

# Development of tools to predict crop yield: the EU-SPICY project

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# Smart tools for Prediction Improvement of Crop Yield (2008 – 2012)

## ■ Aim:

Develop tools to predict phenotypic response for complex traits under a range of environmental conditions

## ■ Objectives:

- Develop genotype-to-phenotype model
- Develop phenotyping tools:
  - Fluorescence sensor
  - Imaging sensor
- Find genes underlying physiological processes



# SPICY - partners

- Wageningen UR, The Netherlands
  - Crop growth model, co-ordination
  - QTL analysis tools, phenotyping experiments
- INRA, France
  - Populations, genomics
- VIB, Belgium
  - Genomics
- BioSS, United Kingdom
  - Image analysis
- BME, Hungary
  - Fluorescence sensor
- EEFC, Spain
  - Phenotyping experiments



# Genotype-to-phenotype model

## Crop growth models

- Break-down of complex trait yield
- Modules for leaf area, morphology, photosynthesis, assimilate partitioning and fruit growth dynamics

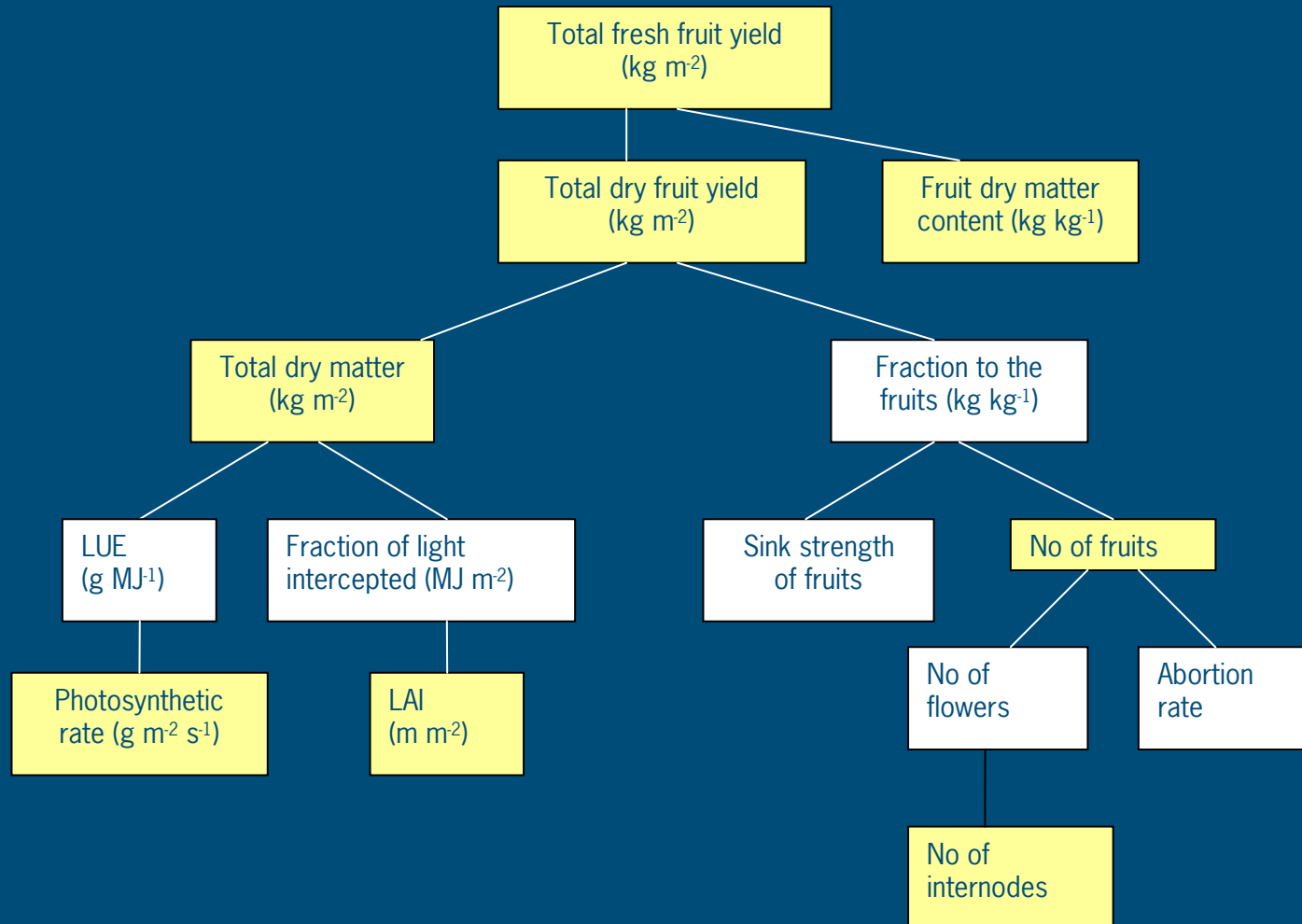
## QTL analysis

- Relate trait to regions in functional genome map to find position of QTL

## Genotype-to-phenotype model

- Relate QTLs to model parameters
- Expected to be more specific and stable

# Components contributing to yield in pepper





# Phenotyping

- To use and validate models, large-scale phenotyping data in different environments are necessary
- RIL population (INRA)

Yolo Wonder x CM 334



- 149 genotypes F6/F7



# Phenotyping experiments

- 2 locations:
  - Wageningen, The Netherlands
  - Almeria, Spain
- 2 seasons:
  - Spring 2009
  - Autumn 2009
- Pruning strategy
- Measurements
  - Climate data
  - Organ weights (start, end)
  - No of internodes, fruits
  - Harvested fruits



# Plant measurements

Genotype	Date of harvest	DW (g plant <sup>-1</sup> )	Leaf area (cm <sup>2</sup> plant <sup>-1</sup> )
Yolo Wonder	10 Dec	140.4	8198
CM334	6 Nov	132.7	5986
F1	23 Oct	223.9	10373
103	30 Nov	235.5	7836
176	20 Nov	288.1	13995

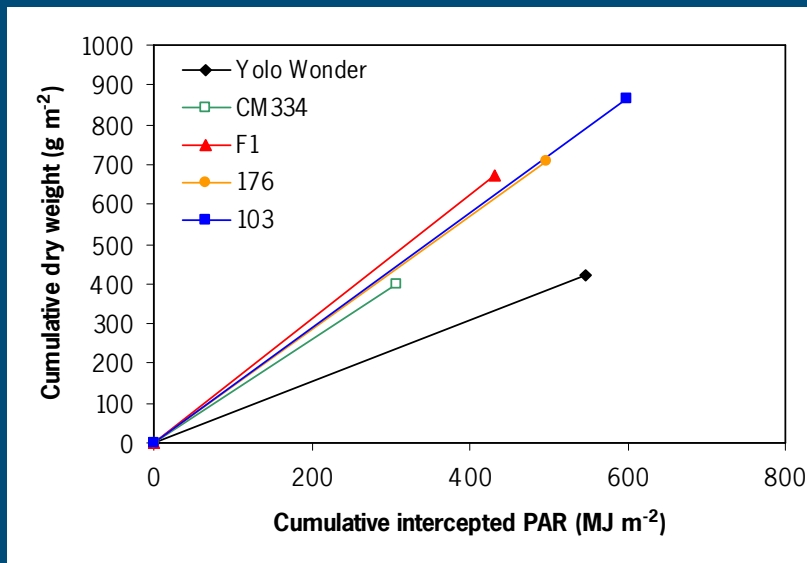
- Data analysis complicated by different moments of destructive harvest
- Link to processes in model



# Analysis into components of crop yield

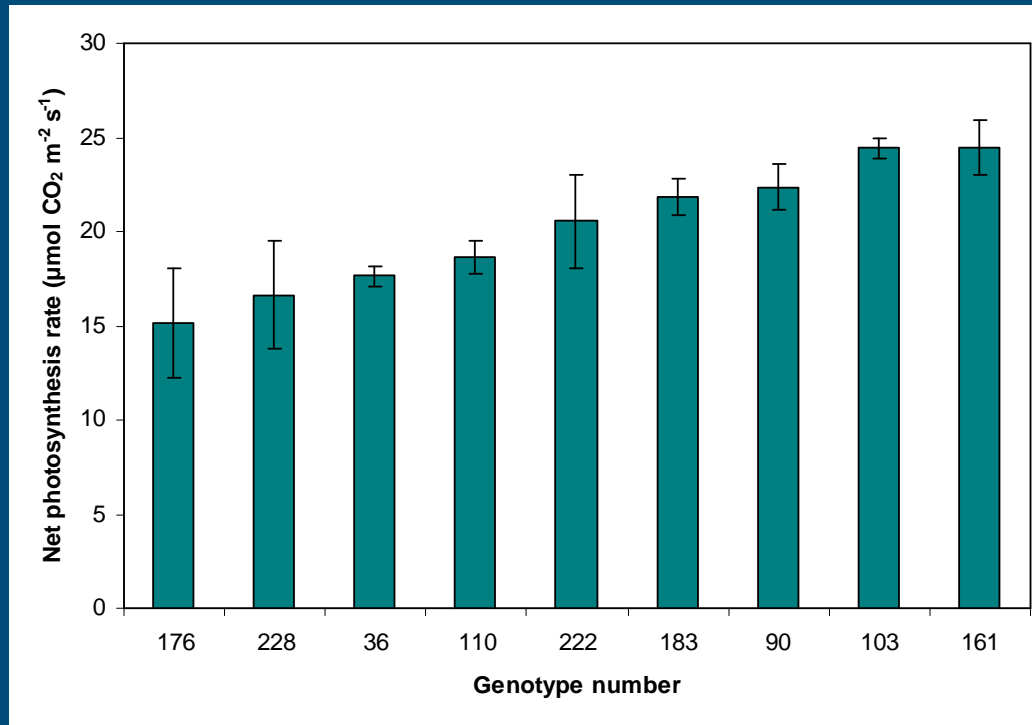
- Date  $\Rightarrow$  radiation sum
- Leaf area  $\Rightarrow$  LAI
- LAI  $\Rightarrow$  light interception
- Light interception and radiation sum  $\Rightarrow$  intercepted radiation sum

$$I = I_0 * (1 - e^{-k * LAI})$$



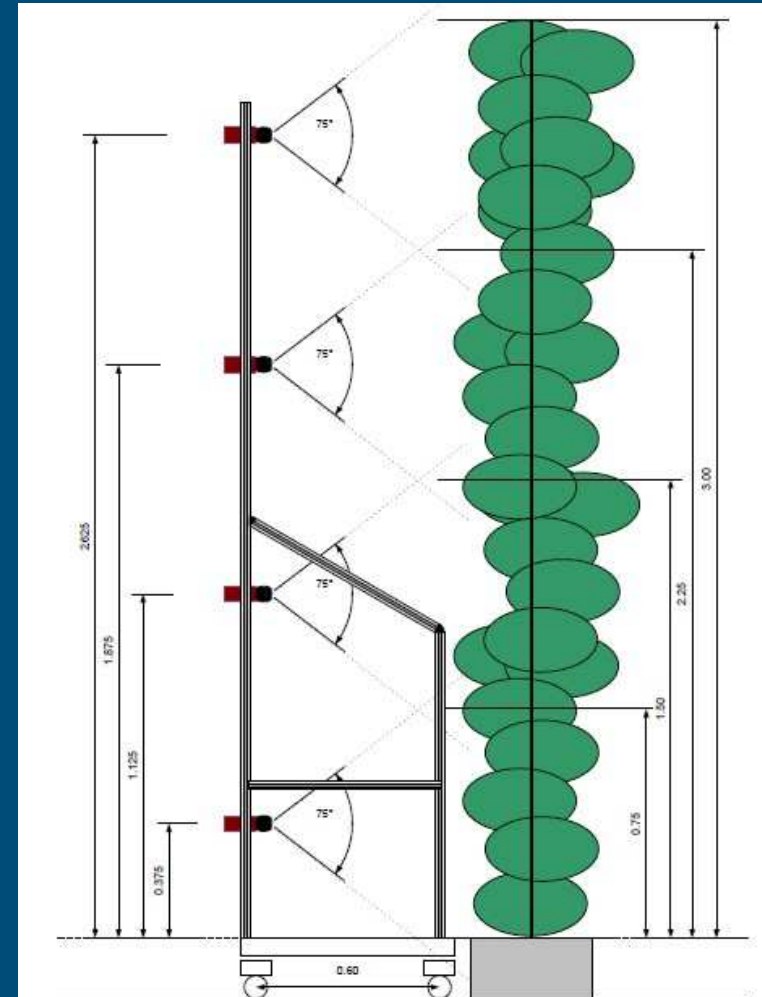
Genotype	LUE (g MJ <sup>-1</sup> )
Yolo Wonder	0.79
CM334	1.28
F1	1.55
103	1.43
176	1.44

# Photosynthesis rate



# Phenotyping by image analysis – SPY-SEE

- Aim: fast phenotyping
- Replace manual labour
- Trolley with cameras
  - 4 RGB camera's
  - 4 infra-red camera's
  - 4 range camera's
- Pulled through canopy
- Reconstruct plant structure and extract features in 3D



# Fluorescence sensor

- Photosynthesis important component of yield
- Measurements time consuming
- Aim: use fluorescence as fast estimate for sub-processes of photosynthesis



# Conclusions

- Genotype-to-phenotype model: possibilities to determine complex traits based on genetic information
- Necessary to know processes underlying complex trait
- Phenotyping: measure relevant processes, fast and automated
- Data analysis important – disentangle climate, time and plant characteristics





# Wageningen UR Greenhouse Horticulture

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