

Big Data and Artificial Intelligence to Estimate Crop-Evapotranspiration on Management Zone Level

Ofer Beerli and Ran Pelta
September 2020



Grand Water Research Institute
The Technion platform for science, technology,
engineering and management of water



Department of Natural Resources
and Environmental Management
החוג לניהול משאבי טבע וסביבה

Virtual Conference



Agenda

- **Manna Irrigation**
- **Main key for irrigation decision-making in the zone level: the crop coefficient (K_c)**
- **Two approaches for big data estimation of K_c using remote sensing:**
 1. **One crop many plots**
 2. **One plot many crops**
- **Examples for each approach**
- **Conclusions and future directions**

Manna Irrigation

- **Integrate inputs**
- **Management zone:** at least 0.5 ha. Equal to pure pixel of 30m, or area control by valve
- **Implementation:** from past (irrigate the amount that was lost) to forecast (irrigate what will be needed)



The Crop Coefficient (Kc)

Presentation goal:

Big data and intelligence analysis to determine crop coefficient (Kc) for management zones of => 0.5 ha

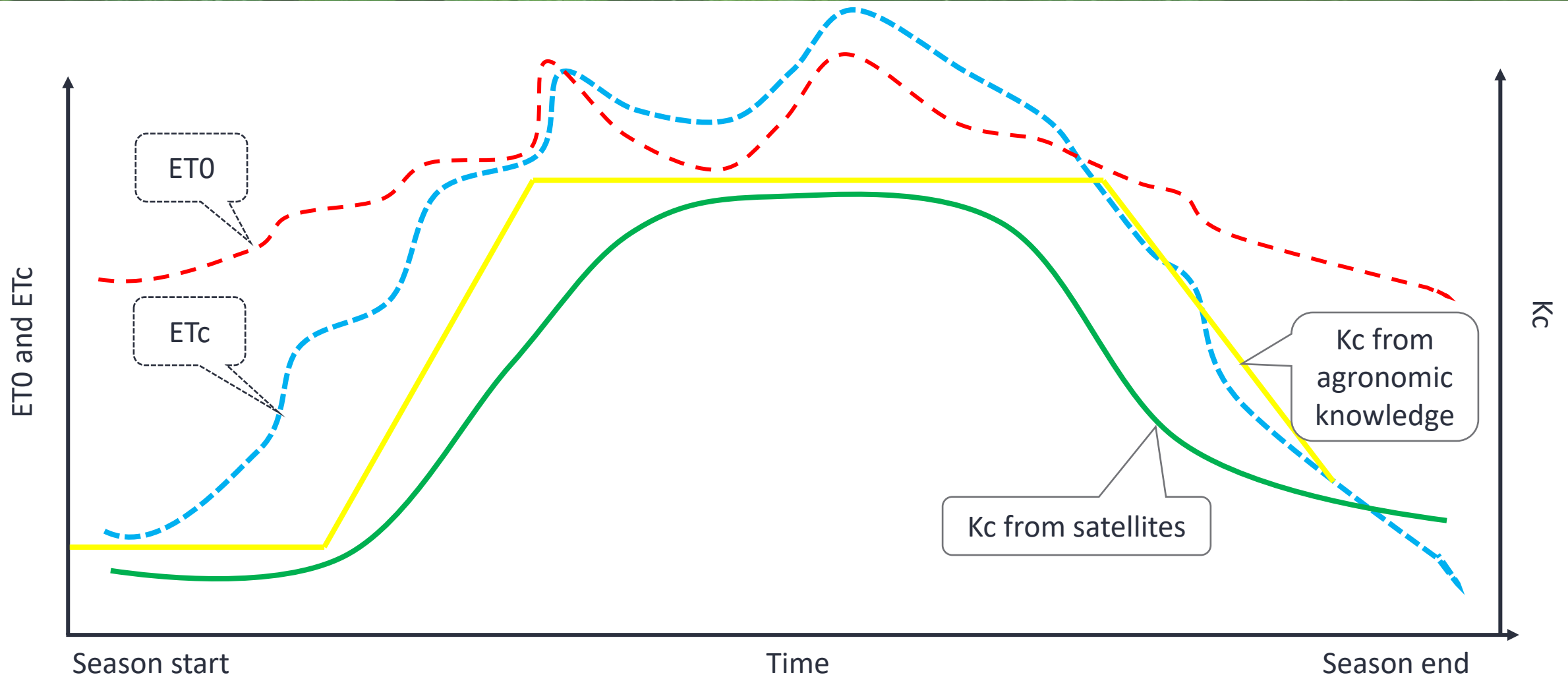
Crop evapotranspiration (ETc) = reference evapotranspiration (ET0) * Kc

ETc (TIR) is >60m and above (not relevant for management zone),

ET0 changes are in mode of several 100 m

Kc change from crop to crop (Agronomic Kc) or from zone to zone (satellite Kc)

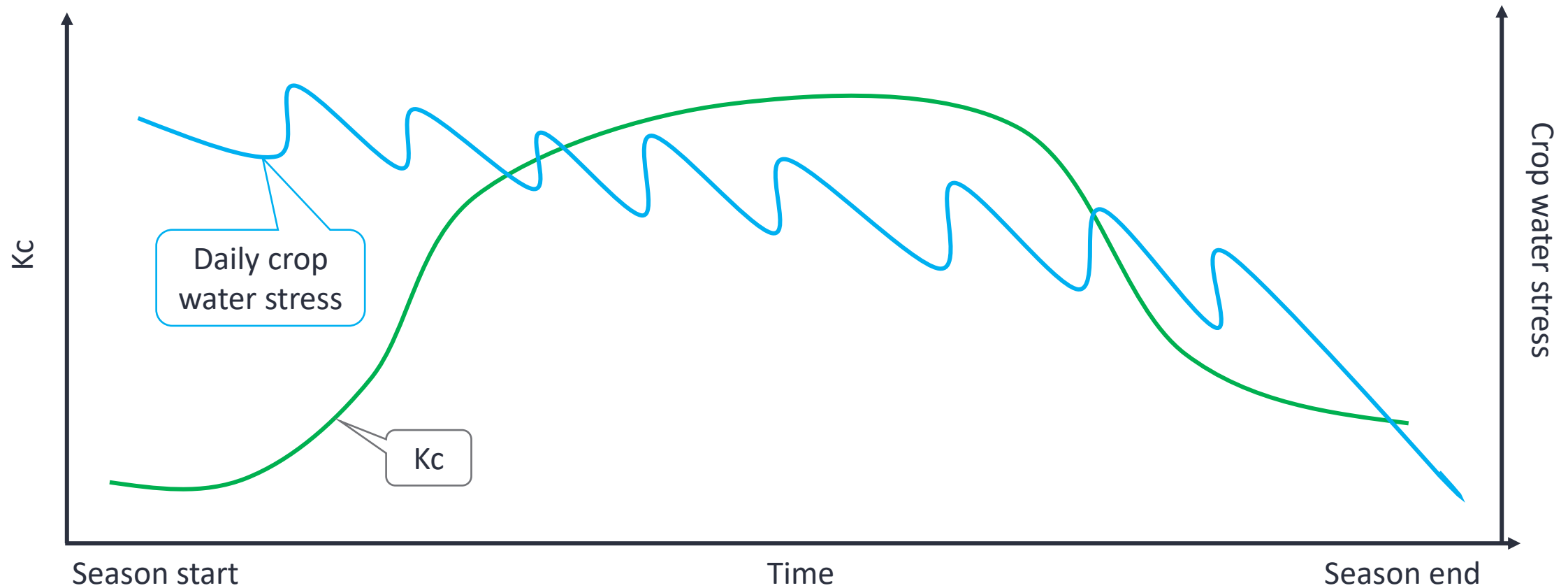
The Crop Coefficient (Kc)



Crop evapotranspiration (ET_c) =
reference evapotranspiration (ET₀) * crop coefficient (K_c)

The Crop Coefficient (Kc)

Crop water stress is another factor for irrigation decision making, but it is not presented here



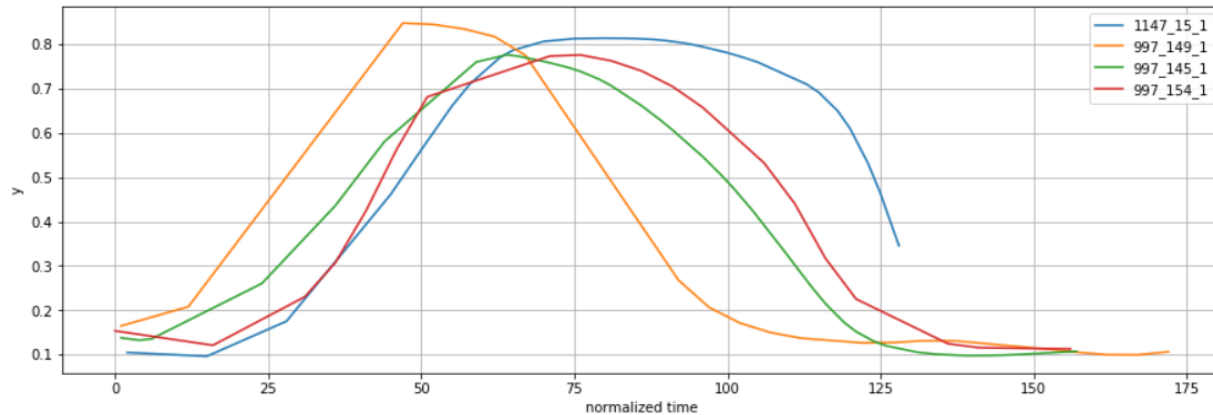
Manna Database for Analysis

For each zone we used the following features:

- Polygon
- Crop type
- Season milestones
- Weather
- Remote sensing
- Crop Kc protocol

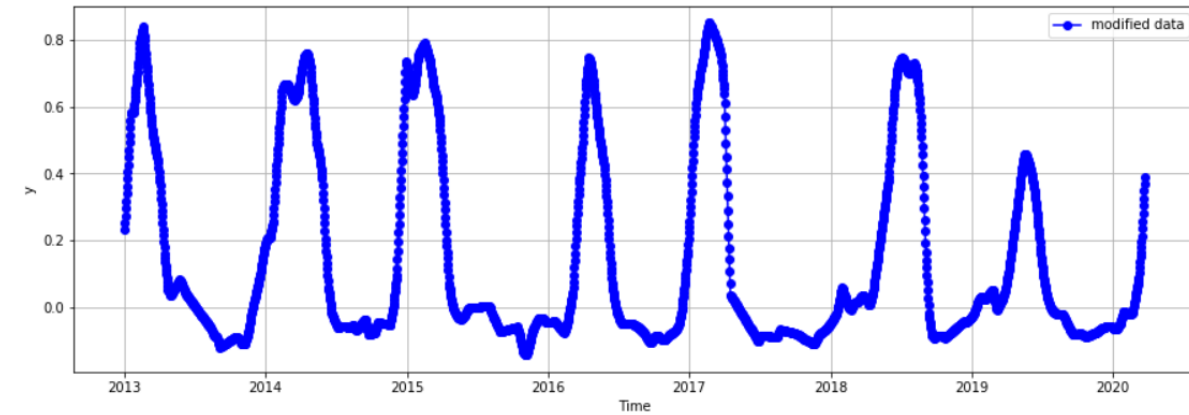
Two Approaches for Big Data Estimation of Kc

One Crop Many Plots



- Consider various soil types, climate, etc.
- Requires a lot of plots with the same crop
- Requires a lot of parameters/features
- Only crops with sufficient data
- **Forecast of entire season**

One Plot Many Crops



- Consider local conditions
- Needs only a few years of data of the same plot
- Requires only past Kc
- Any crop anywhere
- Forecast of near future

First Approach Forecast

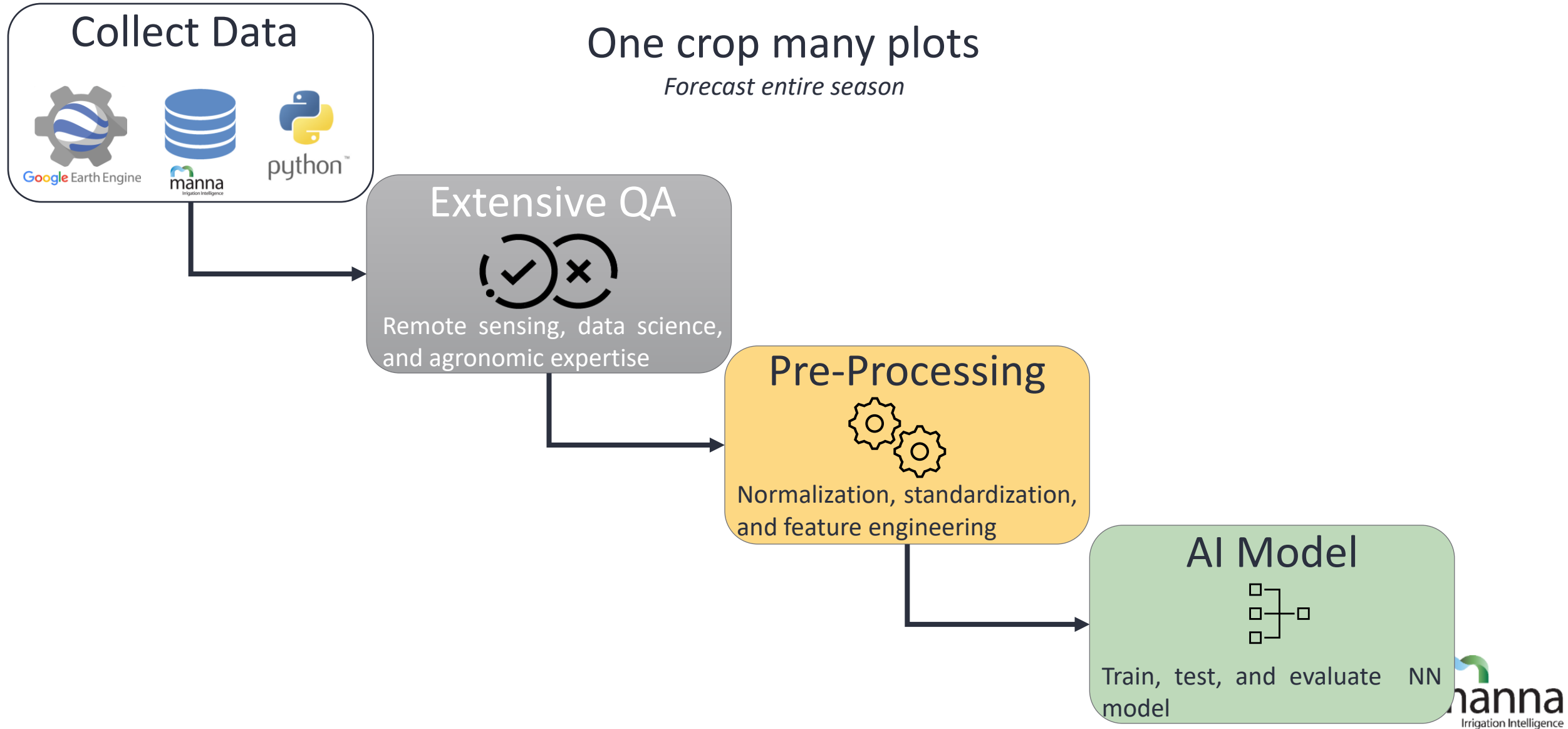
One crop many plots

Forecast entire season

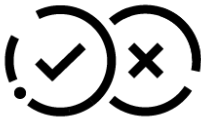
Forecast of the entire season will enable us to:

- Forecast K_c
- Have a growth model at the beginning of each growing season
- Derive better milestones

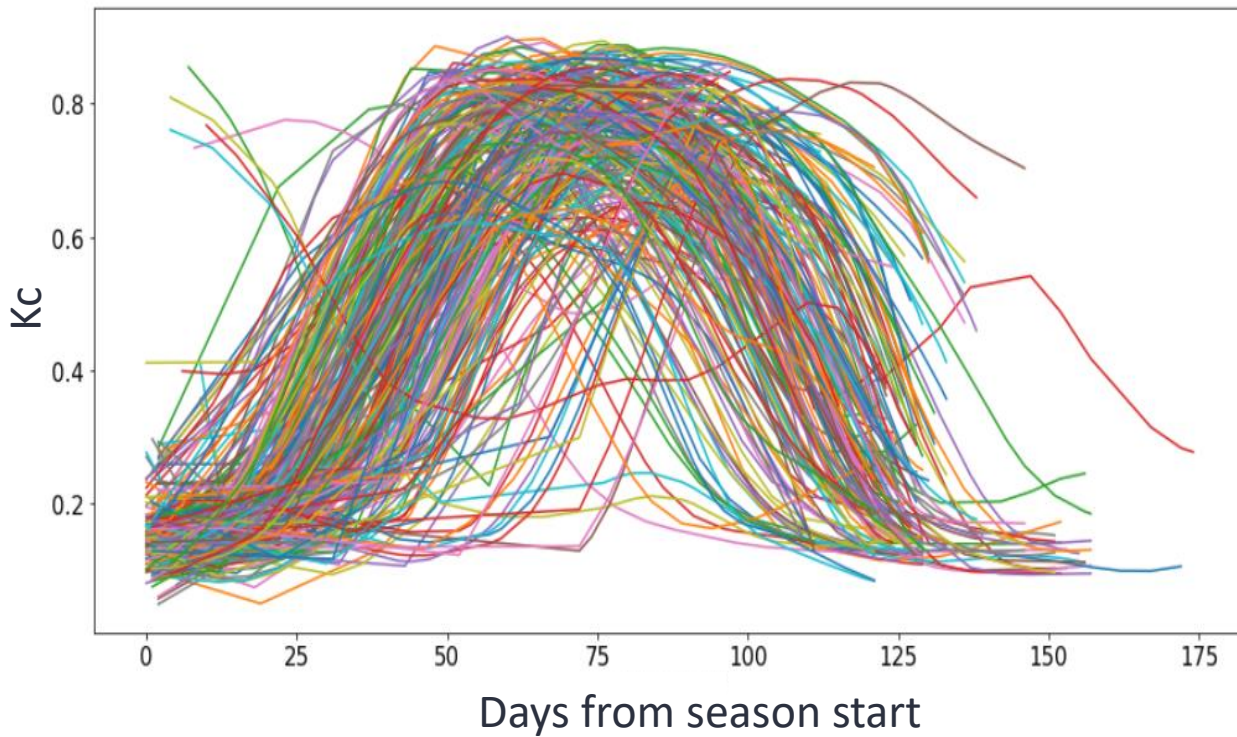
First Approach Methodology



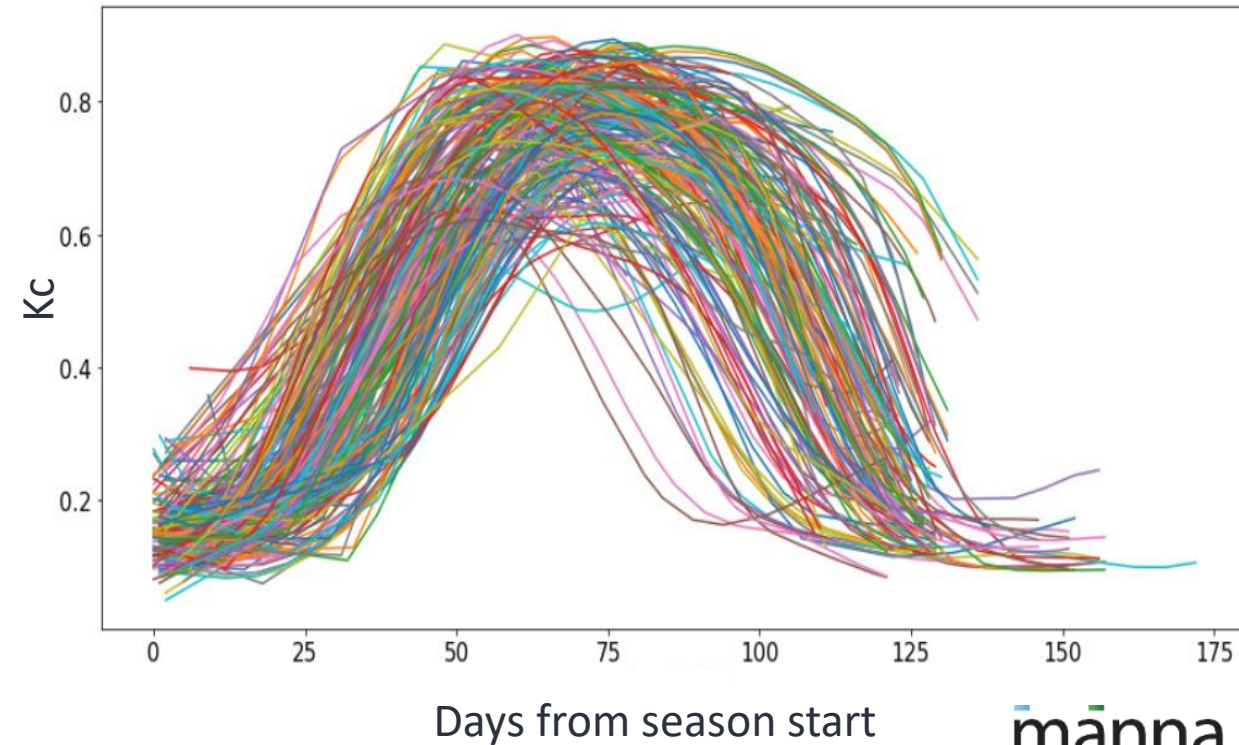
First Approach Methodology

QA example 

Before (394 zones)

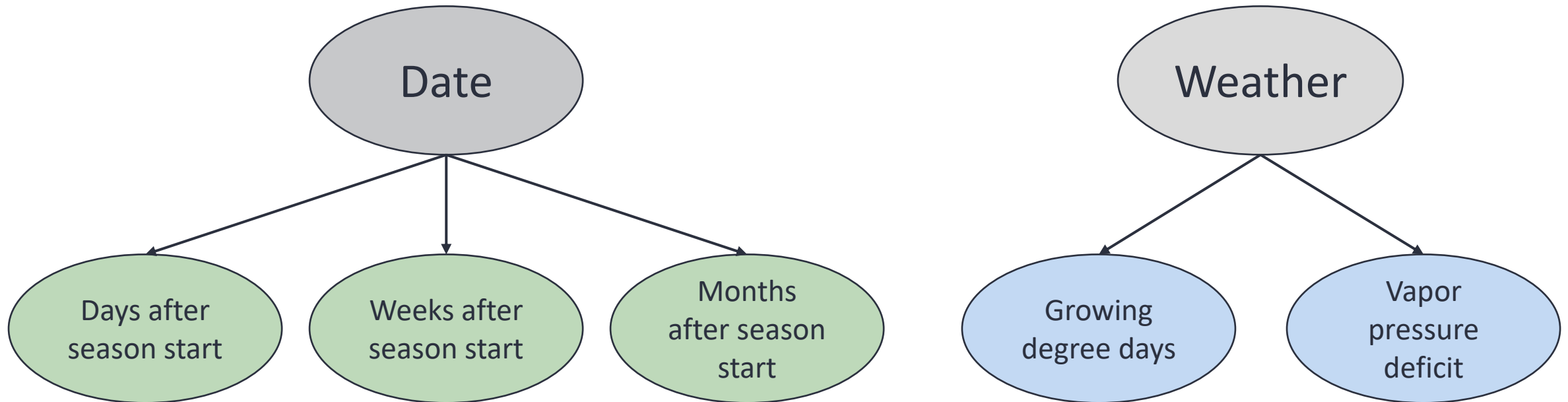
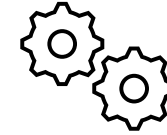


After (231 zones)



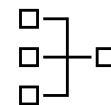
First Approach Methodology

Feature engineering example

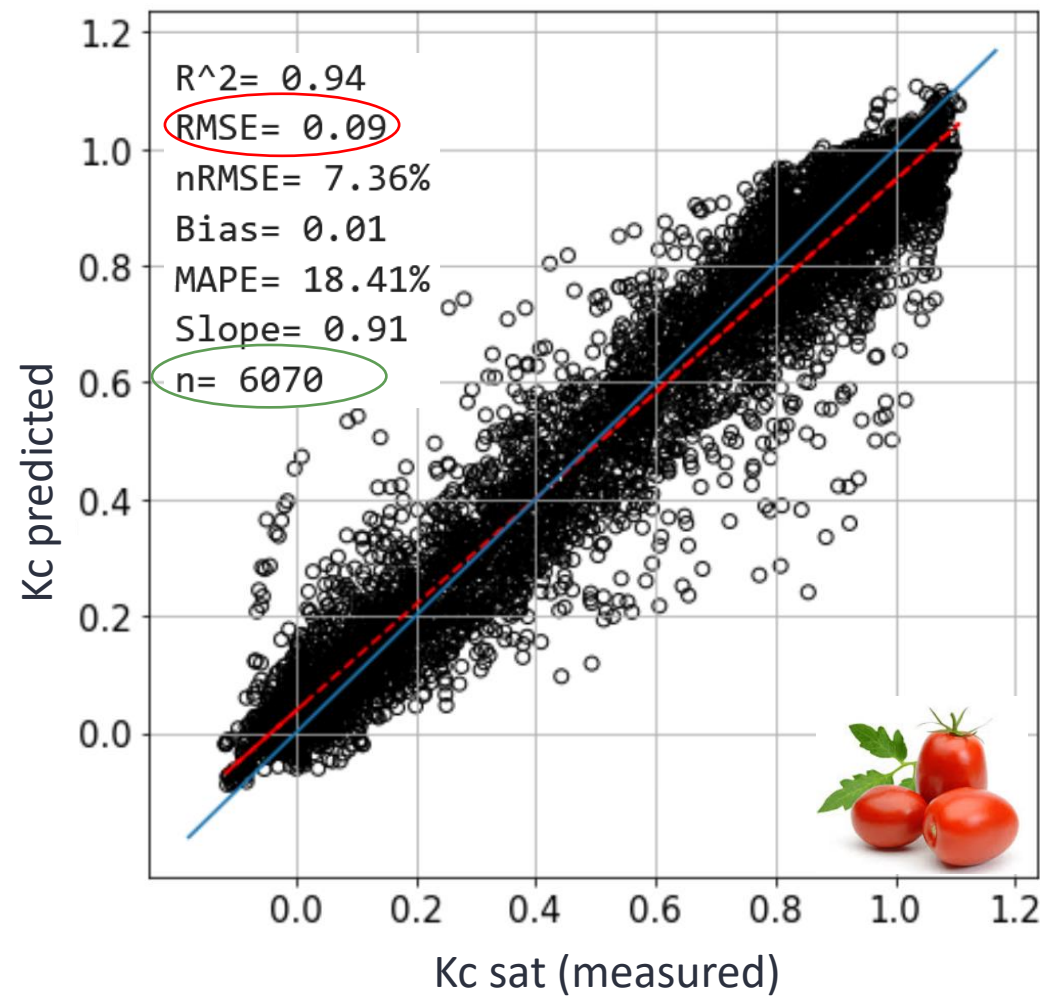
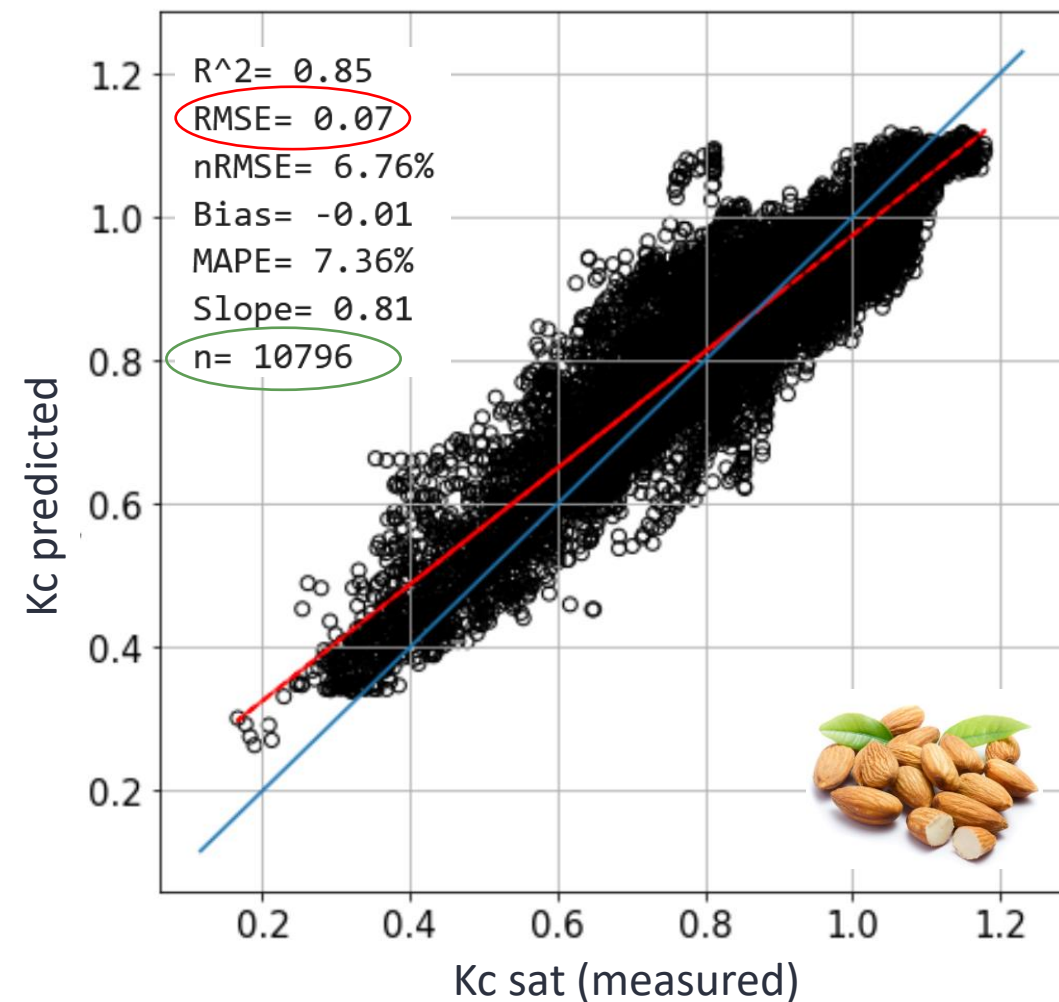


First Approach Methodology

AI Model Results

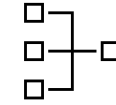


Range of Published RMSE: 0.04-0.30
(with mean around 0.12-0.15)

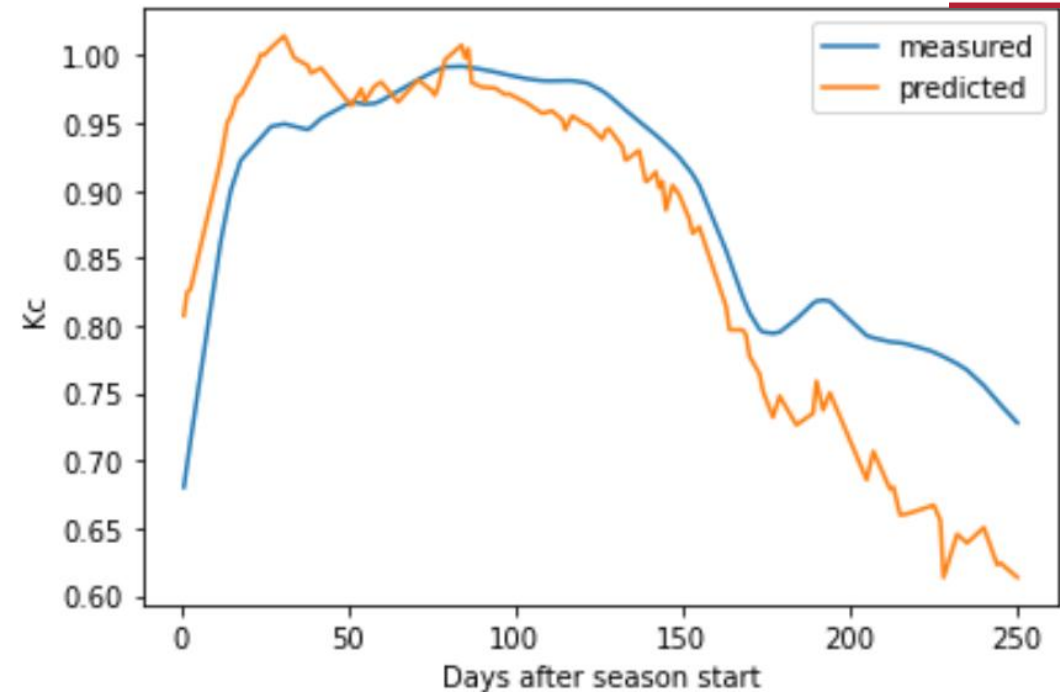
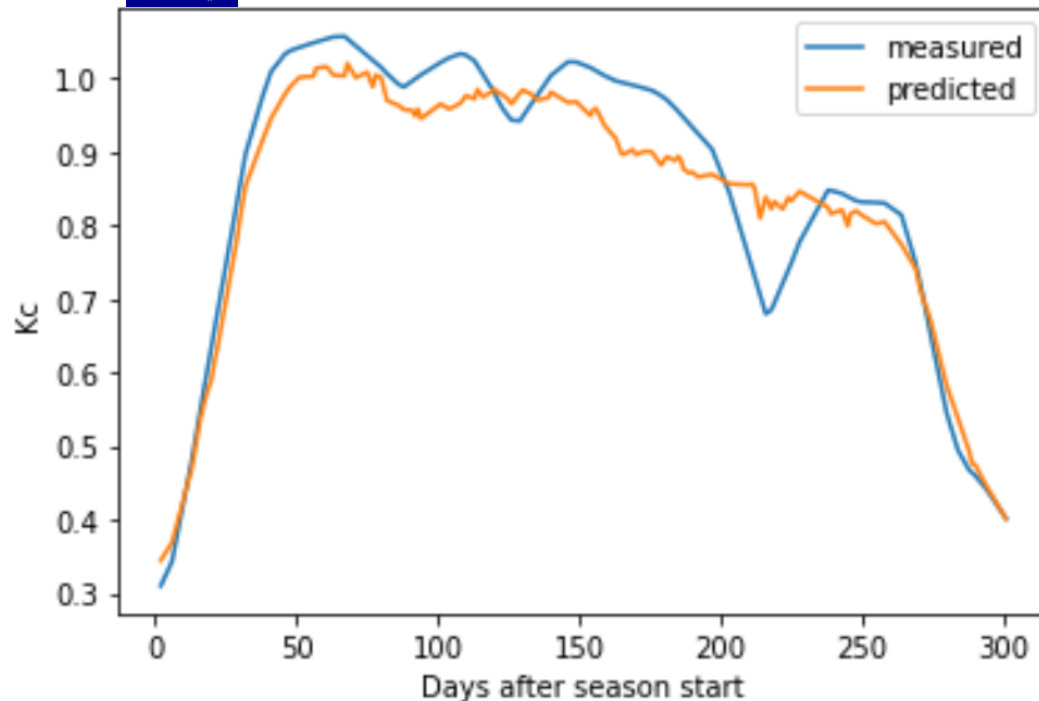


First Approach Methodology

AI Model Results

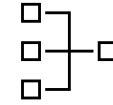


How does it look like?

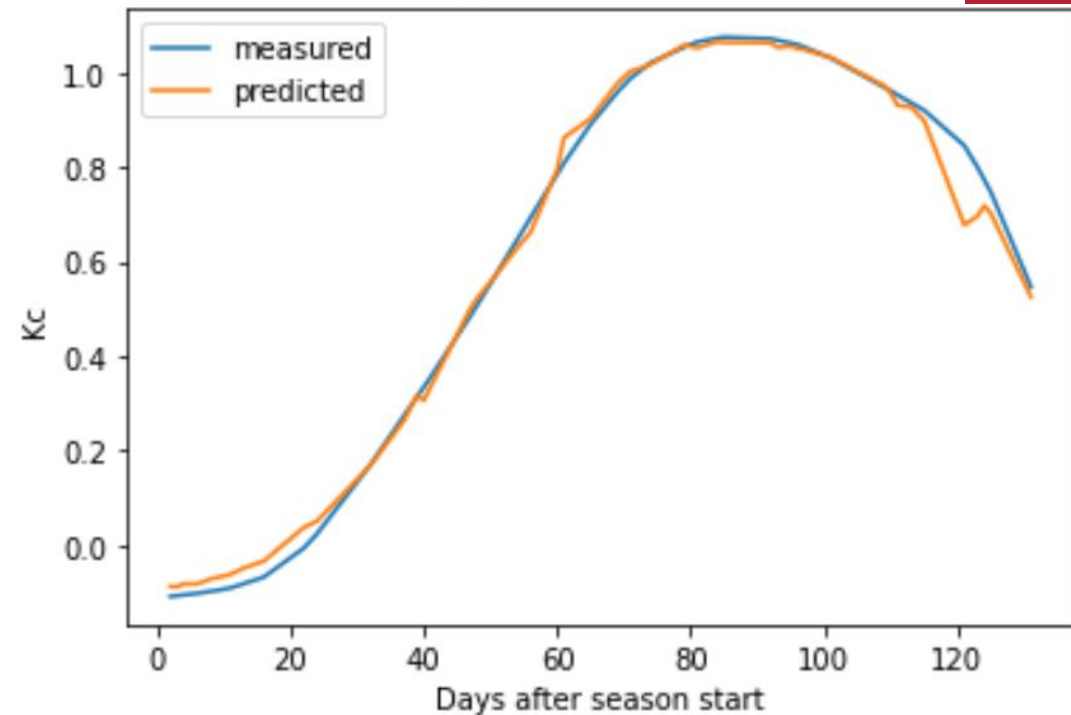
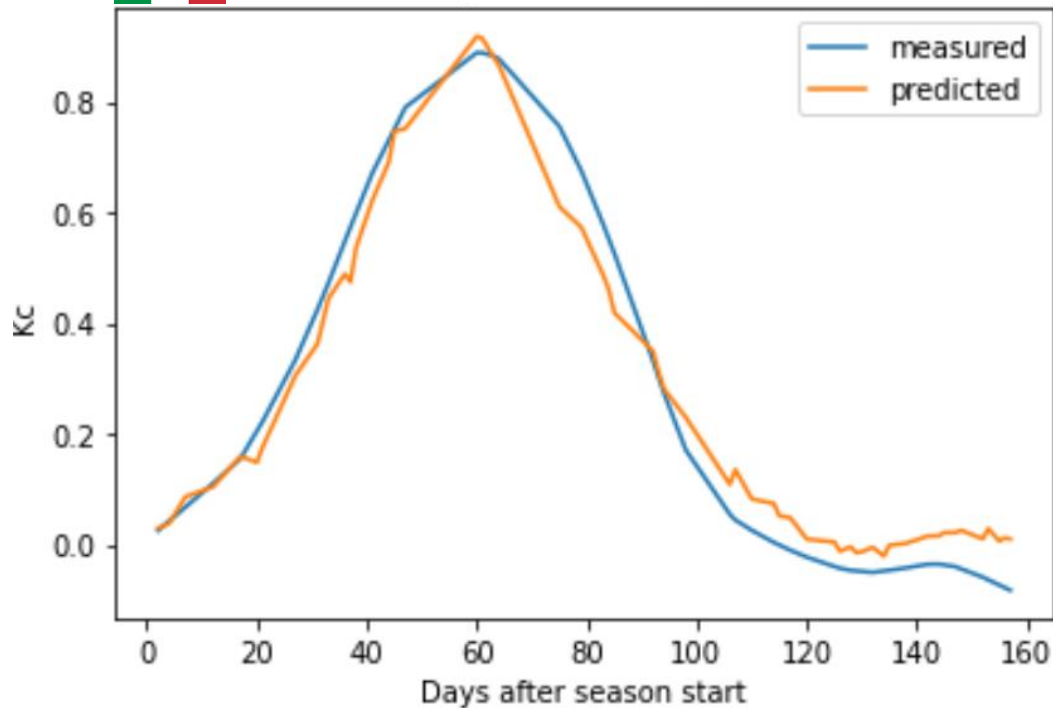


First Approach Methodology

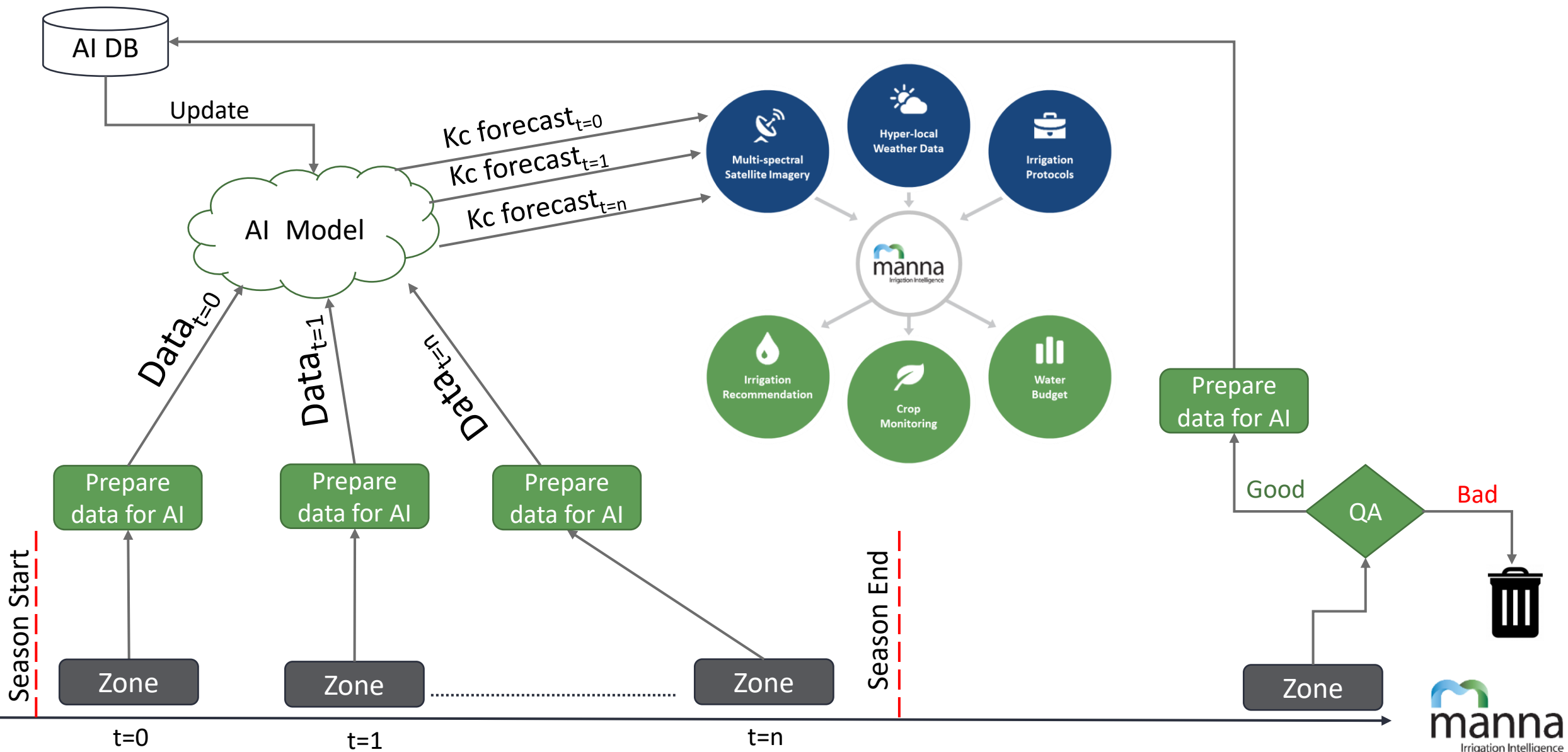
AI Model Results



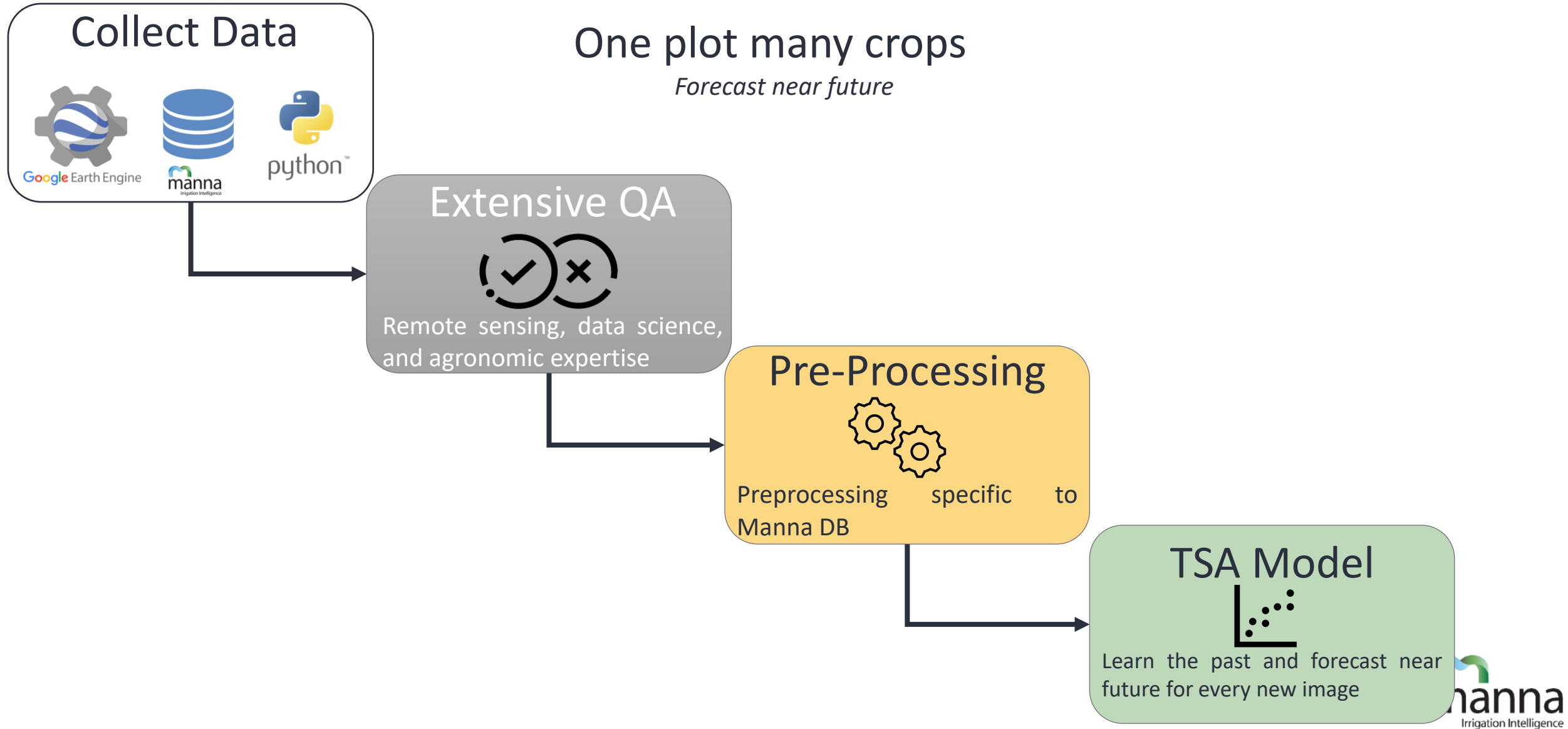
How does it look like?



AI Infrastructure Schema



Second Approach Methodology

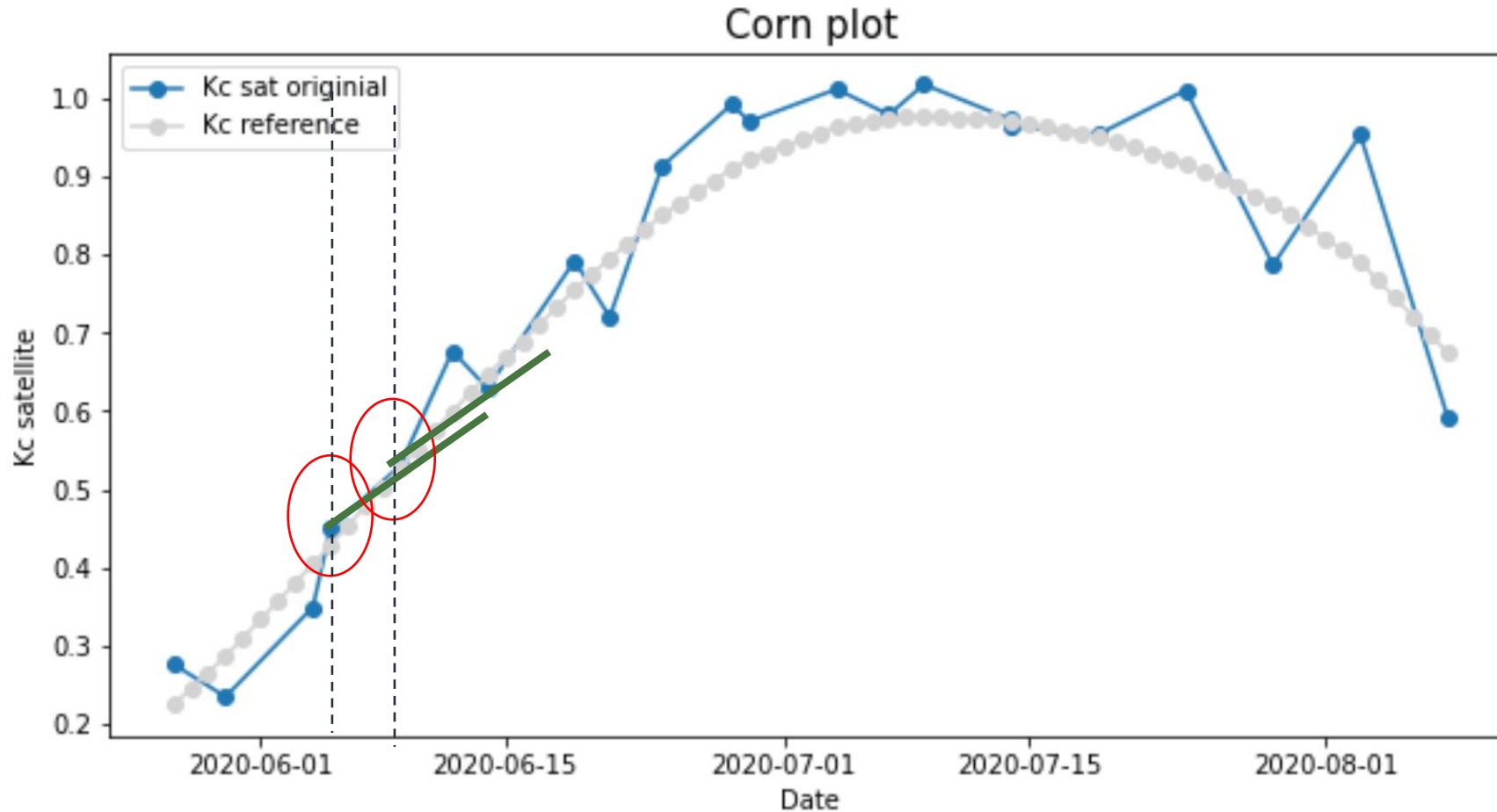


Second Approach Methodology

We collected data from various crops

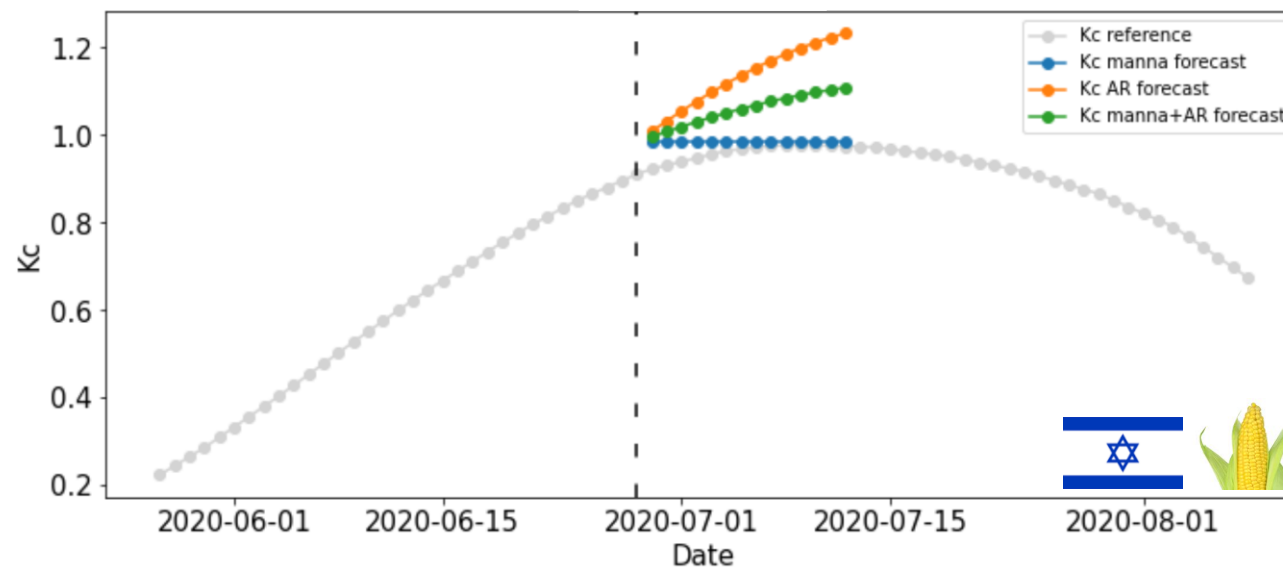
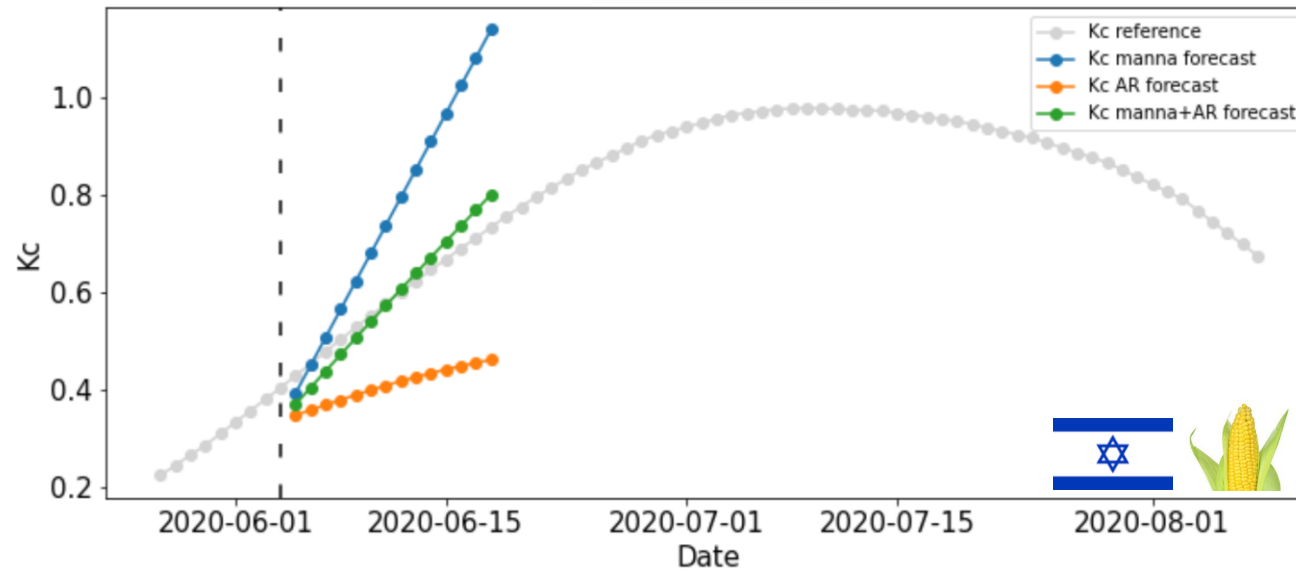


Second Approach Methodology

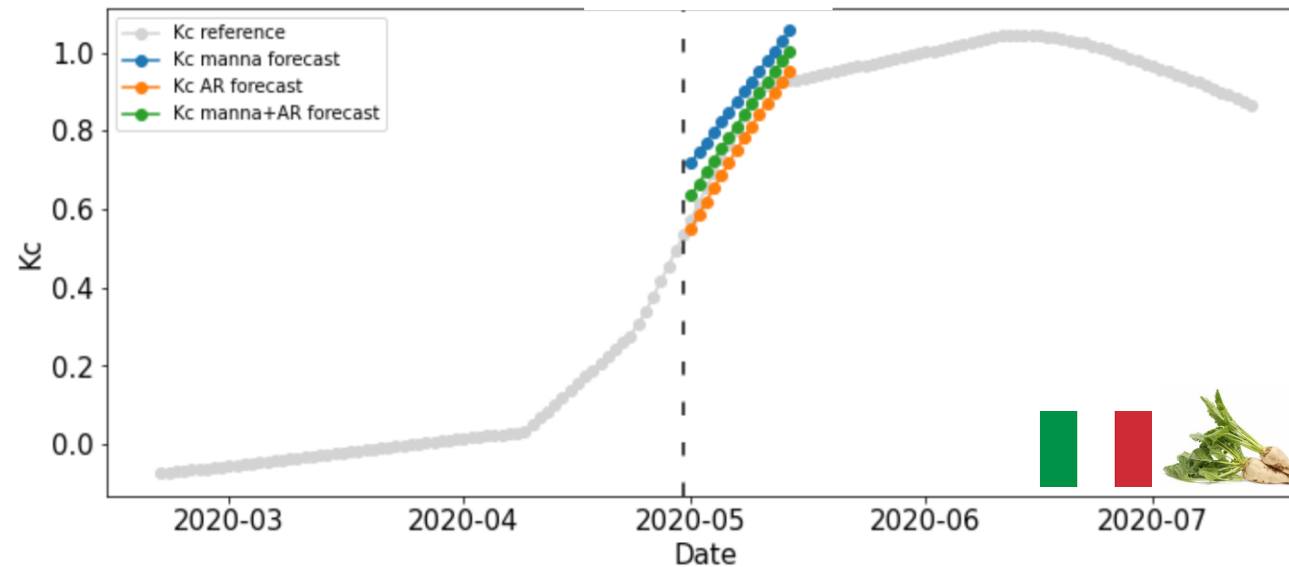
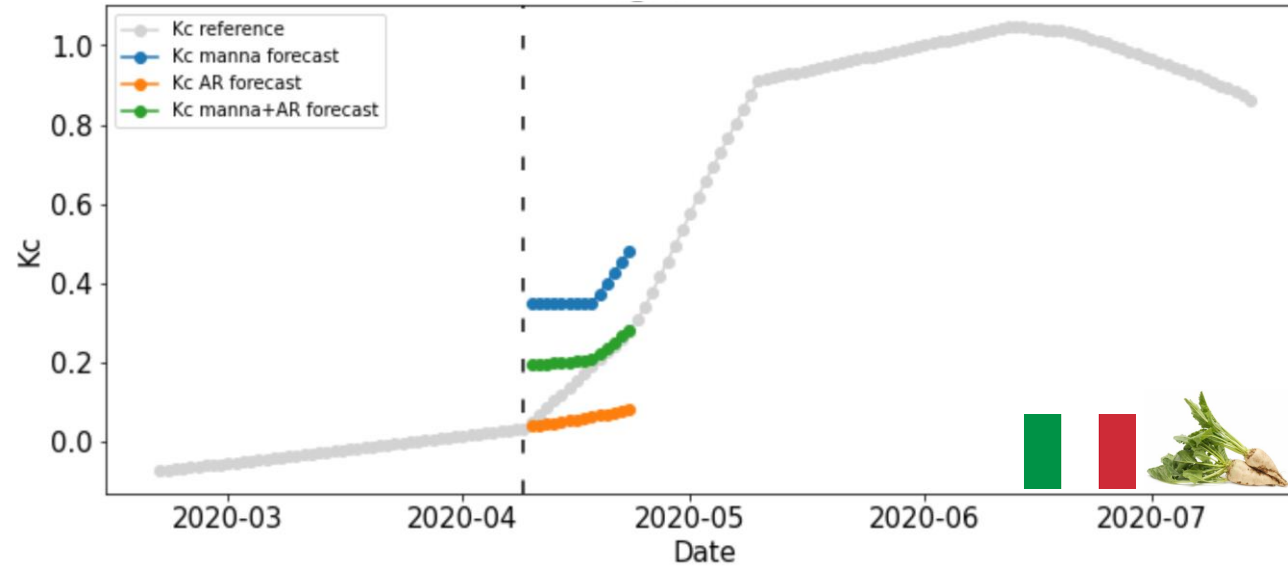


Separately for each plot (3 models)

Second Approach Methodology



Second Approach Methodology

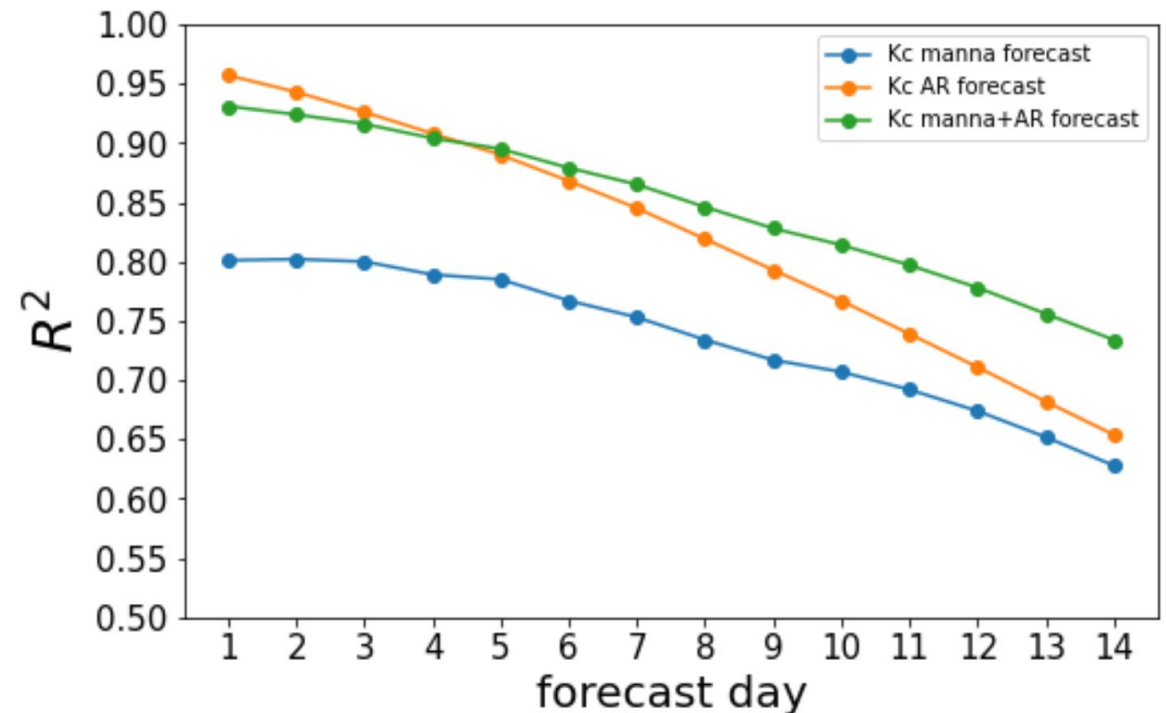
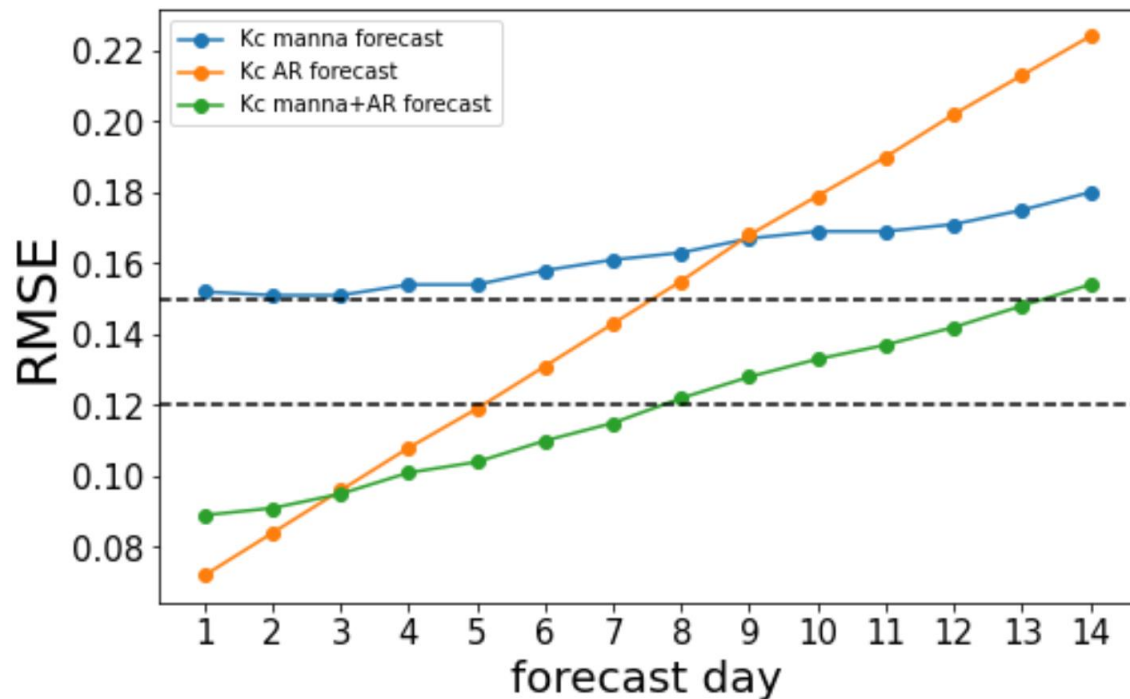


Second Approach Methodology

Results Summary

total observations (all forecast days): 10114

total zones : 34



• Conclusions and Future Directions

Conclusions

- Intensive QA is mandatory and takes most of the time (~70-80%)
- The two approaches complete each other and achieve good results
- Models enable to fill lack of information – past and future

Future directions

- Improve current models
- Find the optimal method to combine the models
- Integrate forecast-Kc with forecast of water stress

Thank You

Ofer Beer

Ofer.beeri@manna-irrigation.com

www.linkedin.com/in/ofor-beeri

www.researchgate.net/profile/Ofer_Beer3

Ran Pelta

Ran.pelta@manna-irrigation.com

www.linkedin.com/in/ran-pelta

www.researchgate.net/profile/Ran_Pelta