Why use a water balance model to evaluate irrigation scheduling

- **Models used for design and evaluation**
  - used to assess or design generic irrigation scheduling decision rules
  - models, when appropriately applied are powerful tools for this application

- **Models used for day to day monitoring**
  - i.e. do I irrigate today?
  - models are less useful for this application
  - better to directly measure soil water status?
  - Shorter timesteps models more appropriate?

Design and evaluation using models

- Water balance models quantify pathways of water; runoff, drainage and evapotranspiration
- They consider complex interactions between soils, land uses and climate
- We cannot measure the water balance for all soils, land uses and climate
- They capture the effects of temporal climate variability
- They extrapolate through space and time
- Value add experimental data

Can we determine ET for any crop in any soil and climate?

APSIM Sugar poster

- **Yes,**
- **with crop models calibrated against ET measurements from Bowen ratio and lysimeter experiments**
- **Is this a case of "Yes" meaning "No"**

We need to

- **Do this without detailed experimental data for model calibration**
- **Simpler models compared with readily available data**

PERFECT

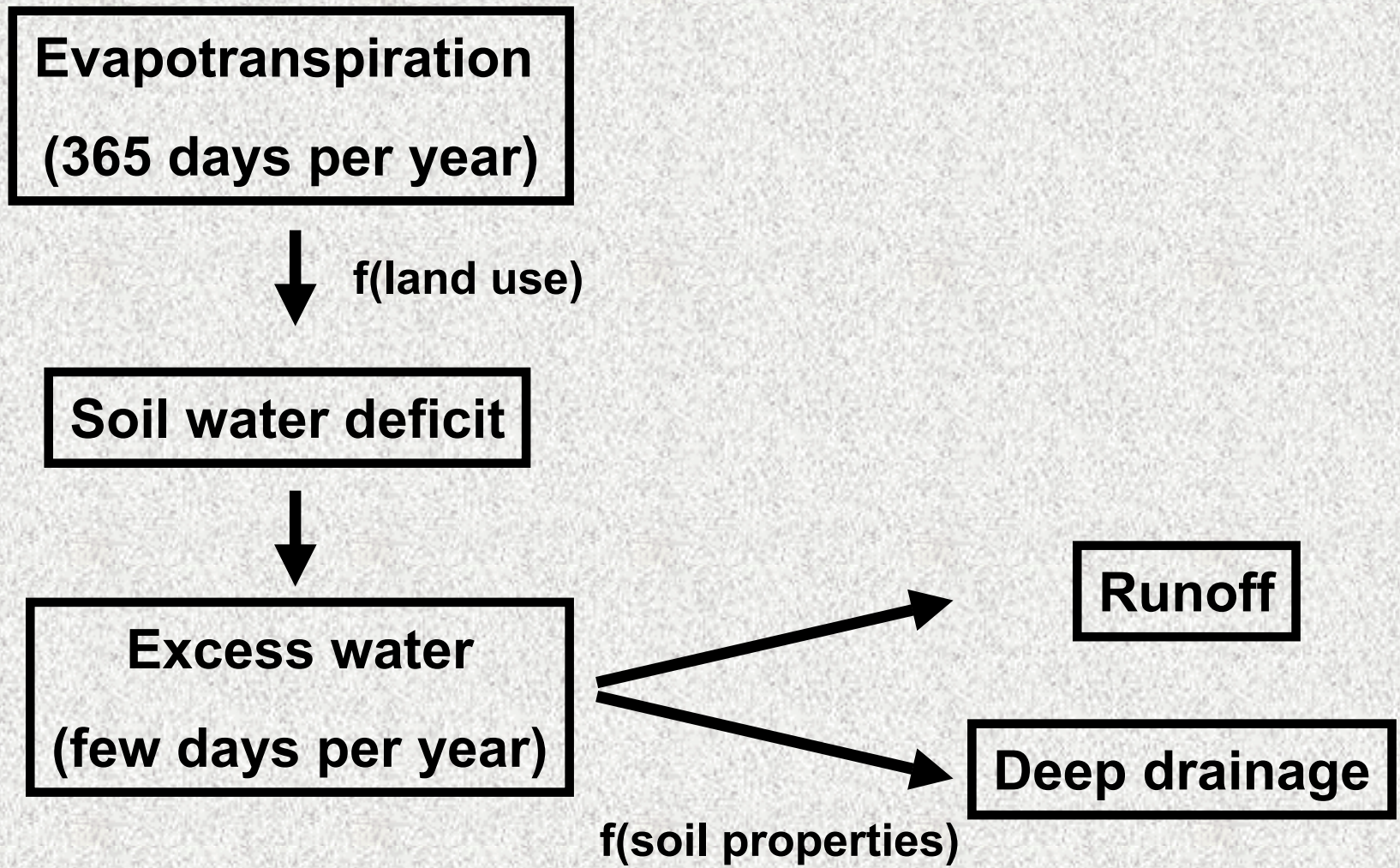
- Evolved from QDPI and USDA crop growth models, and USDA soil water balance models
- Initially released 12 years ago - mature technology
- Cropping systems model. Simulates a range of crop/tillage systems and rotations
- Considers plant growth, evapotranspiration, runoff, change in soil water and deep drainage below root zone
- Daily timestep using daily weather data
- One-dimensional

Previous validation of PERFECT

- Emphasis on dryland cropping systems
- 12 soil types, 18 land uses or cropping systems, and 10 locations
- Mostly throughout Queensland
- Successful validation in India
- Model predictions have been compared to over 400 years of experimental data

To Peter

Getting runoff and deep drainage right



What is deep drainage?

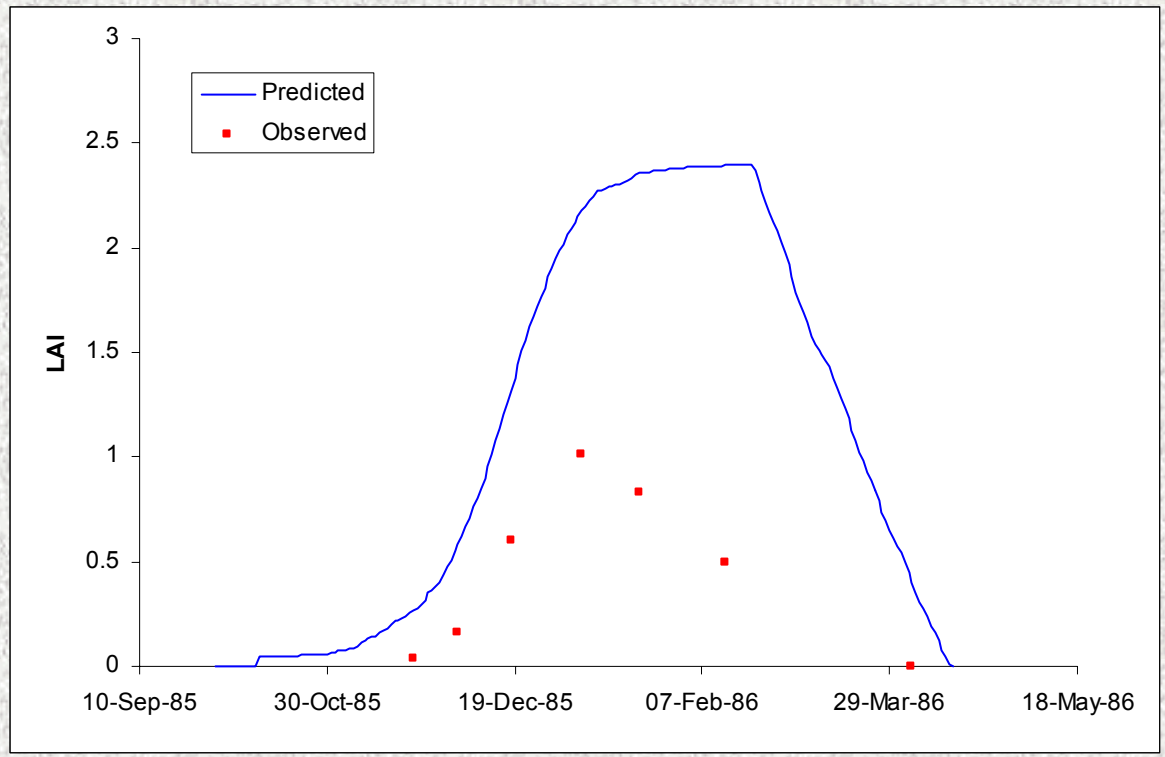
- 1-dimensional models assume all excess soil water above “field capacity” moves vertically to below the root zone
- Deep drainage is not groundwater recharge
- Lateral movement (interflow) ignored in 1-D models
- Need to consider lateral water movement and accumulation to predict waterlogged areas

Overview and model limitations

Prediction of LAI

- We couldn't get it right
- We could get water use right (ie changes in soil water over time) but needed higher LAIs than measured especially for dryland treatments
- If used measured LAIs, we underpredicted plant water use
- Our back of envelope calculations showed that measured level of water use inconsistent with measured LAI
- Unresolved

Predicted vs measured dryland LAI

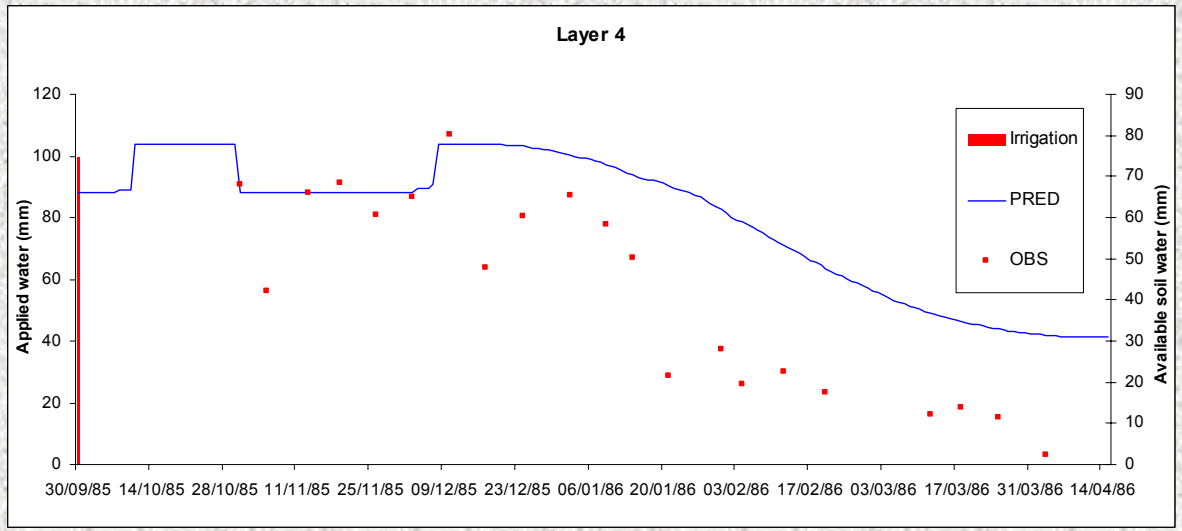


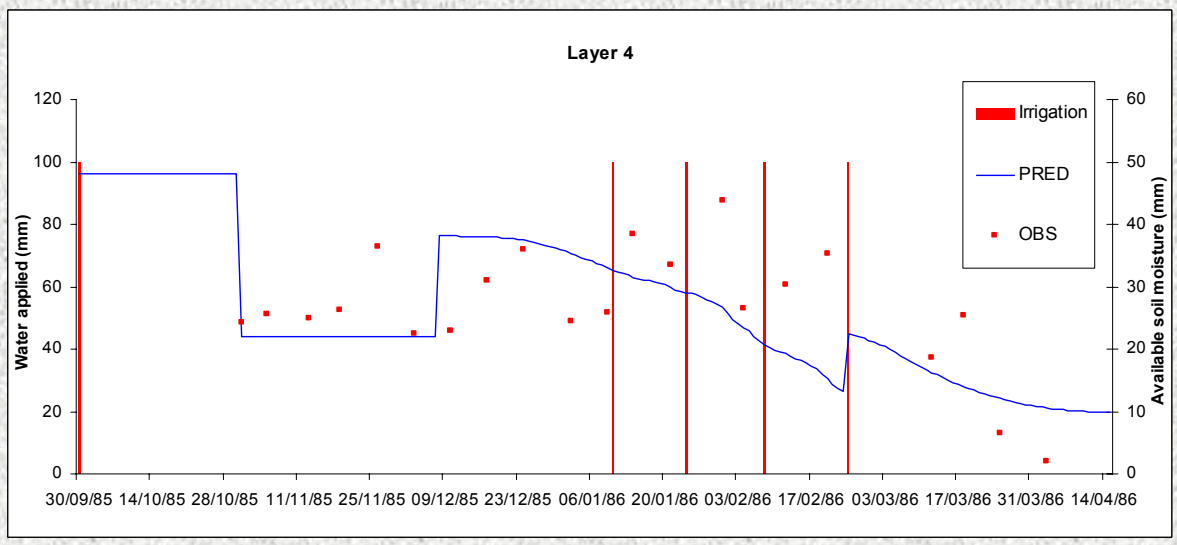
Profile Water extraction

- Got total soil water right
- Layer by layer predictions were less accurate
- Dryland treatments - model did not use enough water from lower profile
- Irrigation treatments - model used too much water from lower profile
- Suggests errors in simulation of root density through time
- Dryland - roots searched deeper water
- Irrigated - root activity in upper profile
- Used same parameter set - we could have fiddled, but didn't!

Predicted vs measured soil water for lowest soil profile layer

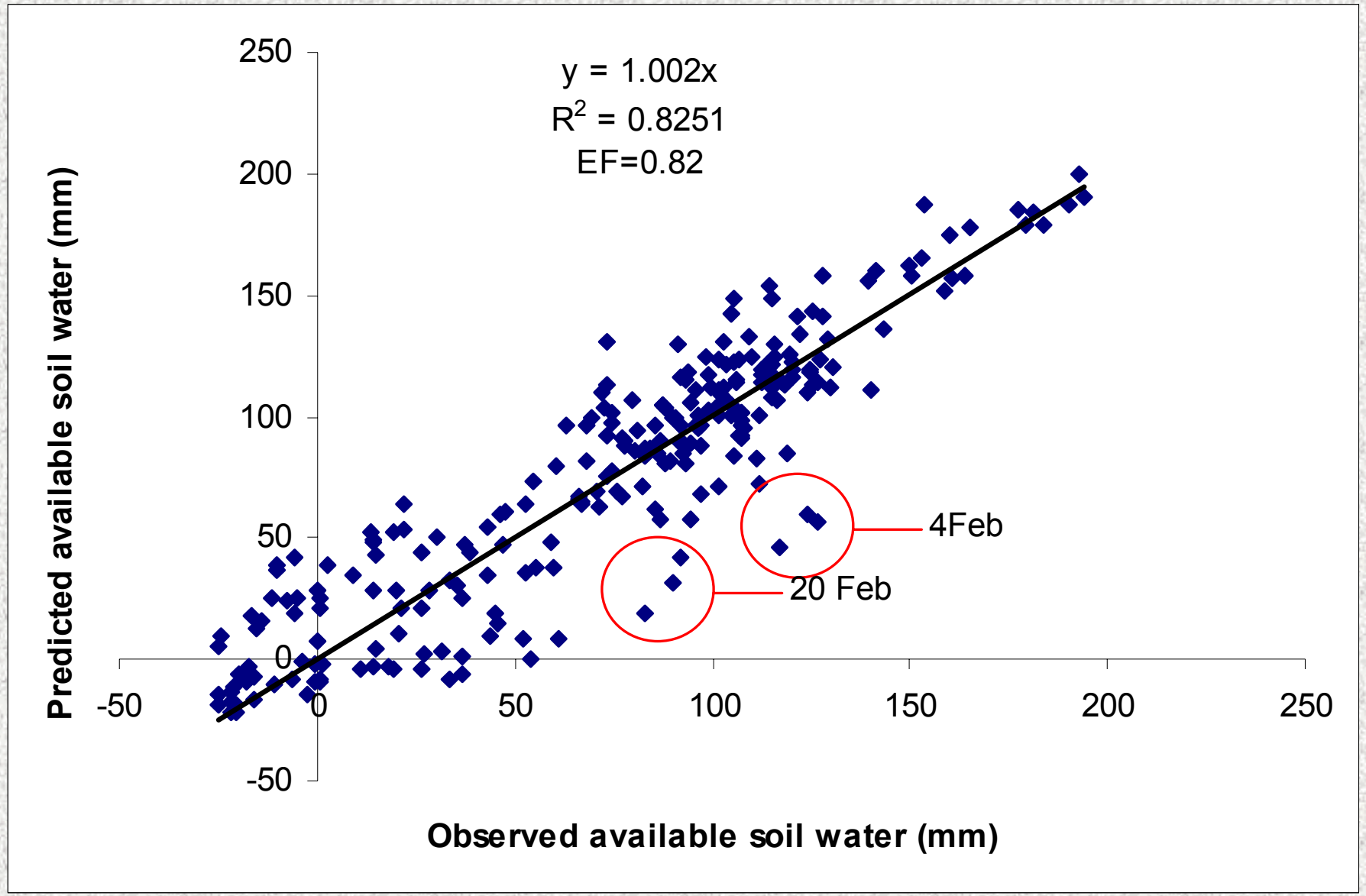
Dryland



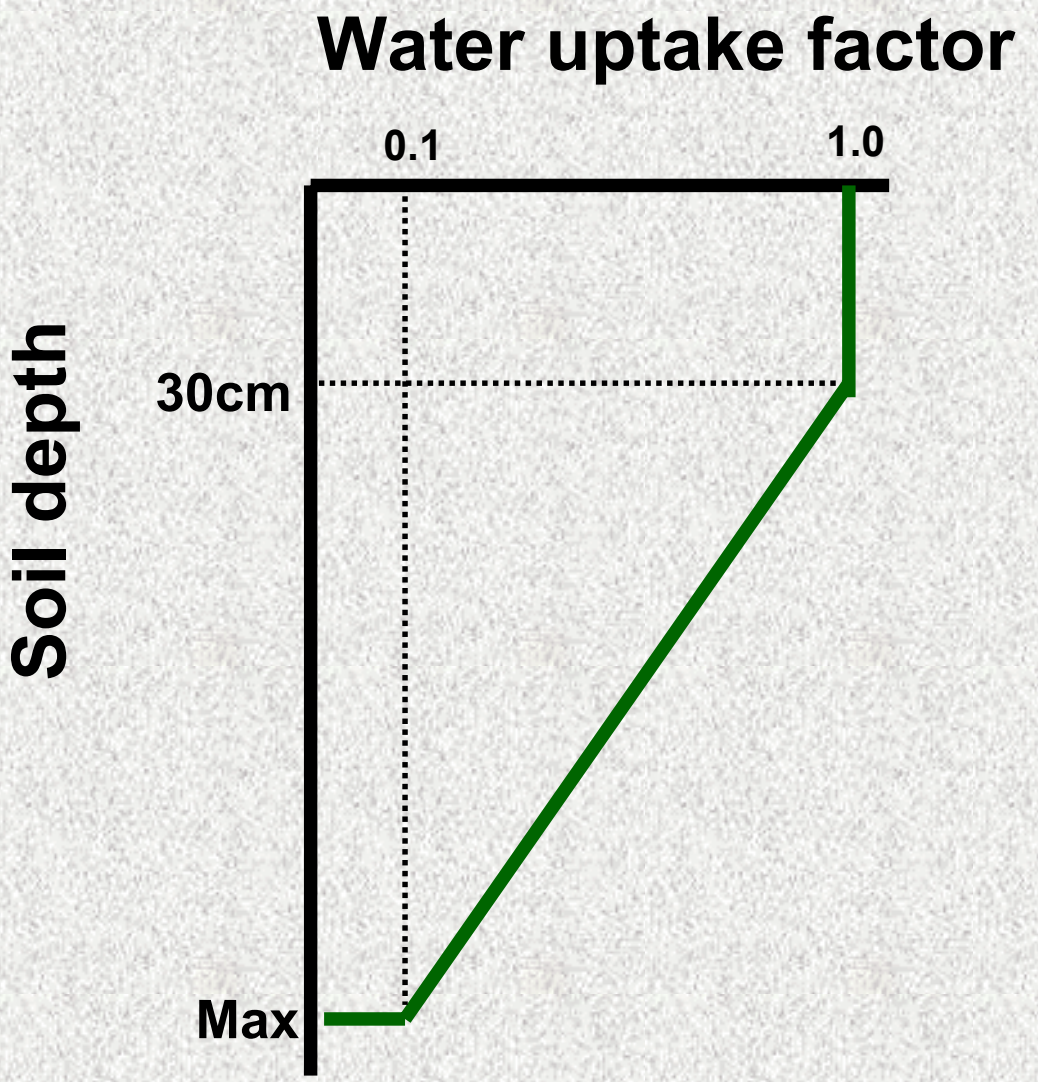


Irrigated

How important? Getting total correct!



Root density function



Suggested Model Improvements

- Improved root density and growth
- Root growth - f(Soil water)
- But does low soil water reduce root growth or increase it (ie searching)
- May increase growth but reduce density??

Effects of water stress

- PERFECT assumes that water stress has the same impact on plant growth regardless of developmental stage
- This is clearly an oversimplification

Effects of waterlogging

- In the past, PERFECT used EPIC algorithm to assess reductions in yield due to excessive soil wetness
- Results promising but no quantitative validation …. Lack of suitable data sets a major limitation
- Wetness algorithm not in release version of PERFECT
- 1-Dimensional soil water balance model also a key limitation

1 D Water movement

- How important is lateral movement?
- Depends on soil properties and slope
- More work currently underway within DLWC to address this for quantifying salinity issues
- Looking at knowledge gained from complex HYDRUS 2D water balance modelling and incorporating simpler algorithms into PERFECT

Further validation in this project

- More soil water data - daily would be NICE!!
- Include yield and biomass validation
- Need to consider more irrigated crops and land uses