A Physiological Model to Quantify Impacts of Climate Change Variables on Cocoa Productivity

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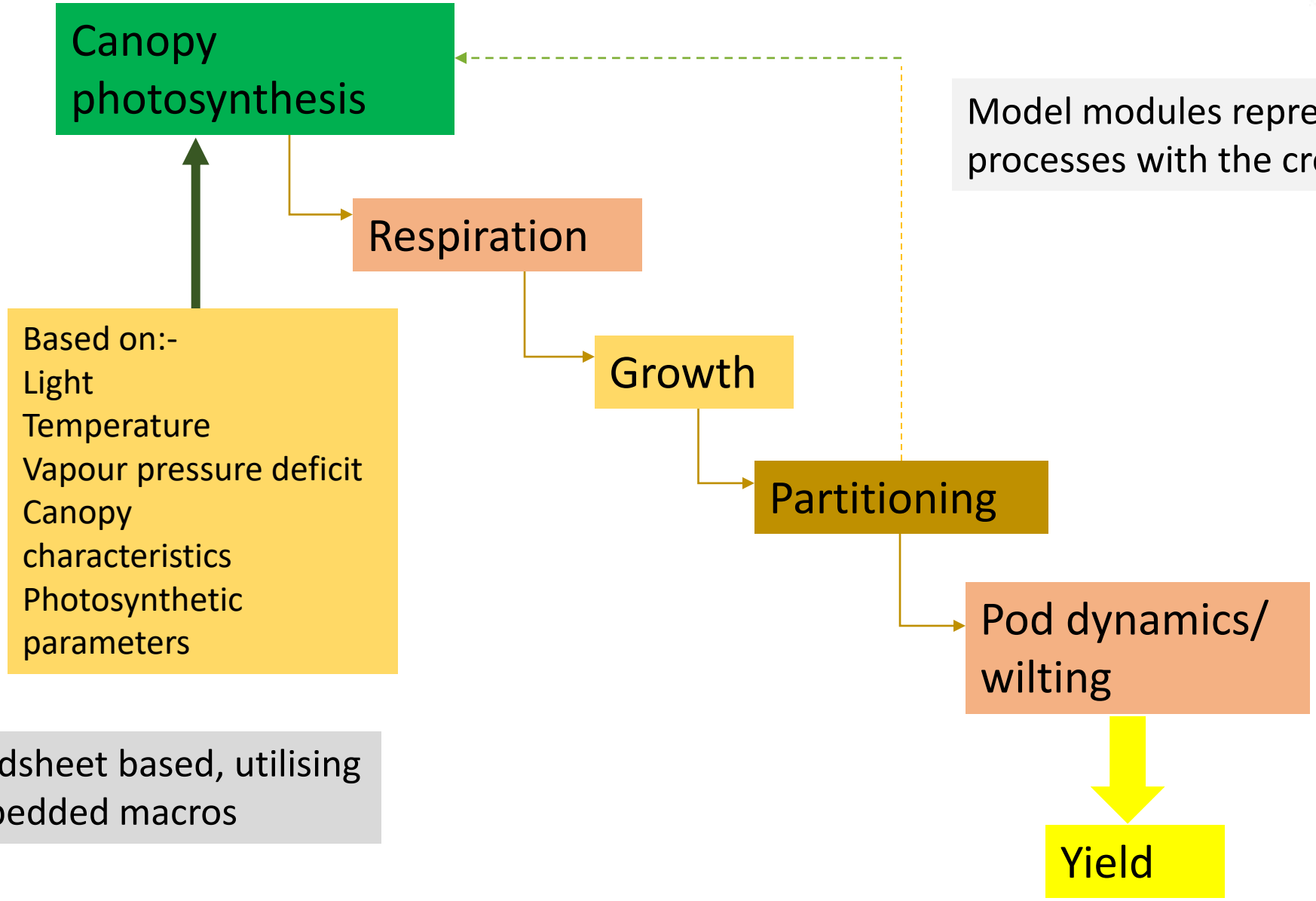
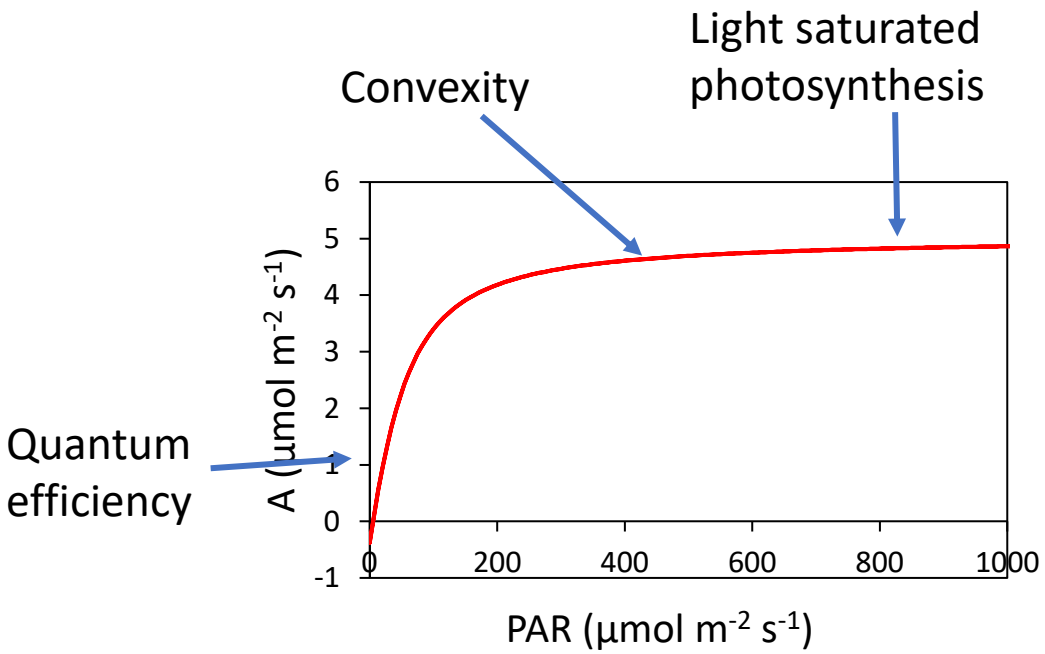
Background & aims

University of Reading

- Climate change has the potential to alter cocoa production
- Crop modelling allows prediction of yield changes in relation to climate events
- Interventions to ameliorate climate change may be quantified through modelling
- Aim: to construct a physiological model for cocoa enabling simulation of different climatic scenarios and interventions


Canopy photosynthesis
Respiration
Growth
Partitioning
Pod dynamics/ wilting
Yield
Based on:-
Light
Temperature
Vapour pressure deficit
Canopy characteristics
Photosynthetic parameters
Model modules represent processes with the crop
Model is spreadsheet based, utilising a series of embedded macros

Canopy photosynthesis- parameterisation



LEAF

Leaf area index (LAI)= leaf area per unit ground area

Extinction coefficient (k) =light attenuation

CANOPY

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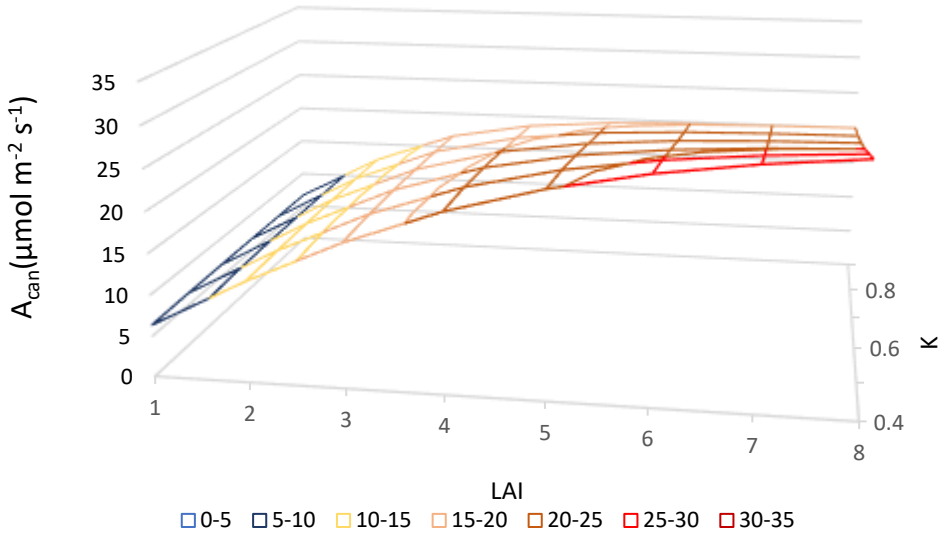
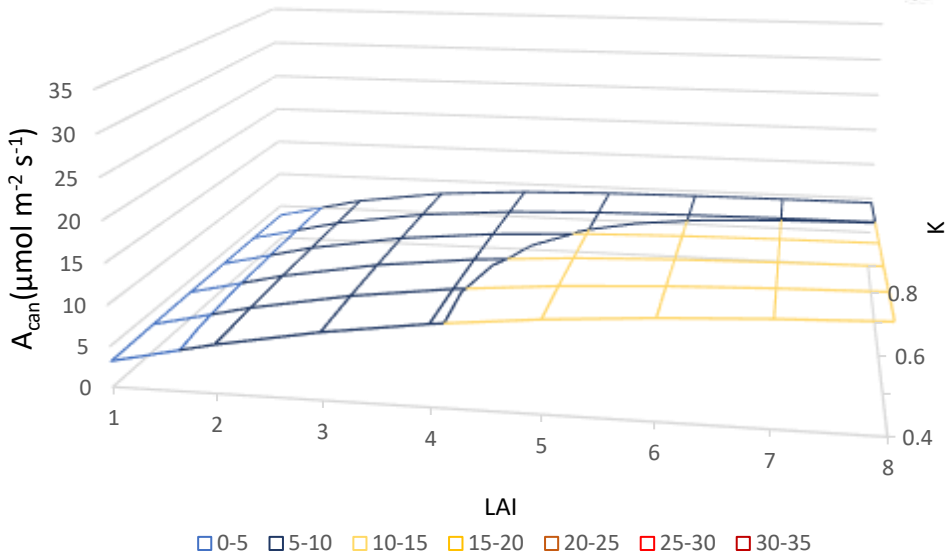
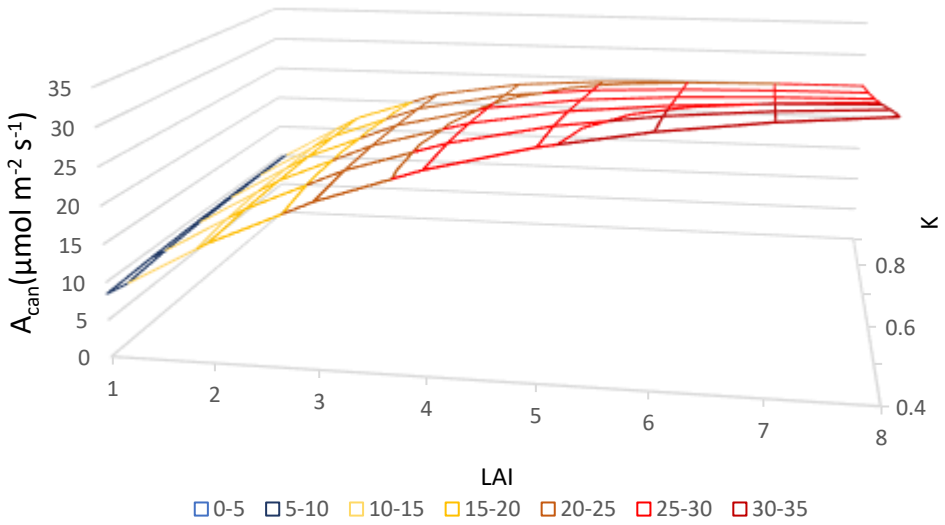
POUND 7/B: Amb CO_2 well-watered



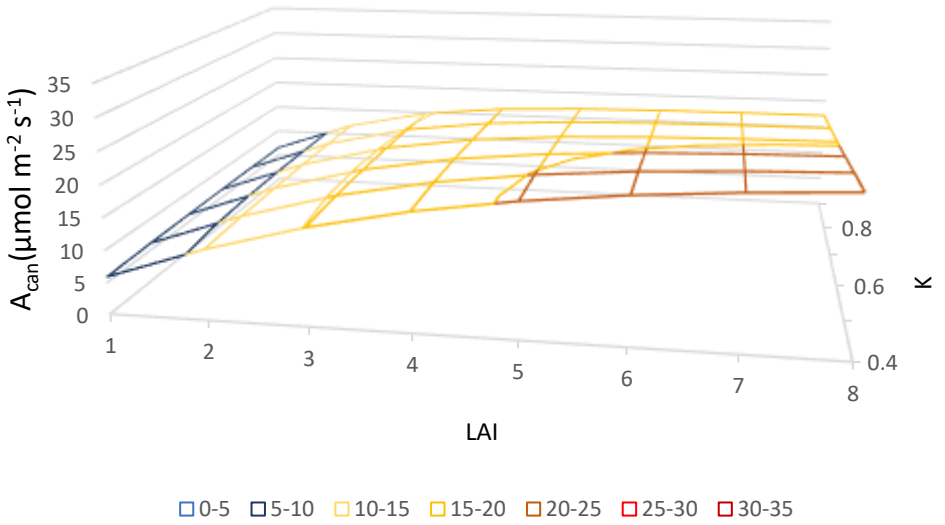
POUND 7/B Amb CO_2 water deficit



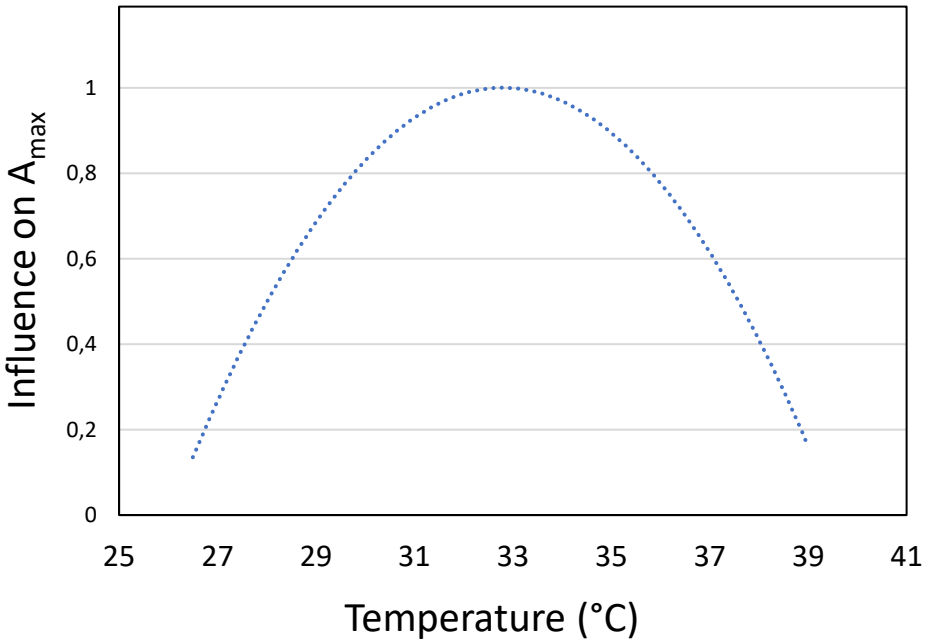
POUND 7/B 700ppm CO_2 well watered

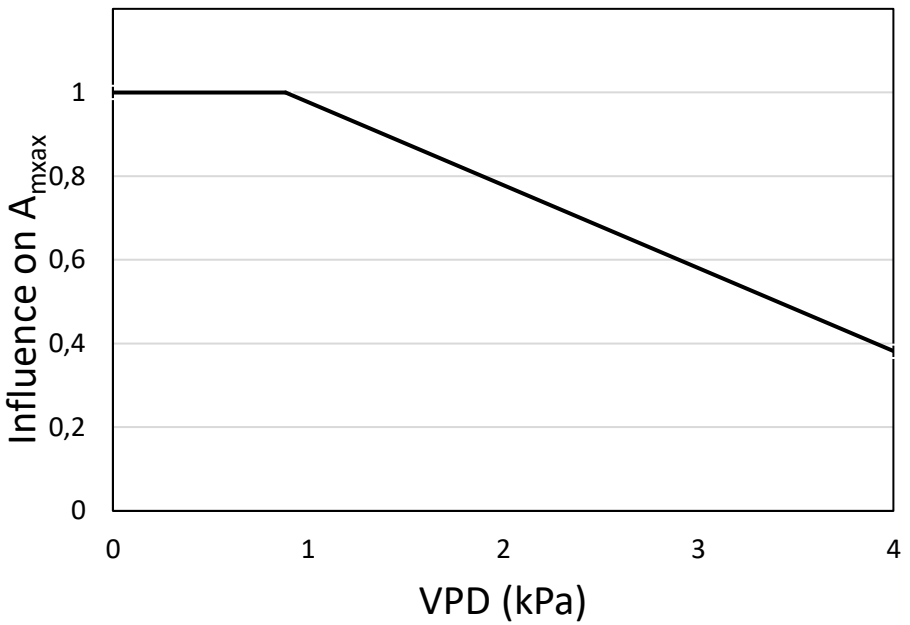


POUND 7/B 700ppm CO_2 water deficit



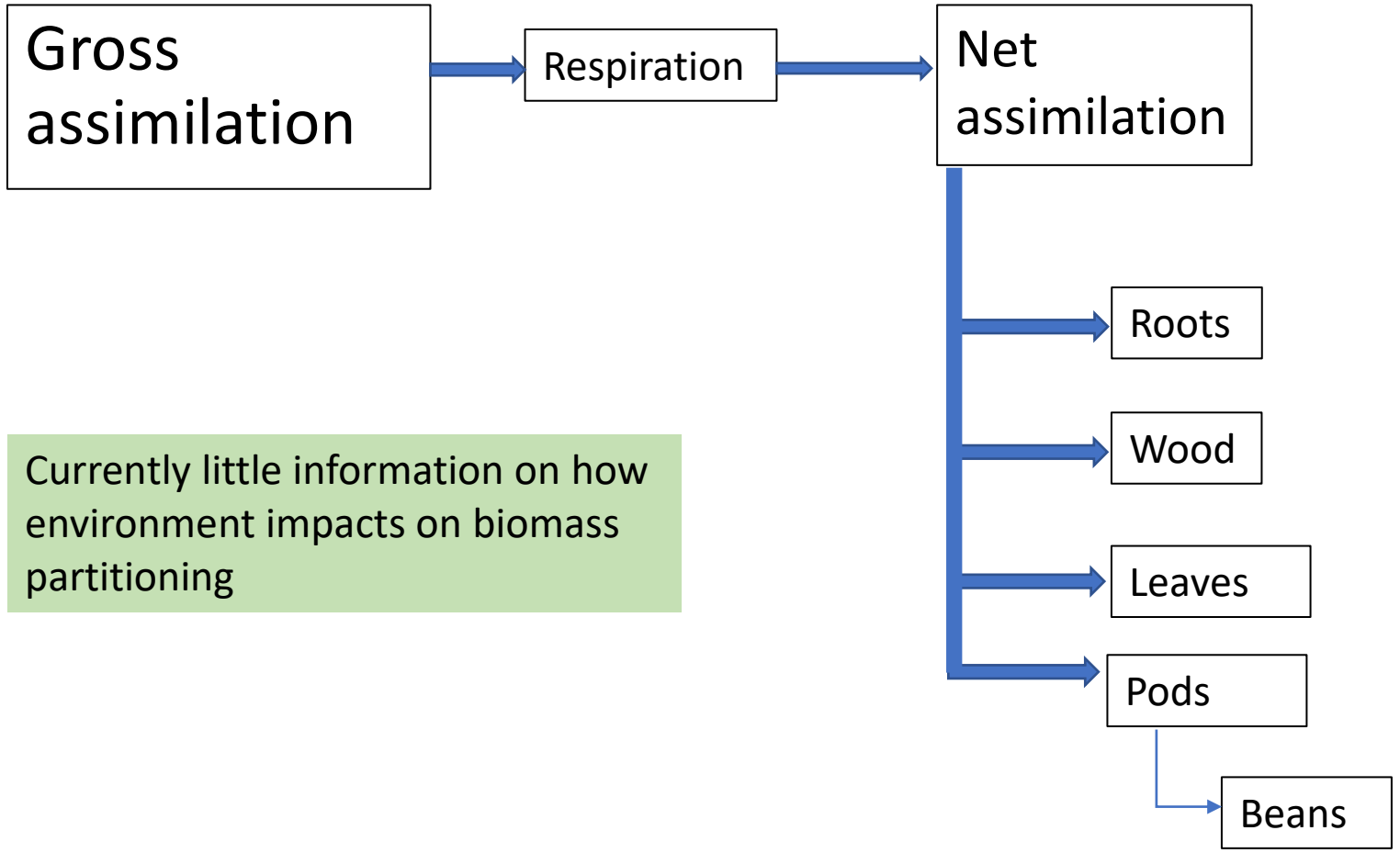
Influence of temperature and VPD





Based on Yapp (1992)

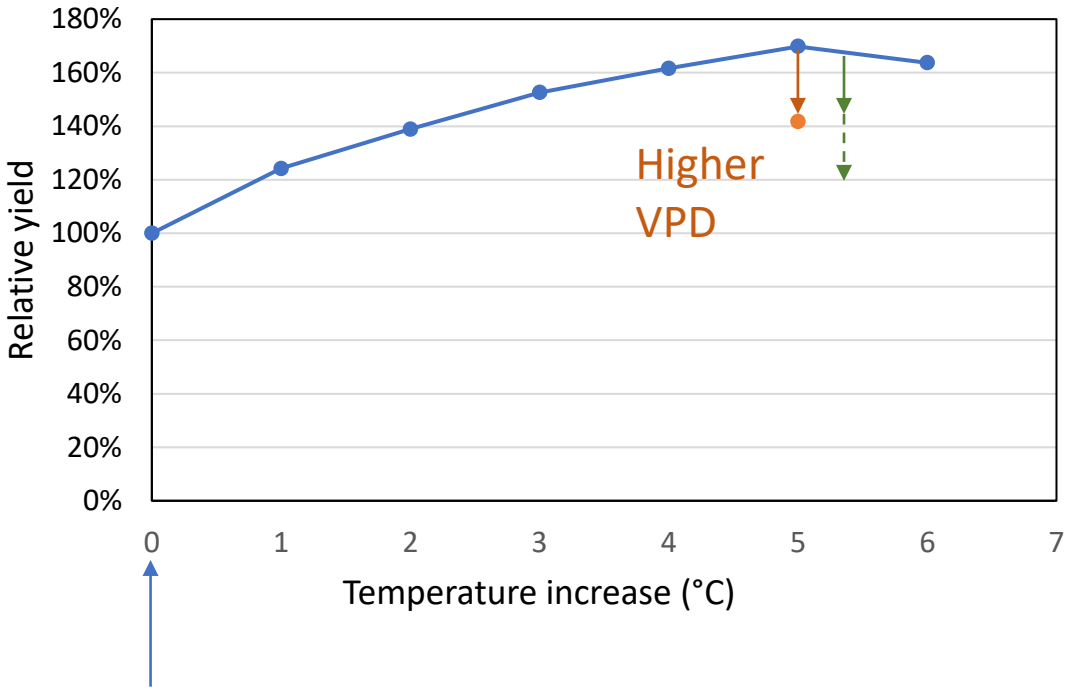
Assimilation to biomass and yield



Currently little information on how environment impacts on biomass partitioning

Each component has a different “physiological cost” according to its chemical constituents

Simulation based on Var: Amelonado, CO_2: 700 ppm

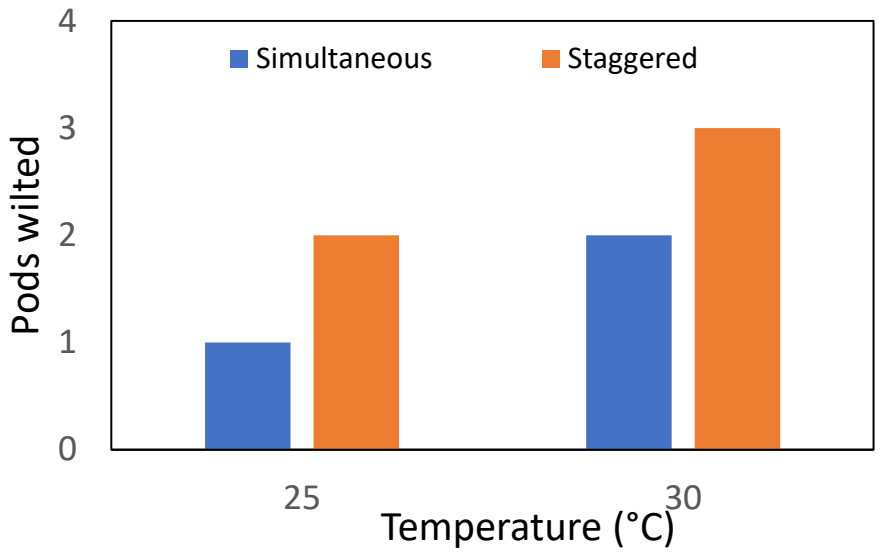


- Simulation based on assimilation only
- Predicted yield may be lower when pod dynamics/ wilting is incorporated

Blue line is absence of water stress
Orange is low afternoon humidity (Higher VPD=2.5 kPa)

Pod dynamics sub-model

- Based on previous model developed at UoR (Pearson et al.)
- Considers assimilate demand of growing pods (greater at higher temperatures – higher respiration)
- Cherelle wilt is simulated based on demand & competition for carbohydrates from pods



Simulation of wilting assuming 6 pods set. Staggered pod set = 5 day interval. Assimilate production assumed to be constant for all simulations

Conclusions

- Simulation of physiological processes allows prediction of relative changes in yield in response to environmental variables
- The model serves as a complement to experimental studies in understanding adaptation strategies to climate change
- We can model the responses of different varieties and management strategies under climate change scenarios

Acknowledgements

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