Multi-leader training for apple and fruit production

Alberto Dorigoni
alberto_dorigoni@libero.it

1968

The first major shift in tree architecture started in 1968 in the Netherlands, Europe, and from there spread to the whole world

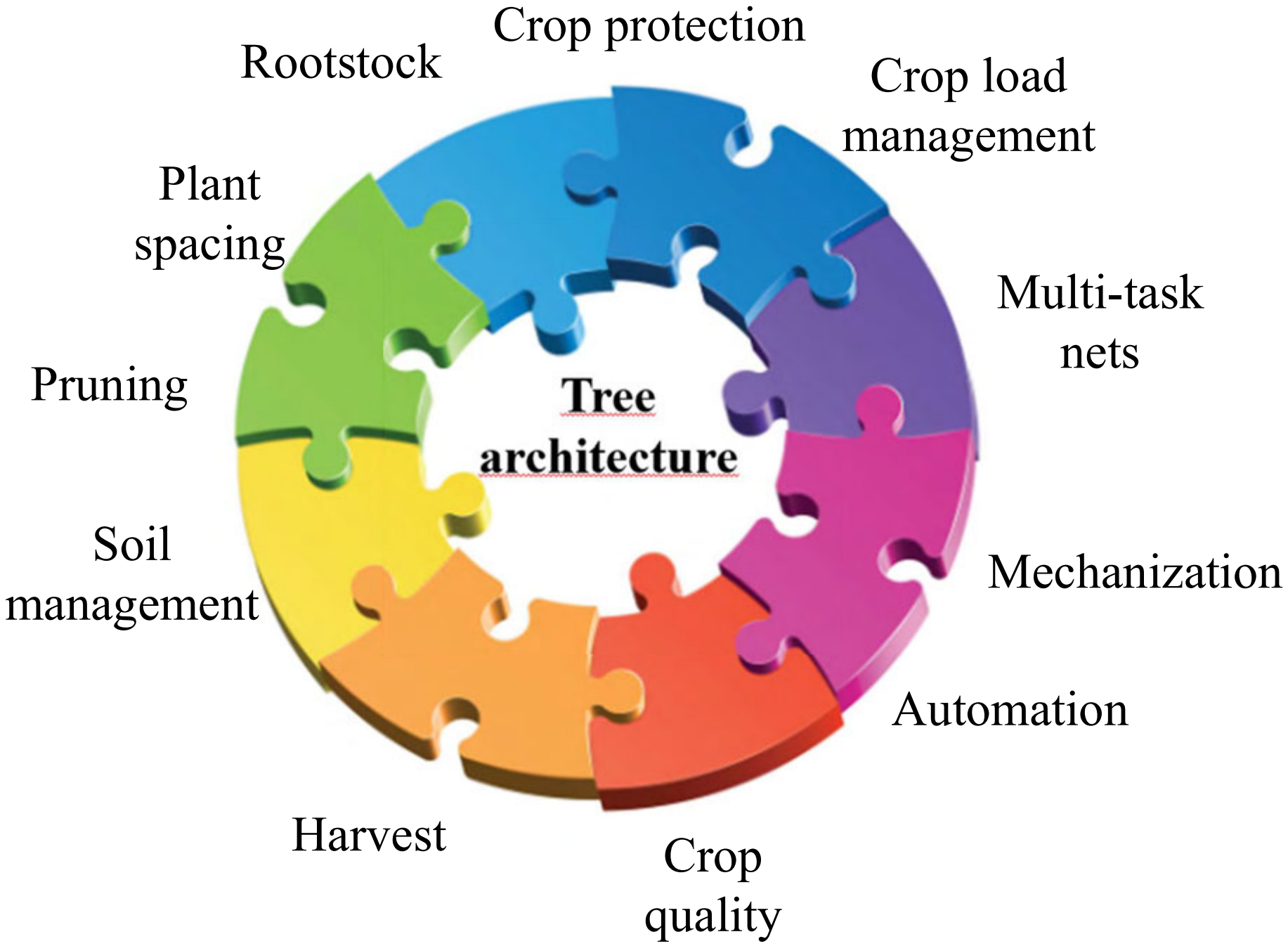
3D (multi-leader) giants to single leader spindle/M9

Fine anni '50. Lezioni di potatura

Tree architecture today in a standard orchard in S. Tyrol (Italy)

N. trees/ha	Between rows	On the row
3000 - 5000	3,2 – 3,5	0,6 – 1,0

Tree architecture is a pivotal factor in the Jigsaw puzzle



Genetics and environment*

(*cultural practices)

+

=

The importance of genetics

Evolution of Gala clones

The importance of «environment» (cultural practices)

From the vase tree to the potted tree

Which training system is most suitable for the future?

LONG

VERT. 2D

SUPER SPINDLE

V SHAPED

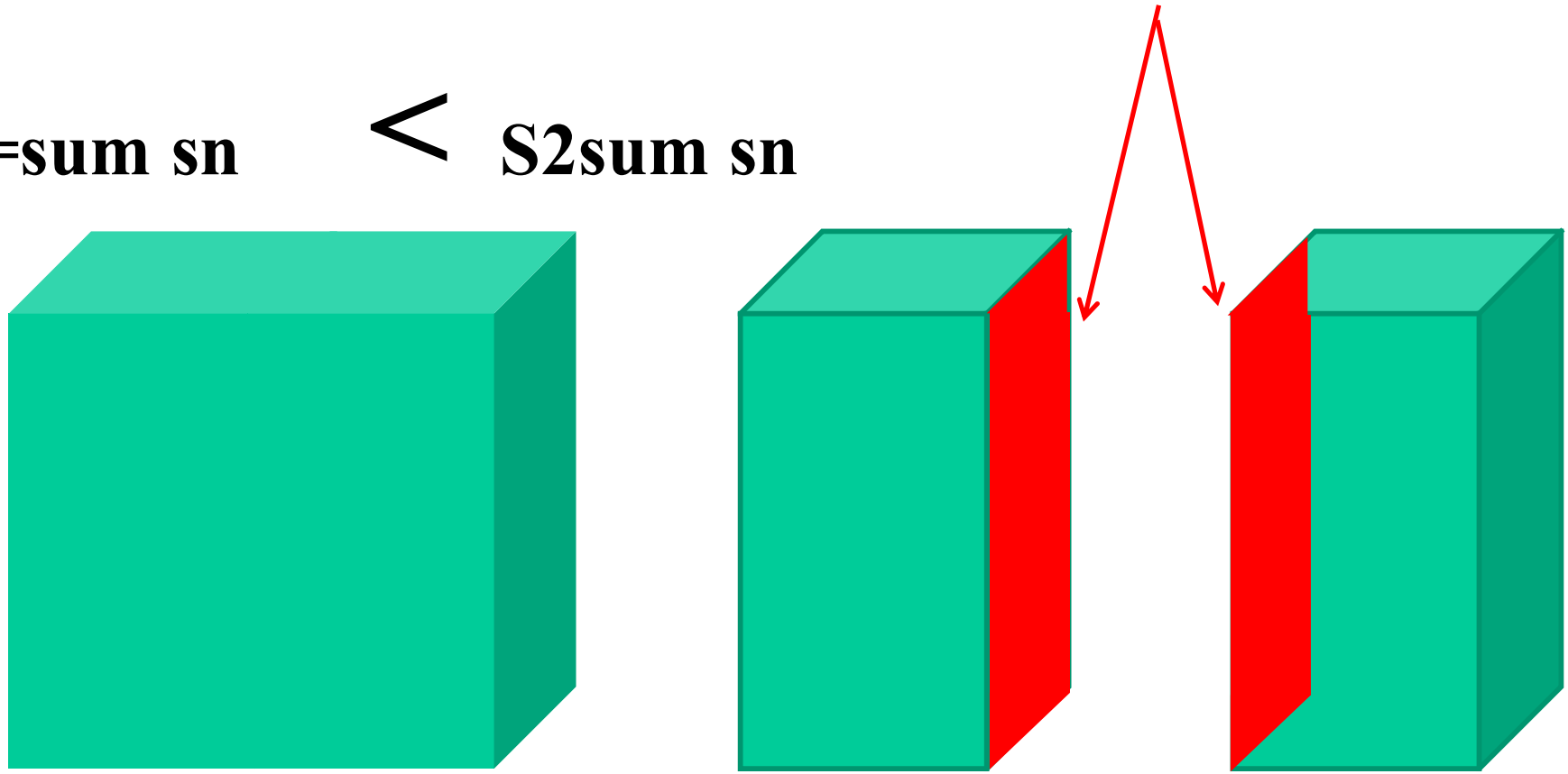
HORIZ. 2D

Which training system is most suitable for the future?

Why multi-leader (or why divide)?

Any division creates **new exposed surface**

S1=sum sn $<$ **S2sum sn**

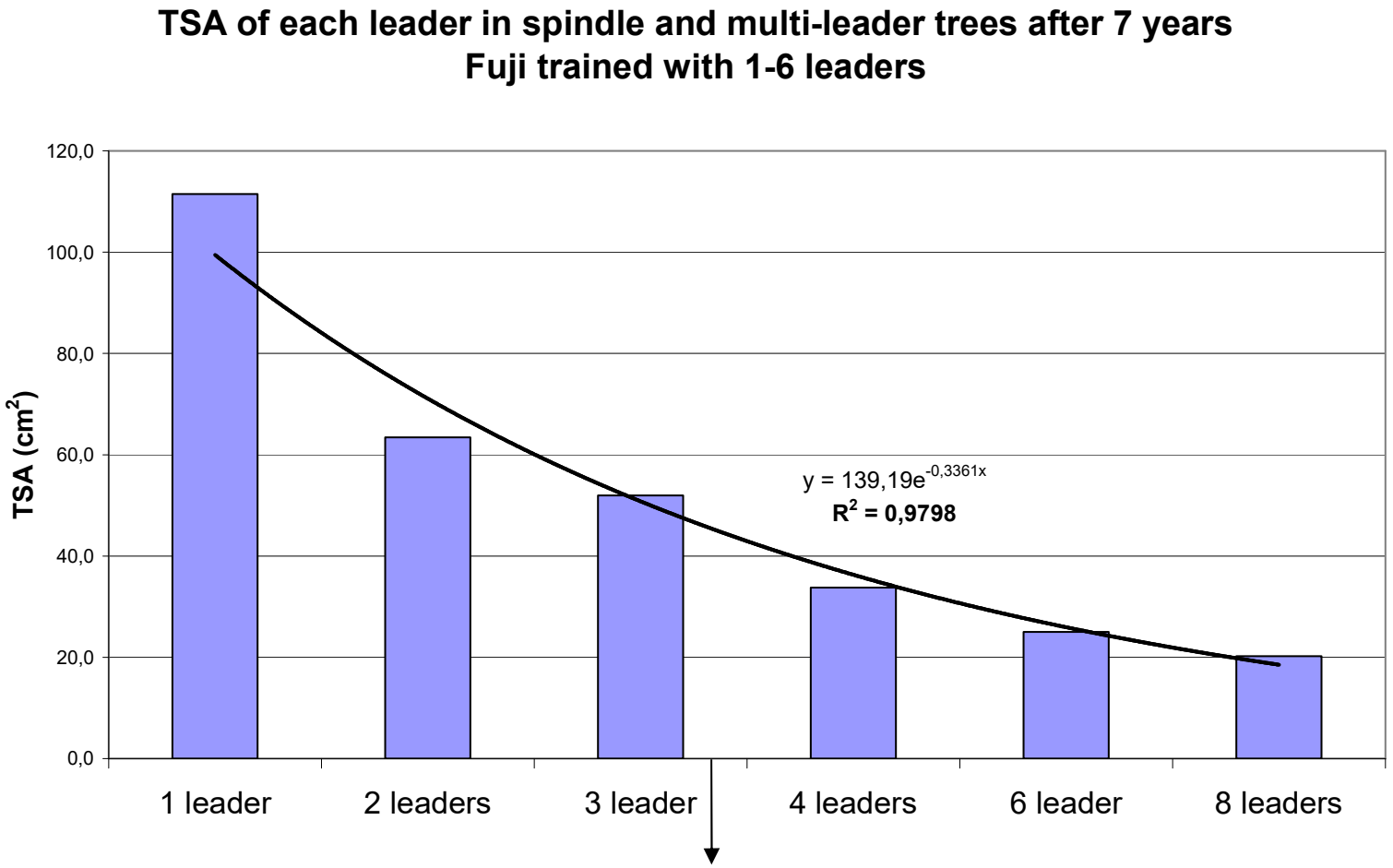


V = va + vb

S/V < S/V

Bibaum ® of Mazzoni Nurseries

Vigour-wise, increasing the n. of axes looks like shifting progressively to more dwarfing rootstocks



N. of leaders: additional variable for chosing the right system in new plantings (beside cv, rootstock and spacing)

Pink Lady: 4 leader at 3.7 x 2.0 m (Friuli)

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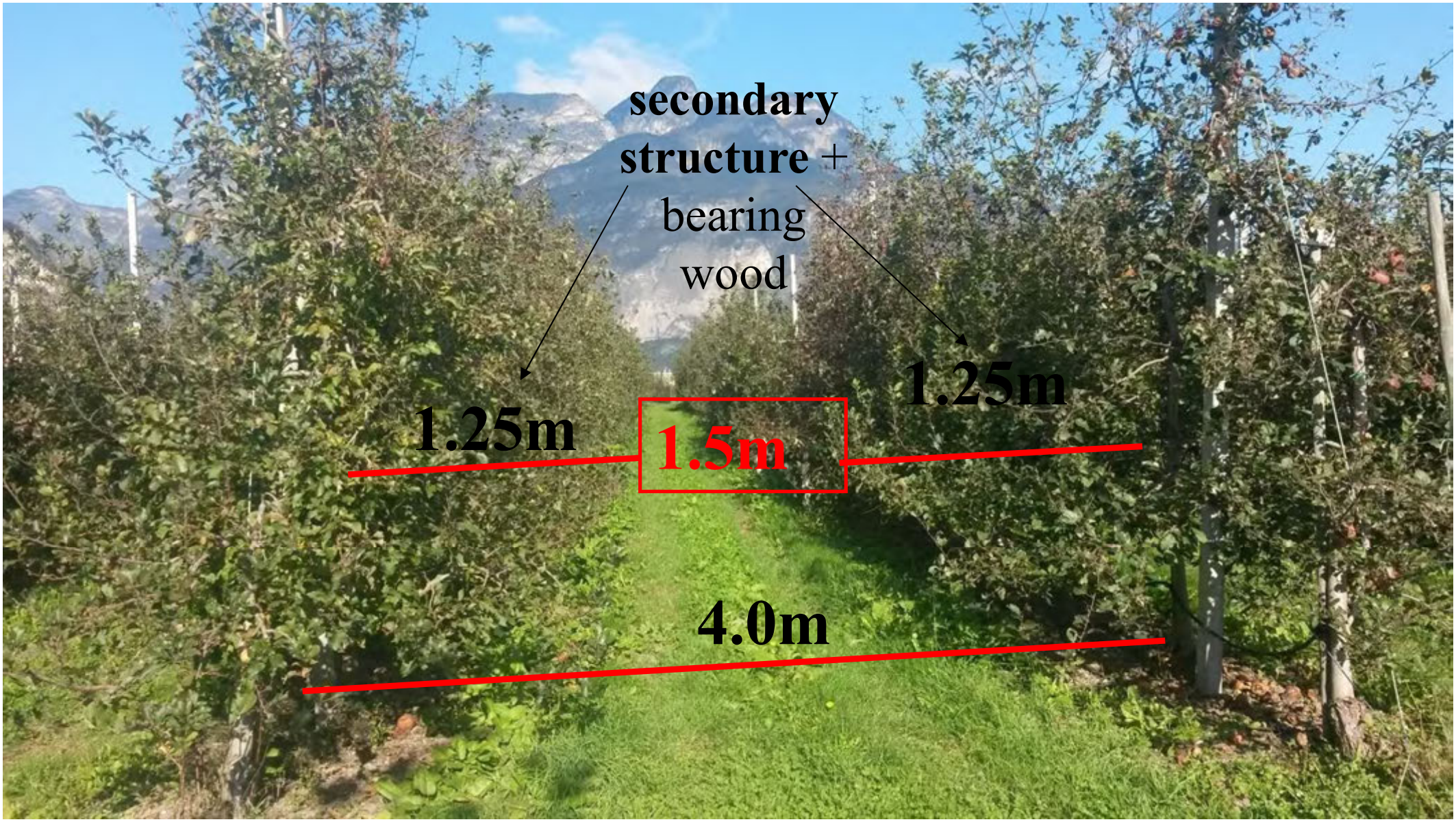
Multi-leader training changes the traditional parameters of orchards:

plant distance

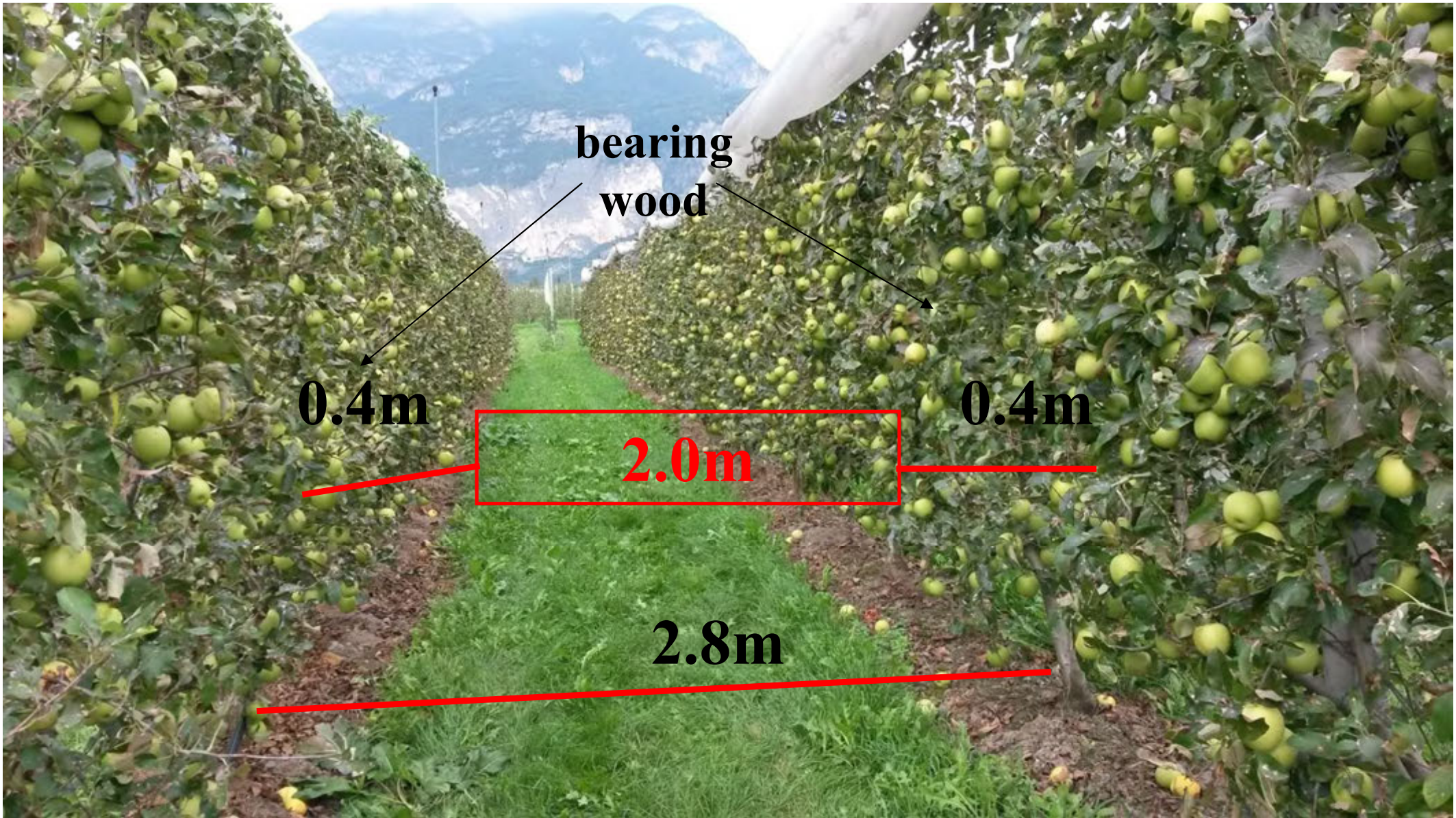
distance between rows

tree height

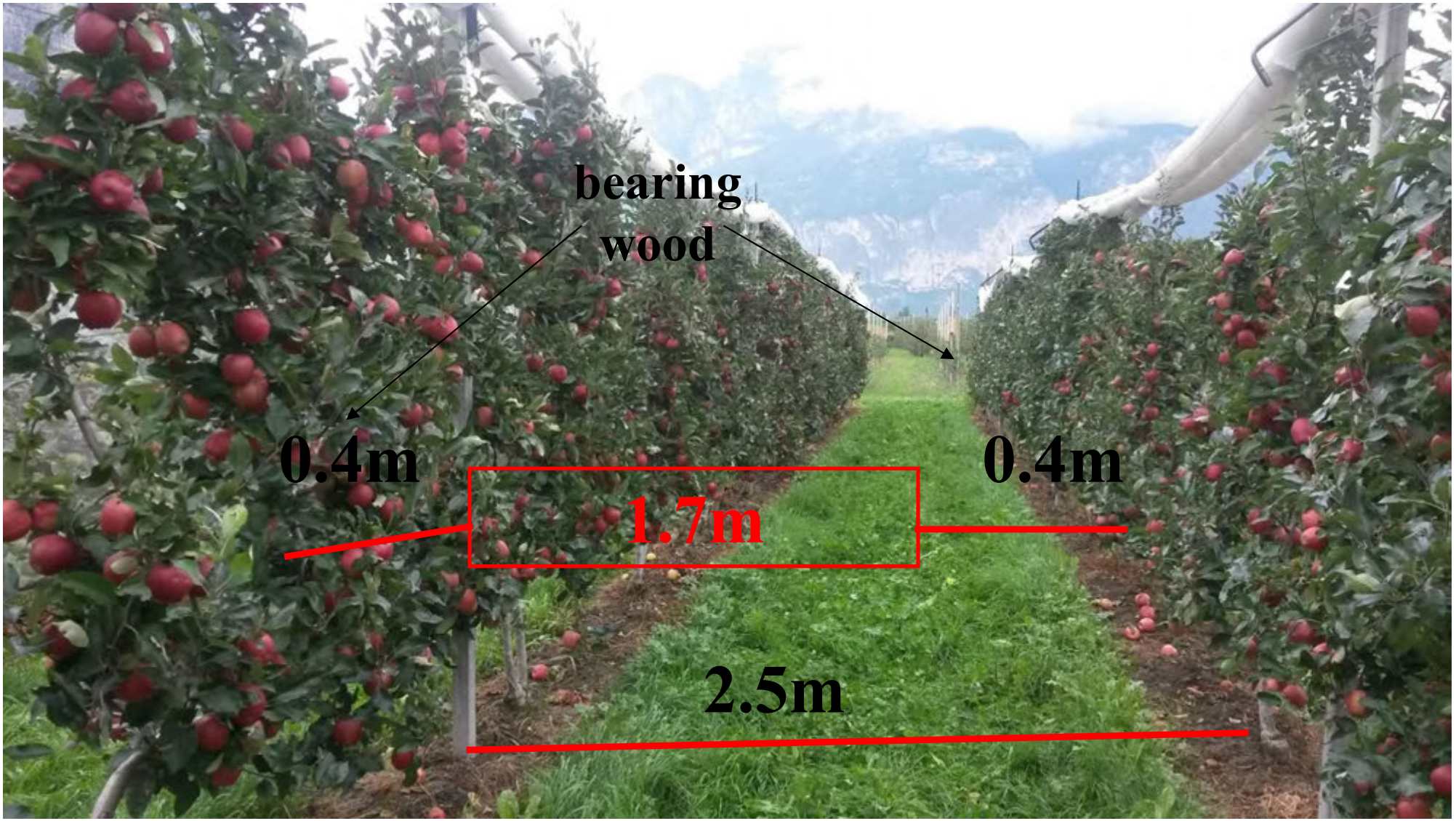
Spindle / long pruning



Multi-leader fruit wall



Multi-leader fruit wall of Gala



Two different ways of «2D» or «fruit walls»

Pink Lady Multi Leader trained (Italy)

Fuji 2D trained (Italy)

Pedestrian
Double row
of Fuji 5th leaf
(2.3+**1.2**m)
2열재배
작업통로,
후지4년생
(2.3+1.2m)

Why vertical?

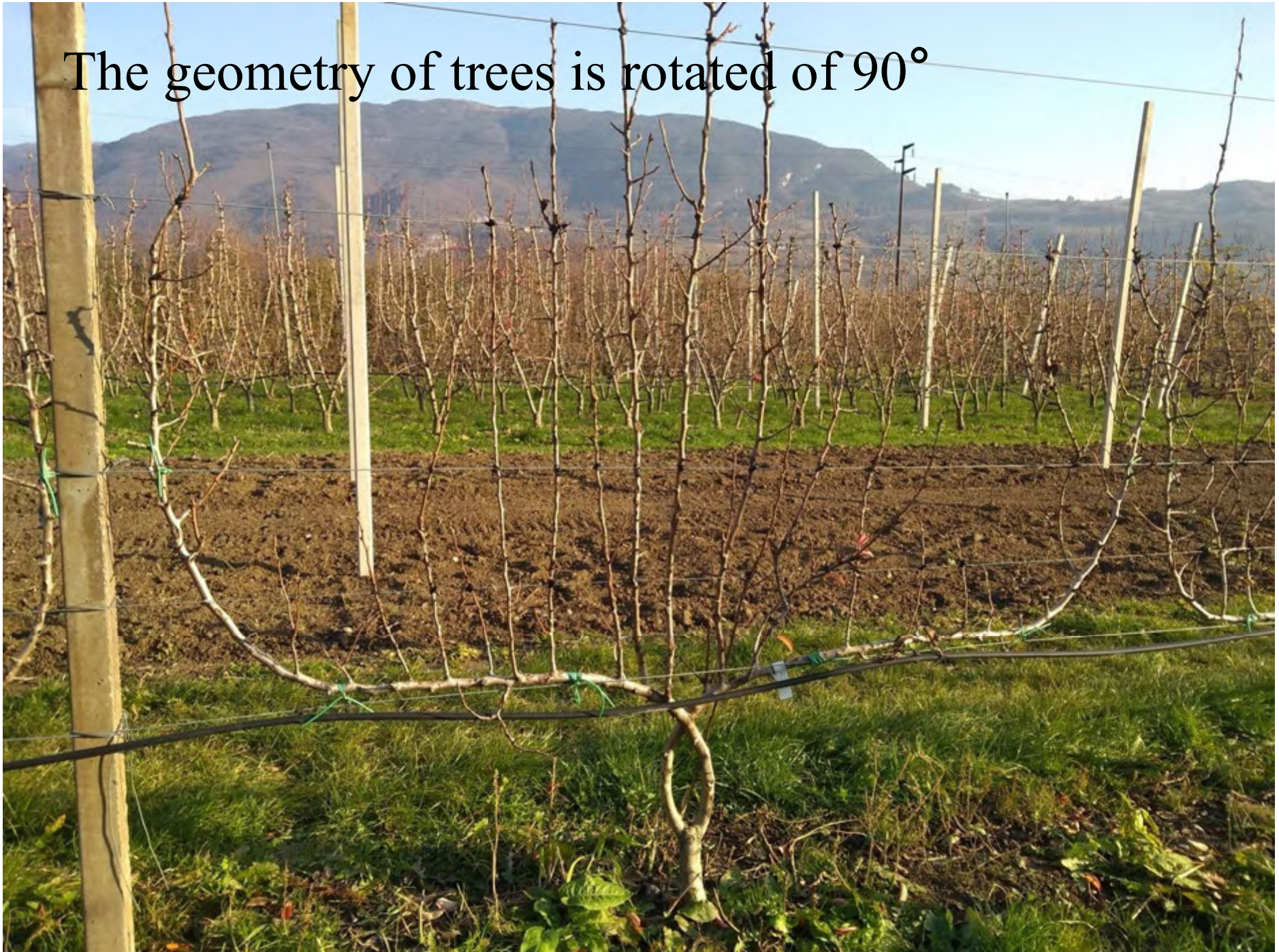
Trees do not like growing horizontally

Trees love growing upright

Ultra-narrow training «Guyot»

Guyot training: beyond the permanent multi-leader

2 year old double Guyot of pear



First attempts of Guyot training at F.E.M. in winter 2009-2010 (photo March 2010)

Pedestrian Fuji double Guyot planted in 2009 (10th leaf)

New concepts of Guyoy vs Permanent vertical leader training (Spindle, Solaxe, Bibaum, 3 and 4 leader)

- Vertical stem(s) becomes horizontal
- Horizontal branches become vertical

- There is *no further structure* (no secondary branching)
- The vertical branches (20.000-30.000/ha) are not permanent
- For the entire life of the orchard the renewal wood starts at the same height, just 0.5 meter from the ground level
- The crop is uniformly distributed from the bottom, just 0.4 meter from the ground level, to the top

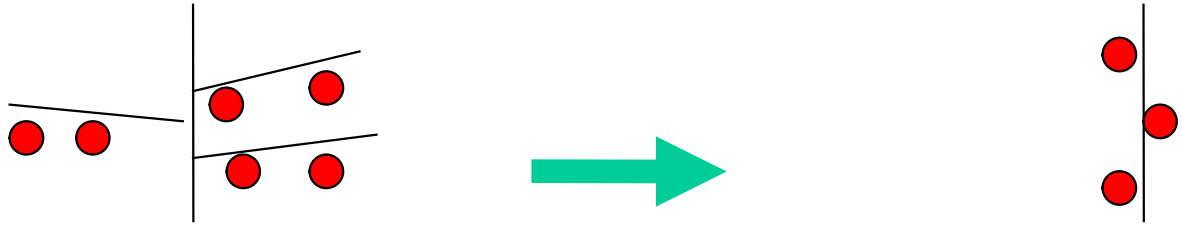
better light interception

Other physiological consequences?

Scaffold of spindle

2D multi-leader of pear

Why get rid of of lateral branching? Because this allows:



3D **2D**

- Any mechanization (thinning, pruning, leaf removal, harvest,…)
- Total uniform fruit exposure from top to bottom
- Fruis to be easily visualized and reached (thinning, havest)
- Fruits held firmly in the same position from Spring to harvest
- Shrink canopy to 0.35 m and reduce alleyways to < 2 meters

Higher Efficiency

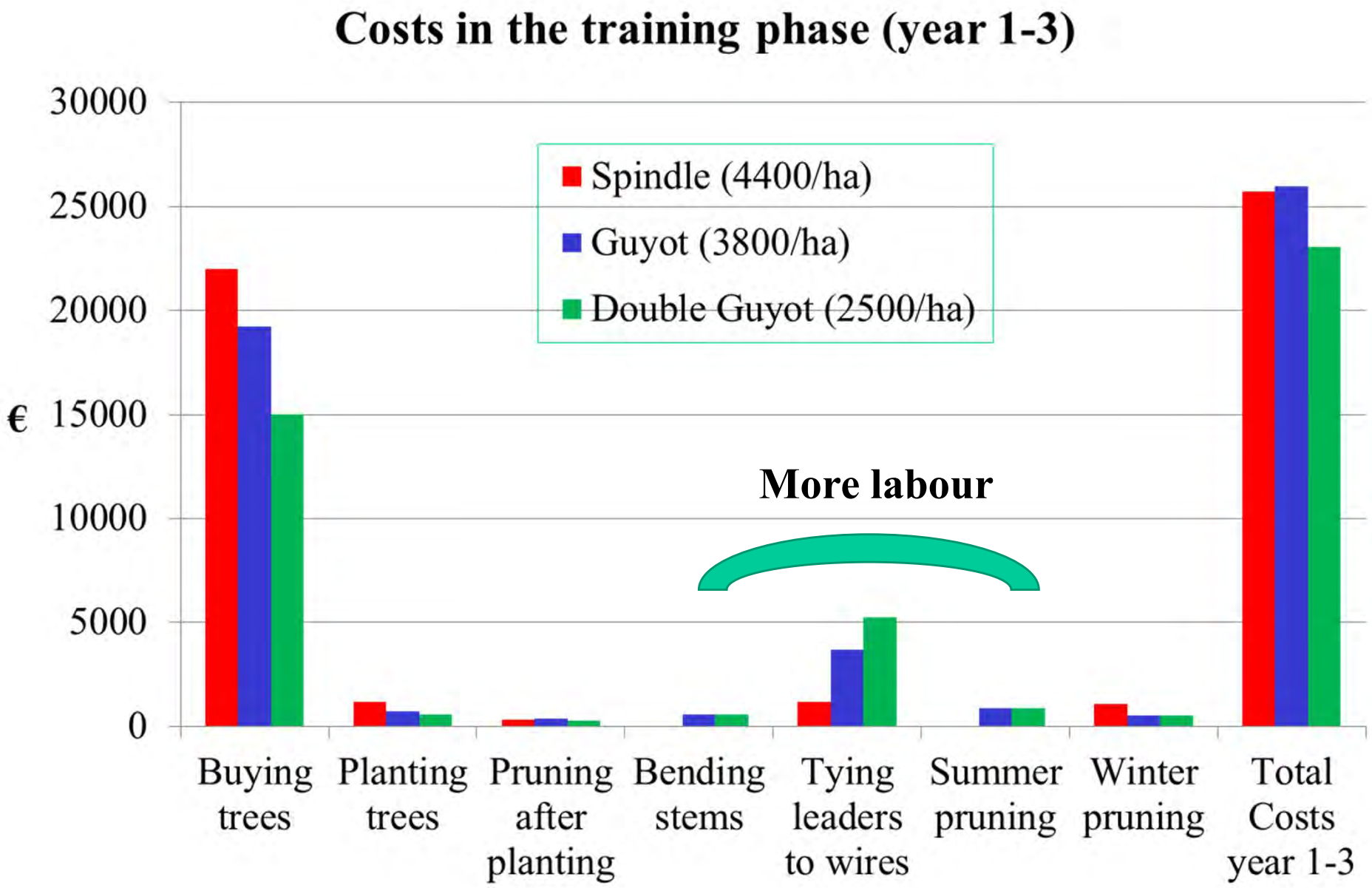
Precision

Horticulture

Planting distances for Guyot with row distance of 2.0-2.4 meters

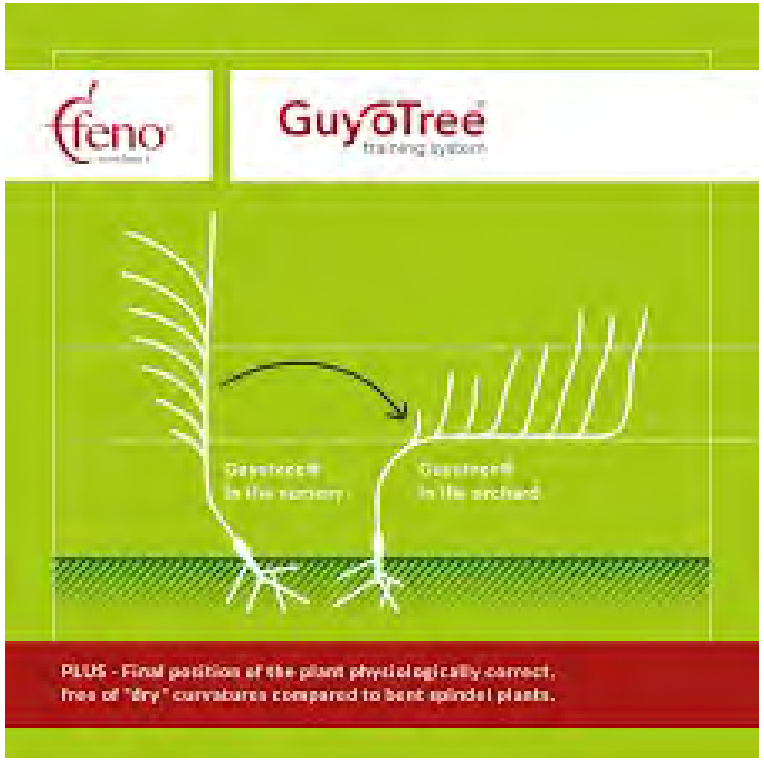
Cultivar / stock / site	weak		medium vigour		vigorous	
Training	on the row	n. trees/ha	on the row	trees/ha	on the row	trees/ha
 simple Guyot	1.3 m	3800	1.5-1.7 m	3125	1.8-2.0 m	2632
 double Guyot	1.8 m	2500	1.9-2.2 m	2439	2.3-2.8 m	1961

Just few years ago the training of Guyot was labour intensive and required about 200 hours/ha in the first year


Costs in the training phase (year 1-3)
30000
25000
20000
€ 15000
10000
5000
0
Spindle (4400/ha)
Guyot (3800/ha)
Double Guyot (2500/ha)
More labour
Buying trees
Planting trees
Pruning after planting
Bending stems
Tying leaders to wires
Summer pruning
Winter pruning
Total Costs year 1-3

GuyoTree®
training system

FENO Nurseries



3rd leaf of double Guyot Pink Lady (Ferrara)

Double Guyot of Fuji at 2 x 2.4 m 5th leaf

n. trees/ha	2032
fruits/tree	229
kg/tree	52.5
tons/ha	107
fruit weight (g)	232
red overcolor %	77

Late spring “Lorette” pruning at 10-14 leaves was named after **Louis Lorette**, whose studies describing the effects of summer pruning date back to 1900-1914.

thus obtained is in its turn pruned back to the stipulary eyes and thus the two upper U's are very simply and perfectly formed.

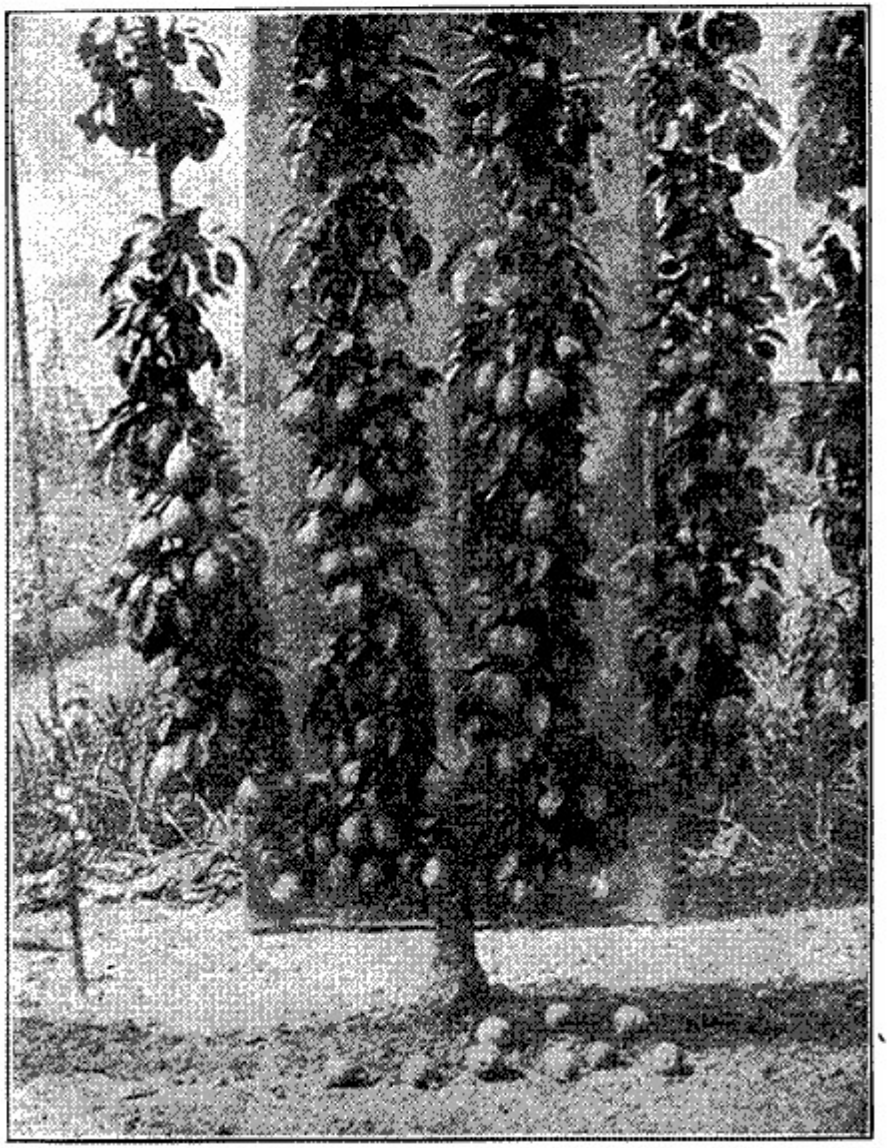
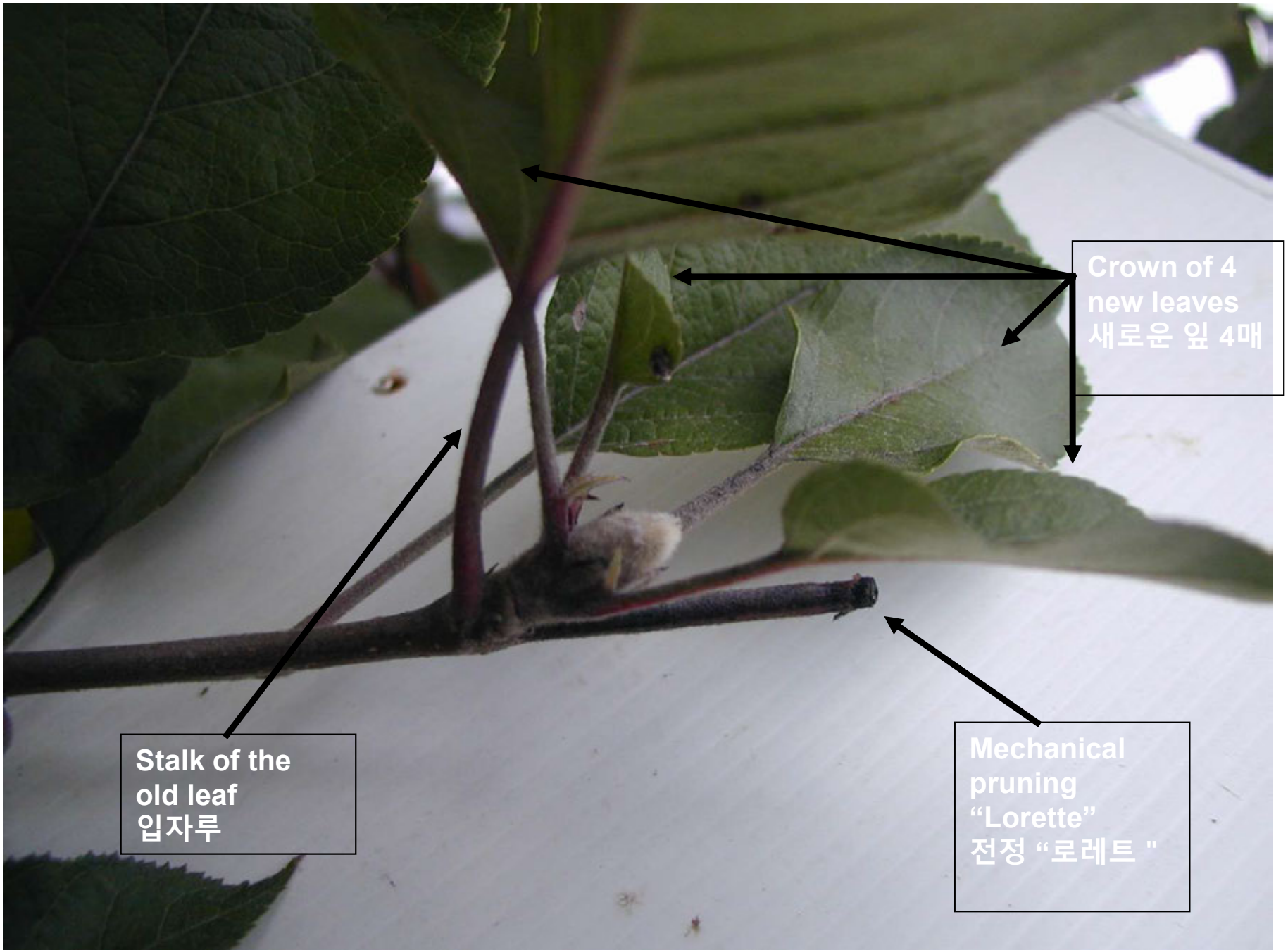


Fig. 26. A full-grown double U pear tree, "Bonne d'Ezée," pruned on the Lorette system.

A simplified version of the Lorette pruning at the end of Spring, at **10-14 new leaves**, can help in shaping a 2D fruit wall.

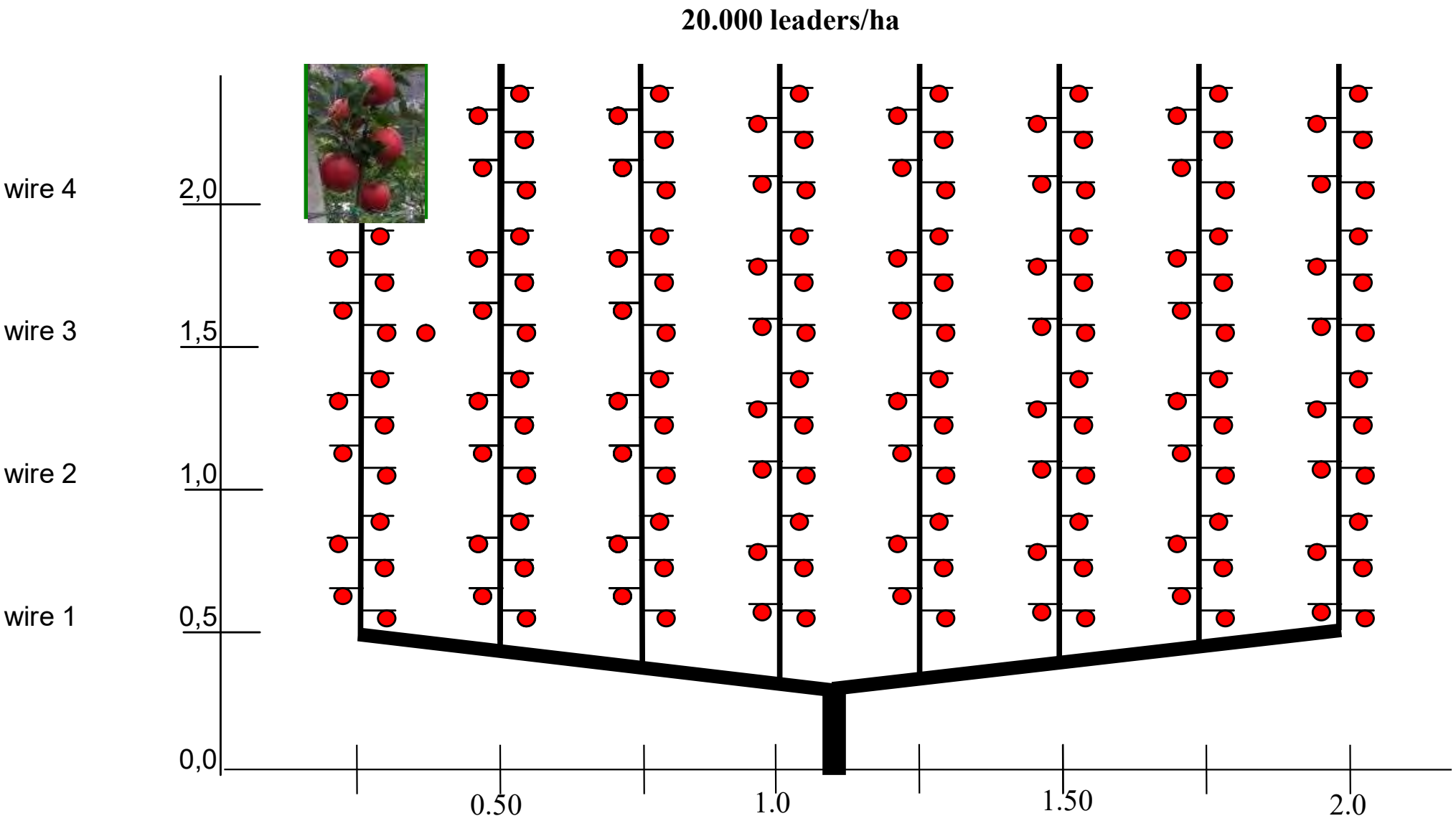
At the end of Summer, 3-4 months after the “Lorette” pruning, the terminal stipulary eyes at the base of the leaf on 1-year old wood produce new spurs near the cut.



Planting at 2 x 2m (pedestrian)

Precision horticulture: multi-leader trees are suitable to **segmentation**

5 fruits*4 wires*8 leaders* 2500 trees*0.200kg= 80 tons/ha



Any faulty apple can be easily spotted and removed before harvest

With any fruit tree training crop and vegetation tend to move upward and outward during the life of the orchard

outward

upward

With Guyot, replacement of strong vertical branches from low is possible for the entire life of the orchard

before

0.5 m

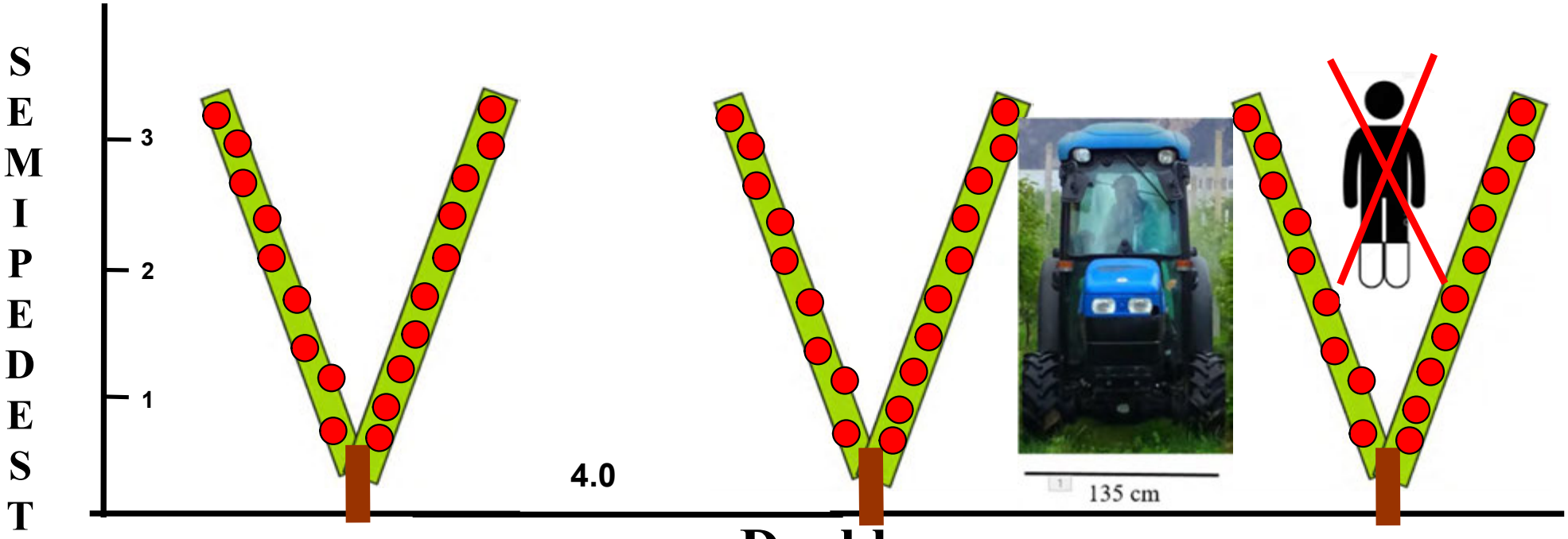
after

Double rows vs «V Tatura»

Modern Tatura planting in Washington State (photo Tom Auvil)

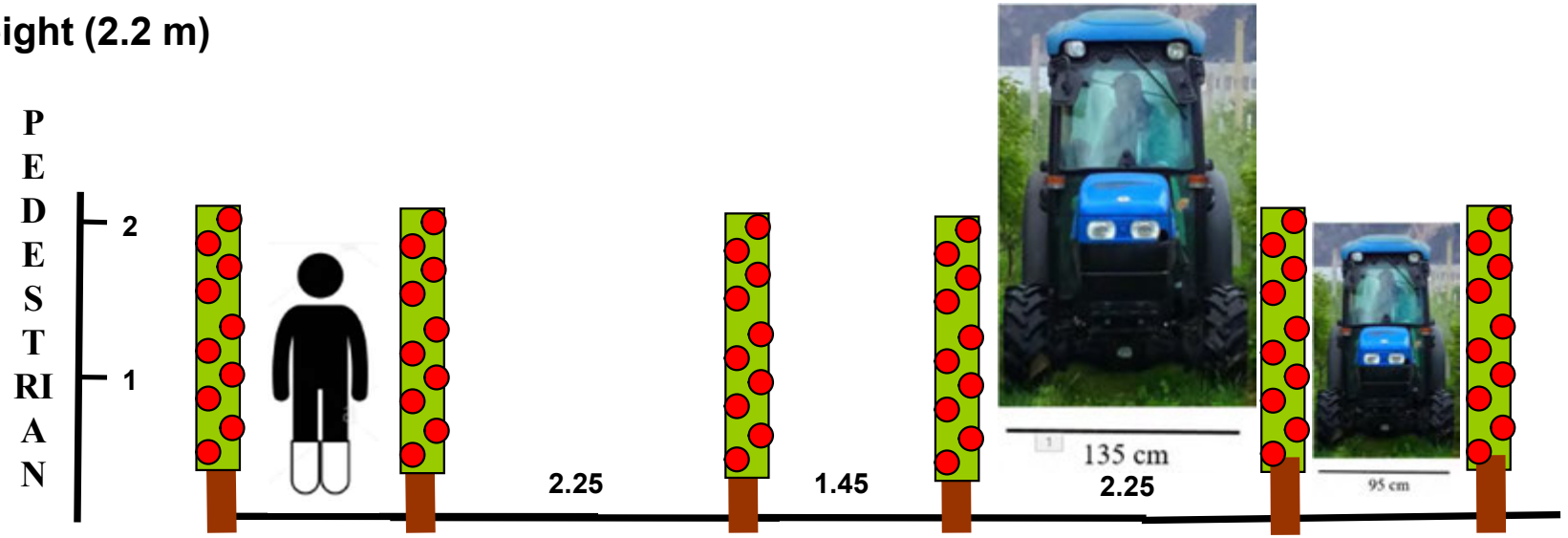
Canopy structures of Tatura and double rows

Height (3.5 m)



Double rows

Height (2.2 m)

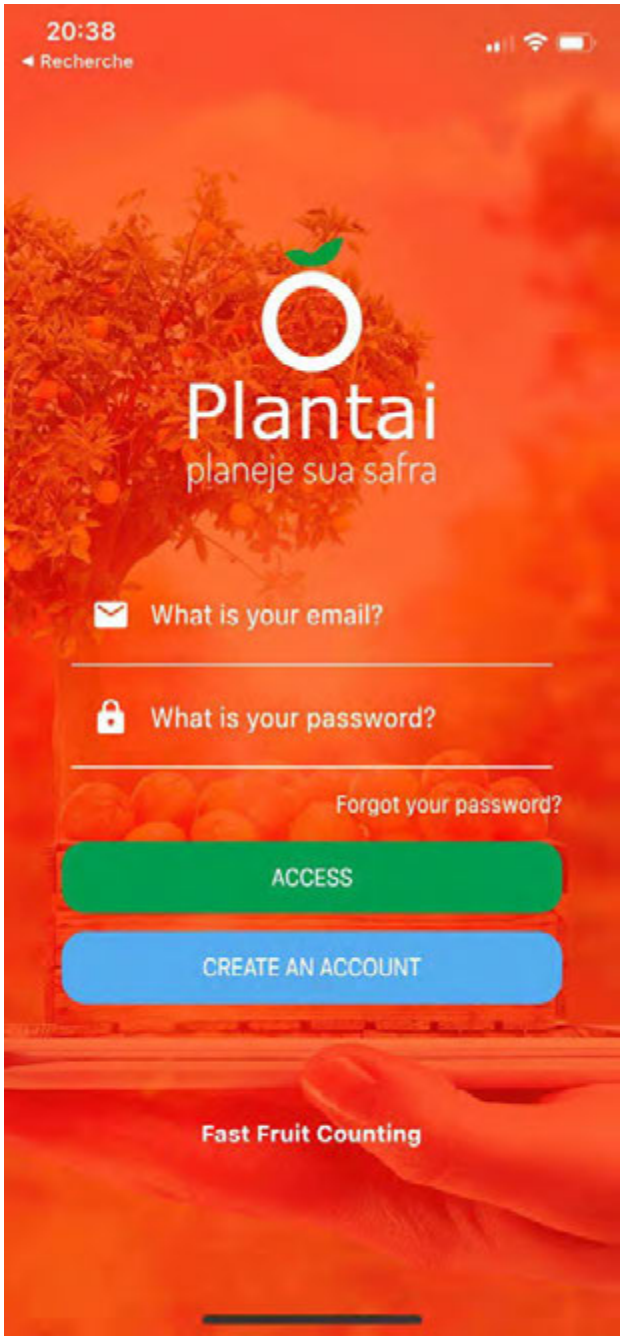


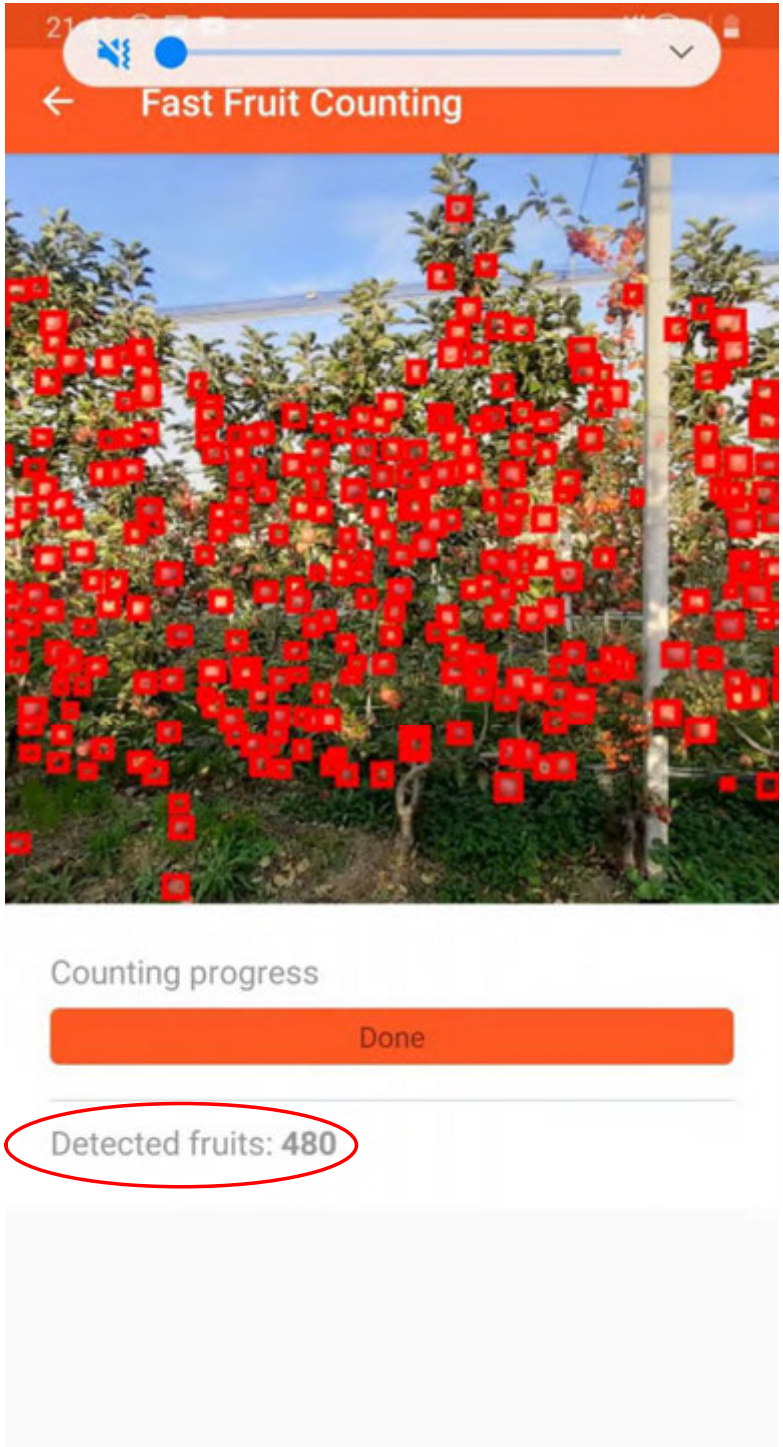
Pedestrian Double row of Fuji 3rd leaf (**2.3**+1.2m)

Pedestrian Double row of Fuji 3rd leaf (2.3+**1.2**m)

Pedestrian Double row of Fuji 4th leaf (2.3+**1.2**m)

Fruit counting via smartphone app Plantai works well on 2 dimensional trees





Pedestrian Double row of Pink Lady Guyot 6th leaf (**2.3**+1.3m)

Year	Kg/tree	N. fruits/tree	Tons/ha	Fruit Weight (g)
2016	11	43	23	256
2017	27	108	57	245
2018	38	203	77	189
2019	44	261	89	167
2020	65	360	131	178

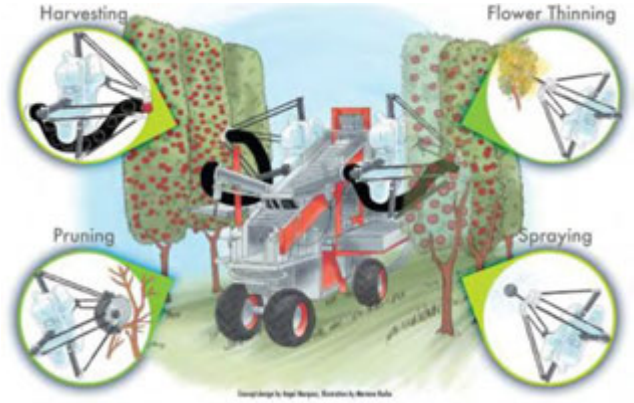
Pedestrian Double row of Pink lady 6th leaf (2.3+**1.2**m)

Mechanization / traditional (Spindle)

Bulky & Heavy

Mechanization / future (Guyot)

SLIM (Small Light Intelligent Manageable)



Robotic harvesting

AGRONOMY

- Branchless Guyot is one of the easiest training systems to be picked by machines
- Apple distribution can be further adjusted to the needs of machines

MACHINERY

- Modern robotic arms can mimic and maybe surpass humans in movement, precision, gentleness and speed
- Vision systems work
- Arms can place fruits straight in the bins or on conveyers
- We need to further develop the software to apply the right movement to the arms

Conclusions: multi-leader is the system for the future

•Superspindle at 5000-6000 trees/ha is very precocious and productive but lasts only 10-12 years and is unsuitable to fertile soils

•V-shaped Tatura is highly productive but expensive, does not respect tree physiology and is difficult to manage

• Mechanization and lack of skilled workers are pushing toward narrower canopy systems or Fruiting walls, both horizontal (2D) and vertical (two-axes, multi-leader, Guyot)

•Guyot is the “last” link in the evolution of (n) multi-leader training, suitable to precision horticulture: fully 2D, all renewable leaders

Preformed in the nursery Feno Guyotree® and Mazzoni Bibaum® can help the growers in achieving a 2D fruit wall.

Thank you for your attention!