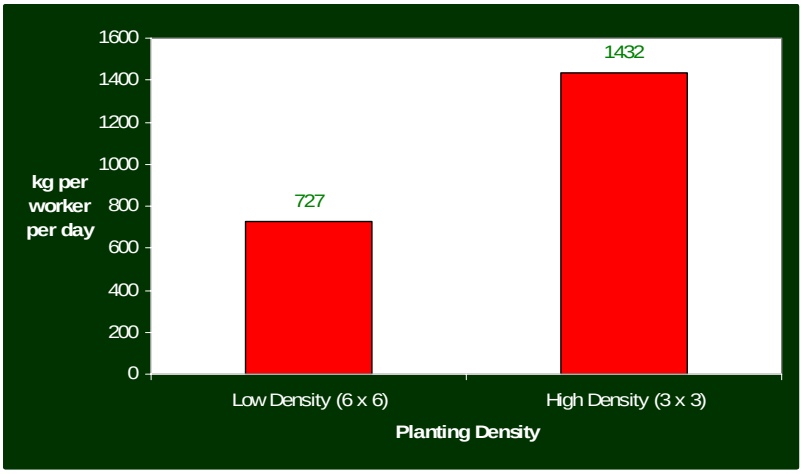
Picking from the ground

Even the inexperienced can do this!

More experience is needed here to use the picking pole

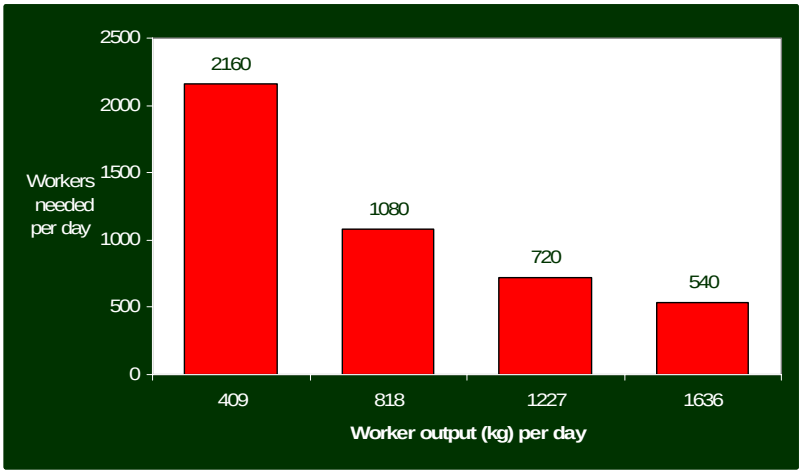
The Ladder
Dangerous and inefficient

Average worker output per day vs. planting system



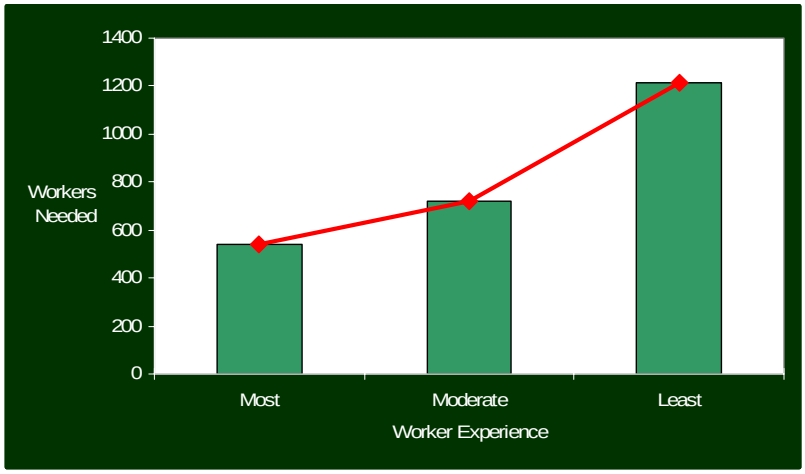
159,091 MT crop; 180 day picking season

Workers needed per day for CA industry vs. worker output per day

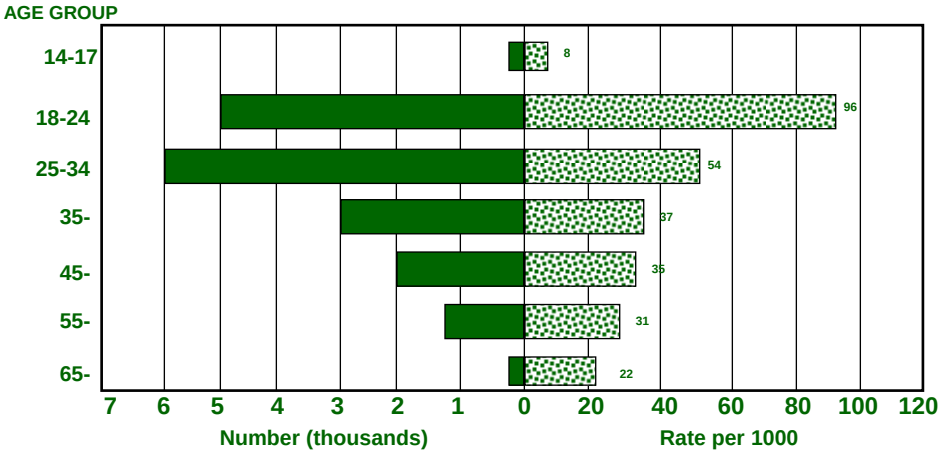


159,091 MT crop; 180 day picking season

Workers needed per day vs. worker experience



Age Specific Injury Rates



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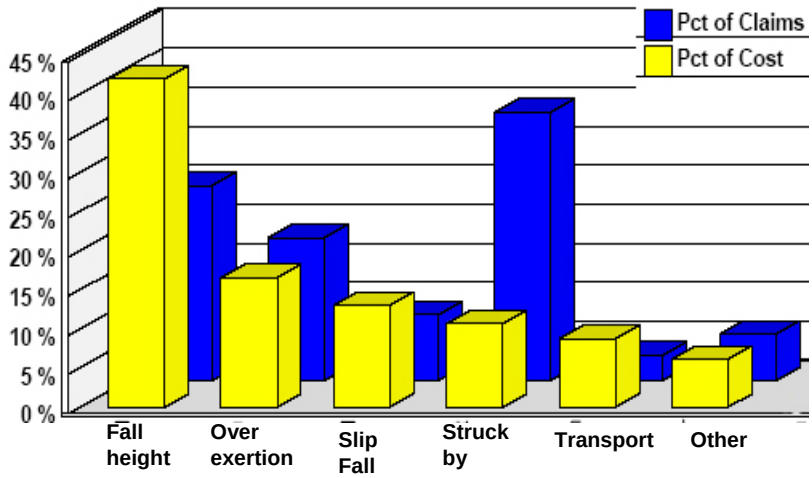
Worker safety

WCI CLAIMS



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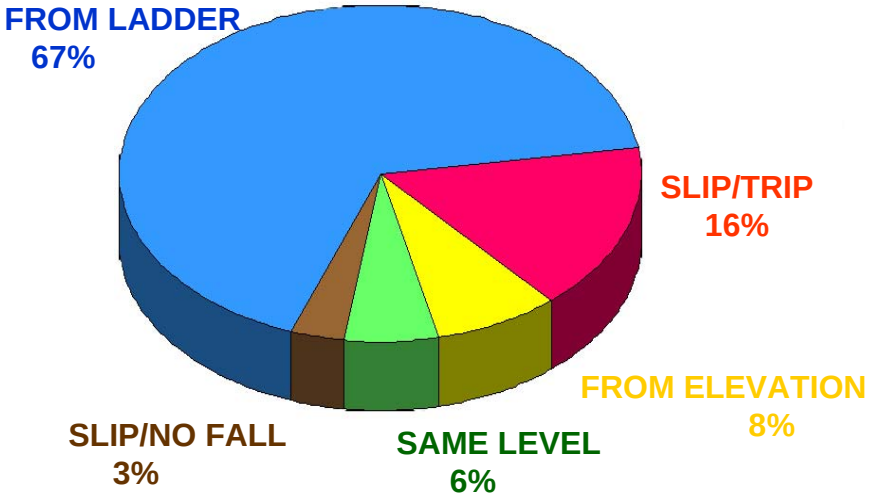
WCI CLAIMS - FALLS



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- *Efficient production is achieved through integrated management of the orchard system and its component parts*
- *Produce avocados of high quality, with a satisfied workforce and lower production costs and higher returns*

High-density plantings achieve these goals

International High Density Plantings

For extensive information about planting systems visit

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