October 2014

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AOTEAROA • NEW ZEALAND

Crop growth–
15 October 2014 Pergamino

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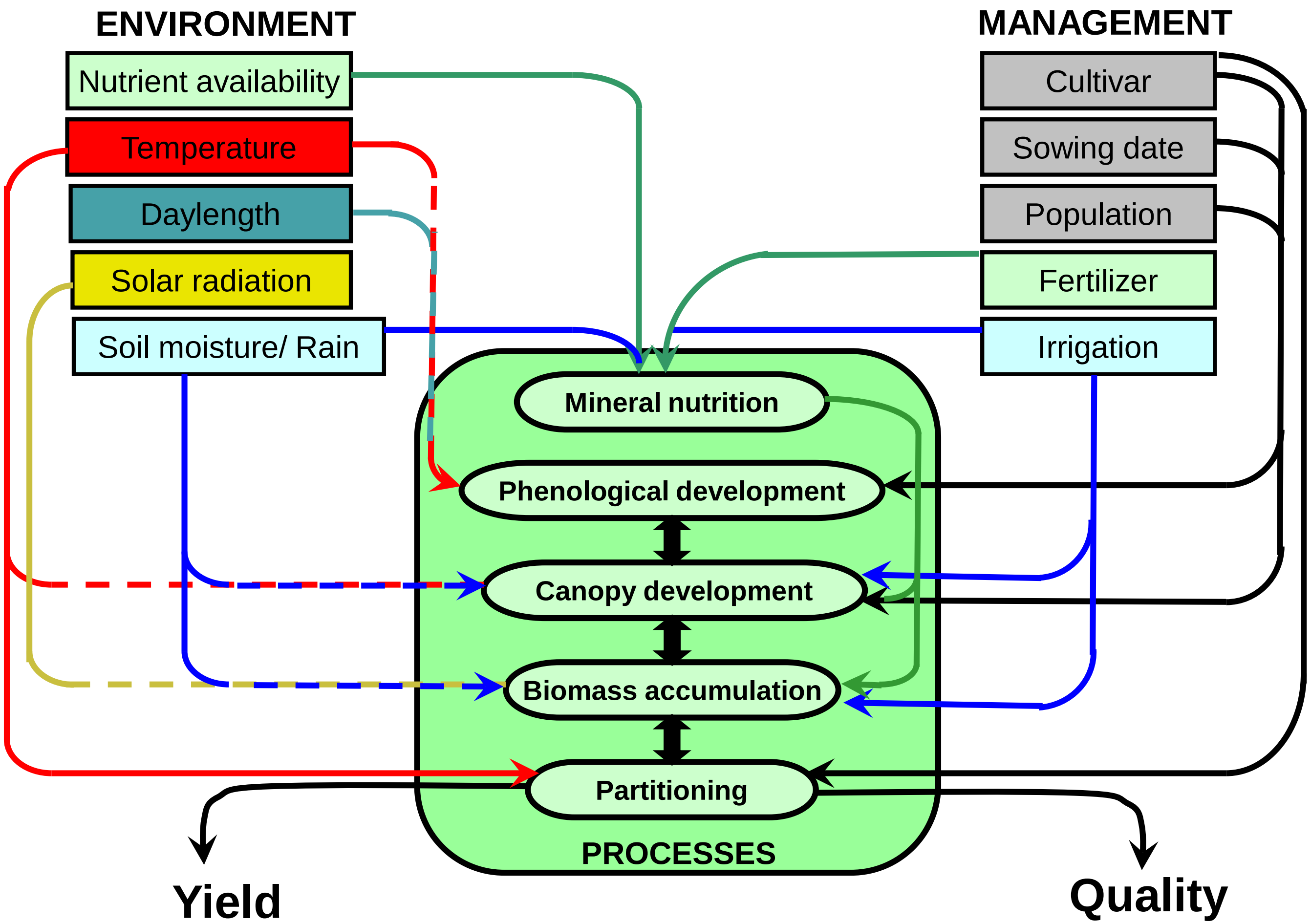
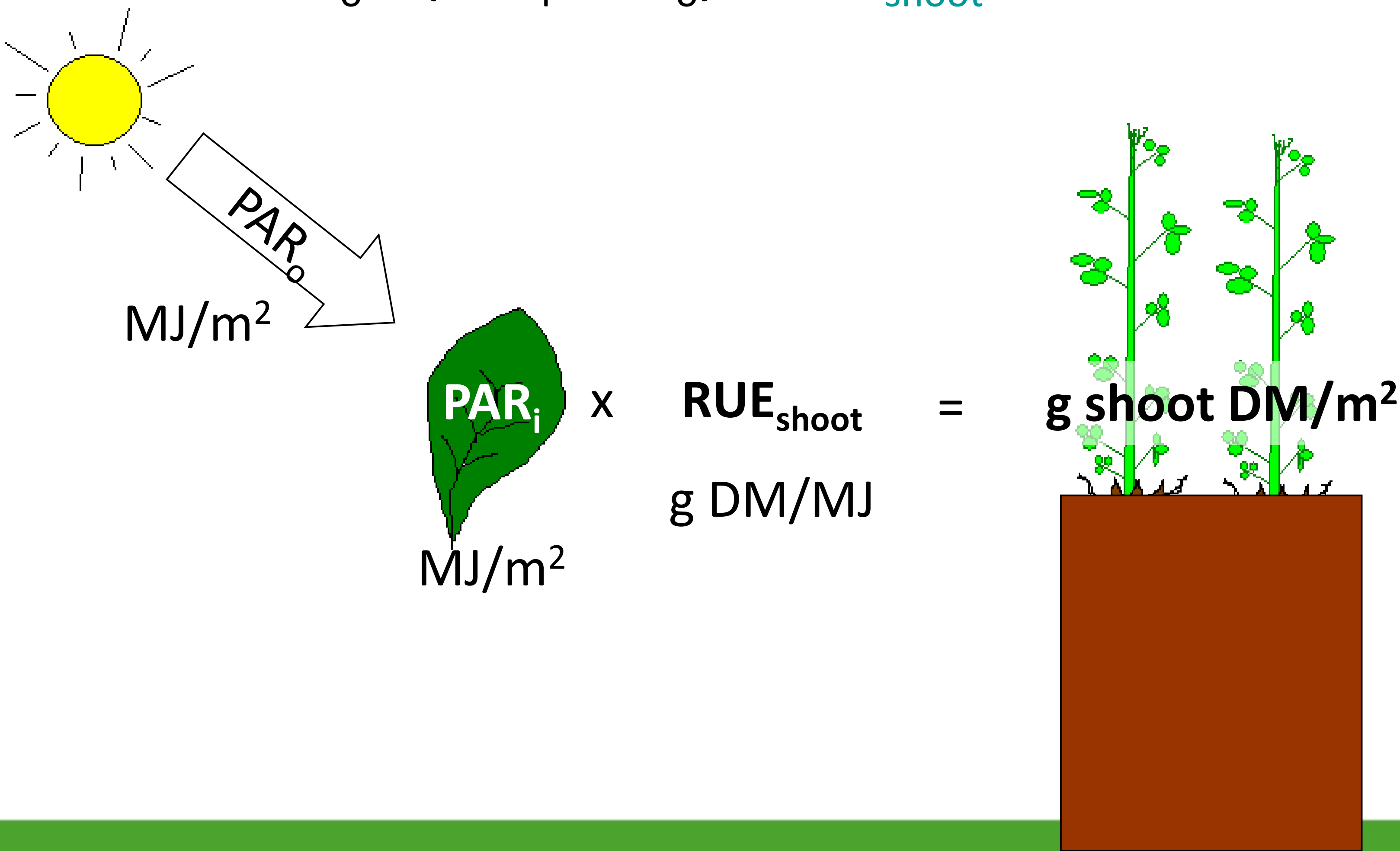


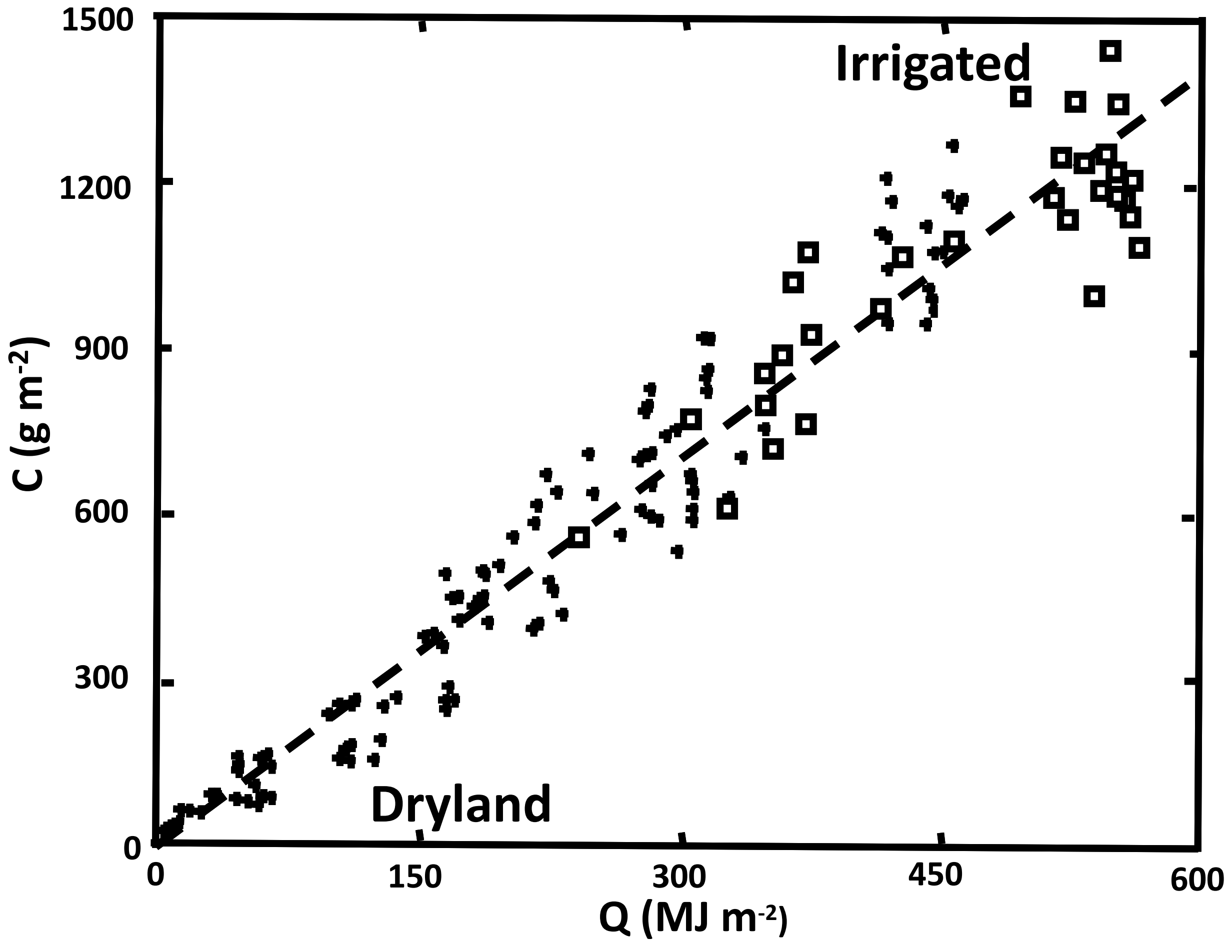
Relationship between environment and management factors and the physiological processes that regulate crop yield and quality. (Source: Hay & Porter 2006).

The canopy:
the energy capture device

Basic model for yield analysis

$Yield = PAR_o \times (PAR_i/PAR_o) \times RUE_{shoot}$ (adapt. Monteith, 1977)





Total DM production (C) from successive harvests and intercepted PAR (Q) for field peas in 5 experiments in 4 seasons with different cultivars, sowing times and irrigation treatments. The form of the regression is: 2.36±0.03 g DM/MJ PAR (R^2=0.97).

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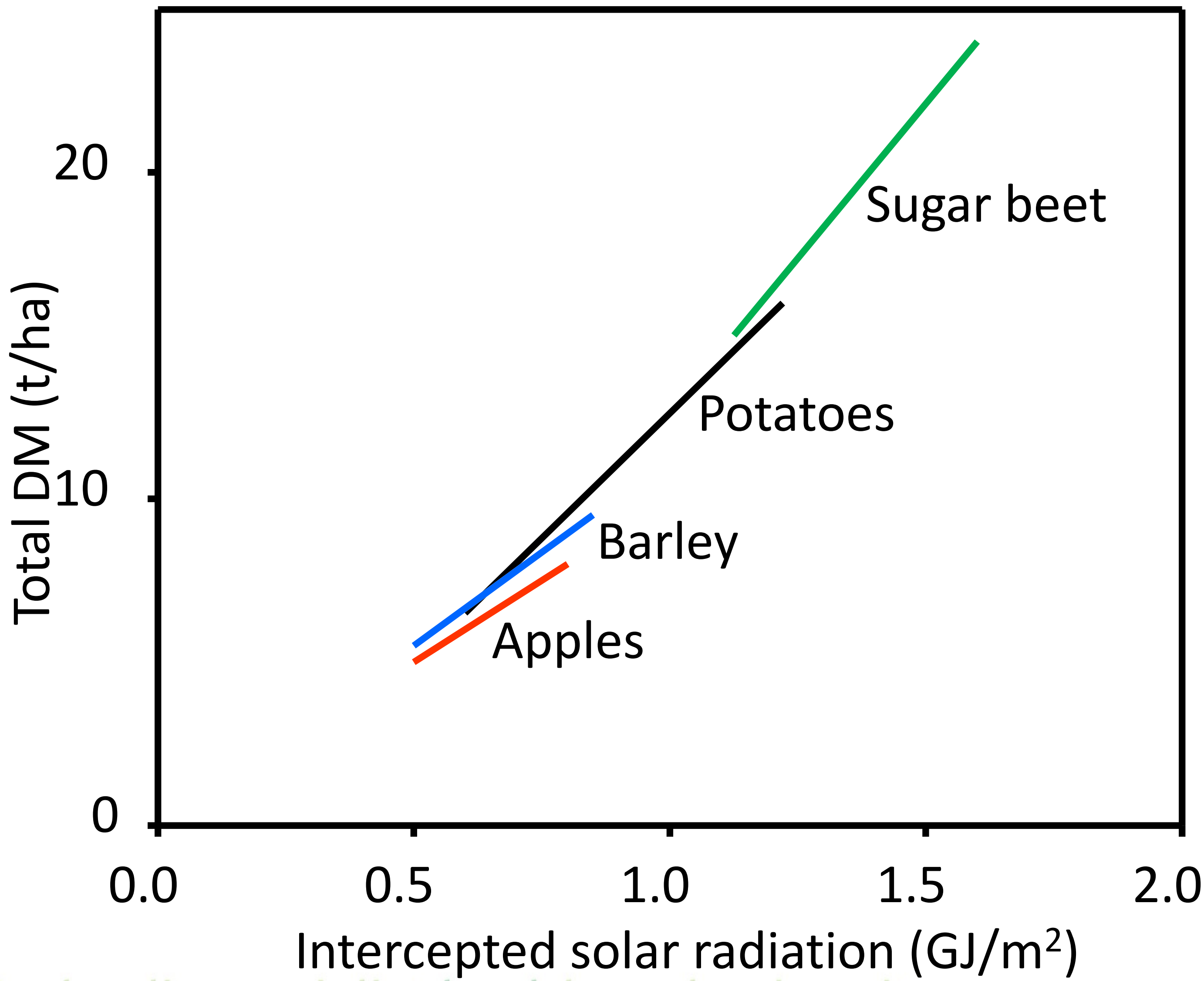
Wilson 1987



Monteith, 1977

Light

- Photosynthesis to produce CHO's for growth.

- Photosynthetically active radiation (PAR) is in the visible range (400-700nm).

- Conversion of PAR to DM

~2.4 g DM /MJ/m^2 for C3 plants

~3.8 g DM /MJ/m^2 for C4 plants

Basic model for yield analysis

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Yield= PAR_o x (PAR_i/PAR_o) x RUE x HI - grain crops

Yield= PAR_o x (PAR_i/PAR_o) x RUE_{shoot} - vegetative crops

PAR_o: Incident PAR (MJ/m^2)
PAR_i: Intercepted PAR (MJ/m^2)
PAR_i/PAR_o: Fractional PAR interception (0-1)
RUE: Radiation use efficiency (g DM/MJ PAR)
HI: Harvest index (0-1)

Challenges for the use of the model for lucerne:

- Perennial crop
- RUE_{shoot} differs seasonally (C and N reserves in roots)
- Effect of perennial reserves on shoot yield

Proposed model for yield analysis

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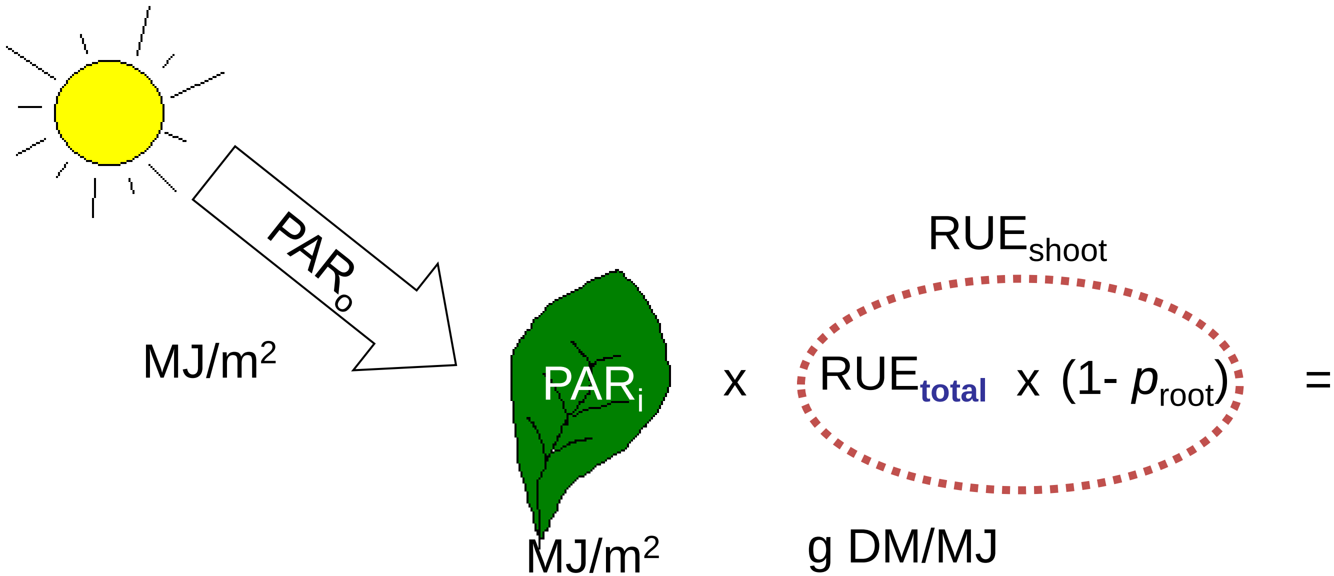
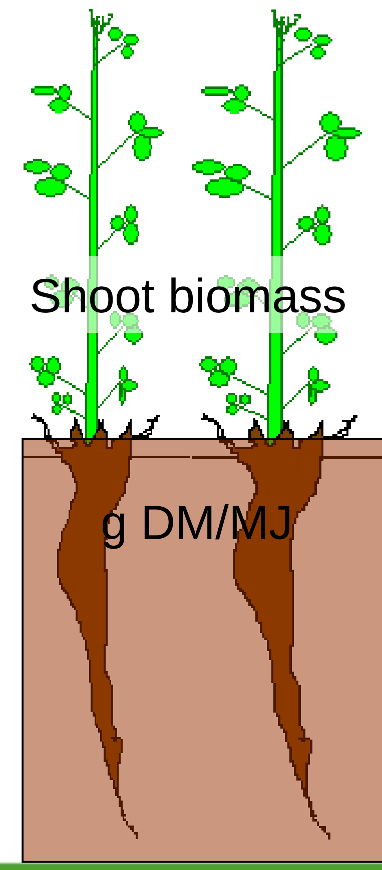
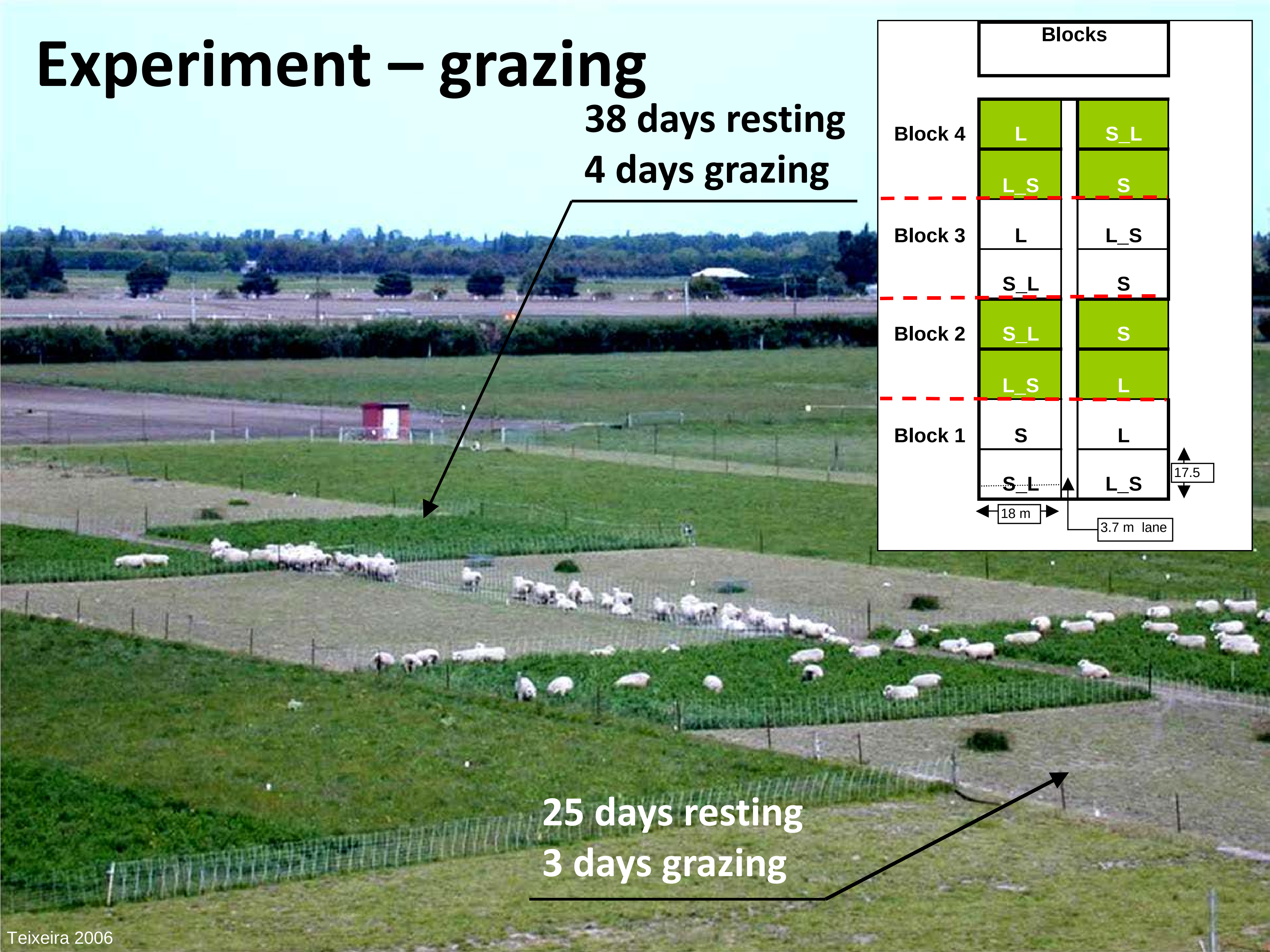
$$\text{Yield} = PAR_o \times (PAR_i/PAR_o) \times RUE_{total} \times (1-p_{root})$$





Experiments to develop the model…..

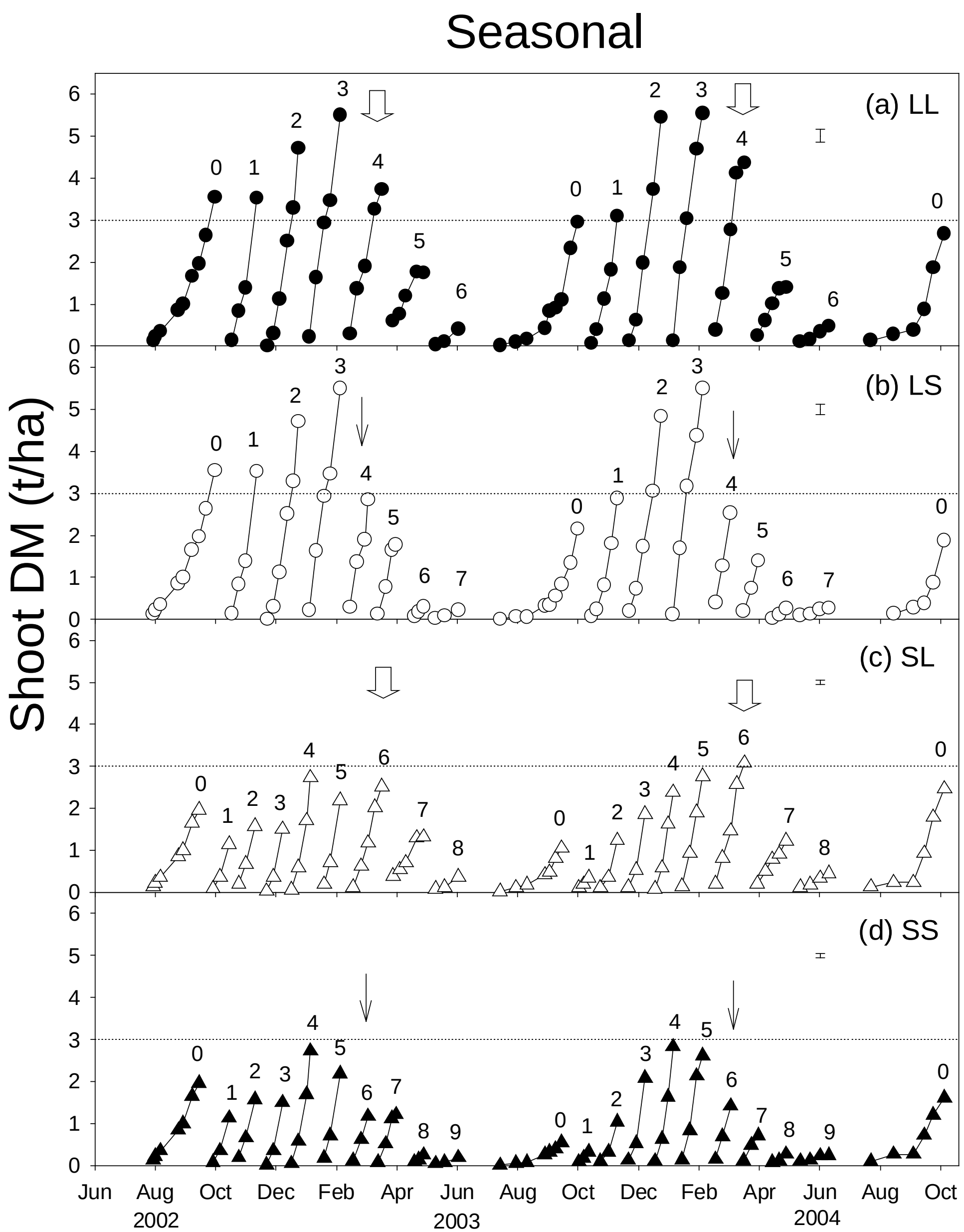
Experiment – grazing

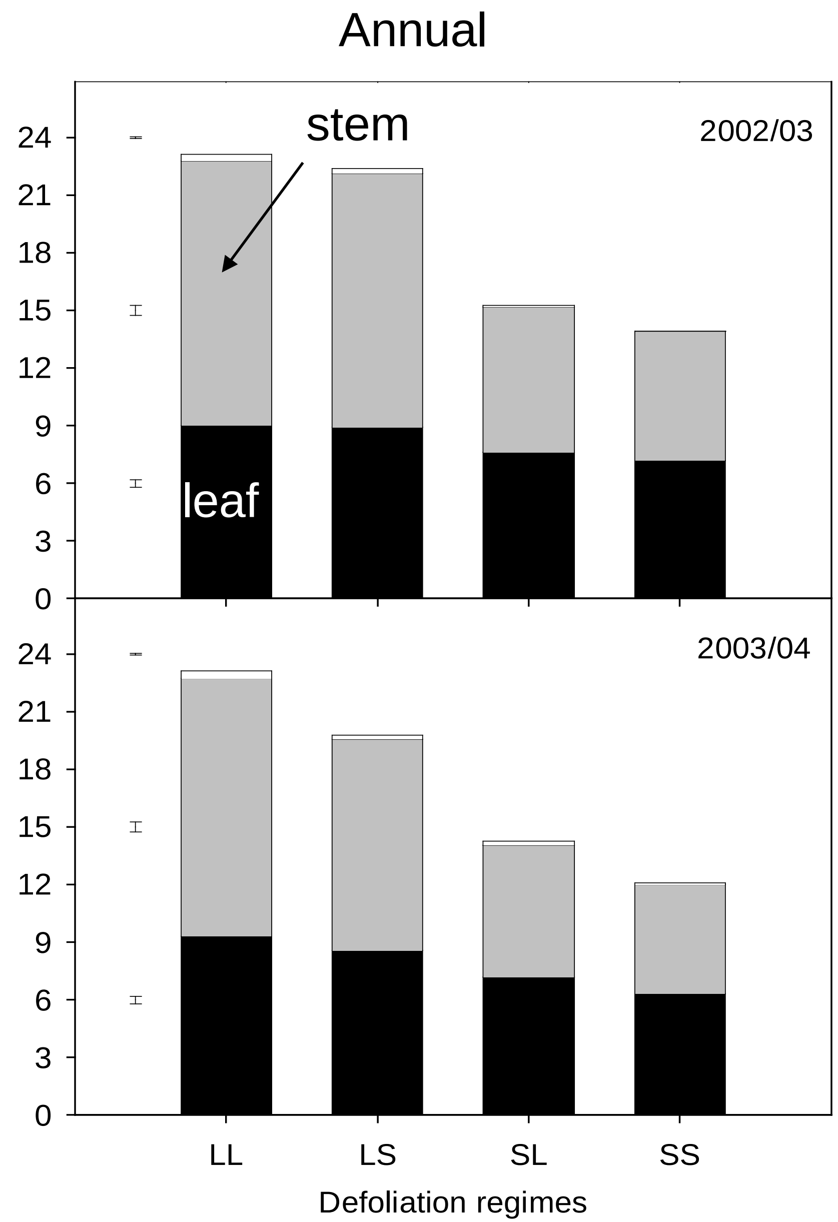


Shoot Yield

$\text{Yield} = PAR_o \times (PAR_i / PAR_o) \times RUE_{total} \times 1-(p_{root})$

Shoot yield

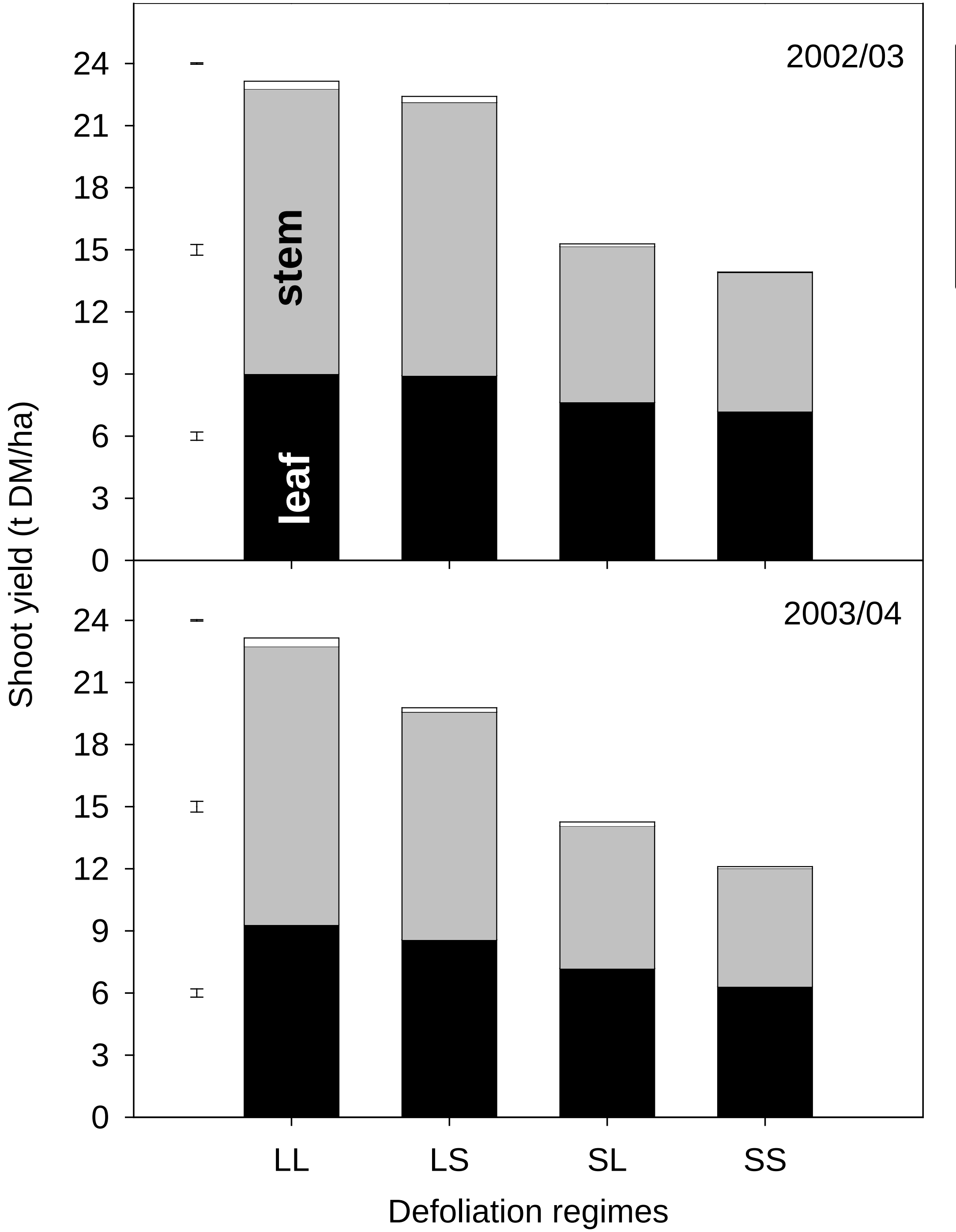




Teixeira *et al*. 2007a, b

Shoot yield

~23.5 t DM/ha/year in LL



PAR interception

$$\text{Yield} = \textbf{PAR}_{o} \times (\textbf{PAR}_{i}/\textbf{PAR}_{o}) \times \text{RUE}_{total} \times 1-(p_{root})$$

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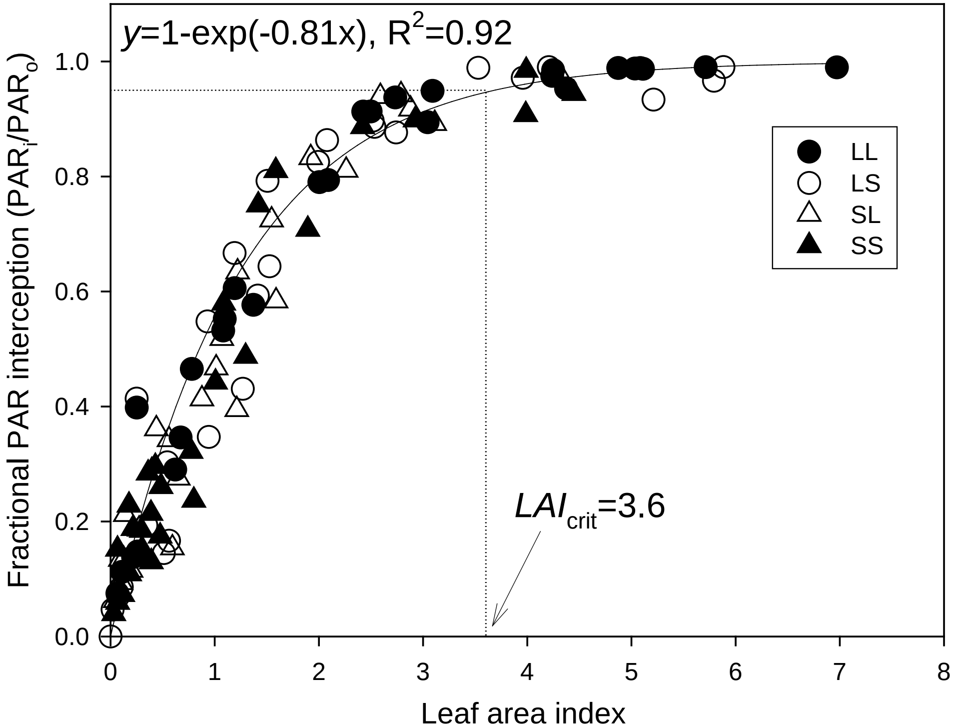
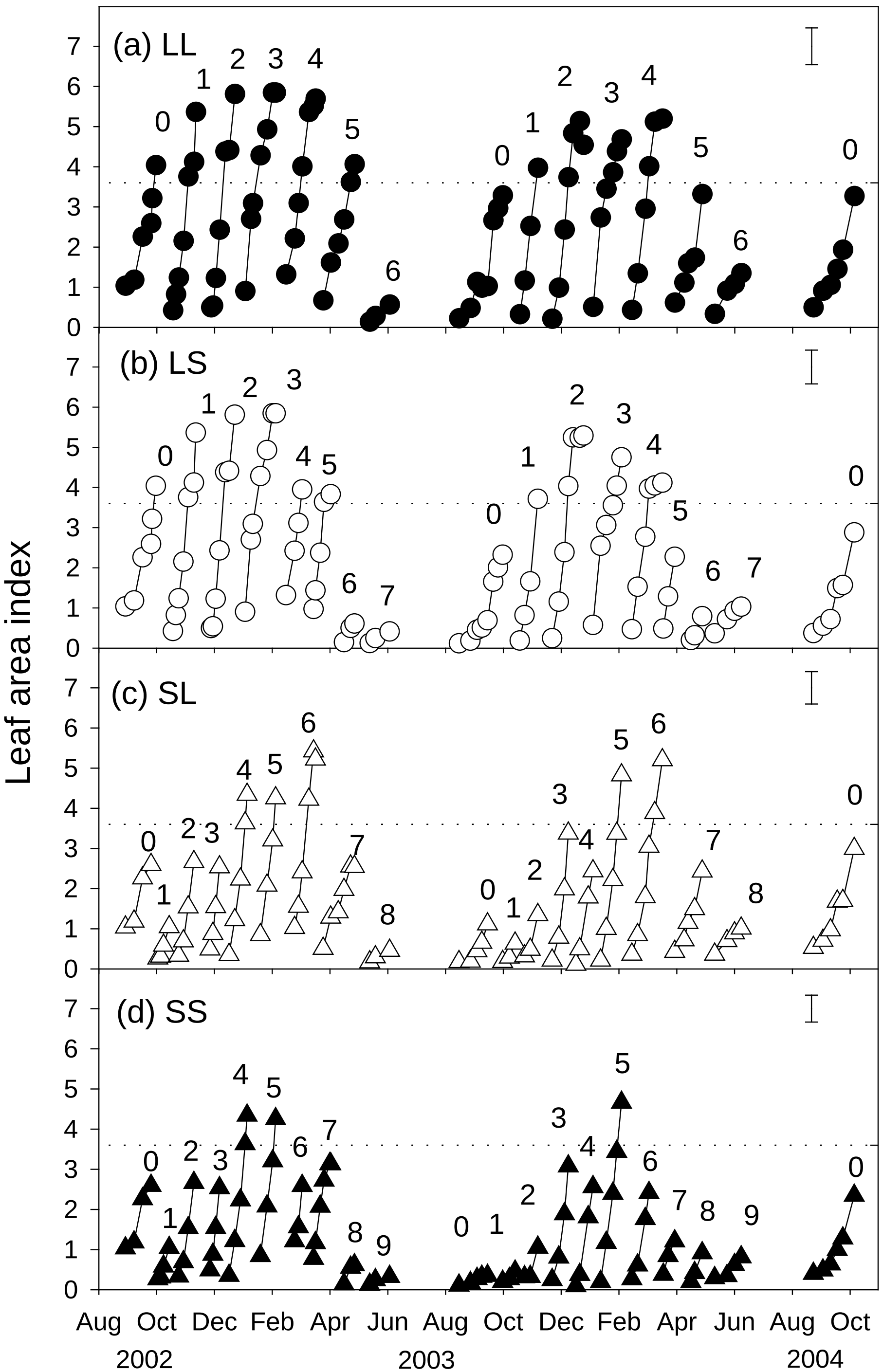
PAR interception





Teixeira *et al.* 2007c

Model for perennial crops

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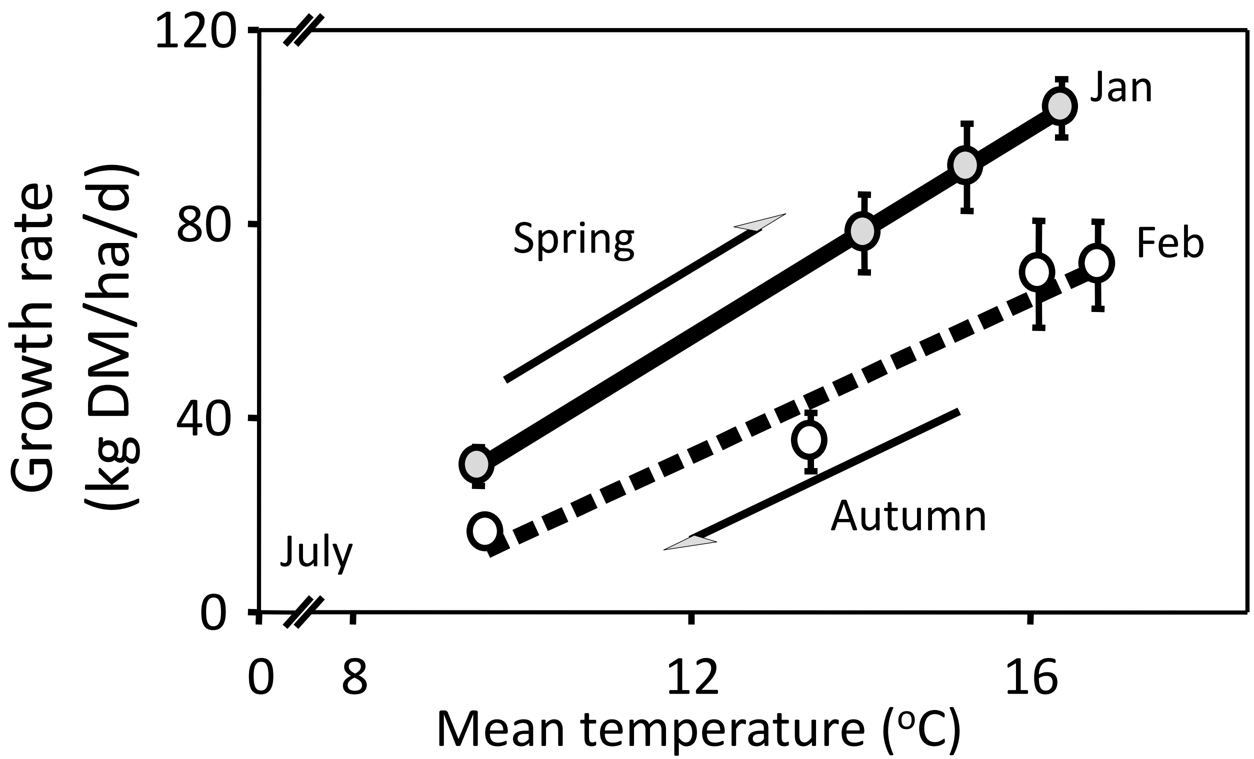
$Yield = PAR_o \times (PAR_i/PAR_o) \times RUE_{shoot}$ APSIM

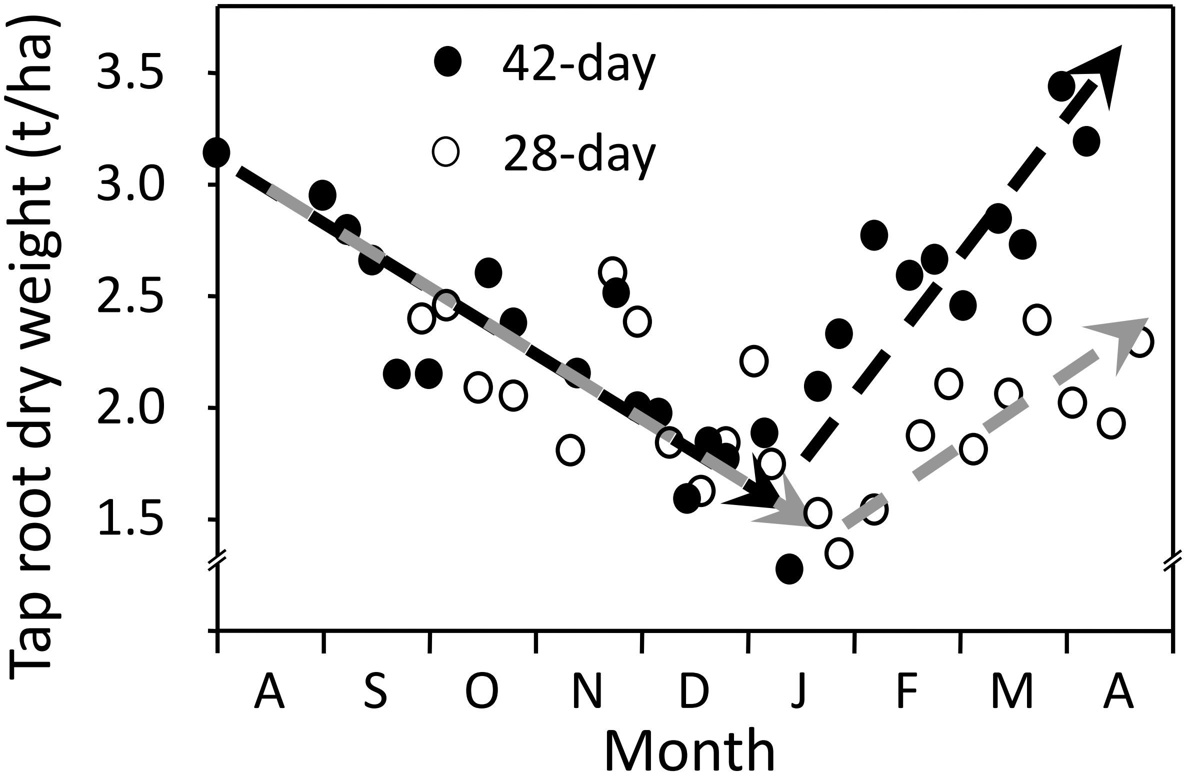
$Yield = PAR_o \times (PAR_i/PAR_o) \times RUE_{total} \times 1-(p_{root})$

PAR_o: Incident PAR (MJ/m^2)
PAR_i: Intercepted PAR (MJ/m^2)
PAR_i/PAR_o: Fractional PAR interception (0-1)
RUE: Radiation use efficiency (g DM/MJ PAR)
p_{root}: Fractional partitioning of DM to roots (0-1)

Vegetative growth



Partitioning to roots



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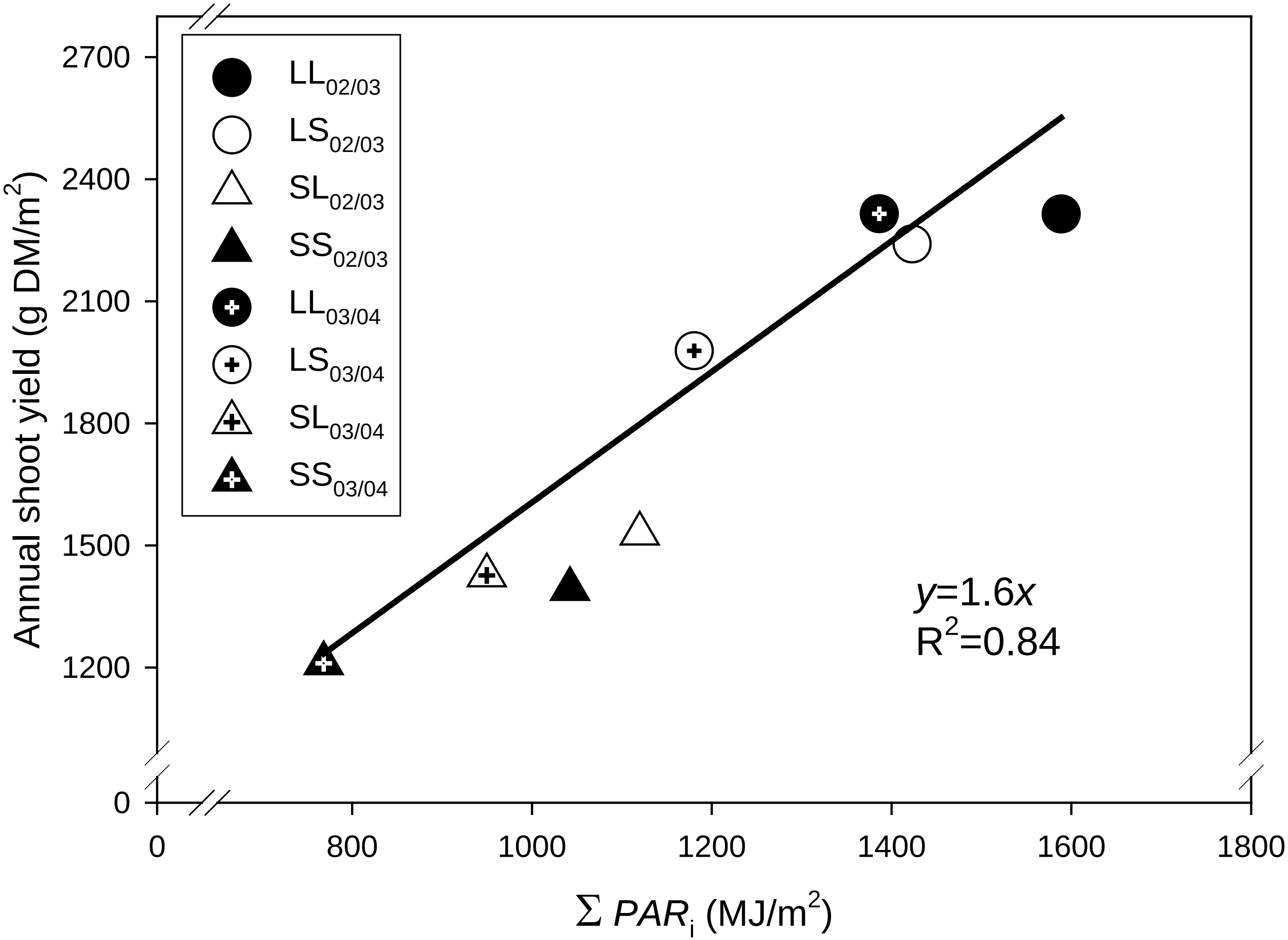
Moot *et al*. 2003

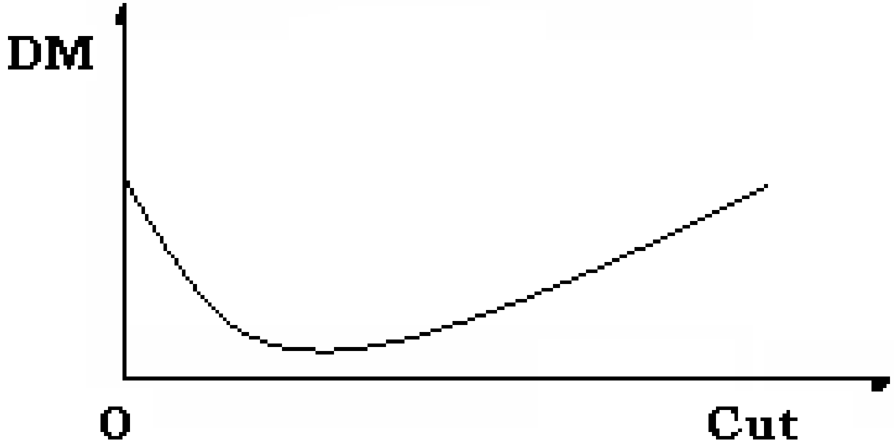
Annual shoot yield and ∑PAR_i



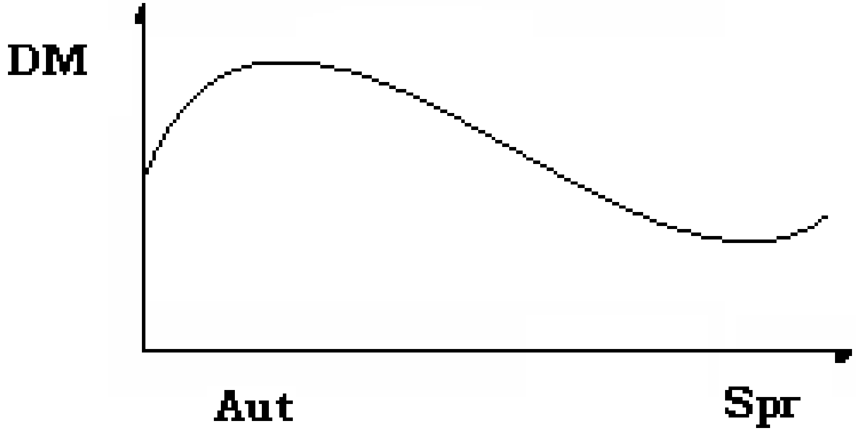
Teixeira *et al.* 2007c

The partitioning of DM to roots differs

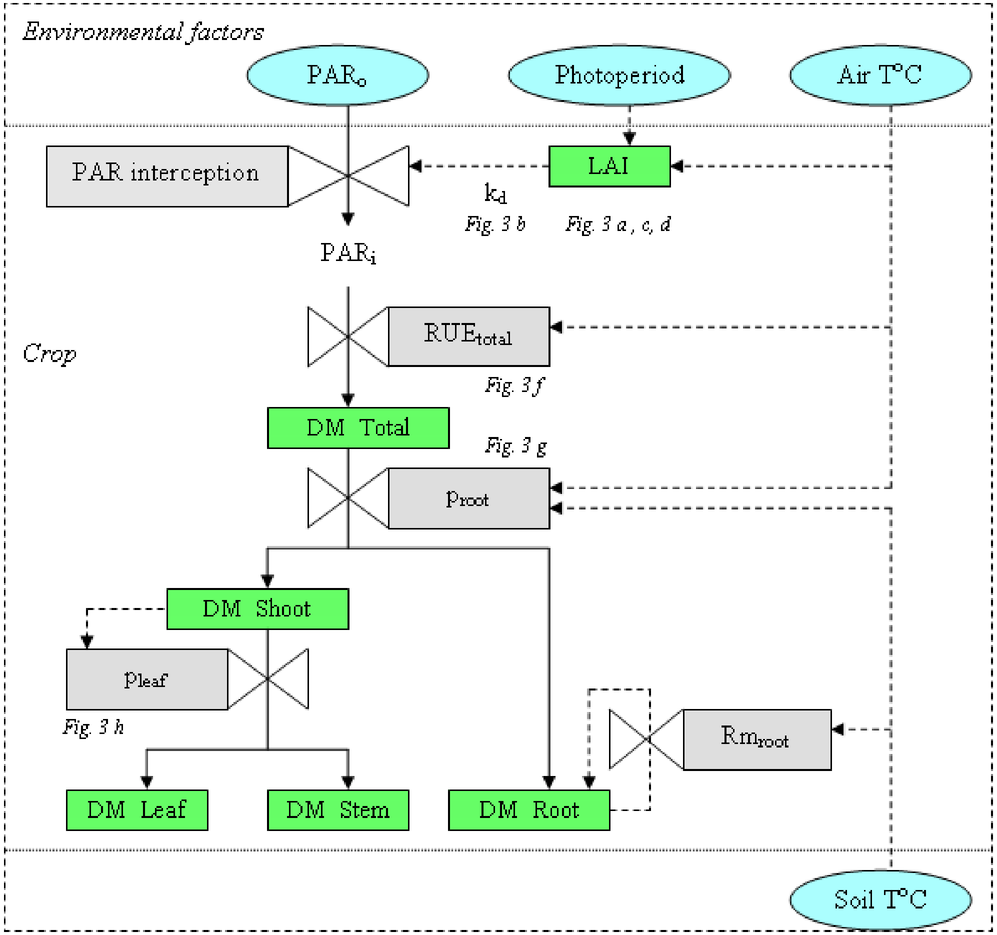
Within cycles

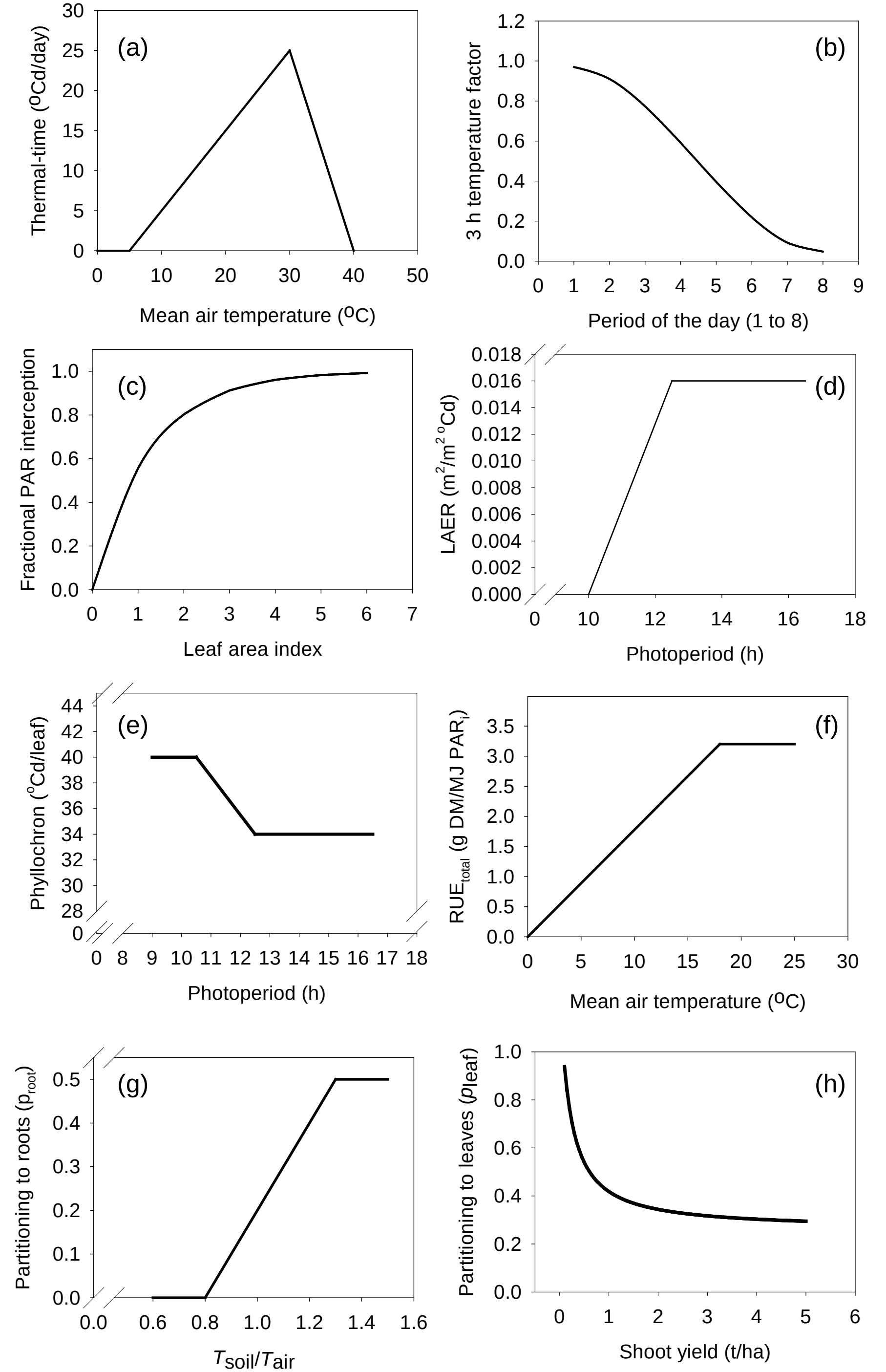


Seasonally



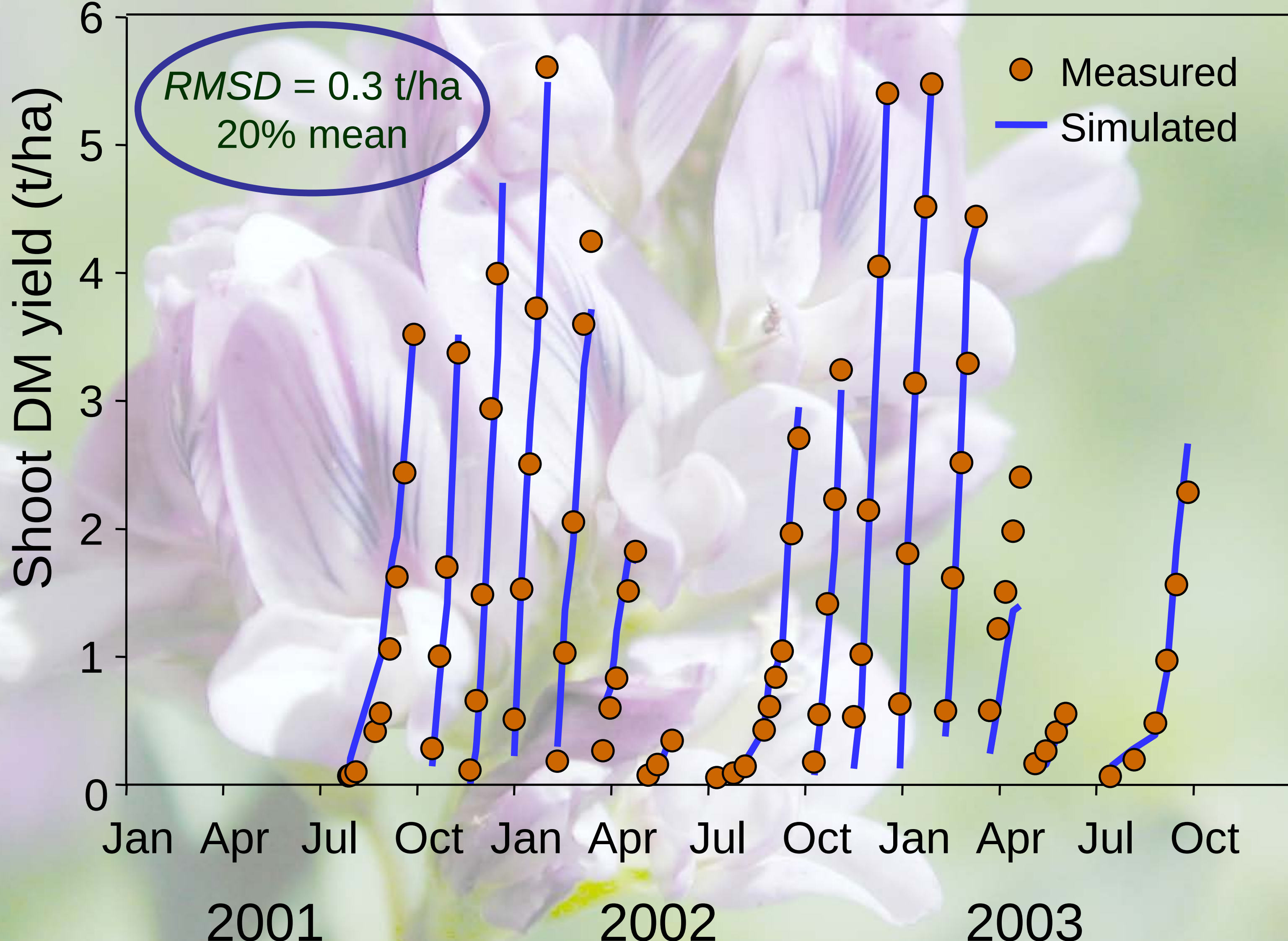
Modelling





Teixeira *et al.* 2009

Predictions of shoot yield



Teixeira *et al*. 2011

Conclusions

- Dry matter = light int. x RUE
- Light interception - more variable than RUE
- RUE is conservative
- Alfalfa - seasonal/rotational partitioning
- Model then to explain treatment effects

  (defoliation, climate change, etc……….)

Validation of the APSIM-Lucerne model for development in a cool-temperate climate

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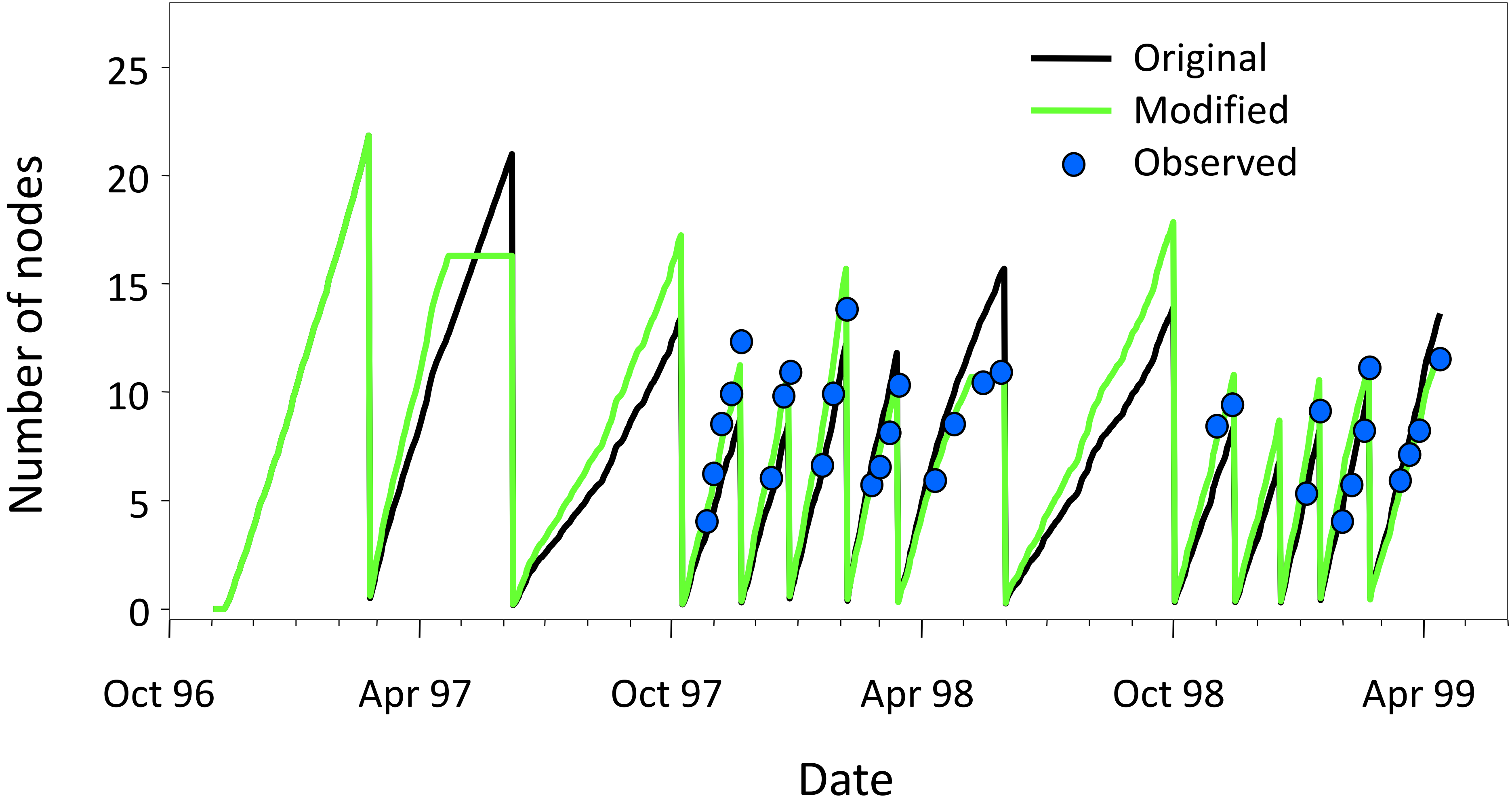
Objectives

- Use the APSIM model to simulate lucerne development in a cool-temperate climate

- Test the model in its original and modified form

APSIM-Lucerne simulation



Conclusions

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- Thermal time to early-bud decreased at longer photoperiods.
- The phyllochron for 'Kaituna' lucerne was faster in spring and summer than in autumn.
- With calibration, APSIM predicted early-bud and node appearance for lucerne in New Zealand

References & Links

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Dryland Pastures Blog: http://www.lincoln.ac.nz/conversation/drylandpastures/

Lincoln University student website: www.lincoln.ac.nz

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