“A Canopy System that Integrates and Facilitates the Adoption of Orchard Technologies”

Mario Miranda Sazo

CCE Lake Ontario Fruit Program

December 8, 2022

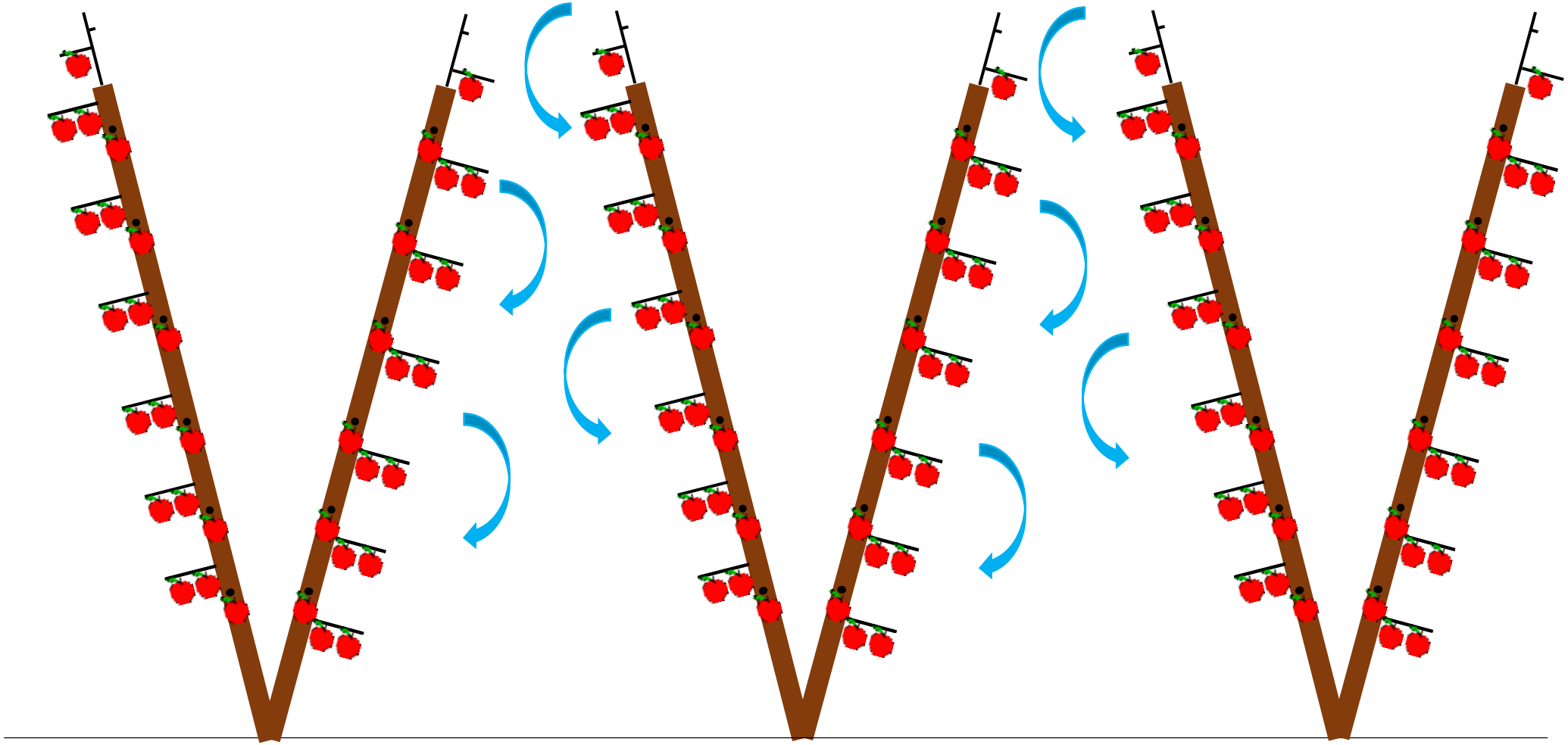
Use Simple Rules and Work Efficiently with High-Density Systems

- **The Best Training System ?**
  - Beware of visiting speakers or consultants who say there is **only one way to train trees!**
  - The best training system is the one that **you understand how**, and especially **why**, you are imposing **each step**

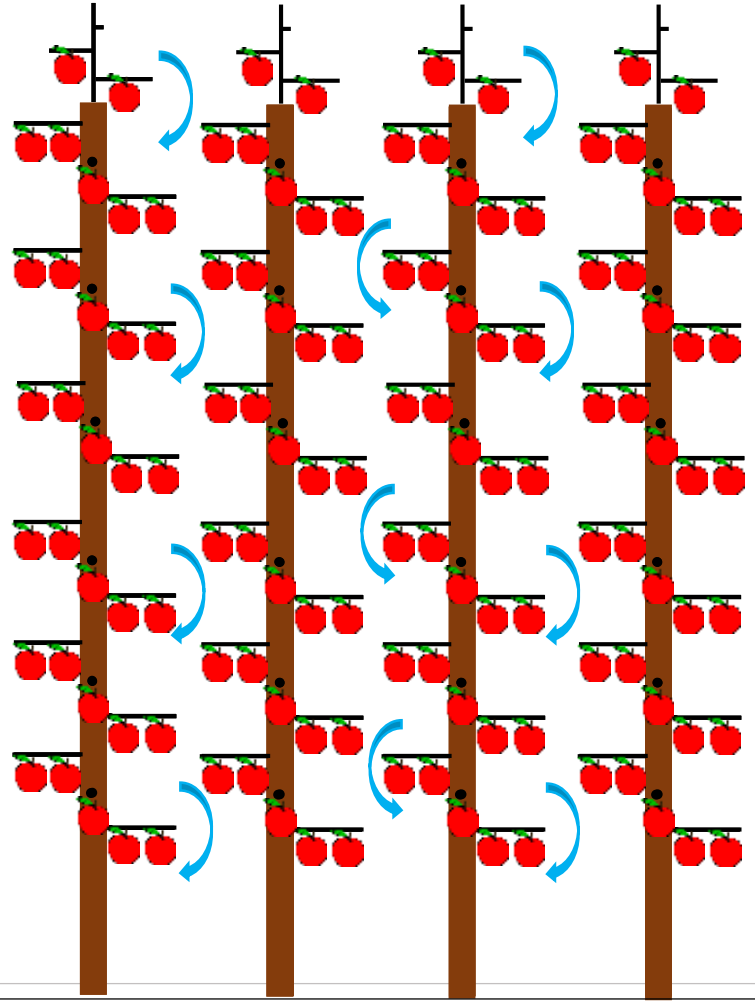
- **Avoid "unnecessary" mistakes**
  - With higher density plantings, the **impact of a mistake on your part** (or the lack of not doing the important things) is **higher** than with lower density plantings

A Canopy (Productive/Fruitful) System for Efficiency and Adoption of Mechanized Orchard Technologies and Digital Technologies (via use of cell phones, drones, or rovers)?

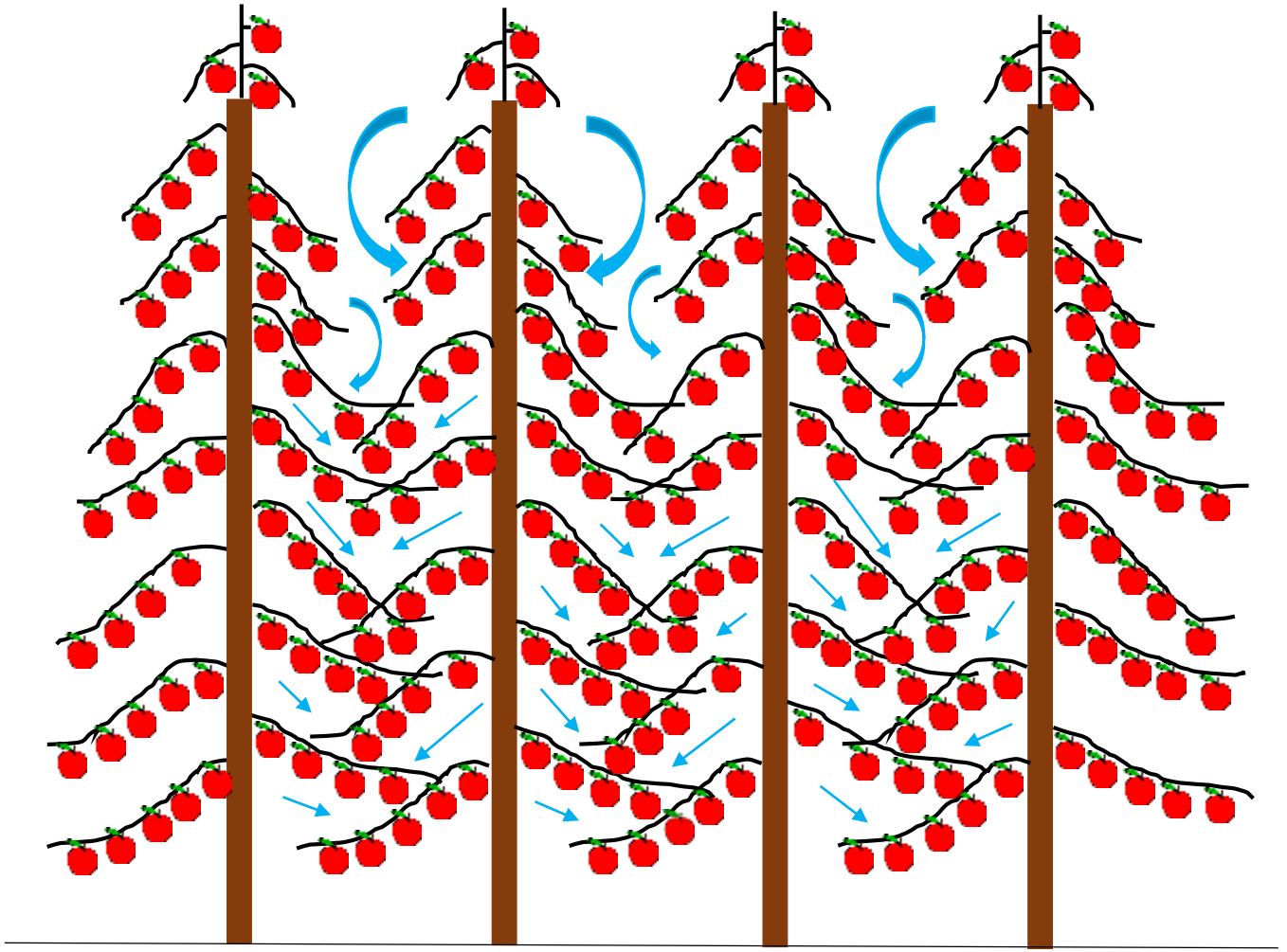
Training system	In-row	Between-row	Planting density
V-trellis	1.6ft (0.5m)	11.5 (3.5m)	2,376 trees/Acre



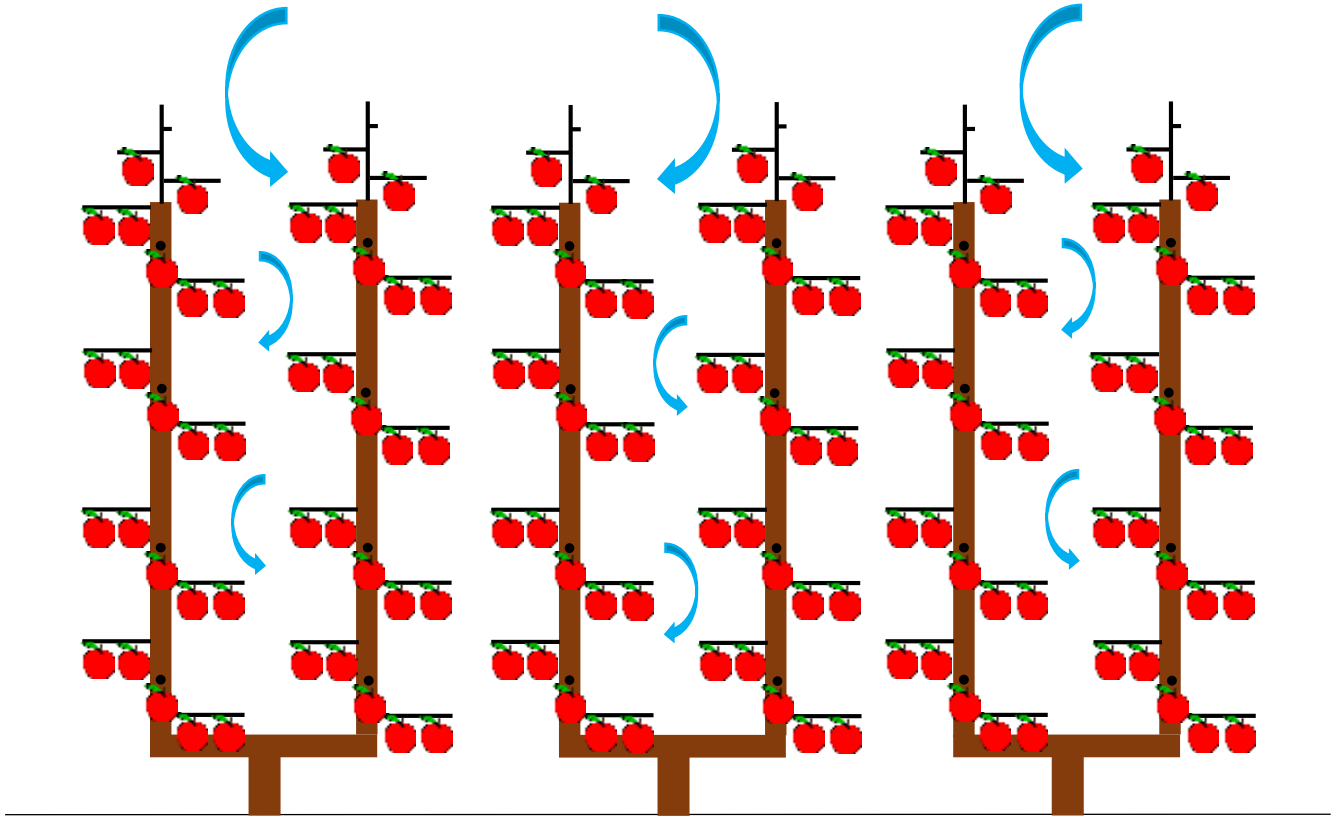
Training system	In-row	Between-row	Planting density
Fruiting wall (2D)	2.5ft (0.75m)	10ft (3m)	1,742 trees/Acre



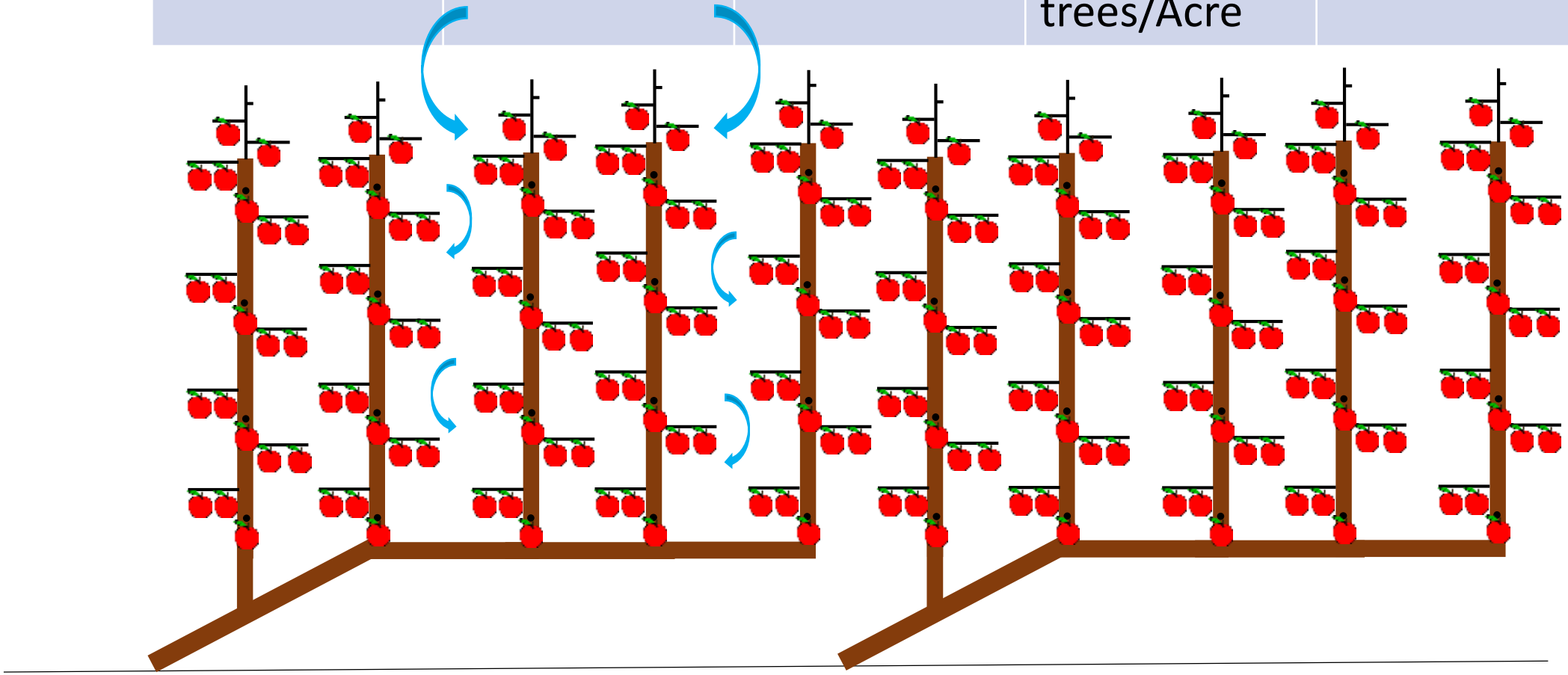
Training system	In-row	Between-row	Planting density
Tall Spindle (3D)	3ft (0.9m)	11ft (3.3m)	1,320 trees/Acre



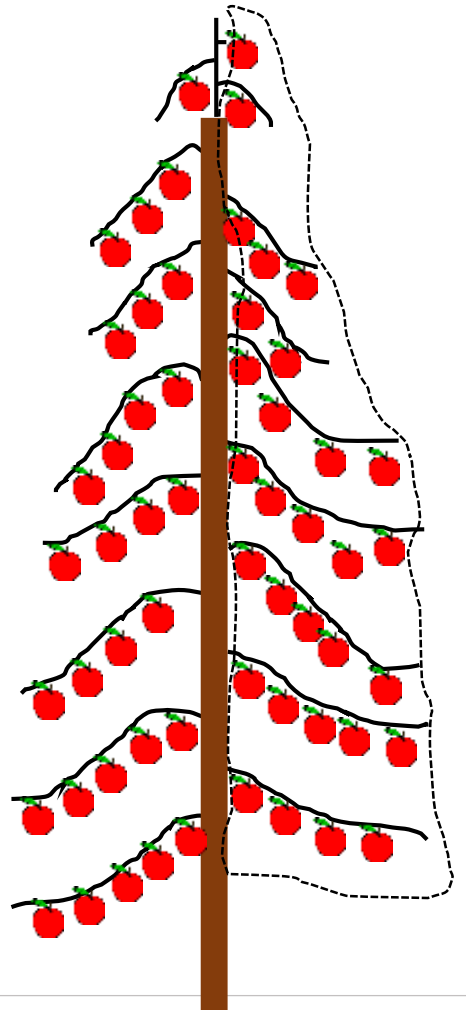
Training system	In-row	Between-row	Planting density	Leaders/Acre
Bi-axis (2D)	3.3ft (1m)	11.5ft (3.5m)	1,148 trees/Acre	2,296



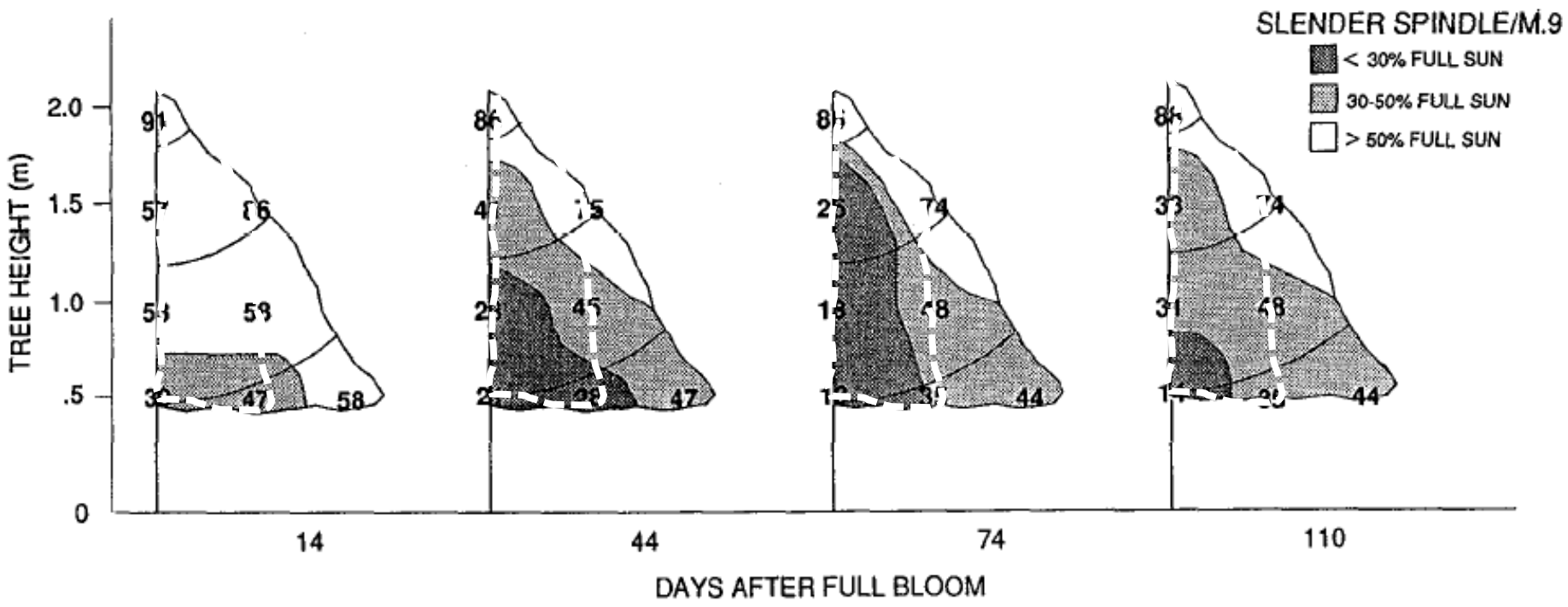
Training system	In-row	Between-row	Planting density	Leaders/Acre
Cordon (2D)	5ft (1.5m)	6.5ft (2m)	1,340 trees/Acre	6,700



Light distribution pattern (3D canopy)

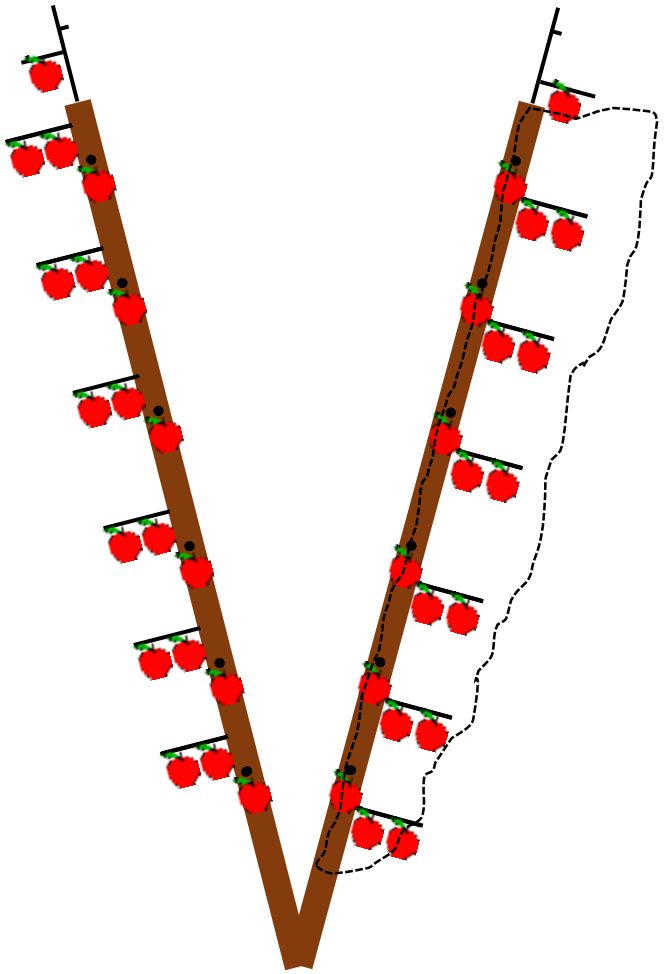


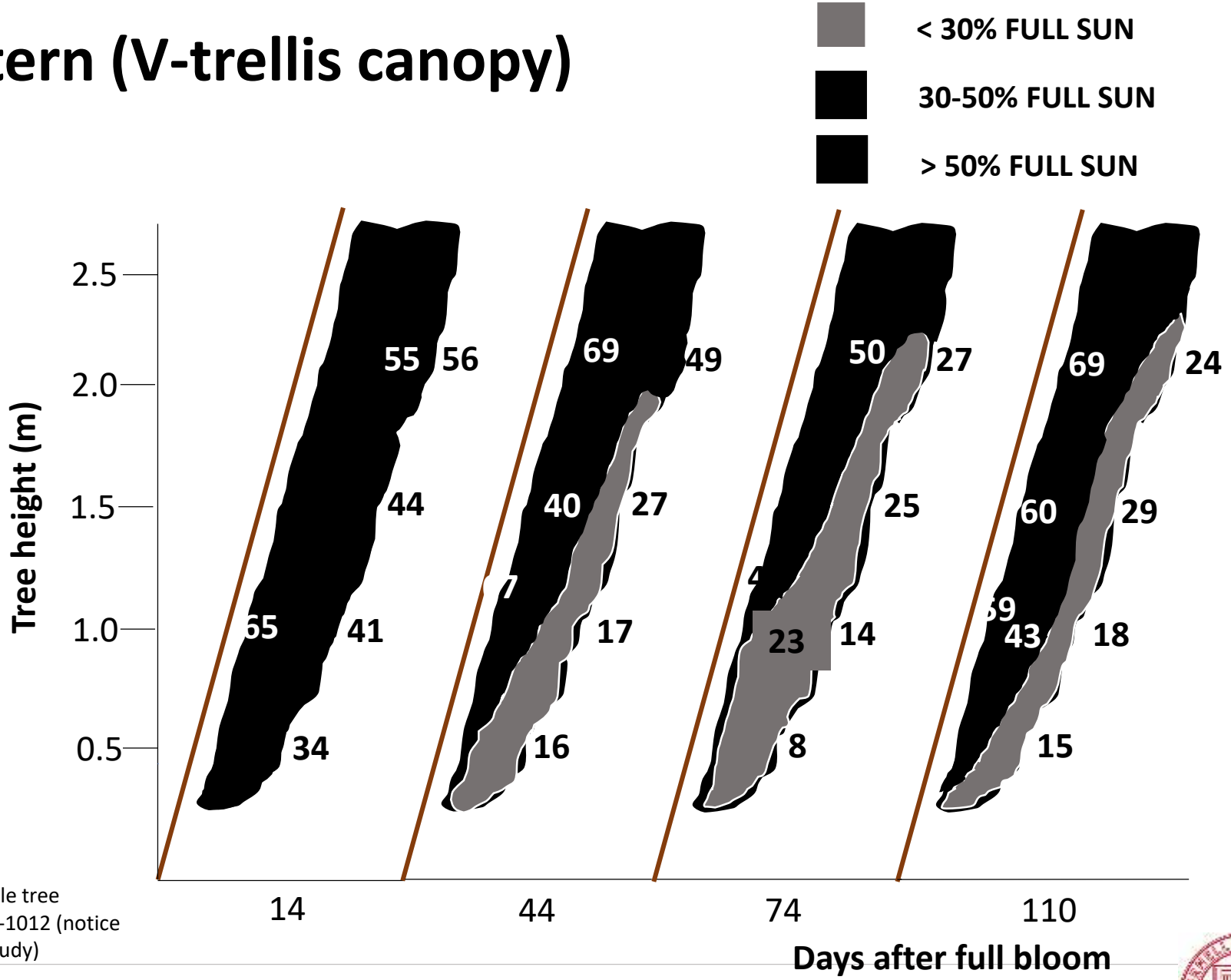
< 30% FULL SUN 30-50% FULL SUN > 50% FULL SUN



Source: Robinson, T.L., A. N. Lakso and Z. Ren. 1991. Modifying apple tree canopies for improved production efficiency. HortScience 26: 1005-1012

Light distribution pattern (V-trellis canopy)

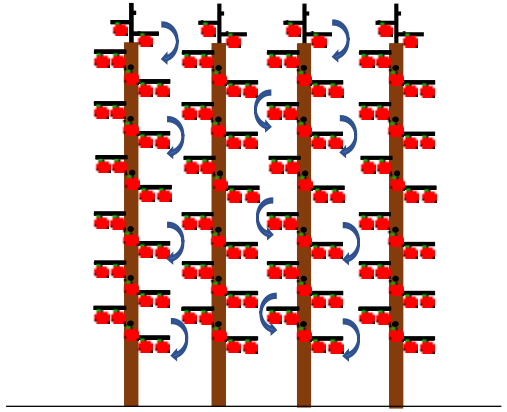




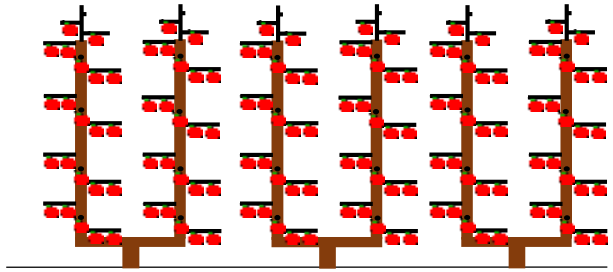
Source: Robinson, T.L., A. N. Lakso and Z. Ren. 1991. Modifying apple tree canopies for improved production efficiency. HortScience 26: 1005-1012 (notice that the V-trellis light patterns correspond to a Y-trellis/M.9 light study)

Light distribution pattern (2D canopy)

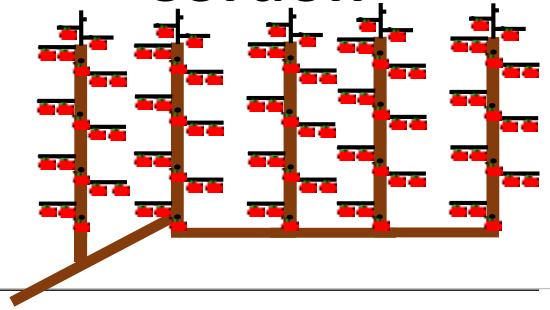
2D - Vertical

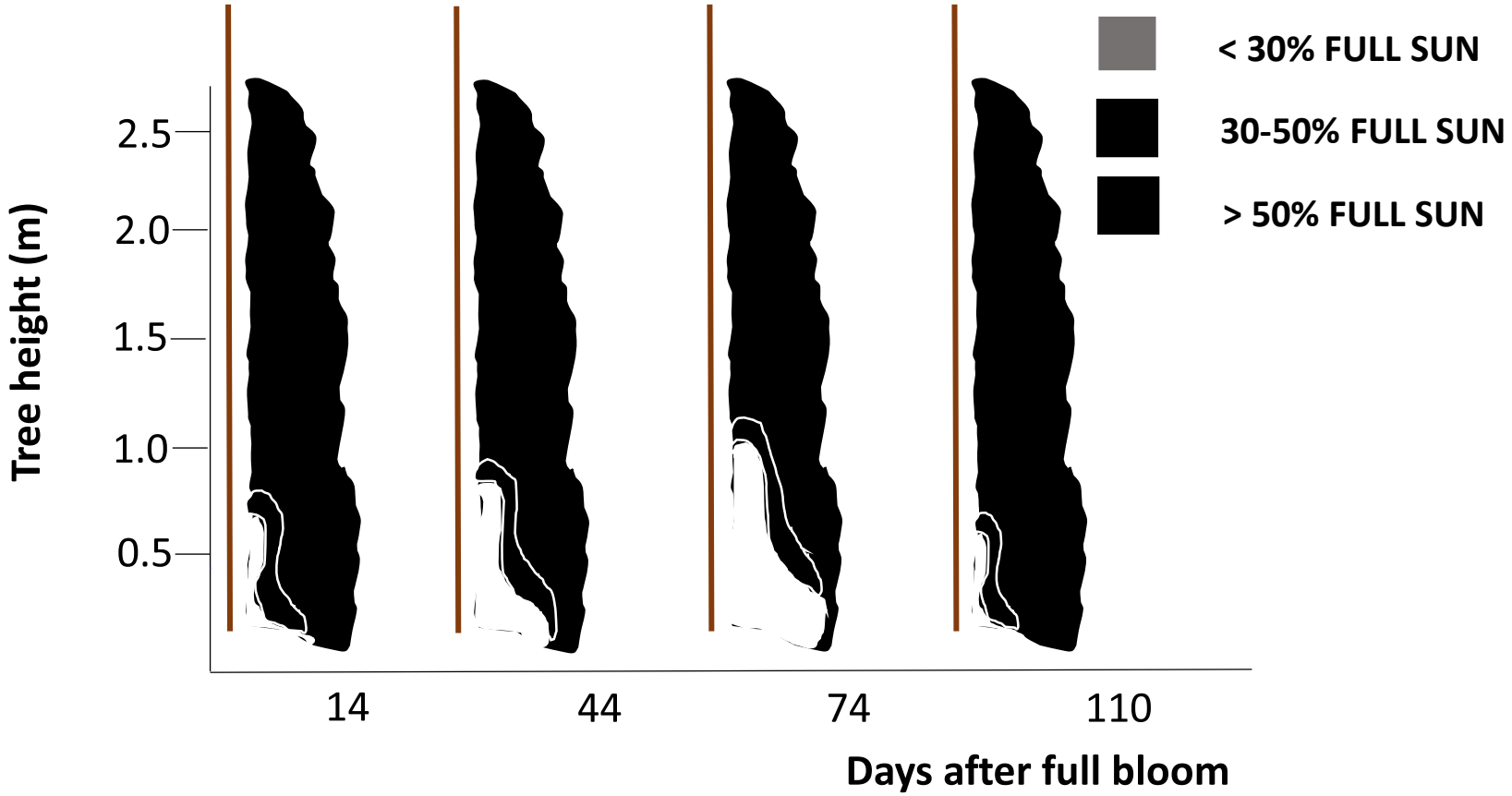


Bi-axis



Cordon





Source: estimated light distribution patterns drawn by MMS

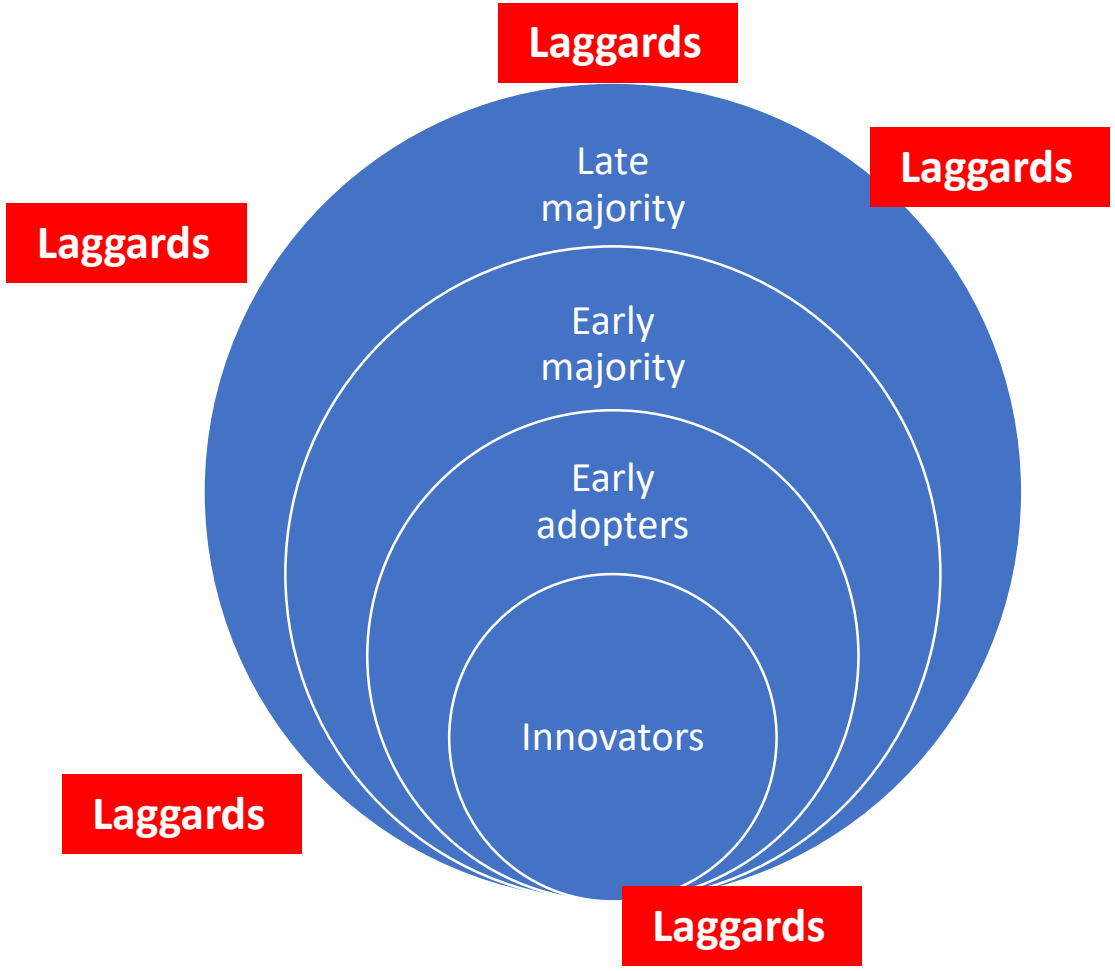
The Production System for Efficiency?

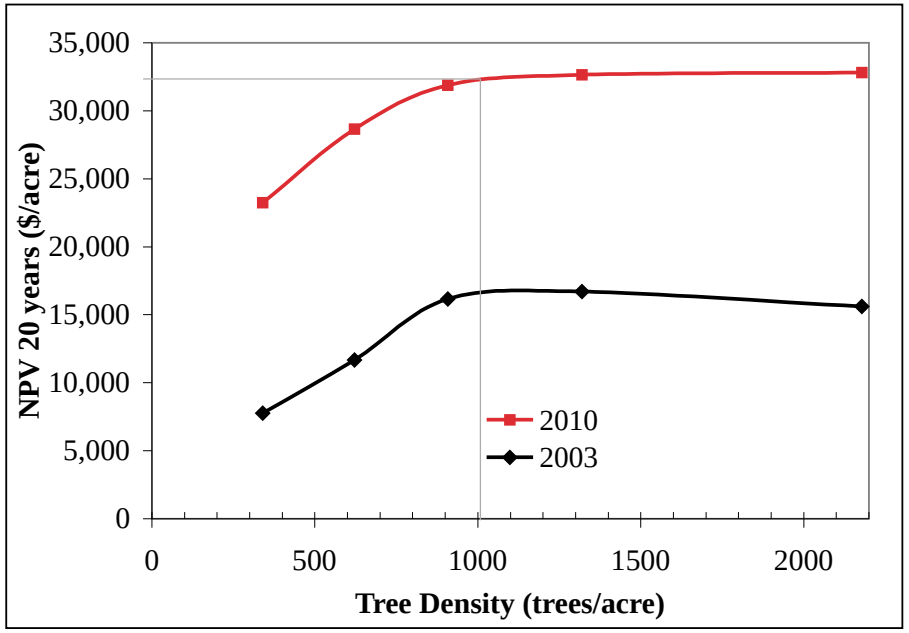
- The **more complicated** you make the tree in terms of making decisions, the **harder the system** becomes for you and your workers
- With a very **simple training system**, workers have to make **few decisions**
- A **very simple training system** also makes the fruitlets, branches, and fruit **very accessible** to workers for hand thinning, pruning, or harvest
- Start getting the benefits of **Using Simple Rules**

How Simple Rules Make It Easier to Work and Be More Efficient

- Complex tree architectures create **many** possible courses of action for pruning, which can **confound** workers
- When workers are faced with a superabundance of pruning cut alternatives, workers are **afraid** of making the **wrong choice**
- As a result workers **delay** the pruning cut decision, **default** to the safest “obvious” cut, or **avoid** choosing altogether
- Your pruning crew ended up being **less** efficient
- They **Work Harder Not Smarter**
- You ended up **Growing Wood Not Fruit**

High Density Adoption Stages and Economic Value





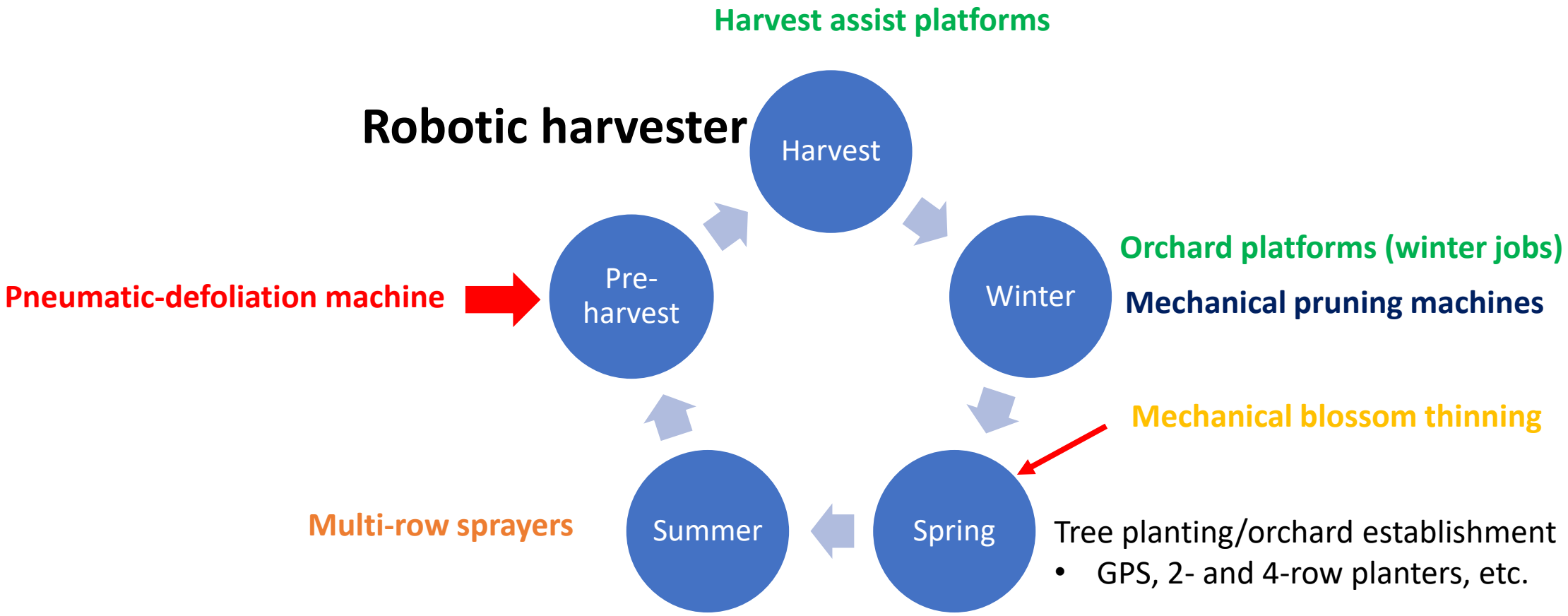
Source: Robinson, Hoying, and DeMarree Cornell U.

- Innovator **"Try it!"**
- Early adopter **"Get Ahead"**
- Early majority **"Stick with the Herd"**
- Late majority **"Hold on!"**
- Laggards **"Skeptics: No way!"**

Sequence of integration and adoption of technologies to maximize labor efficiency and orchard productivity

Past	Orchard mechanization		Next-generation orchard machines-hybridization	Full automation for tree fruit perennial systems (Digital Agriculture)
Horse Tractor 1-row planter	Root pruner 2- and 4-row planters **Orchard platforms** • Winter-spring-summer jobs **Harvest assist machines**	**Mechanical blossom thinner** **Mechanical pruner** **Multi-row sprayers** **Pneumatic defoliation**	Some technologies are somewhat **MODULAR** It will be possible to address the needs of a particular: • **Orchard task** • **Growth stage** • **Fruit farm scale** • By **combining** or **modifying** existing technologies and equipment	**Fully automated robotic systems that will:** • **See** • **Count, Measure** • **Spray, Thin, Cut** • **Pick** the fruit in a manner **comparable** to or **better** than human pickers

Sequence of technology adoption in NY



Ideal timing for mechanical blossom thinning

Ideal timing and floral cluster comparison for string thinning as shown by Adolf Beltz:

- his left hand shows a very **late/advanced blossom stage** for string thinning
- his right hand shows the **optimal blossom stage** for string thinning with a king flower open and the lateral flowers at the balloon stage

- A **narrow fruiting wall** and a **correct method of application** are **critical** for the successful adoption and safe use of a string thinner during bloom
- A Darwin's driver must get **closer to the trunk** so that when its cords **hit the canopy**, some also **hit the trunk**, **fruiting branches**, or the **wires**, allowing them to **retract** when they struck these surfaces

Simple Pruning Rules

- Because they are easy to put into practice, simple pruning rules can **induce action without unnecessarily limiting options**
- Use one simple pruning rule with a platform
- **Limit tree height each year to 11 ft by cutting to a side branch**

You have the right tree structur

You have the right people

You have the right technol ogy

Benefit by Using **Simple Rules**

Simple Pruning Rules

- Because they are easy to put into practice, simple pruning rules can **induce action without unnecessarily limiting options**
- Use one simple pruning rule with a platform
- **Prune 2-3 of the largest limbs (>1 inches diameter) in the canopy this year by cutting them back to a 1-1.5 inches long stub**

You have the right tree structur

You have the right people

You have the right technol ogy

Benefit by Using **Simple Rules**

Simple Pruning Rules

- Because they are easy to put into practice, simple pruning rules can **induce action without unnecessarily limiting options**
- Use one simple pruning rule with a two person crew
- **Prune 2-3 of the largest limbs (>1 inches diameter) in the canopy this year by cutting them back to a 1-1.5 inches long stub**

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Benefit by Using **Simple Rules**

Simple Pruning Rules

- Because they are easy to put into practice, simple pruning rules can induce action without unnecessarily limiting options
- Use one simple pruning rule with a platform
- **Use a pole with a chainsaw and make one/two big cuts per tree in the lower section**

have the right tree structur

You have the right people

You have the right technol ogy

Benefit by Using **Simple Rules**

Simple Pruning Rules

- Because they are easy to put into practice, simple pruning rules can induce action without unnecessarily limiting options
- Use one simple pruning rule with a platform
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Benefit by Using **Simple Rules**

Simple Hand Thinning Rule

- Because they are easy to put into practice, simple hand thinning rules can induce action without unnecessarily limiting options
- Use one simple hand thinning rule with a platform
- **Hand thin peaches with a baseball bat**

have the right tree structur

You have the right people

You have the right technol ogy

Benefit by Using **Simple Rules**

Simple Support Rule

- Because they are easy to put into practice, simple rules for installing a wire can induce action without unnecessarily limiting options
- Use one simple support rule with a platform
- **Install a wire-stabilizer to the top wire right above each tree**

have the right tree structur

You have the right people

You have the right technol ogy

Benefit by Using **Simple Rules**

Simple Support Rule

- Because they are easy to put into practice, simple training rules can induce action without unnecessarily limiting options
- Use one simple training rule with a platform
- **Attach a steel stake to the top wire using a wire tie to each tree**

have the right tree structur

You have the right people

You have the right technol ogy

Benefit by Using **Simple Rules**

Simple Trellis Construction Rule

- Use one simple trellis rule with a machine
- **Install 4 wires early in the spring with a grower-built machine**

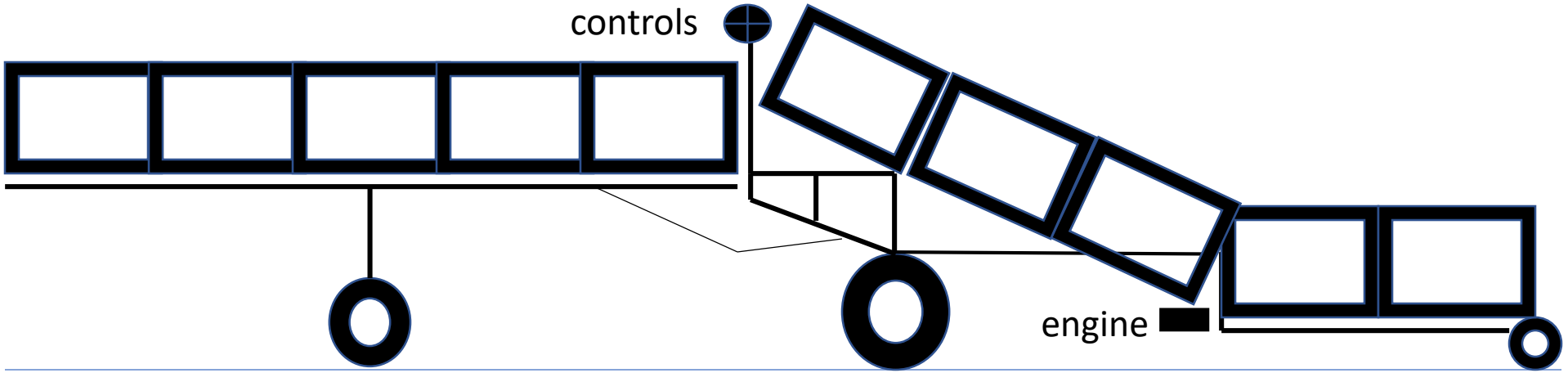
have the right tree structur

You have the right people

You have the right technol ogy

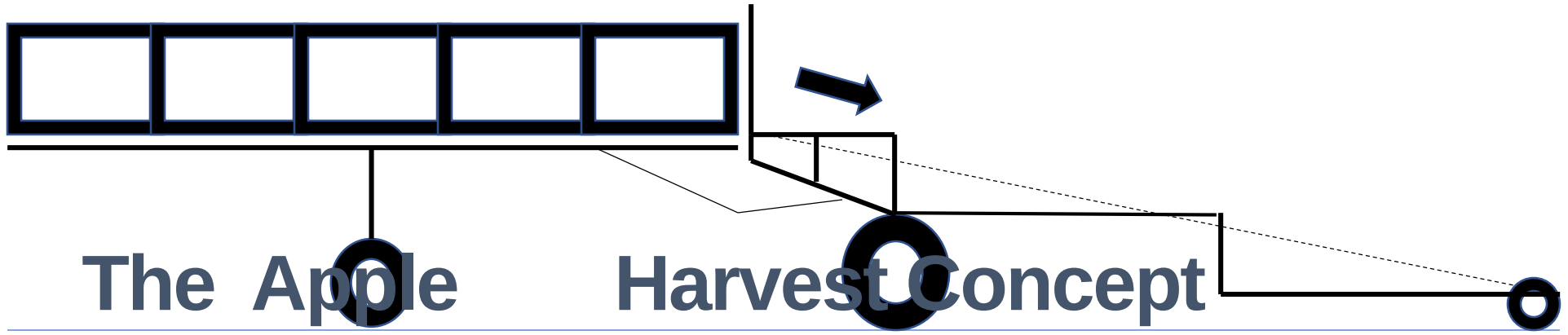
Benefit by Using **Simple Rules**

Over-the-Row Platform

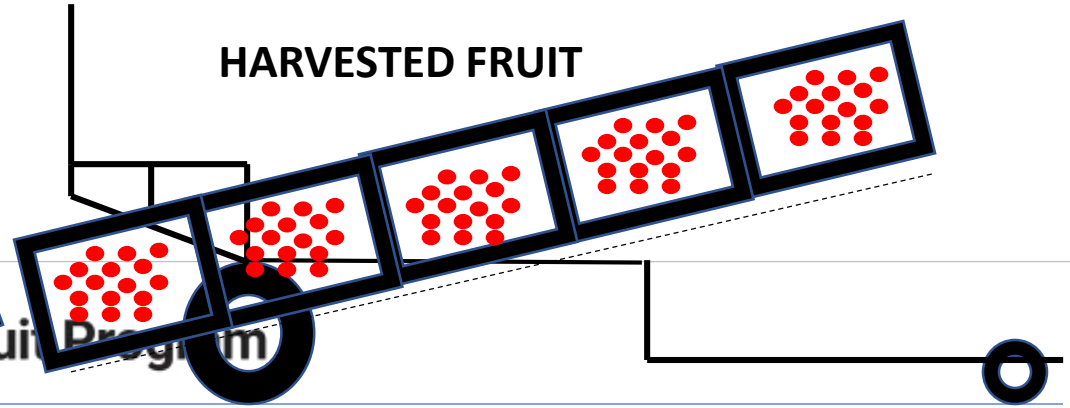


Picking Direction →

EMPTY BINS



The Apple Harvest Concept



Simple Harvest Steps

Platforms

- **Some Major Brands in Use in WNY**
  - Automated Ag Systems (Moses, WA)
  - Huron Fruit Systems (Wolcott, NY)
  - N. Blosi (Italy)
  - Orsi (Provide Agro, Canada)
  - Phil Brown Welding (Conklin, MI)
  - REVÓ Piuma (OESCO, Conway, MA)

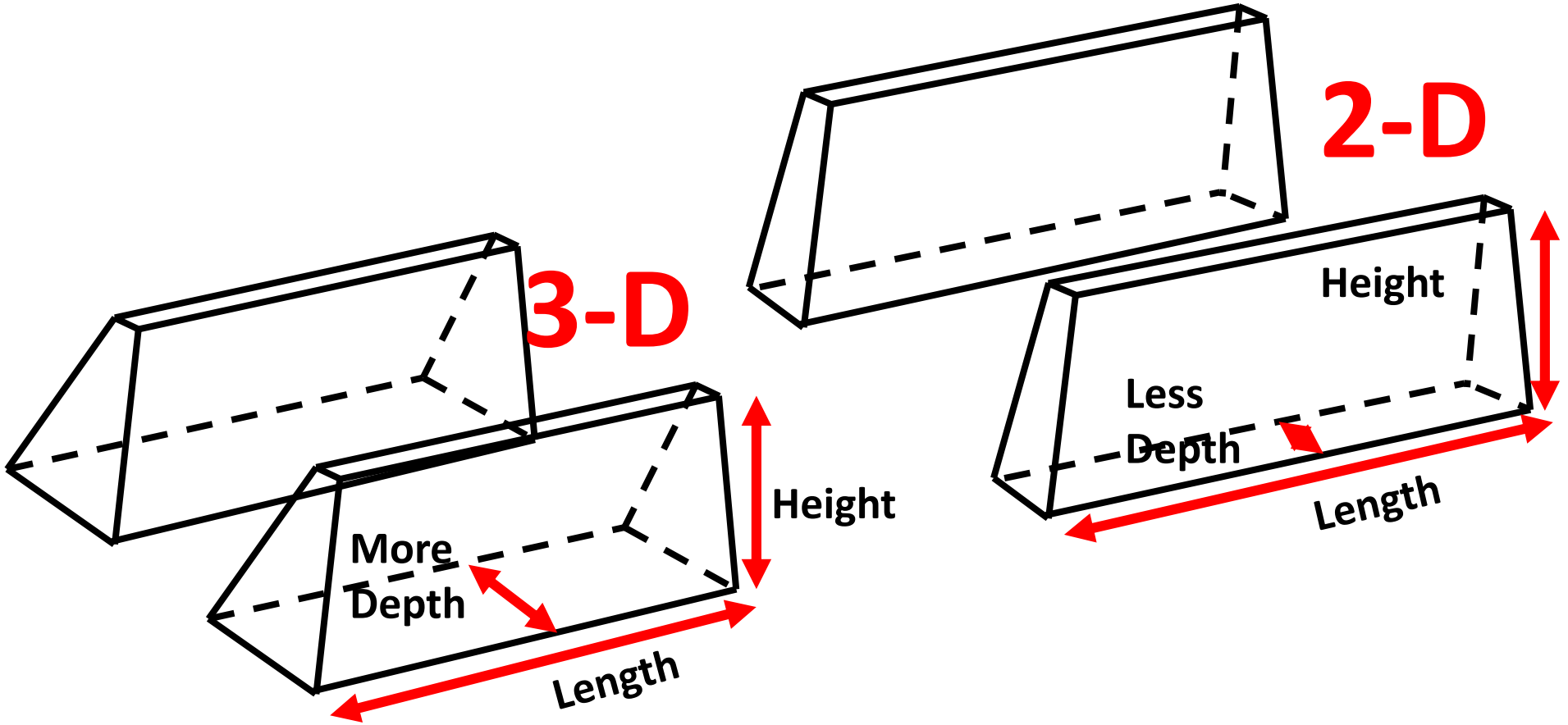
Most popular harvest platforms in WNY

Huron Fruit System Harvest Platform

Automated Ag Systems 'Bandit"

Adoption of mechanical pruning in NY

Some 3-D Tall spindle mature canopies can transition to 2-D Fruiting Walls via manual and mechanical pruning



Single-sickle bar versus Double-sickle bar

Doyle block

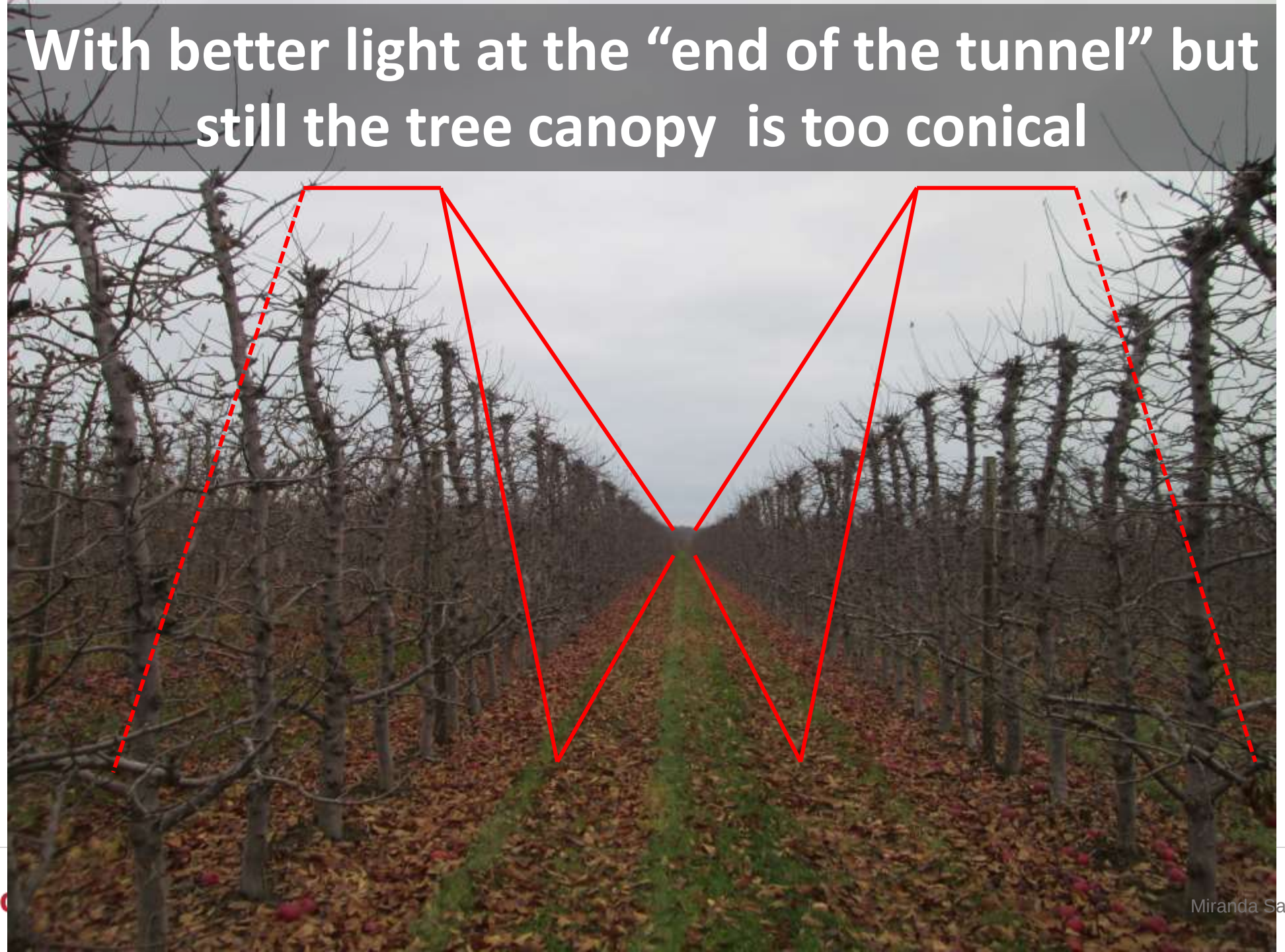
Going Vertical for Maximum Fit versus ‘Opening’ the Tunnel

First time “opening” the tunnel

Doyle block

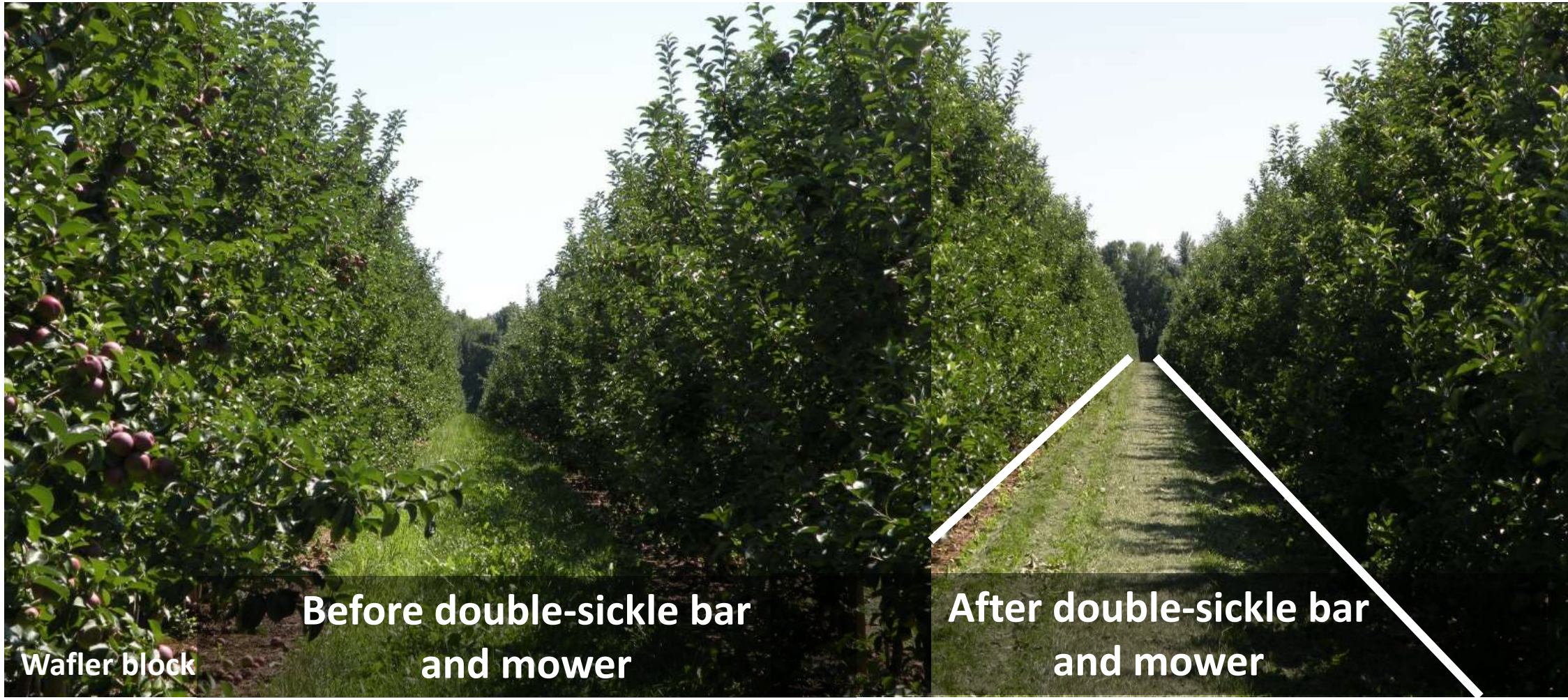
Miranda Sazo

With better light at the “end of the tunnel” but still the tree canopy is too conical



Again, opening the tunnel

Mowed and hedged. Orchard Ready for mechanized harvest



THINK Vertical and Narrow for a 2-D fruiting wall

Single-sickle bar for better Mechanical FIT

Corn

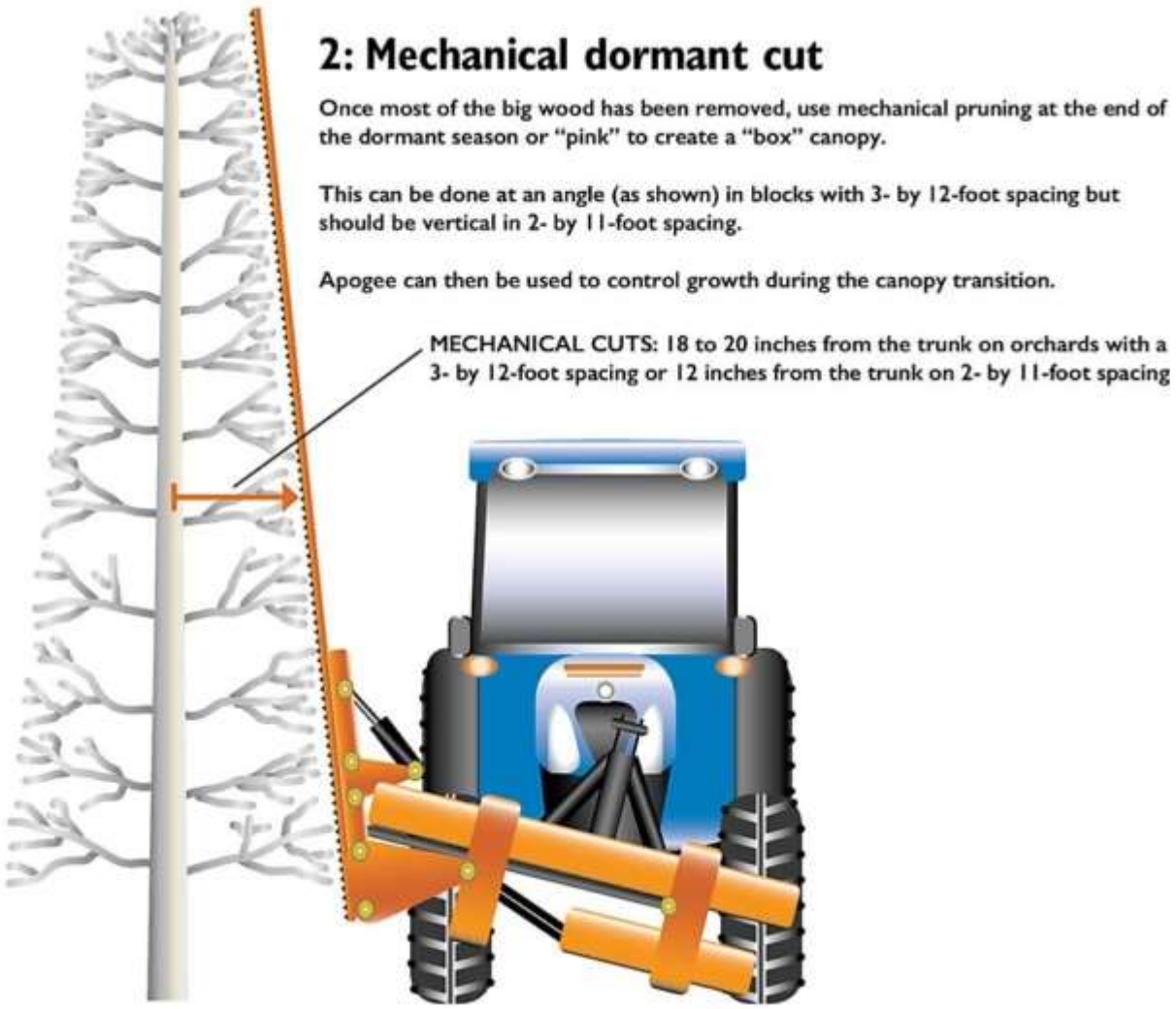
Miranda Sazo

3x12ft planting

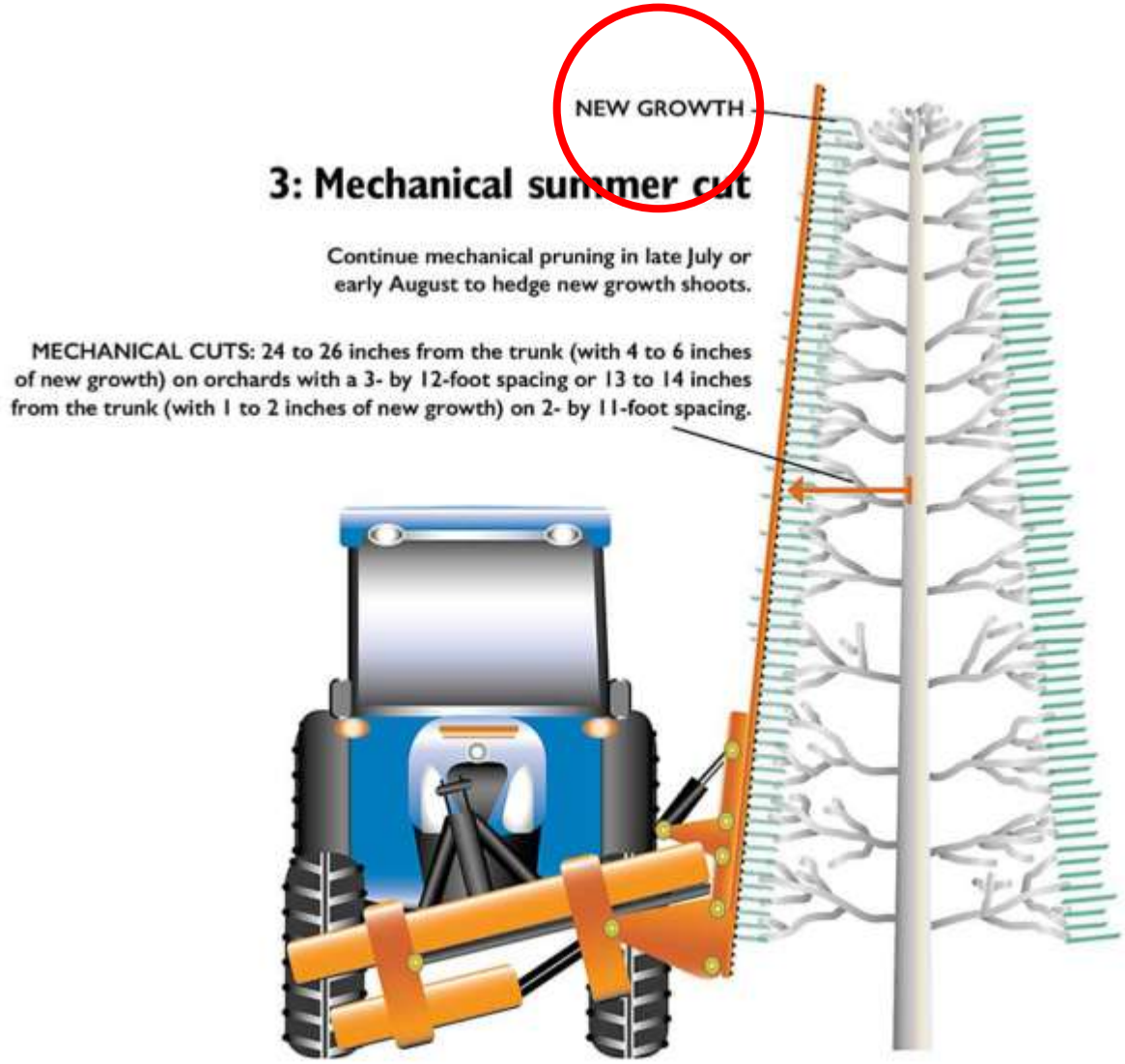
Van DeWalle block


12 inches
16-18 inches
2x11ft planting
Lamont FF. block
Miranda Sazo

Mechanical dormant cut



Mechanical summer cut



Cornell Cooperative Extension | Lake Ontario Fruit Program

Graphics: Jared Johnson/Good Fruit Grower
Source: M. Miranda Sazo, Cornell Cooperative Extension

Manual summer cut

Mechanical summer cut

Manual summer cut

Side-grafted super spindle planting

Mechanical summer cut

Mature super spindle planting



Pruning and length of stubs (3-4 fingers length) conducted in the dormant (left picture) and summer (middle and right pictures) seasons



Mechanical
summer cuts


One-year old shoots

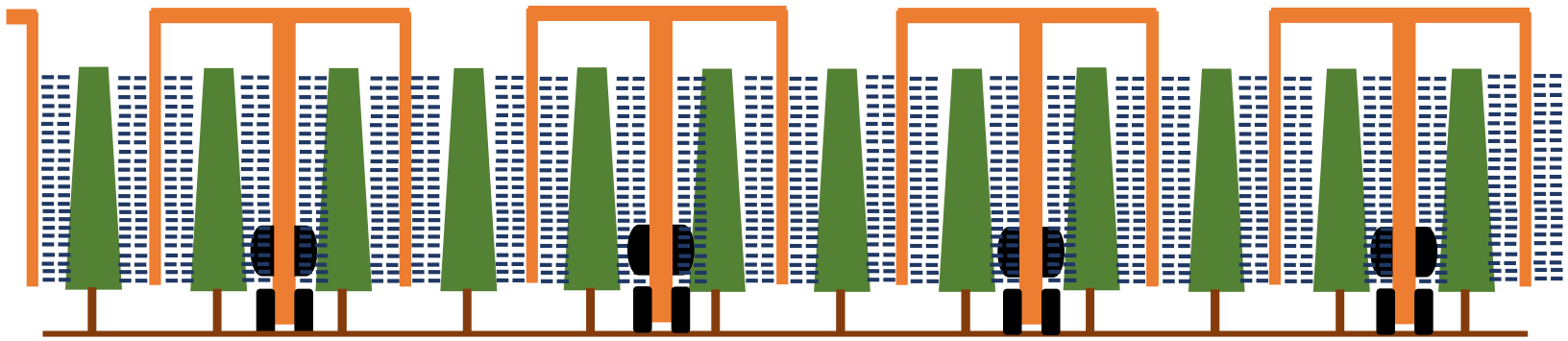

Tall spindle tip (TST), Wafler planting

Manual summer cut

Ultra-high density planting, Lamont FF.

One-year old shoots

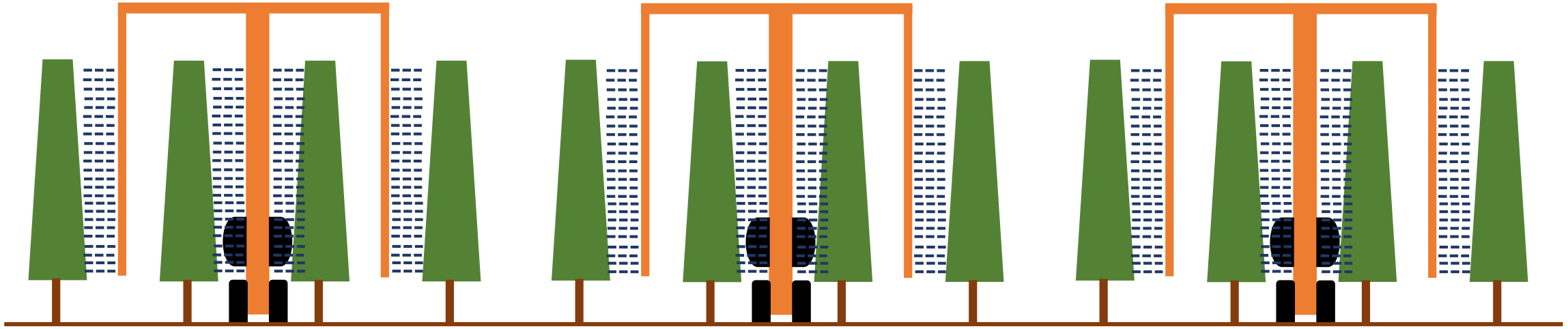
Adoption of multiple-row spraying in NY



Work rate efficiency comparison when spraying both sides of trees			
Canopy size	**Parameter**	**Multiple-row sprayer**	**Traditional sprayer /New turbo mist**
Mature canopy	Tank size (gallons)	800	500-600
	TRT	40	40-50
	Coverage	20 acres/tank	@ 12 acres/tank
	Speed	3.6 miles/hr	4-4.2 miles/hr
	Work rate efficiency	100-120 acres/day	40-50 acres/day

Table info: S. Van DeWalle and TJ Beach

Spraying young/baby trees every-other row



Work rate efficiency for young trees sprayed every other row (only one side of the tree) with a multi-row sprayer		
Canopy size	**Parameter**	**Multi-row sprayer**
Small canopy volume, Young trees	Tank size	800 gallons
	TRV	20 GPA
	Coverage	40 acres/tank
	Speed	3.6 miles/hr
	Work rate efficiency	100-120 acres/day (3x12ft), 160-180 acres/day (22-24”x10-11ft)

Source: S. Van DeWalle and TJ Beach

Pneumatic Defoliation

First Grower Experiences with Pneumatic Defoliation in 2020, 2021, and 2022 growing seasons

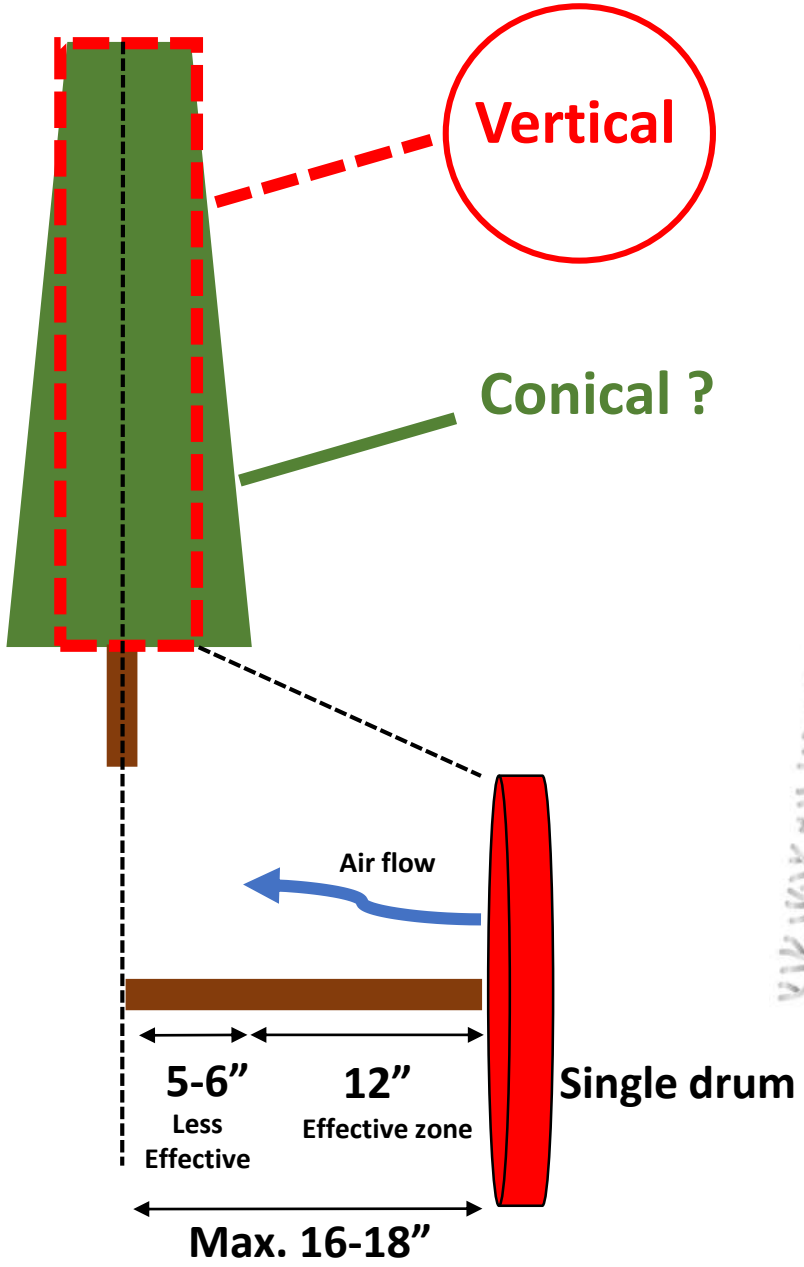
There is a lot more to learn !!

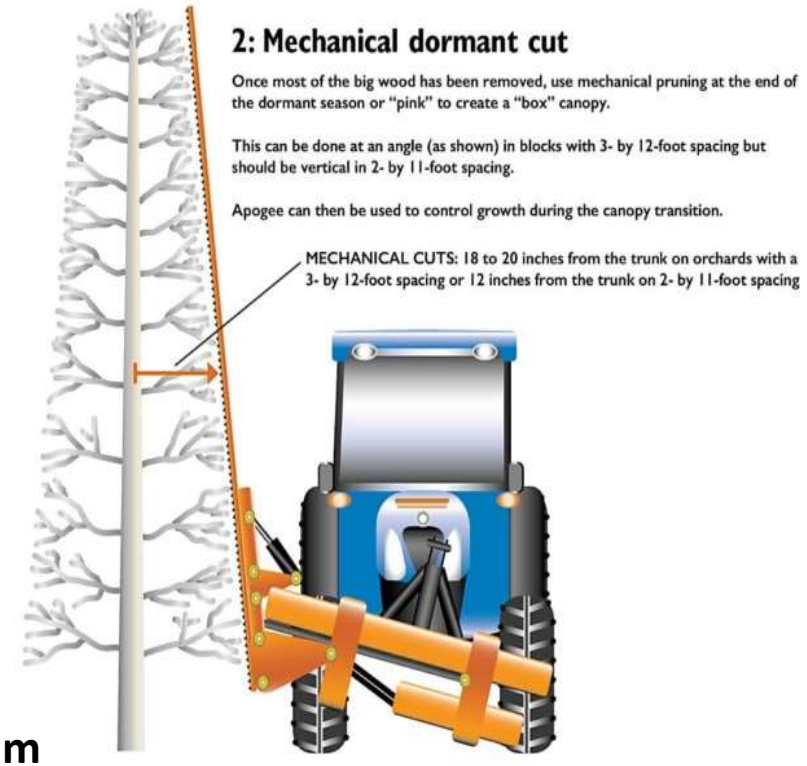

Lamont Fruit Farms

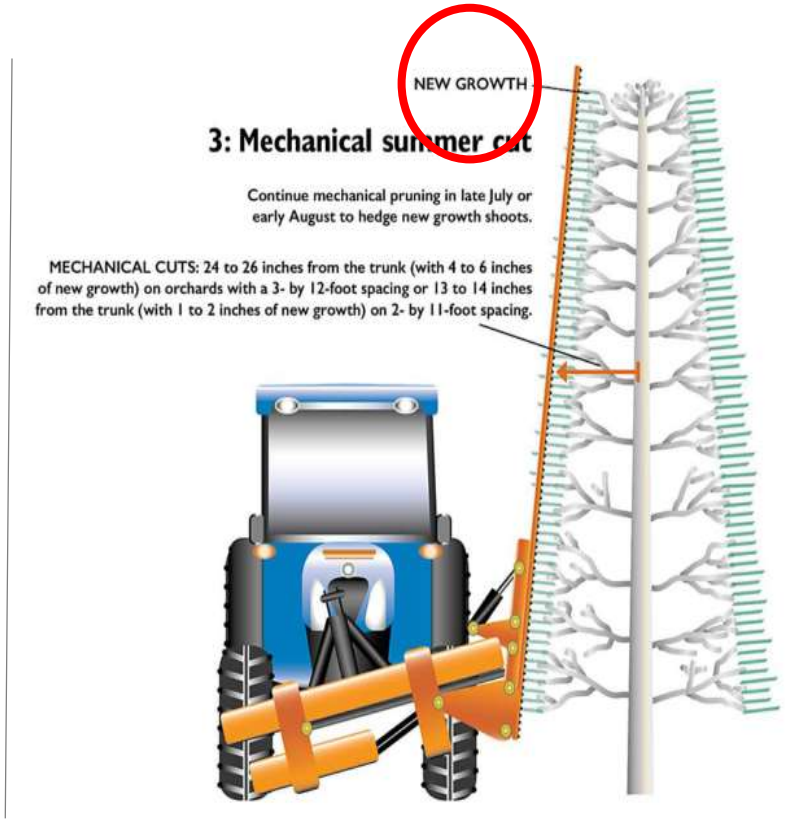
Factors	Data/notes from growers in NYS and the U.S.
Tractor speed	• **0.71 -1.5mph** - low range • **1.7-1.9 mph** (2.8-3.2 km/h) – high range (too fast?)
Air pressure	• **0.7-0.8 bars** (high if compared to the air pressures recommended at Laimburg, Italy)
Timing and efficiency of application	• **Less effective** if applied **15 days** before anticipated harvest DBAH (1st pick) • **Sometime good results** if applied **12-14 DBAH** (1st pick) – **weather dependent** • **Better results** when applied **@ 8-10 DBAH** (1st pick) • **Less effective** when applied **≤ 7 DBAH** (1st pick) • **Improved defoliation** if done at **night** than during the **day** (anecdotal)
Critical factors for improved work rate efficiency	• Require a **good/experienced** operator • Require **an ideal/narrow** canopy shape • Row length **≥ 1,300 ft** (65 mins/acre; both sides of row) • Row length **≤ 500 ft** (72 mins/acre; both sides of row)
Orchard age	**Young trees (1-2 year-old trees)** • Defoliate **only one-side** of the row **Mature trees (≥ 3-year old)** • Defoliate **both sides** of the row

To Adopt or Not to Adopt	Pneumatic defoliation
Variables/ Downsides	• 1 sided machine is **slow** (1-2 hours per acre) – 2 or 3 drums • **Can/does knocks apples off** of trees • Can cause **fruit damage** depending on variety and machine use • What about future **return bloom**, **spur health, etc**
Grower's comments/opinion	• Well worth the investment when used in **narrow canopies** (1' to 2' canopies) • **Less solid** but worthwhile ROI in **somewhat narrow** canopies (~ 3' canopy) • Worthwhile investment if using the machine in a **mix of the first two canopy width conditions** • **Questionable investment** if planning to use machine exclusively in **wide canopies** (4' or especially wider than 4')

The importance of canopy shape for maximum mechanical fit



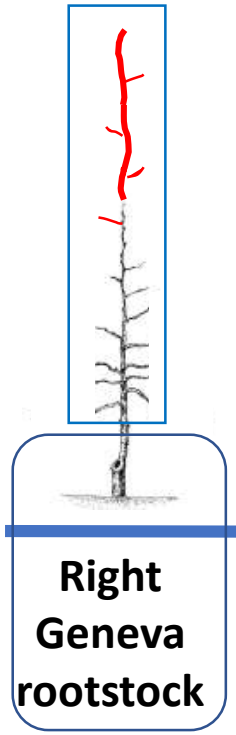




Graphics: Jared Johnson/Good Fruit Grower
Source: M. Miranda Sazo, Cornell Cooperative Extension

Possibilities of Mechanical Pruning for Processing Orchards

Ideal tree for an instant processing orchard



Right Geneva rootstock

Less vigor **G.969**

More vigor **G.890**

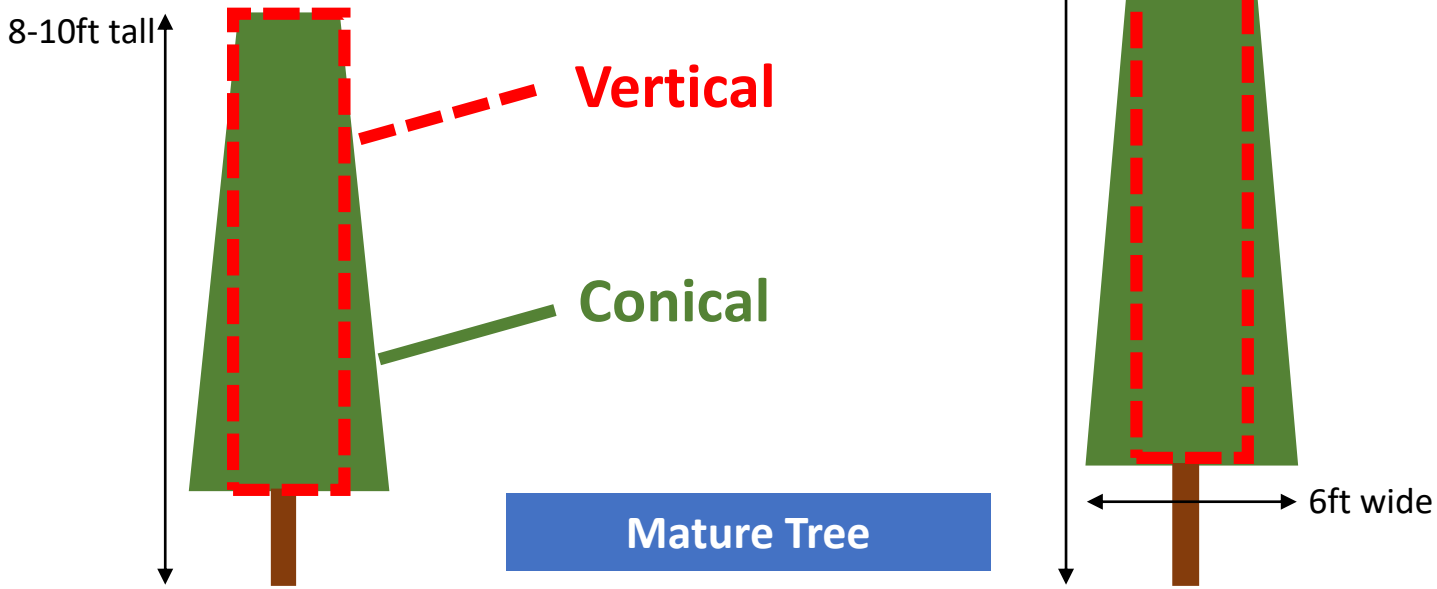
Vertical axe trees on G.890:

- Establish scaffold limbs (4-5 permanent limbs only in the lower part to fill space)

Tall Spindle trees on G.969:

- Grow the tree and don't head the leader

Young Tree

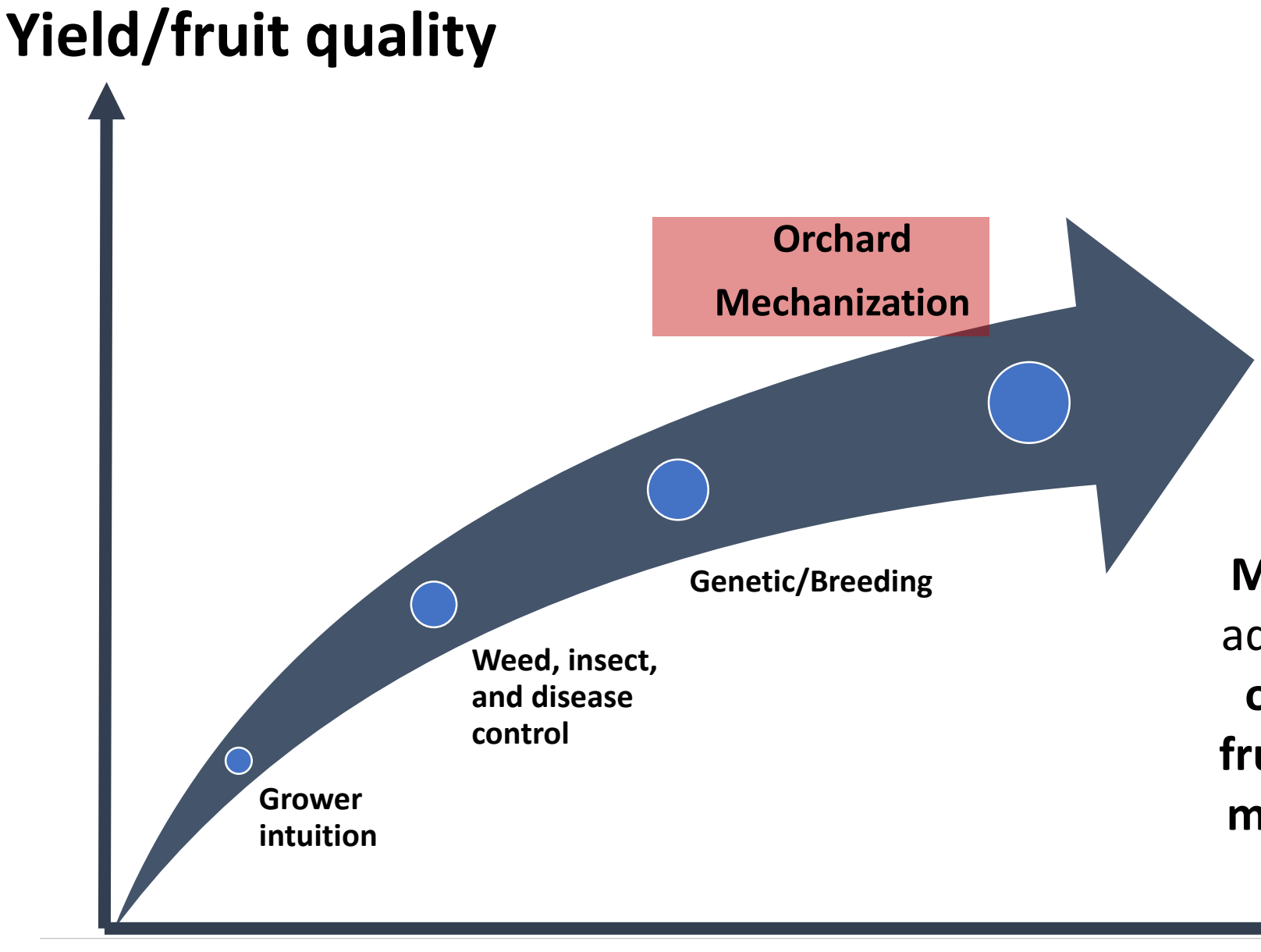


Mature Tree

End 3rd year

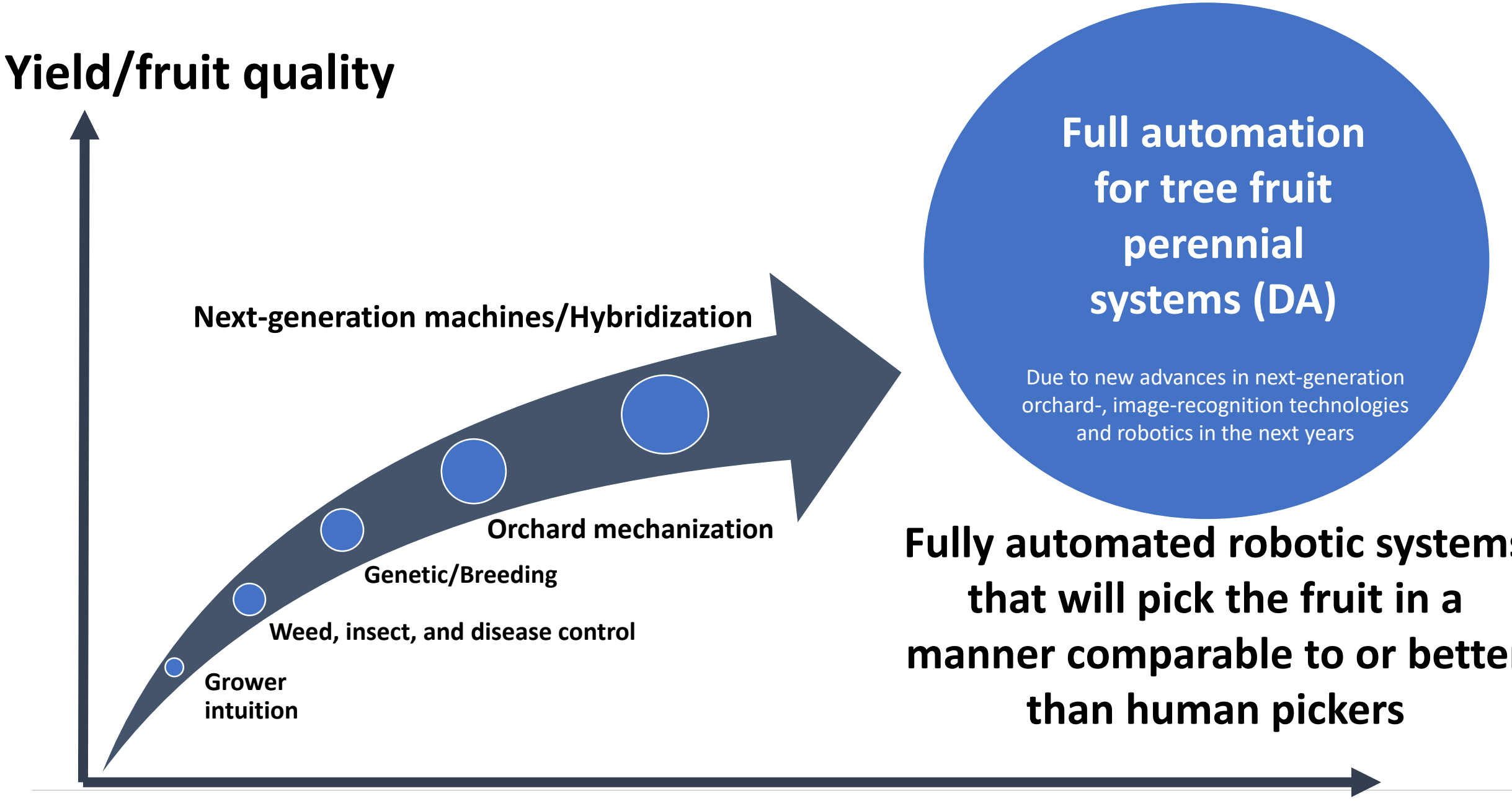
End 5th year

- **Start a simple/repetitive mechanical pruning process every year**
- **Conduct manual pruning to remove large branches when limb diameter exceeds 2 inches**



Next-generation orchard mechanization technologies

Because some of the technologies are somewhat **MODULAR**, it will be possible to address the needs of a particular **orchard task**, **growth stage**, or **fruit farm scale**, by **combining or modifying existing technologies and equipment**



Full automation for tree fruit perennial systems (DA)

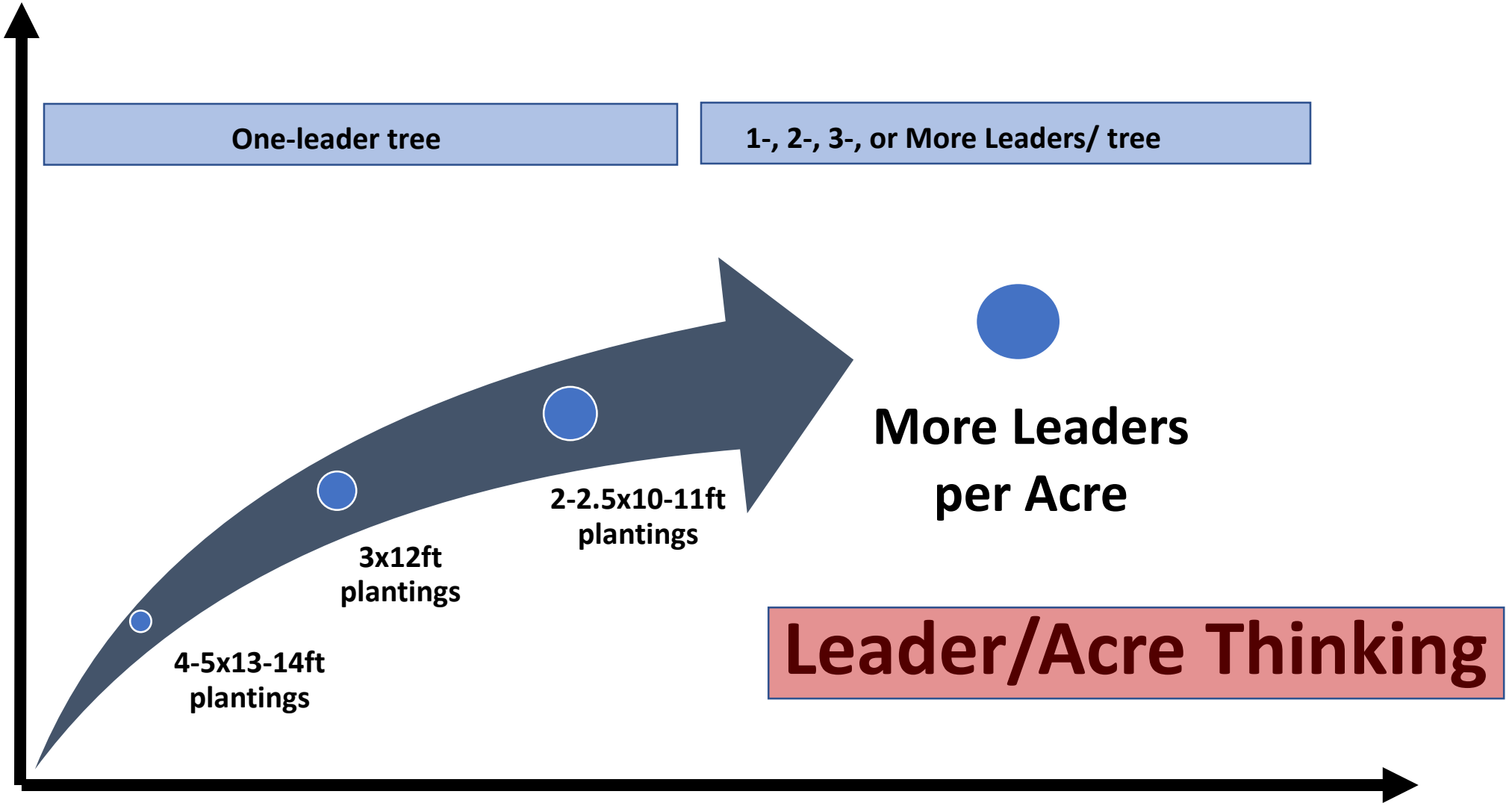
Due to new advances in next-generation orchard-, image-recognition technologies and robotics in the next years

Fully automated robotic systems that will pick the fruit in a manner comparable to or better than human pickers

Simplicity Factor will Define Rate of Success of DA technologies

Simplicity, Uniformity, Repetition, Brick Wall, Organized, Formal,

2D



Thank You

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