



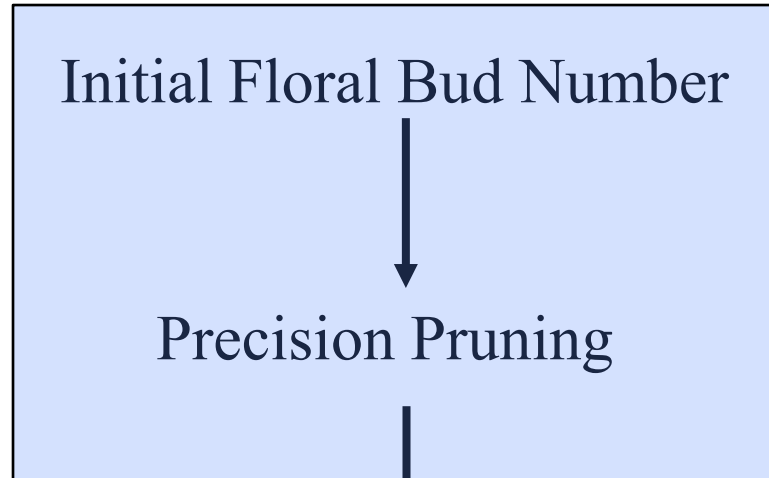
**Horticulture Section, Cornell AgriTech  
Geneva, NY, USA**

# **Progress on Precision Crop Load Management with Digital Tools**



**Terence Robinson, Yu Jiang, Luis Gonzalez, Mario  
Miranda Sazo, Craig Kahlke, Mike Basedow and  
Brian Lawrence**

# Steps in Precision Crop Load Management



Precision Chemical Thinning

Precision Hand Thinning

Final Target Fruit Number

1. Count buds before pruning with computer vision

2. Calculate the target number of buds (bud load) (using Trunk Cross-sectional area, total branch length, total branch cross-sectional area or canopy volume)

3. Communicate actionable information to human worker to guide pruning

4. Count buds after pruning with computer vision

# Orchard Robotics



**Trunk Cross Sectional Area**

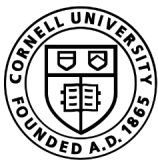
**Number of Buds**

**5 mph**

**Information of each single tree**

**Calibration (5 trees)**



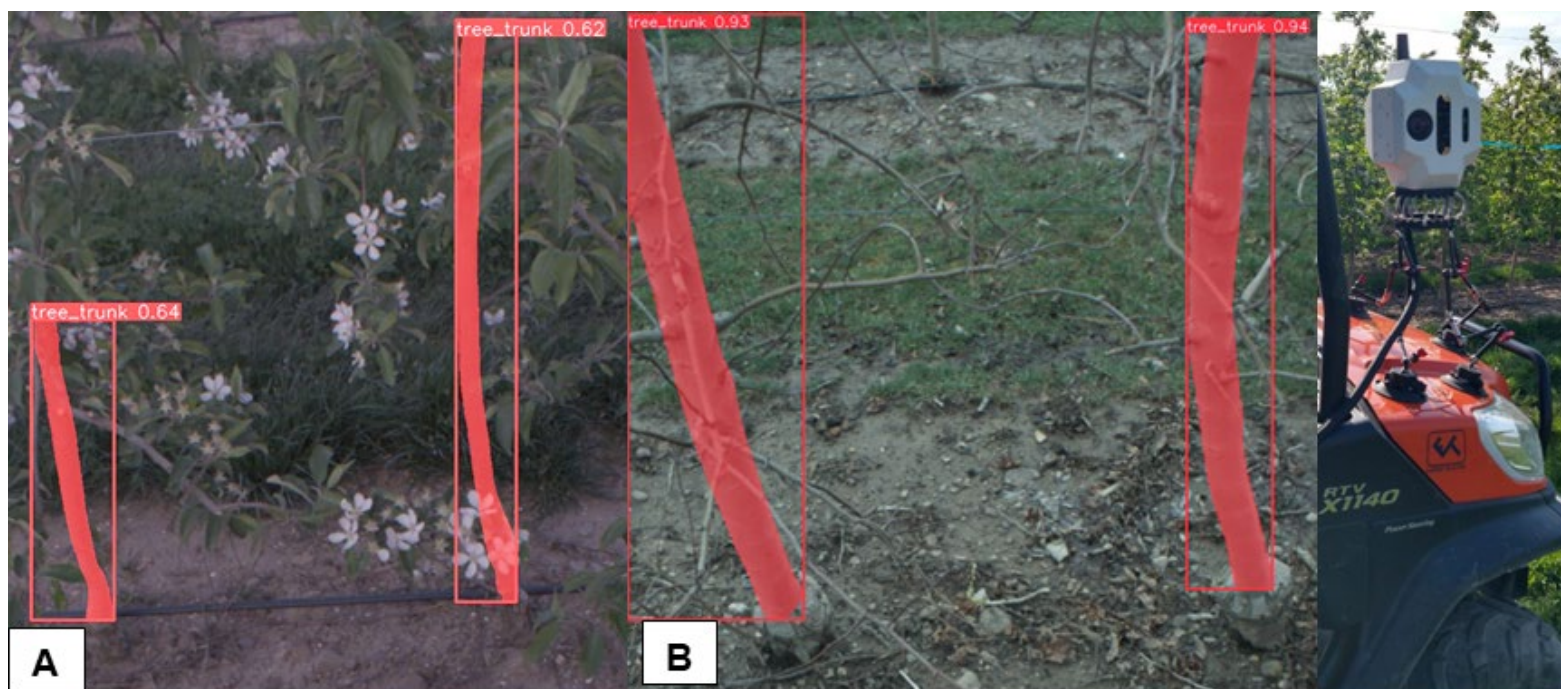


# Trunk Cross Section Area 2023

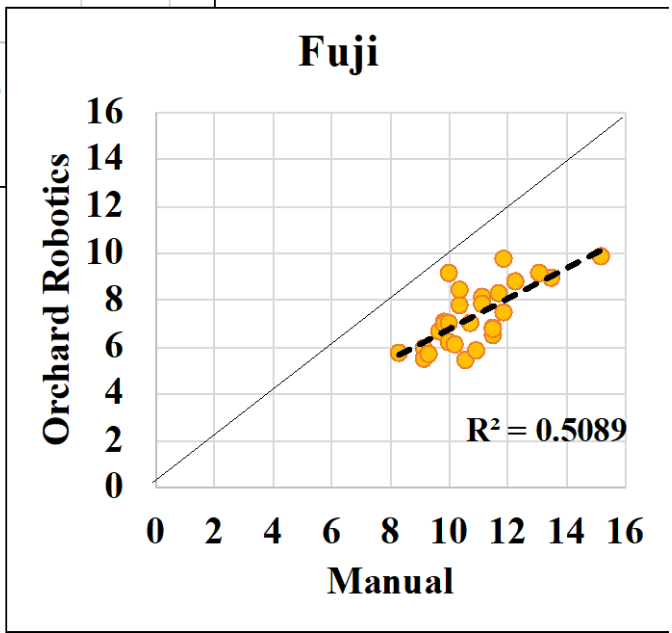
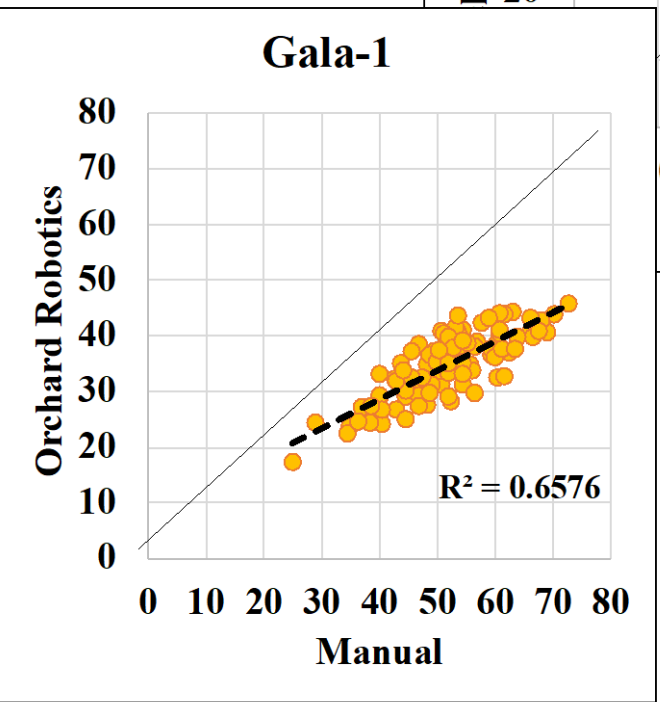
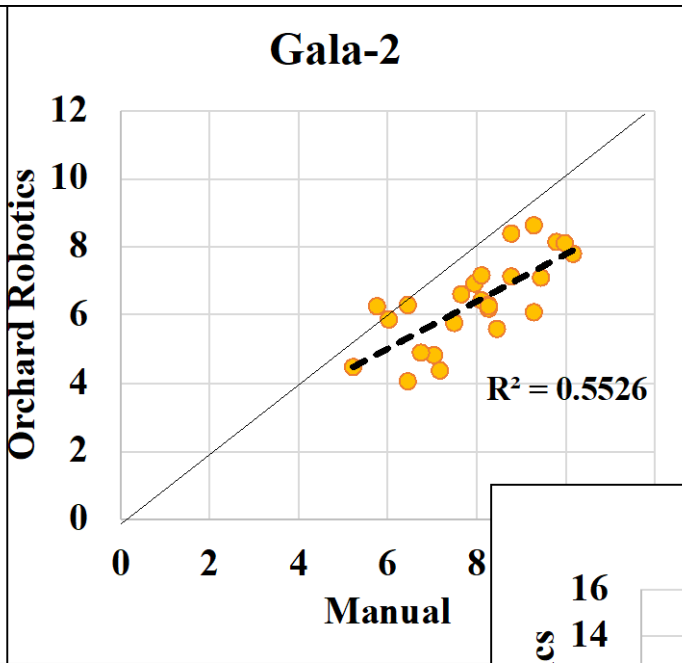
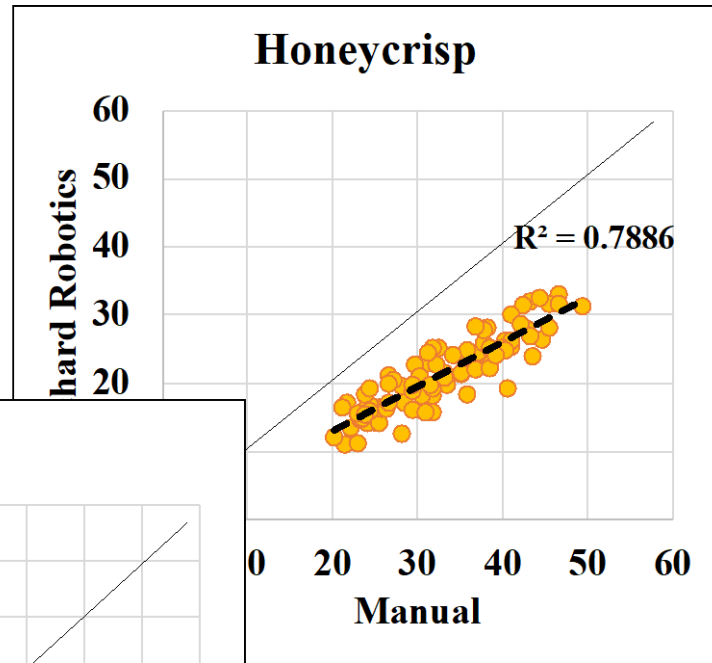
‘NY1’, ‘Gala’ y ‘Fuji’

Young trees (5 years) and Older trees (17 years)

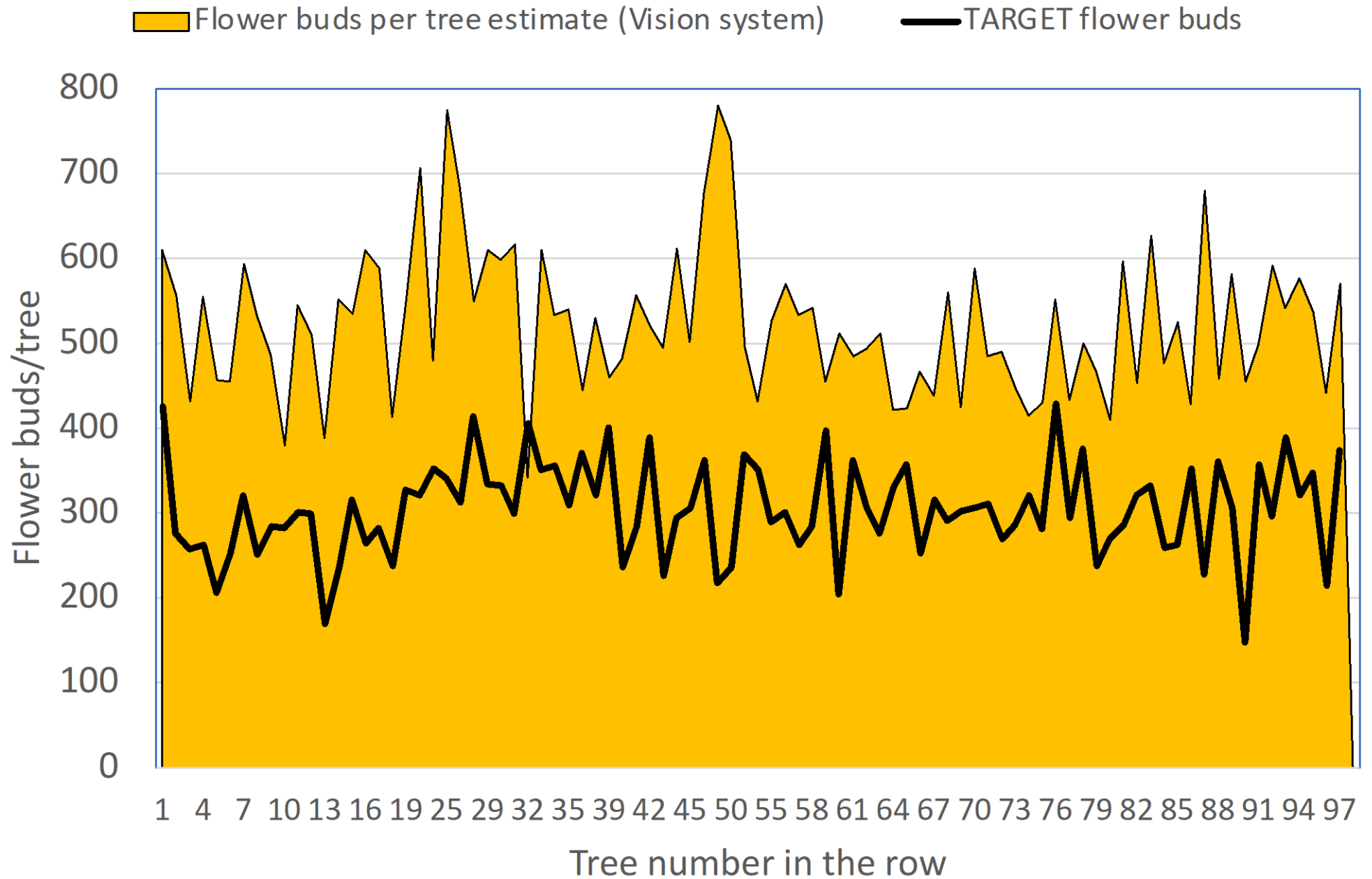
Orchard Robotics measurements and manual (30 cm)



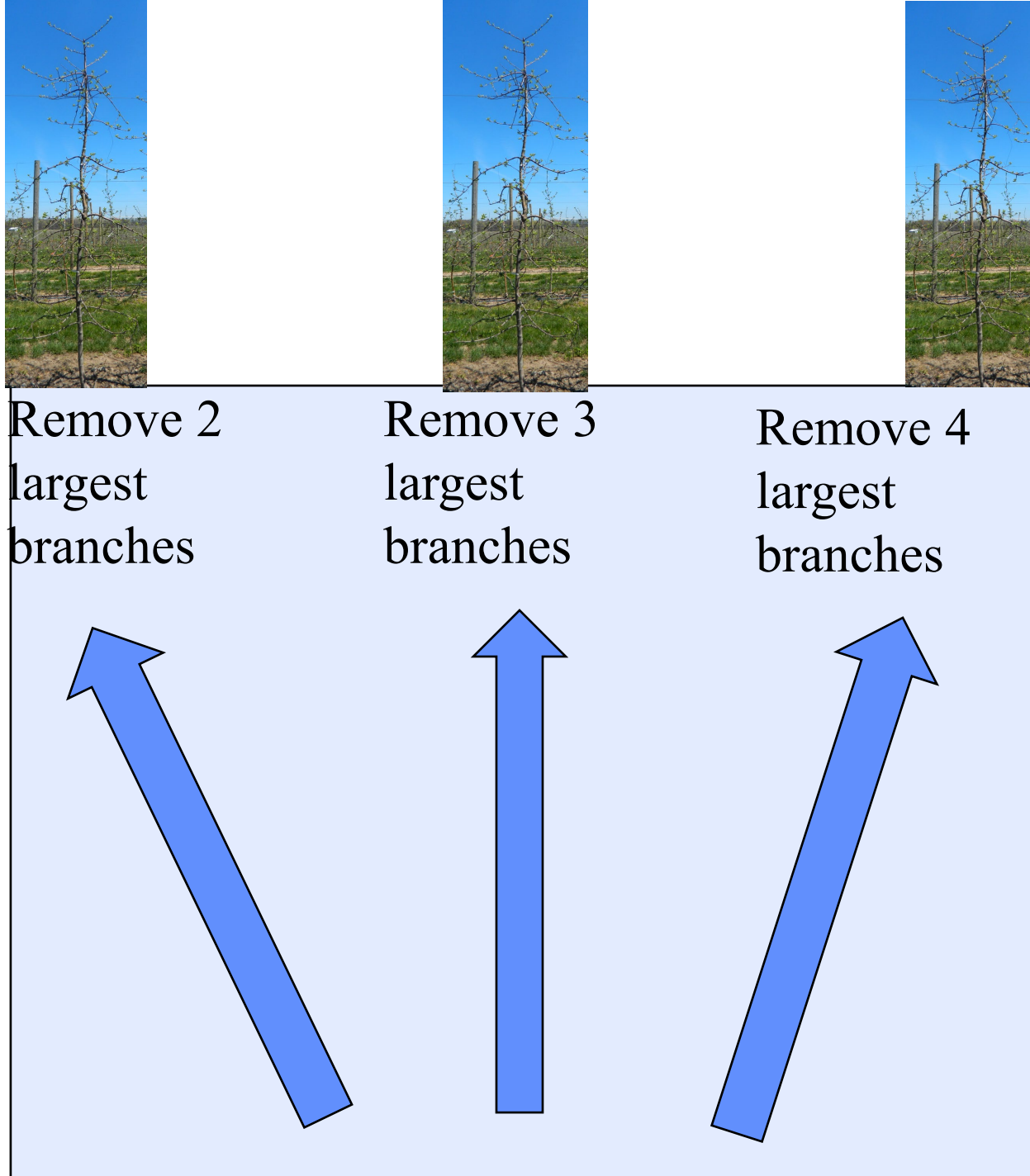
# Computer vision estimates of Trunk Cross Sectional Area



# Variability in dormant bud numbers along the row

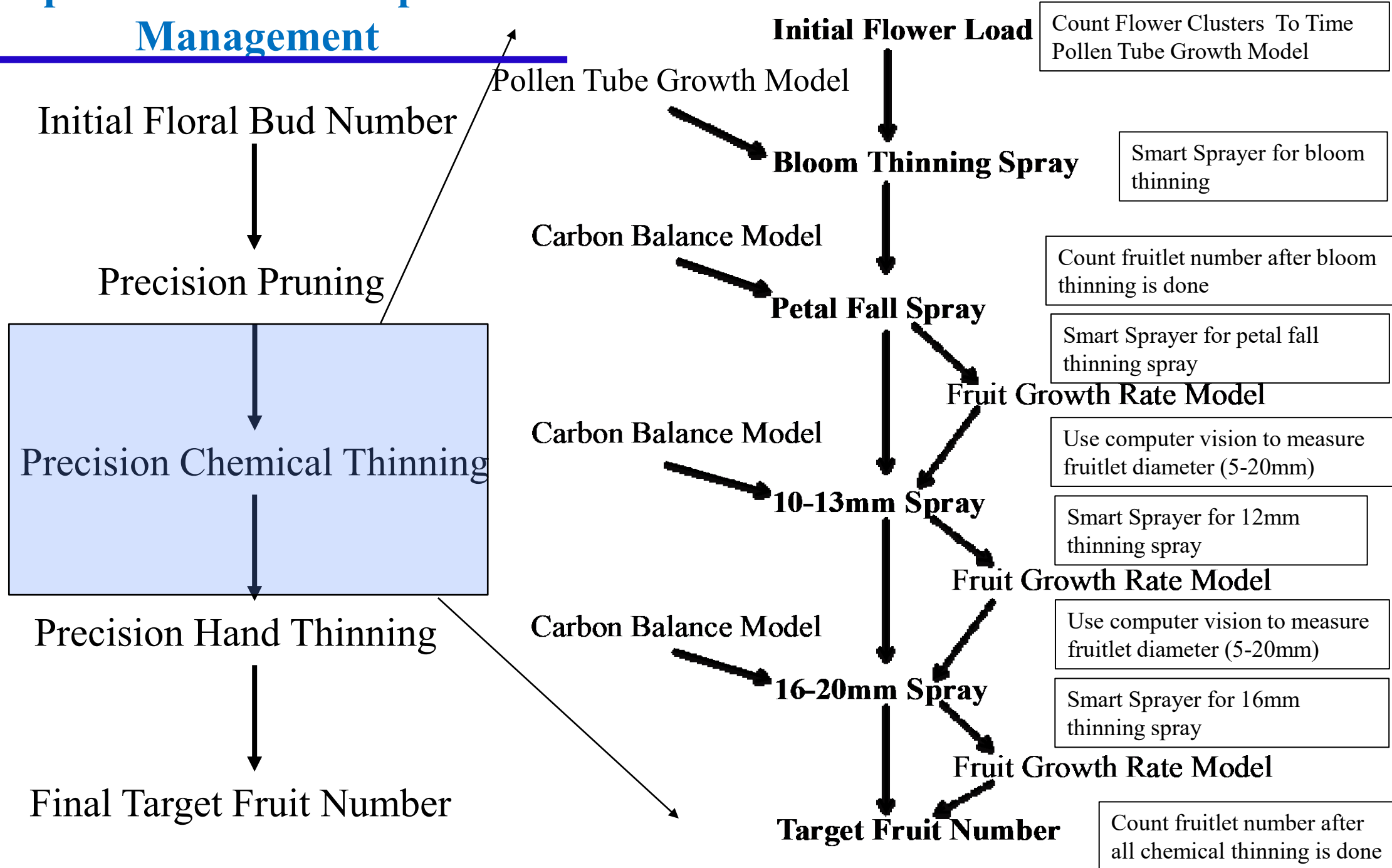


One concept of  
how to  
communicate  
pruning  
instructions to  
human workers



iPad mounted on a pruning platform

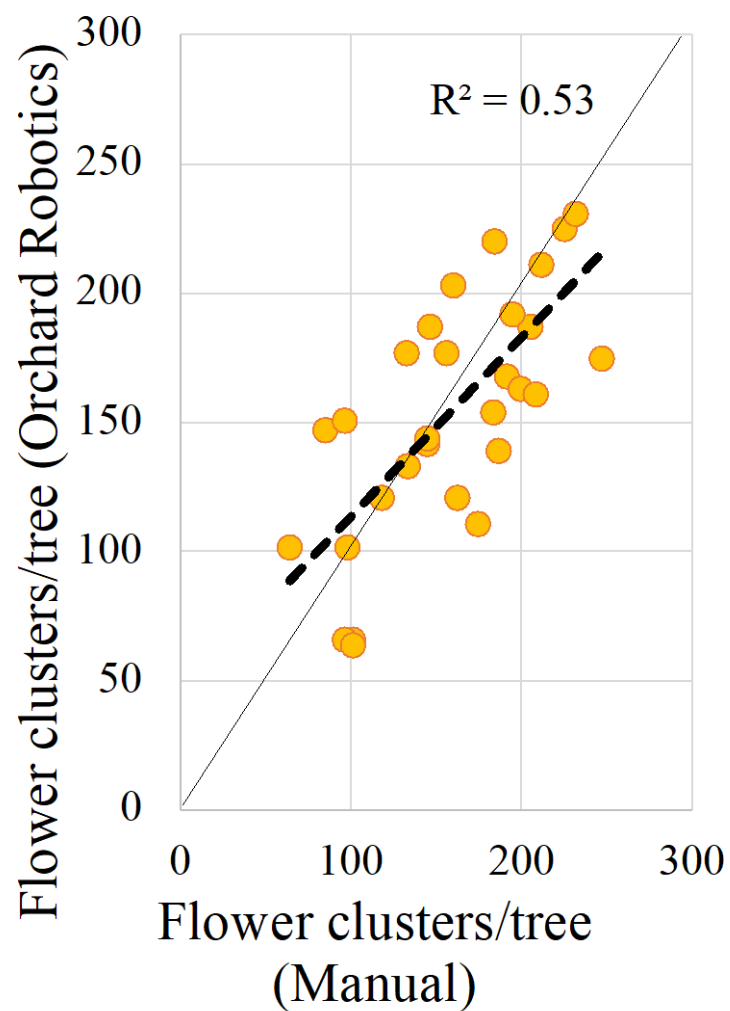
# Steps in Precision Crop Load Management



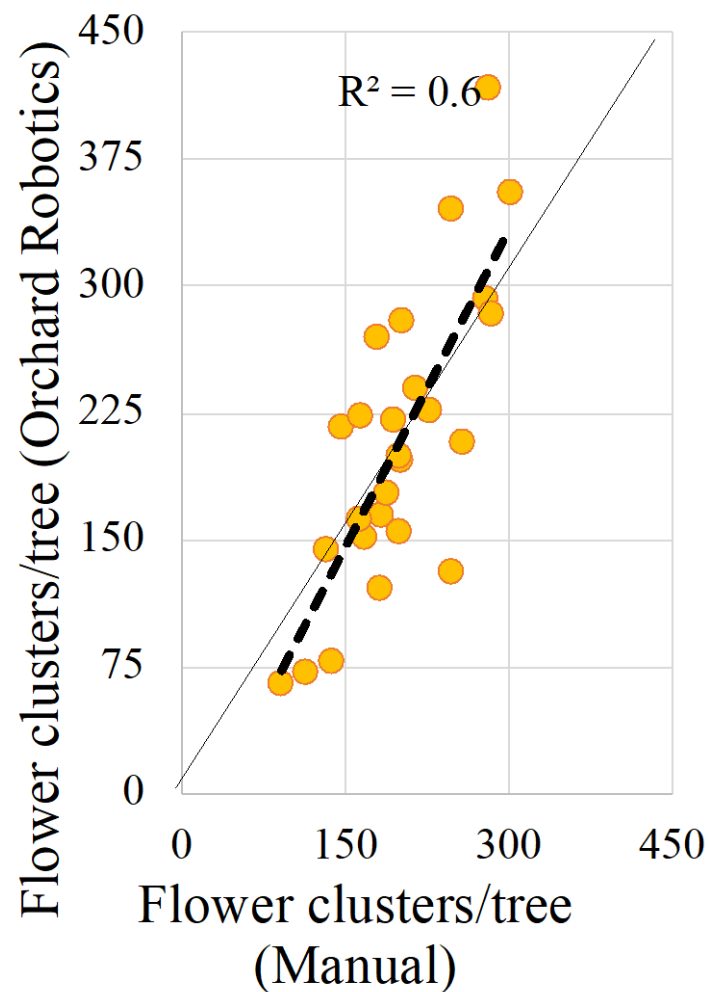


# Computer vision counting of Flowering

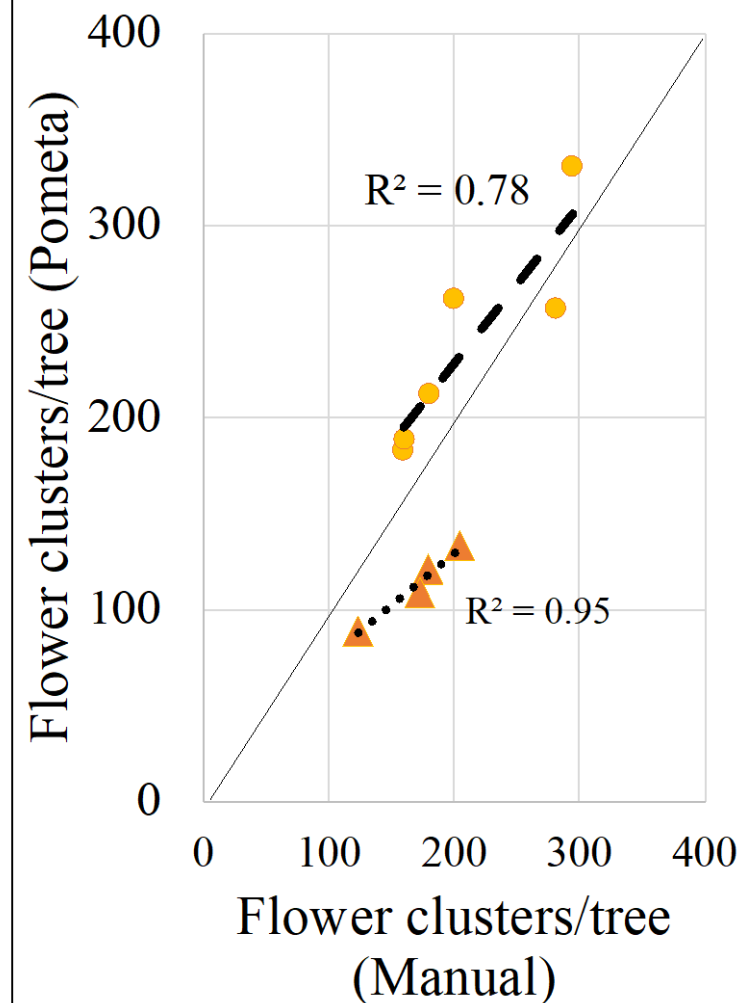
## Fuji



## Gala



▲ 'NY1' ● 'Gala'



With a flower density map it can be used to guide a variable rate sprayer.

A variable rate sprayer can apply more chemical to trees with more flowers and less chemical to trees with fewer flowers and no chemical to trees with no flowers.

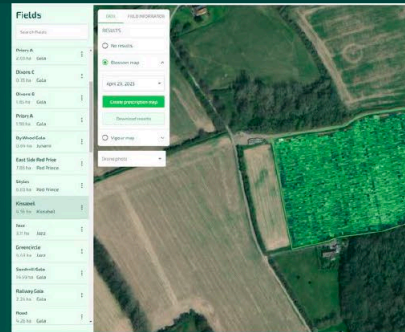
## Aurea Imaging and Variable Rate Spraying

### TreeScout product and process

Farmer drives with TreeScout in orchard



Processing onboard and uploading to the cloud



Client creates prescription map



Prescription maps executed by machine





Horticulture Section, Cornell AgriTech  
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# Progress on Digital Methods of using the Fruit Growth Rate Model





**Vision systems evaluated**  
**Pometa- cell phone system**



**Flowering**

**Fruitlets**

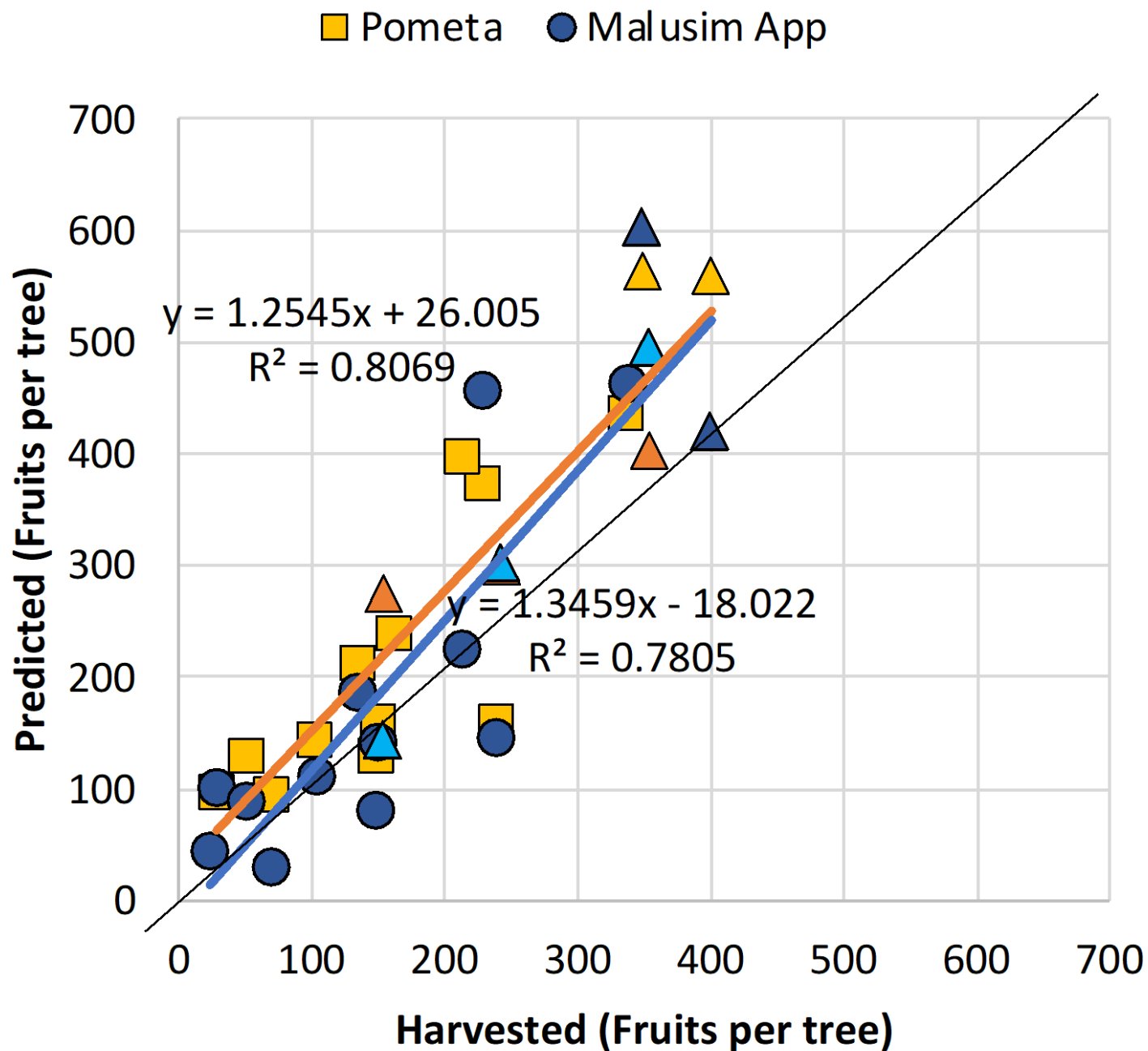
**(Chemical thinning prediction)**

**Yield Estimation**

**Walking and video recording the trees**

**Information at level of orchard**

# Computer vision estimates of fruit set vs Malusim manual method



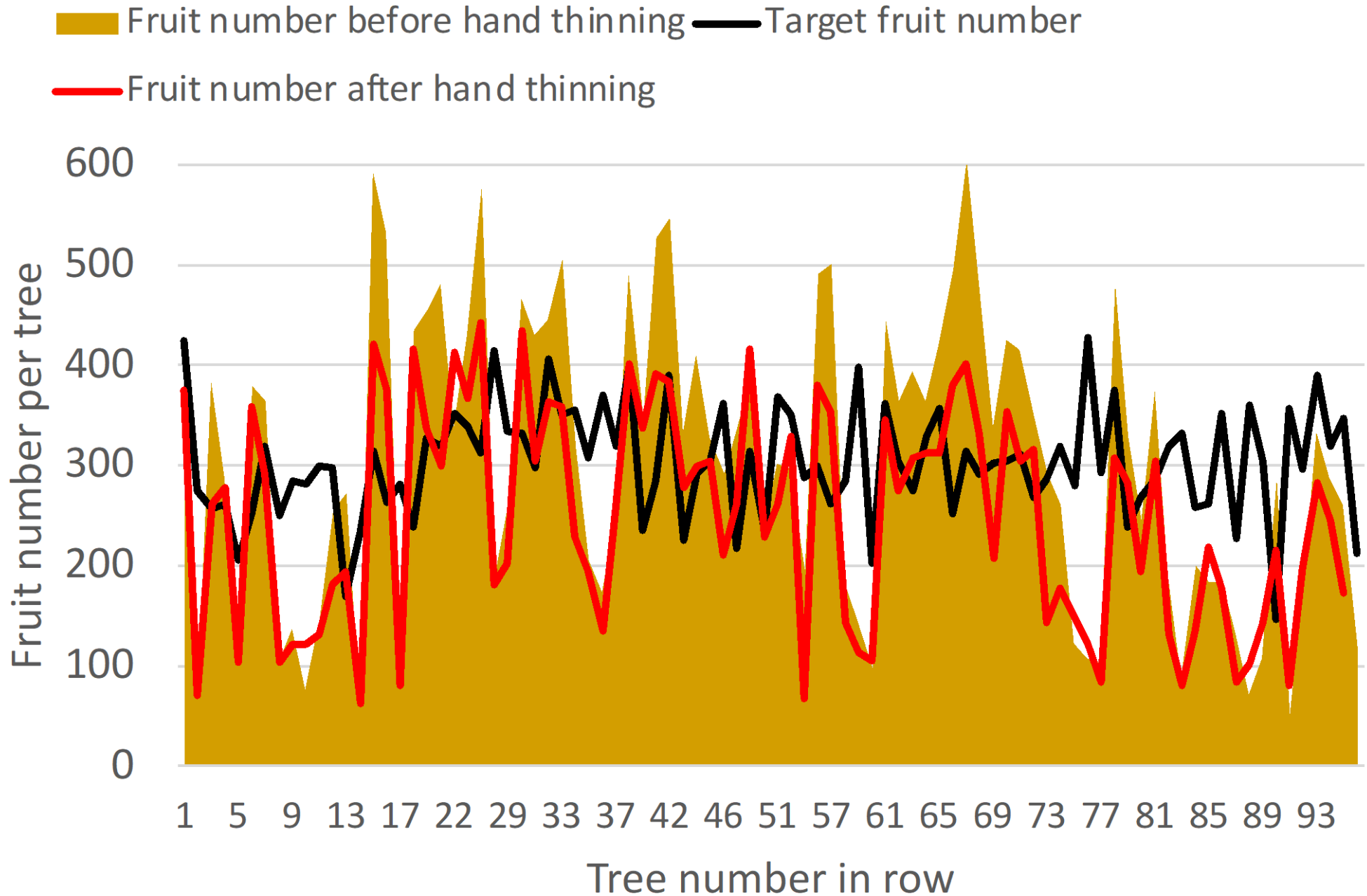


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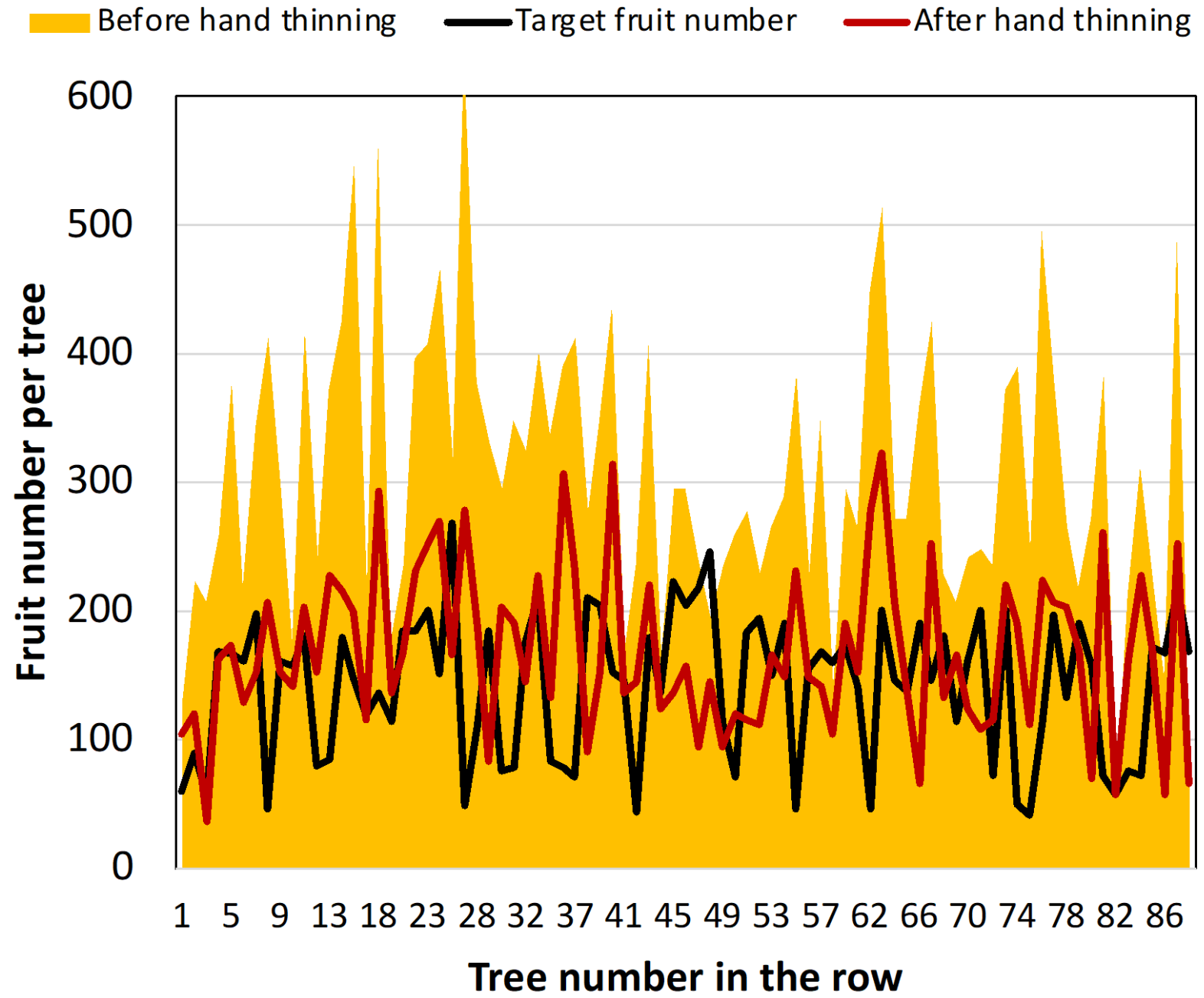
# Progress on Precision Hand Thinning for Individual Tree Optimization-2023



# Variability in fruitlet number along the row - Geneva

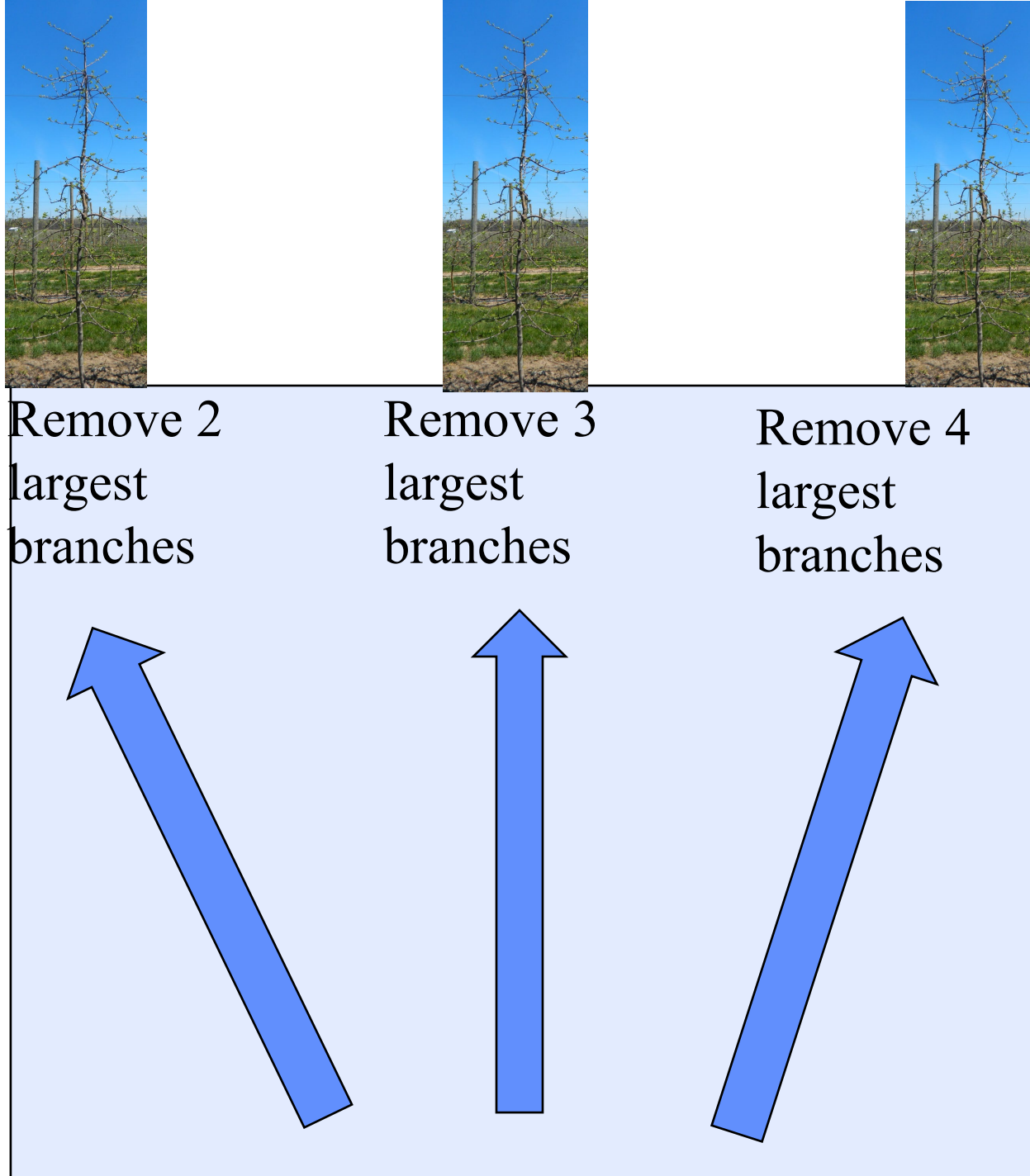


# Variability in fruitlet number along the row – Hudson Valley





One concept of  
how to  
communicate  
pruning  
instructions to  
human workers



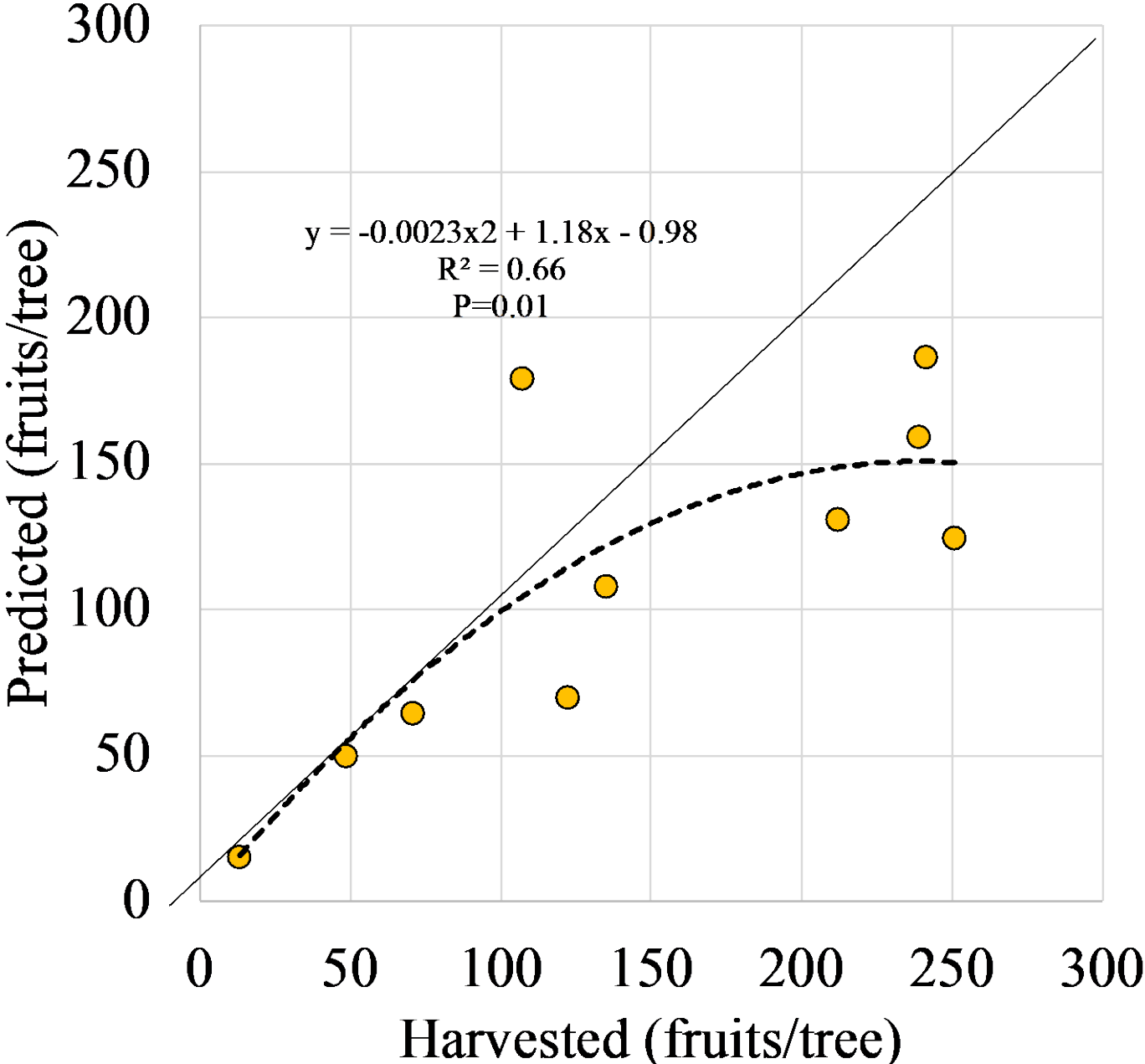
iPad mounted on a pruning platform

# Summary of what we can do in 2024 with digital technology to implement precision crop load management

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- Counts of dormant buds per tree with geo-referencing each tree.
- Measurement of a trunk diameter.
- We cannot yet communicate pruning severity for each tree to human workers.
- Counts of flower number per tree at bloom to first start pollen tube growth model and second to guide smart sprayer for variable rate blossom spraying.
- Apply variable rate chemical thinning using a blossom density map.
- Counts of fruitlets after blossom thinning (5-10mm) to guide chemical thinning.
- Digital measurements of fruit size increase to run the fruit growth rate model after each thinning spray.
- Counts of fruitlets per tree before hand thinning.
- We cannot yet communicate hand thinning severity for each tree to human workers.
- Counts of fruits and measure fruit size to predict yield and size.

# Yield Estimation-Pometa



# Questions

Irrigation.