Agroforestry Engineering Department
University of Santiago de Compostela

II JORNADAS DE LÚPULO E CERVEJA

A REGA NO CULTIVO DO LÚPULO: CLAVES PARA O SEU MANEXO

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PART I

HOP WATER REQUIREMENTS

INTRODUCTION

Hop is a vulnerable crop to Climate Changes
Temperature and Rainfall distribution

IRRIGATION IS A SOLUTION?

REVIEW – SJR - Web of Science

- Farm scale
  - Wample and Farrar (1983) – Trickle and furrow irrigation
  - Svoboda et al. (2008) – Drip irrigation - Δ Yield ~ 21%
  - Delahunty et al. (2011) – Drip irrigation and Mulch practices
  - Nakawuka (2013) + Nakawuka et al. (2017) – Subsurface Drip Irrigation
  - Fandiño et al (2015) – Drip irrigation: yield and quality aspects
- Plant scale
  - -Keukeleire et al. (2007) –
  - - Hniličková et al. (2009) – Greenhouse conditions
  - - Gloser et al. (2013) – Drought physiology effects

- Hop water requirements
  - -Bárek et al. (2009) – Slovakia requeriments – 360 mm year^{-1}
  - - Krofta et al. (2013) – Sap flow measures - Transpiration

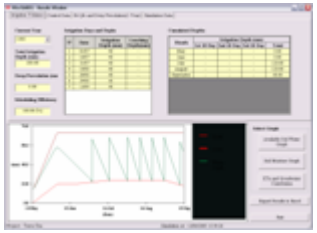
HOW? and WHEN?

SOIL WATER BALANCE MODEL

ISAREG – SimDualKc - ISA- UTL (Pereira *et al.*, 2003)
(Rosa et al., 2012 AWM 103:8-24)

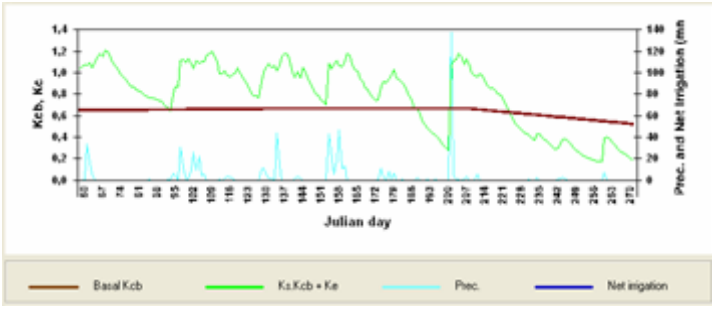
ETc = Kc ETo

$$ET_a = (K_s K_{cb} + K_e) ET_o$$



- Soil Water Balance
  - Crop coefficients (Kc, Kcb)
  - Depletion fraction for no stress (*p*)

- Calibration and Validation



HIPOTHESIS

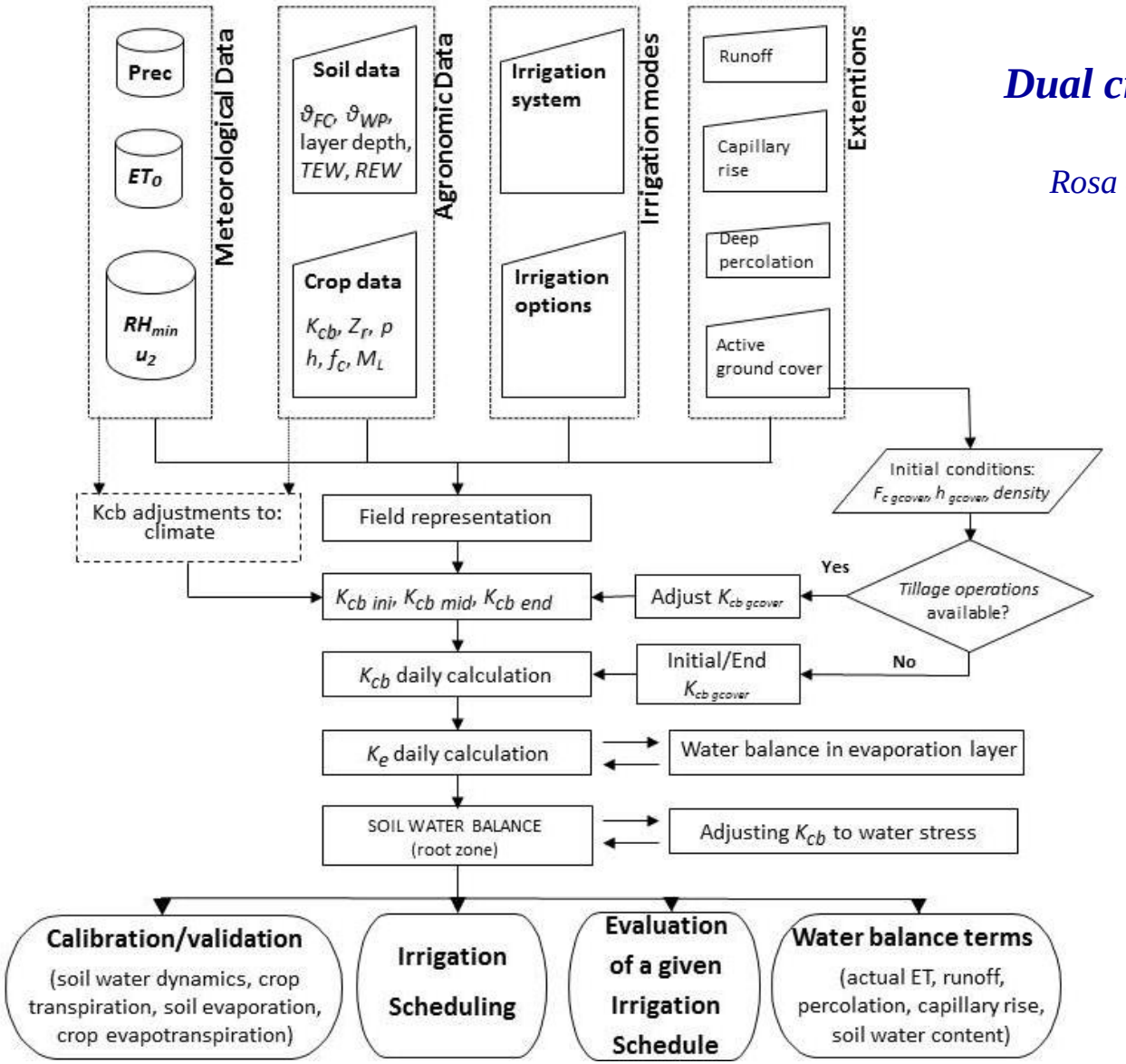
- *Humulus lupulus* cv 'Nugget' + Active Ground Cover

- *Humulus lupulus* cv 'Nugget' + Active Ground Cover + Tillage Practices

- Adjust to Density (Kd)

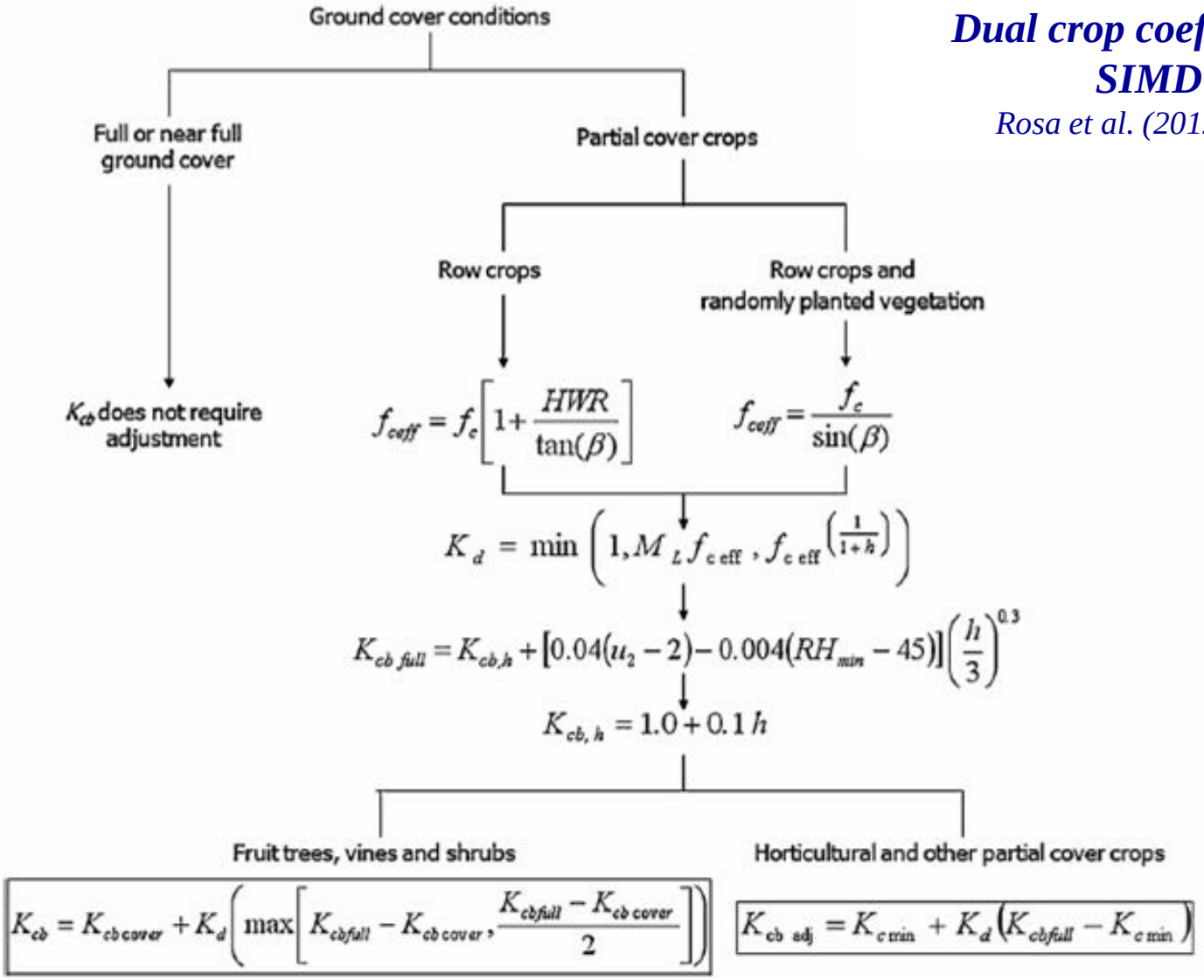
Dual crop coefficient approach SIMDUAL-Kc

Rosa et al. (2012), AWM 103:8-24



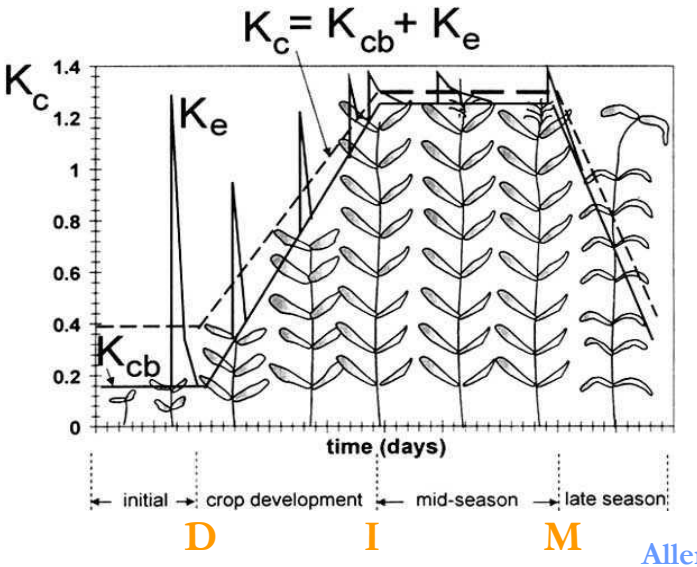
Dual crop coefficient approach
SIMDUAL-Kc

Rosa et al. (2012), AWM 103:8-24



Phenological Stages

D – Start Grow
I – Full Cover
M – Senescence



Allen *et al.* (1998)

20 April

10 July

20 August

Industrial Crops and Products 77 (2015) 204–217

Contents lists available at ScienceDirect

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[a] GI-1716, Department of Agroforestry Engineering, University of Santiago de Compostela, Campus Universitario, 27002 Lugo, Spain

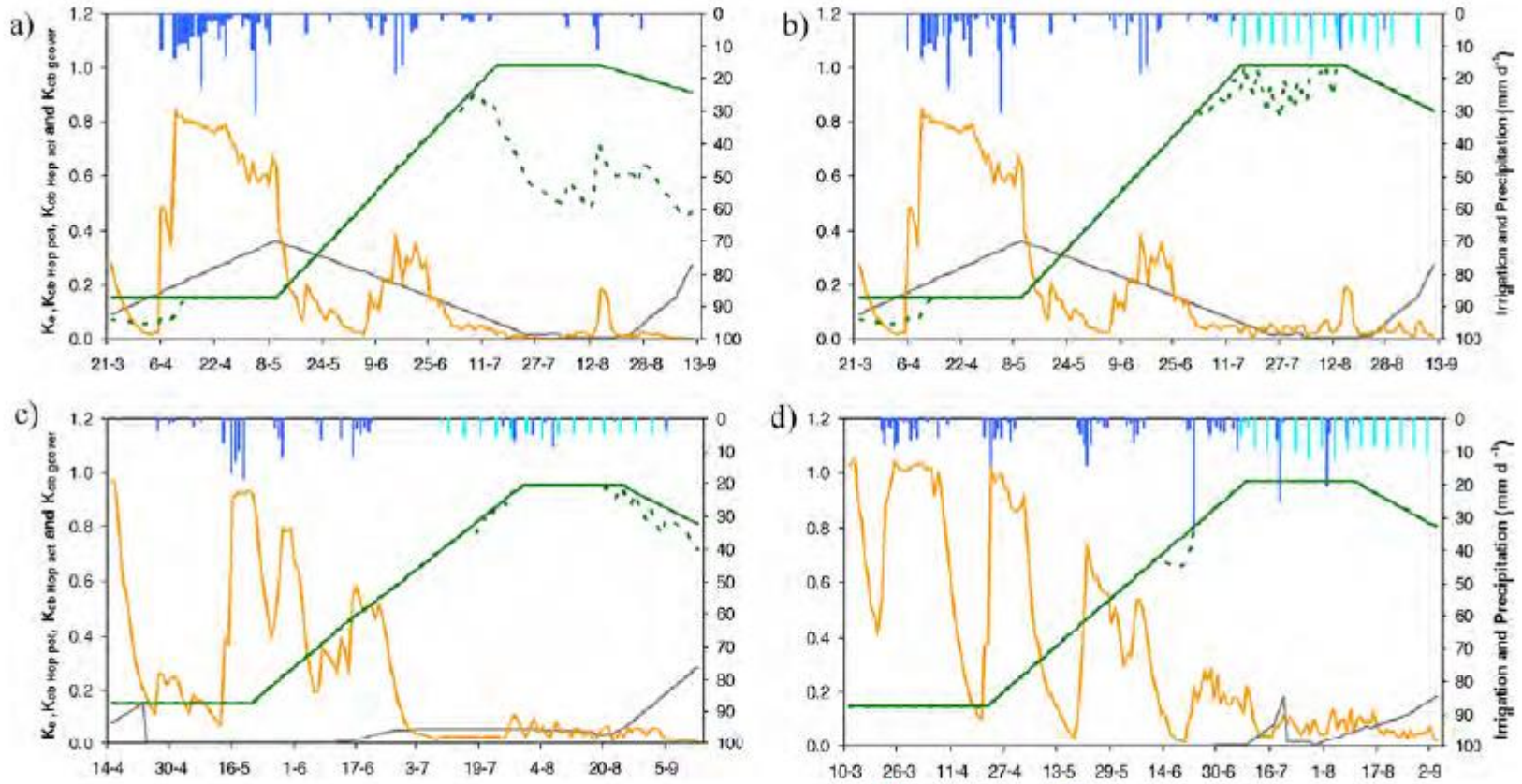

Fig. 3. Variation of $K_{cb\ Hop\ pot}$ (——), $K_{cb\ Hop\ act}$ (- - - - -), $K_{cb\ gcover}$ (——), K_e (——), irrigation (▮) and precipitation (▮) relative to: (a) Plot 1, rain-fed, 2012, (b) Plot 2, irrigated, 2012, (c) Plot 1, irrigated, 2013, and (d) Plot 2, irrigated, 2014.

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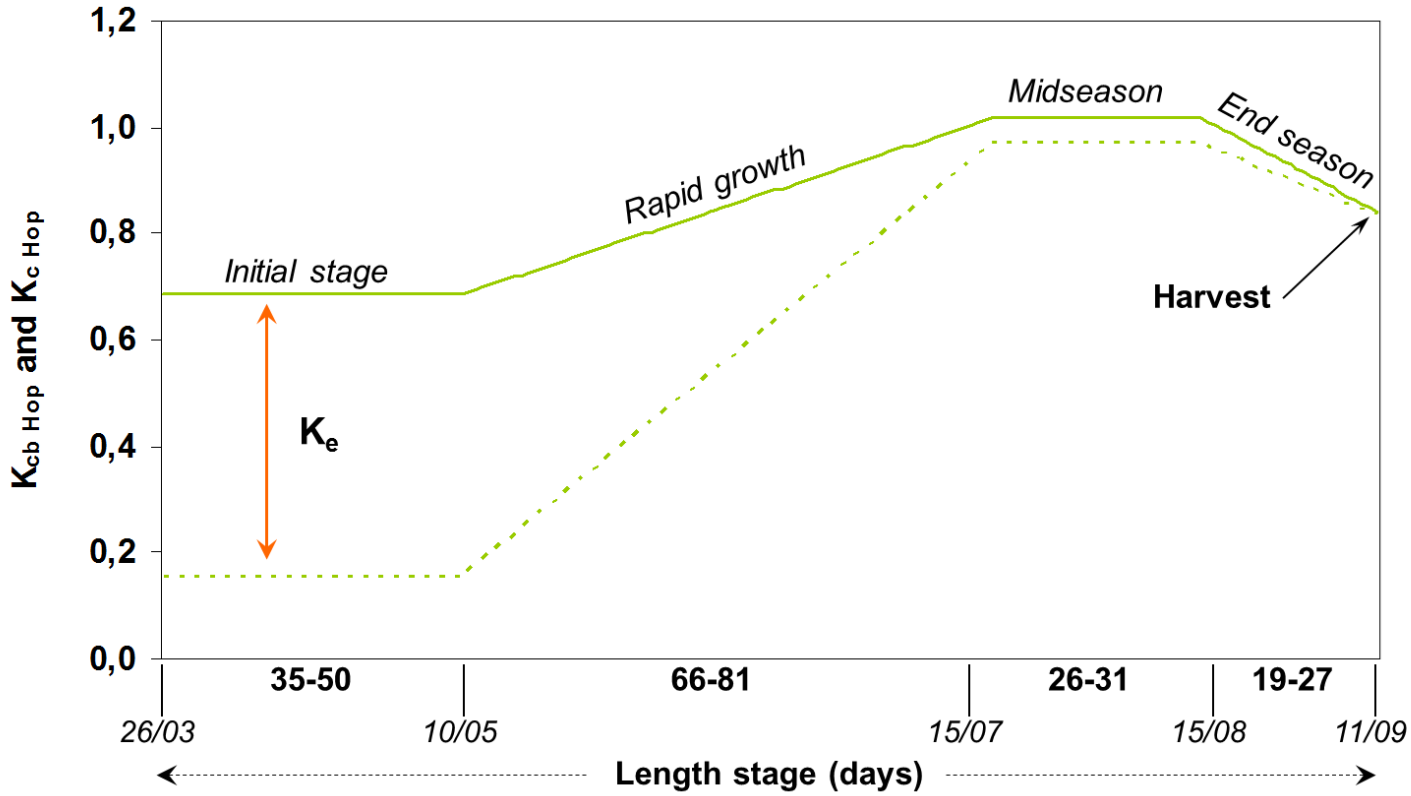


Irrigation advisory system:

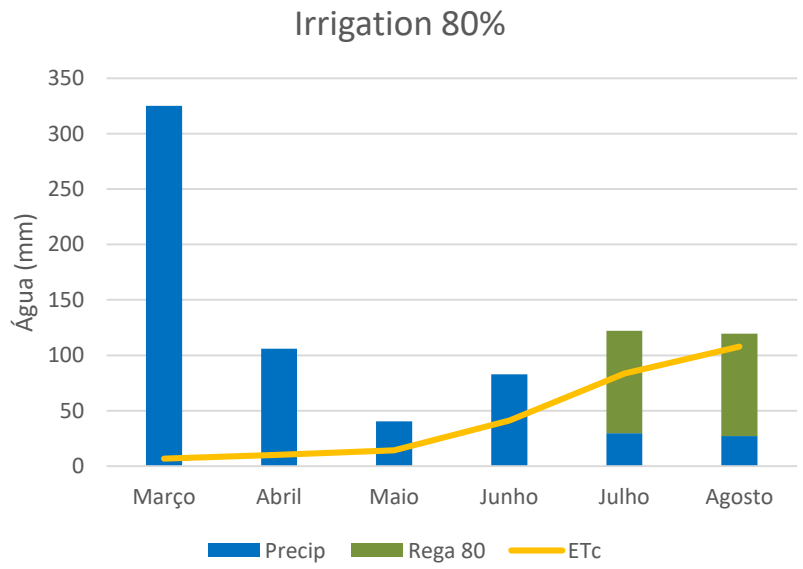
'ET_o+ K_c or K_{cb}' + 'Soil water content (sensor network)'

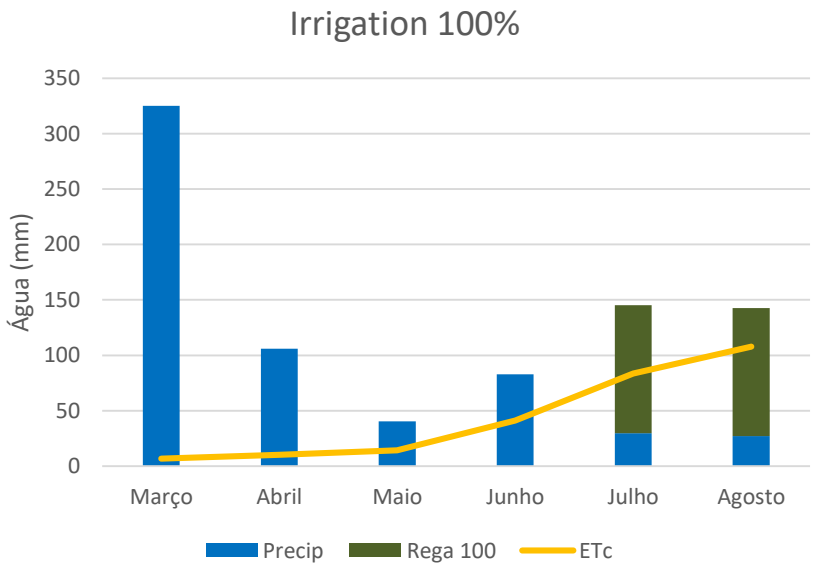
$$\lambda ET = \frac{\Delta(R_n - G) + \rho c_p \frac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \frac{r_c}{r_a}\right)}$$

Kc	Value	Phenology
Kc ini	0,15	00 - 20
Kc med	1,00	60 – 79
Kc end	0,80	80 - 89

(Allen et al., 1998)

ETo = 515,5 mm **ETc = 263,5 mm**





PART II

IRRIGATION MANAGEMENT

WIRELESS SENSOR NETWORK

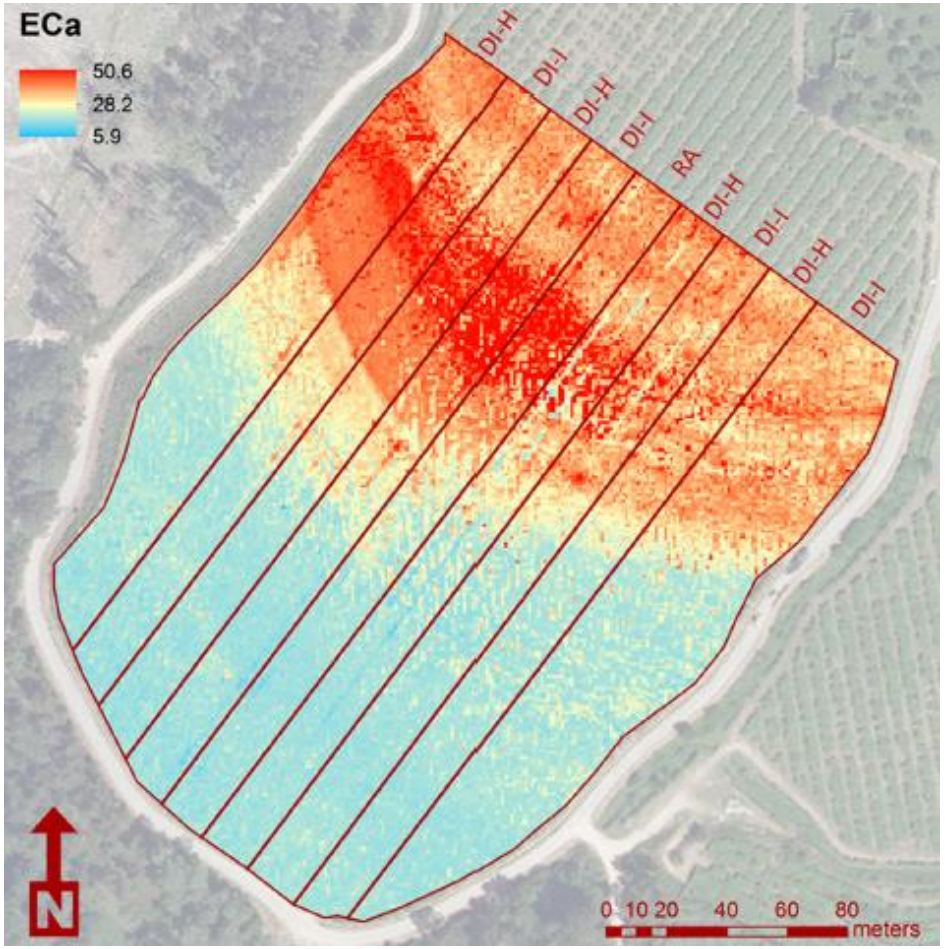
- **CLIMATE:** Temperature, humidity, rainfall, …

- **SOIL**

- **PLANT**

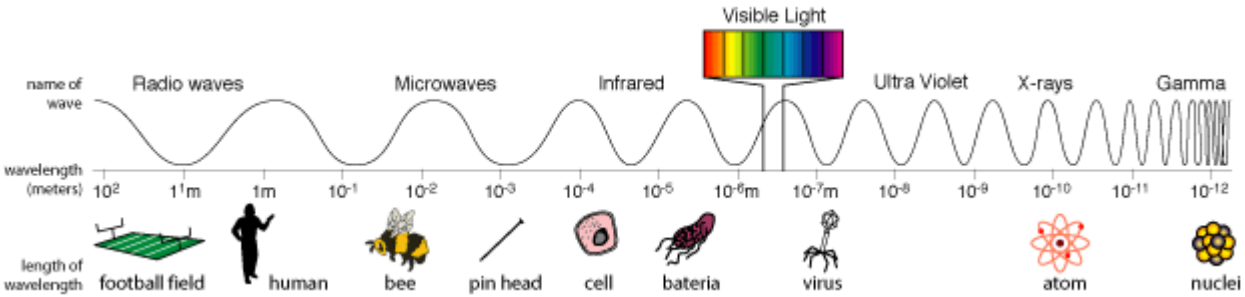
MEASURING WITH EM38

EM38 CALIBRATION

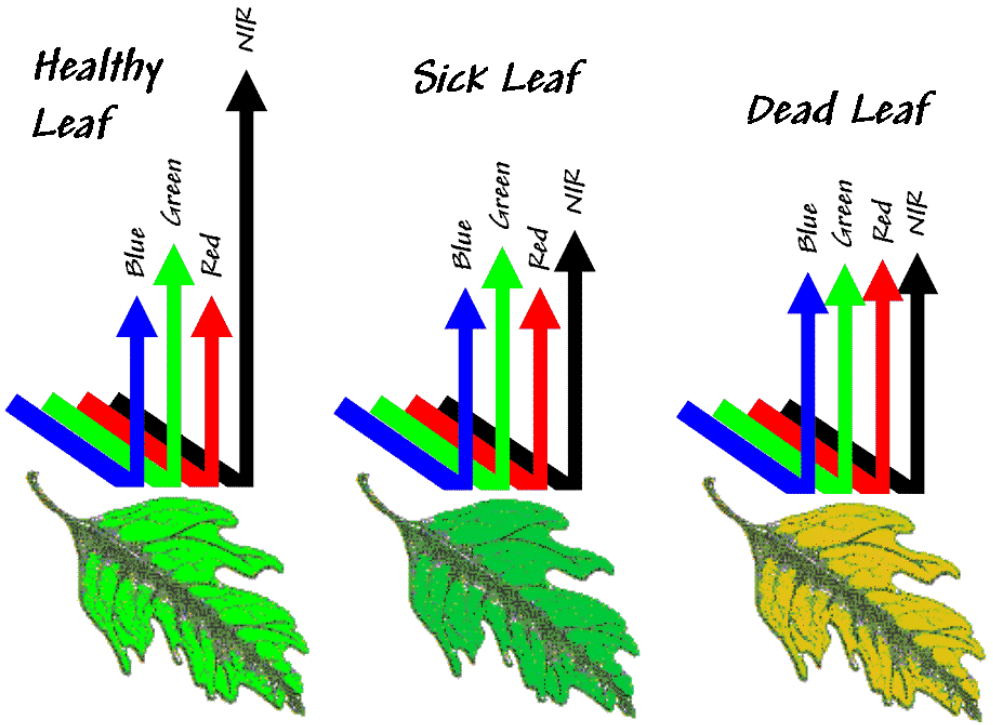


SOIL APPARENT ELECTRICAL CONDUCTIVITY

ELECTROMAGNETIC SPECTRUM



REFLECTANCE



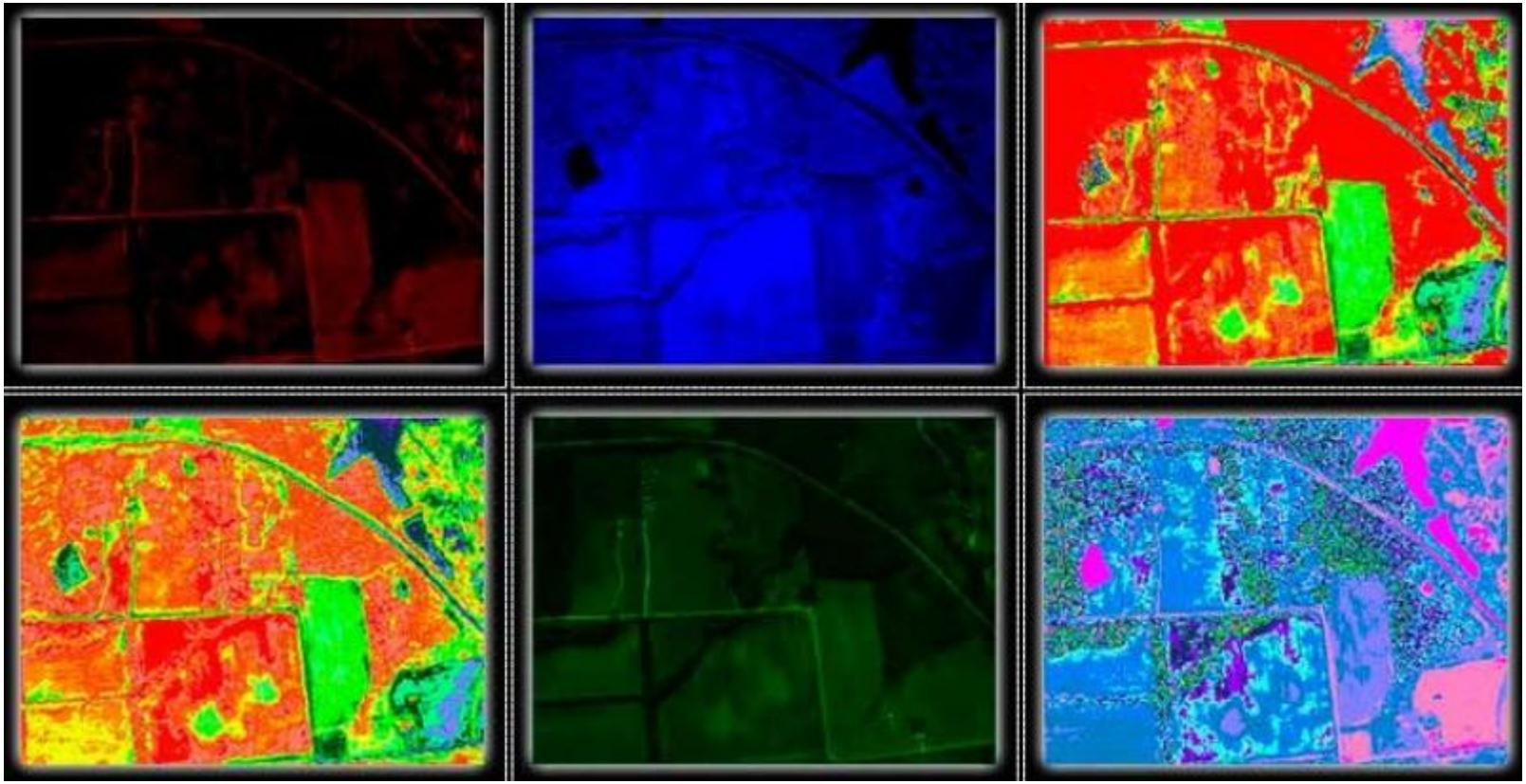
PHOTOGRAPHIC CAMERA

CANON SX-530

MULTISPECTRAL CAMERA

TETRACAM

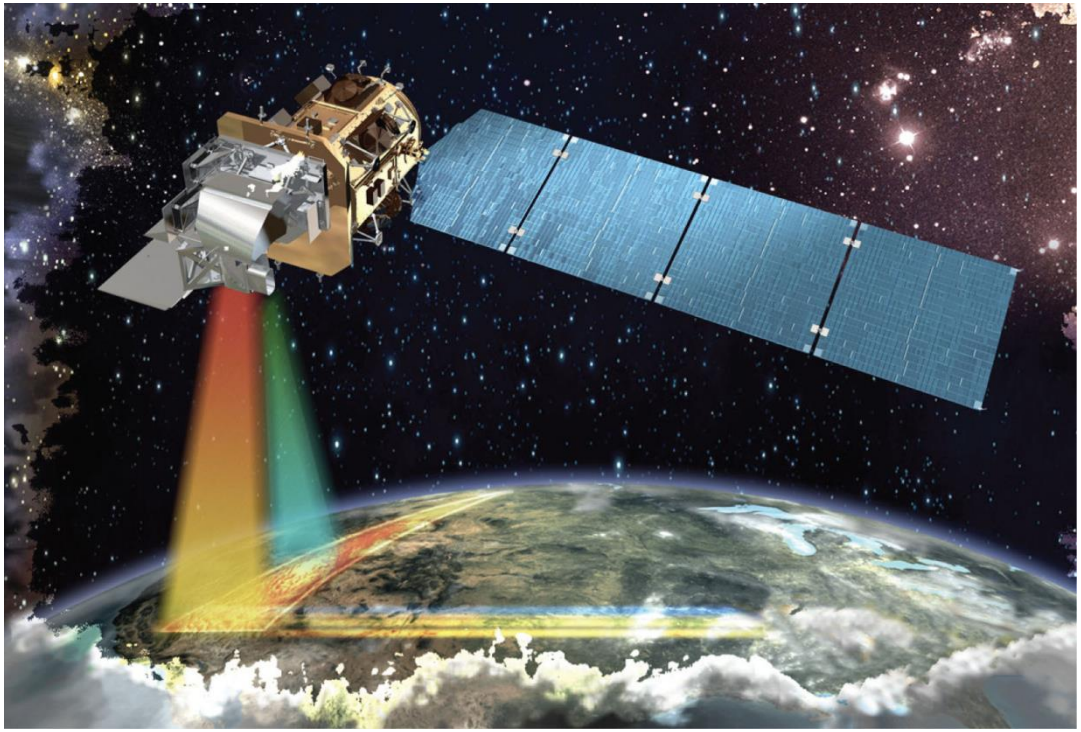
MULTISPECTRAL IMAGES



TETRACAM IMAGES

PLATFORMS:

a) SATELLITE: Landsat, Geoeye, Sentinel, etc.



PLATFORMS:

b) UAV/DRONE:

PLATFORMS:

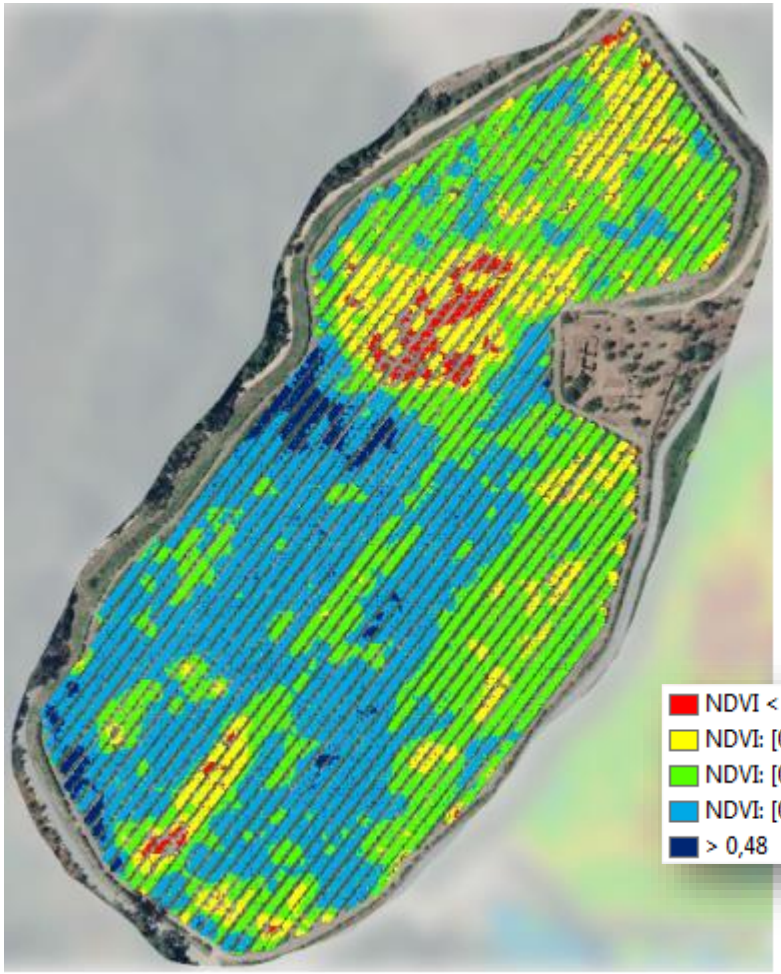
c) OTHER:

HOW TO PROCEED?

- **VEGETATION INDEX**
  - NDVI (normalized difference vegetation)

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red})}$$

  - CSWI (Crop Water Streess Index)
  - PCD. (Plant Cell Density)
  - PVR (Photosynthetic Vigour Ratio)
  - LAI (Leaf Area Index)
  - fPAR (Photosynthetically Active Radiation)
  - …
- **MACHINE LEARNING: Image recognition**



NDVI

OUR TEAM

Benjamín J Rey Sanjurjo

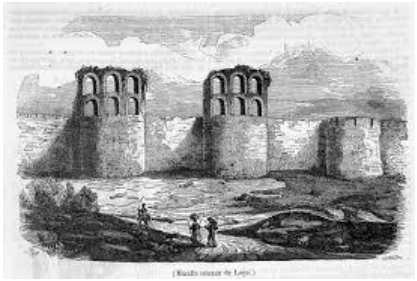
María Fandiño Beiro

Javier J Cancela Barrio

Xesús Pablo González Vázquez

Scientific-Technical Commission
International Hop Growers` Convention

See you in Lugo in June - July 2021



THANK YOU FOR YOUR ATTENTION

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