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Australian Export Grains Innovation Centre

Improved Wheat Yield and Production Forecasting with a Moisture Stress Index, AVHRR and MODIS data (in Western Australia)

Dr David Stephens (AEGIC)

Department of Agriculture and Food

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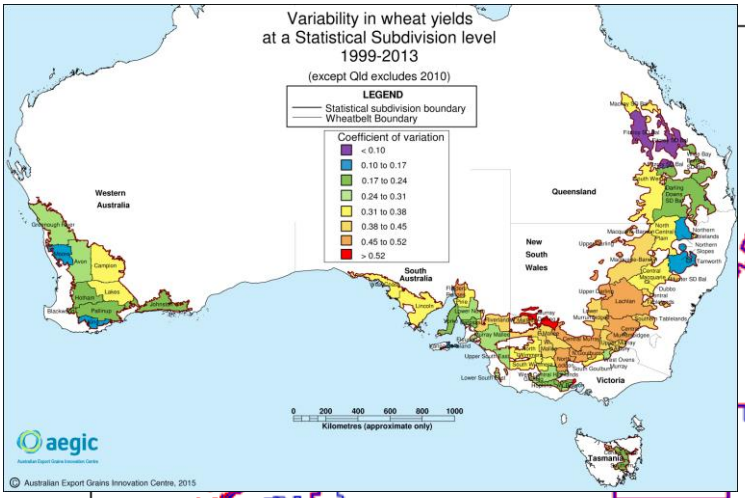
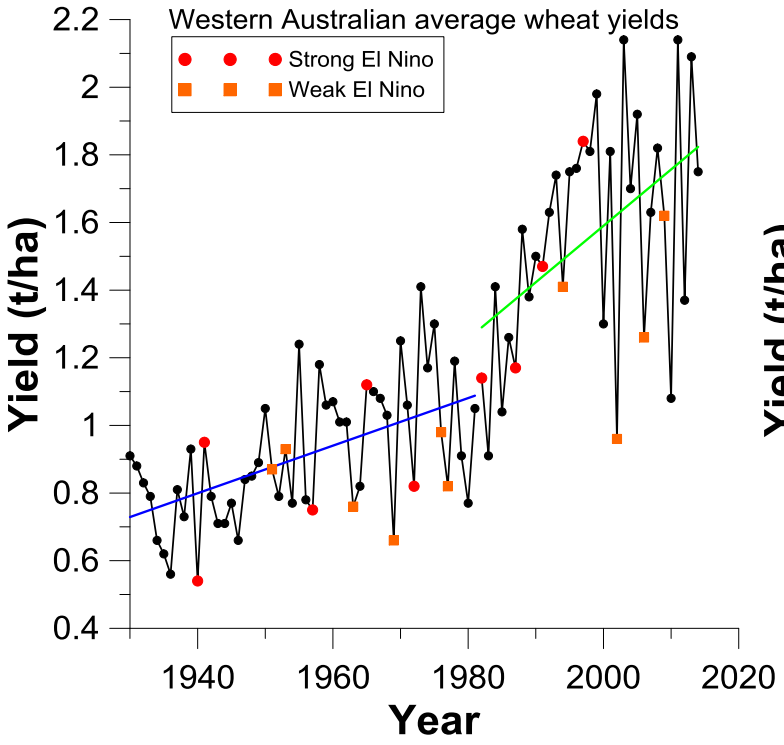
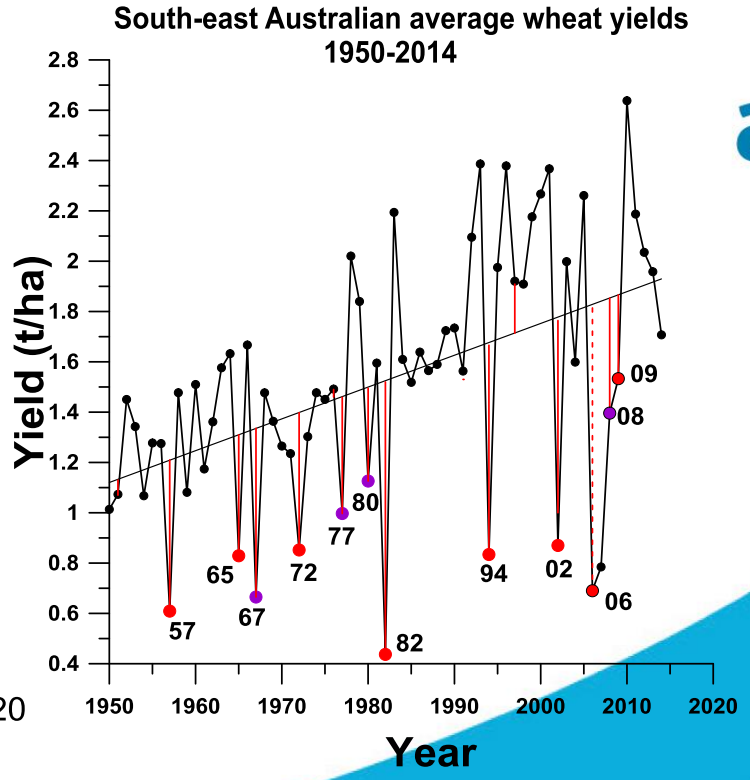
Broad overview – Crop Forecasting

- Crop Forecasting - moisture stress
- Integration climate/crop forecasting
- Crop forecasting – moisture stress + NDVI
- Productivity gains – N Fertilizer important
- APSIM simulation modelling/climate extremes

Australian Grainbelt –STIN crop forecasting system







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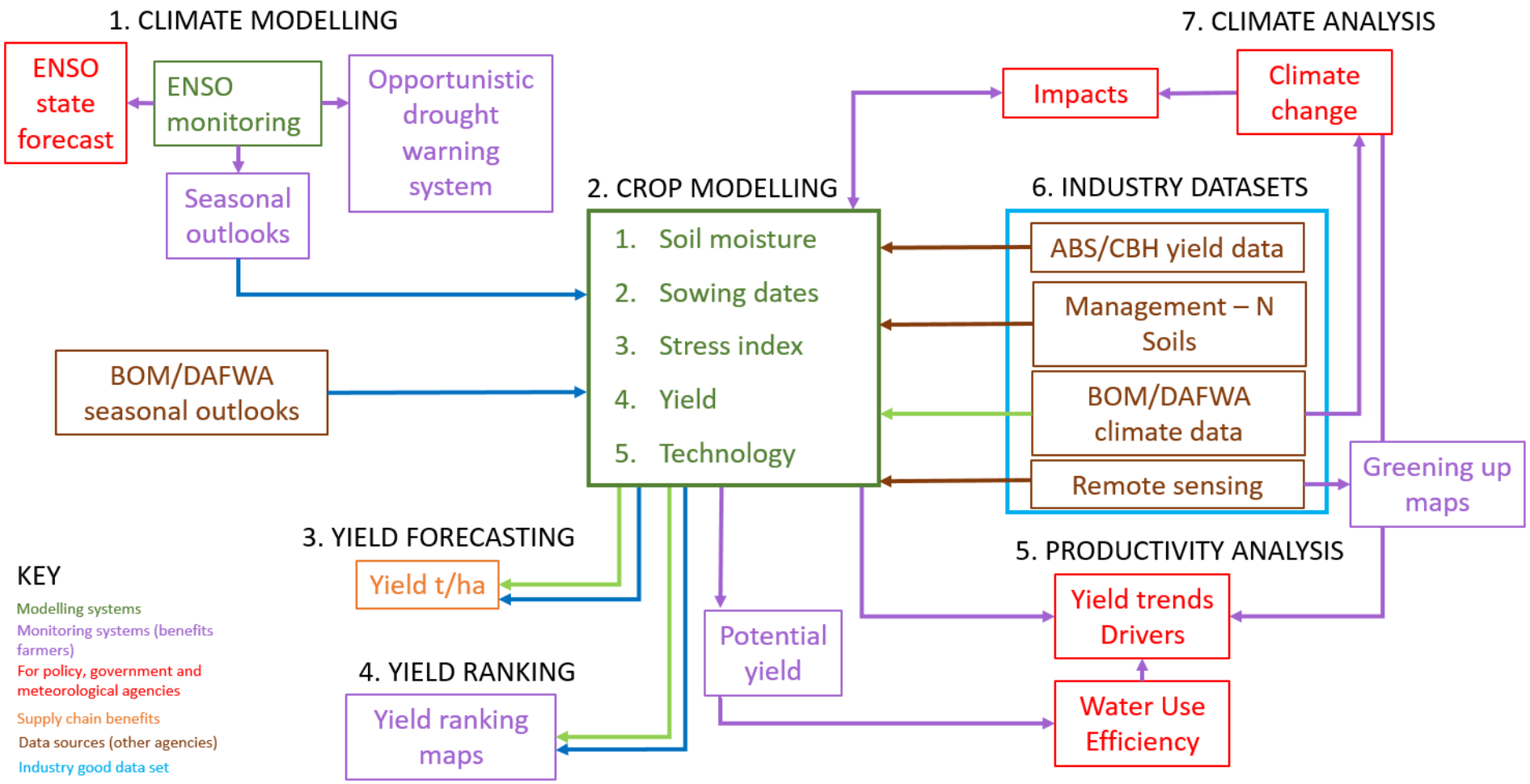
AEGIC Strategic Agro-climatic Modelling for the Australian Grains Industry



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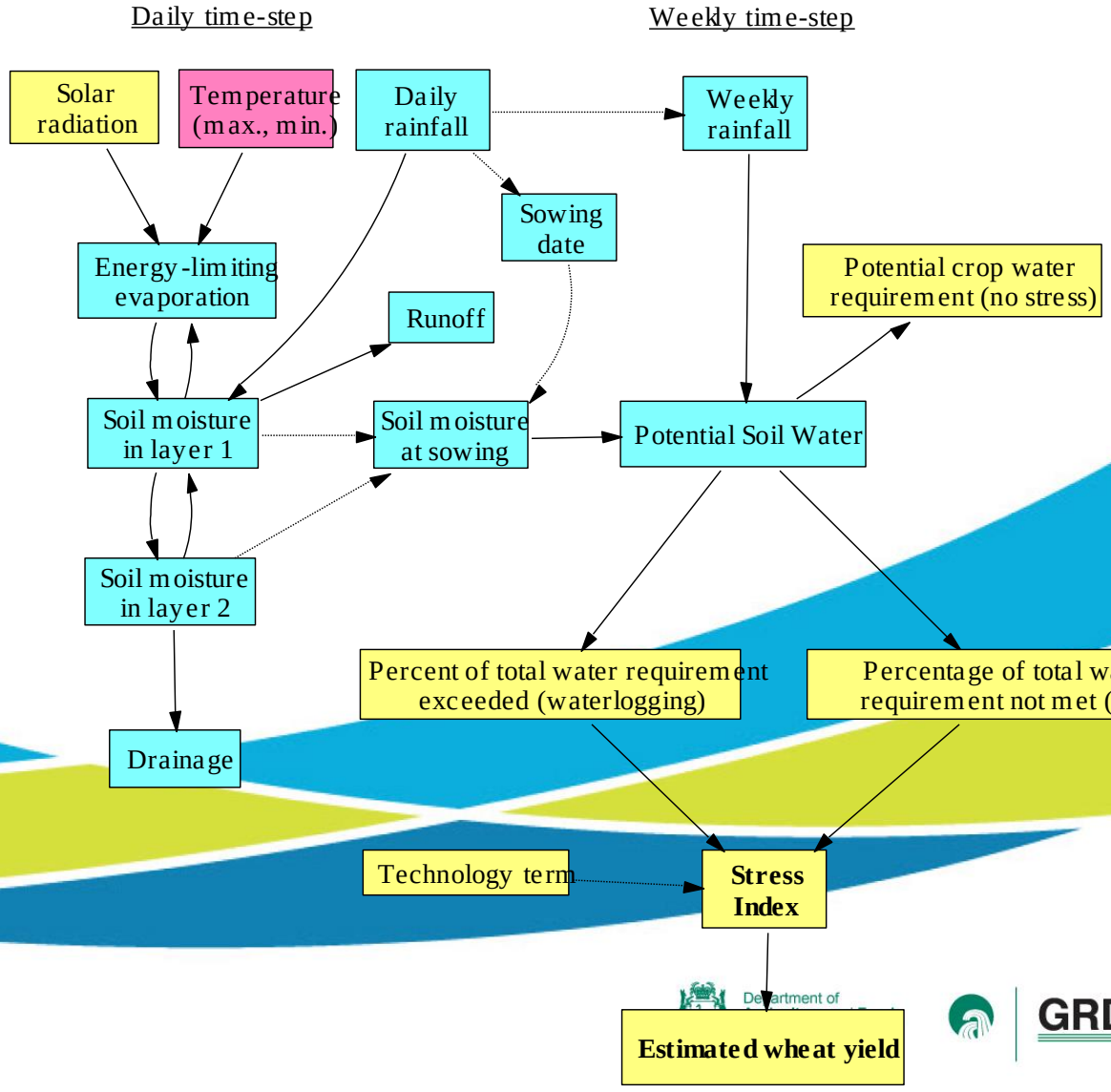
STress INdex for wheat (STIN) - Stephens

1) Ritchie 2-stage Water balance 2) FAO Crop Monitoring Model



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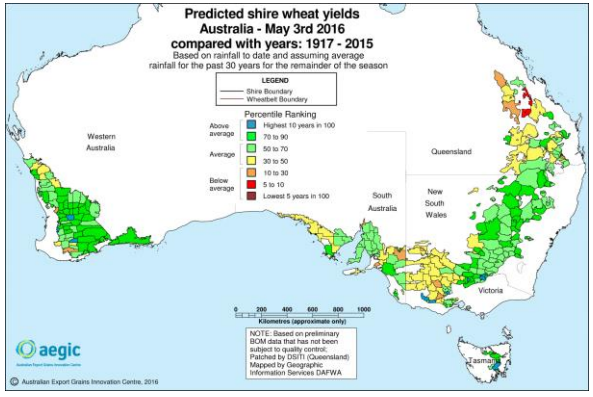
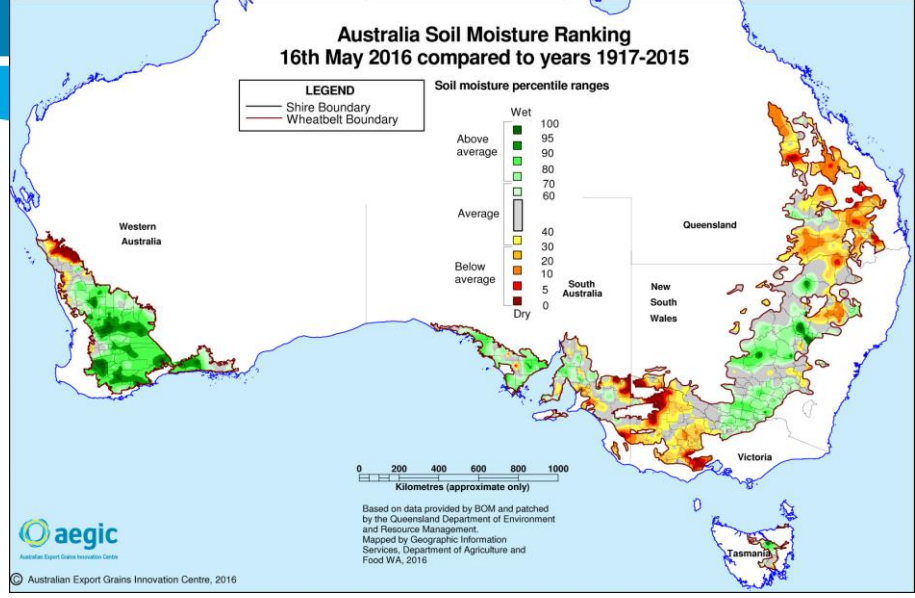
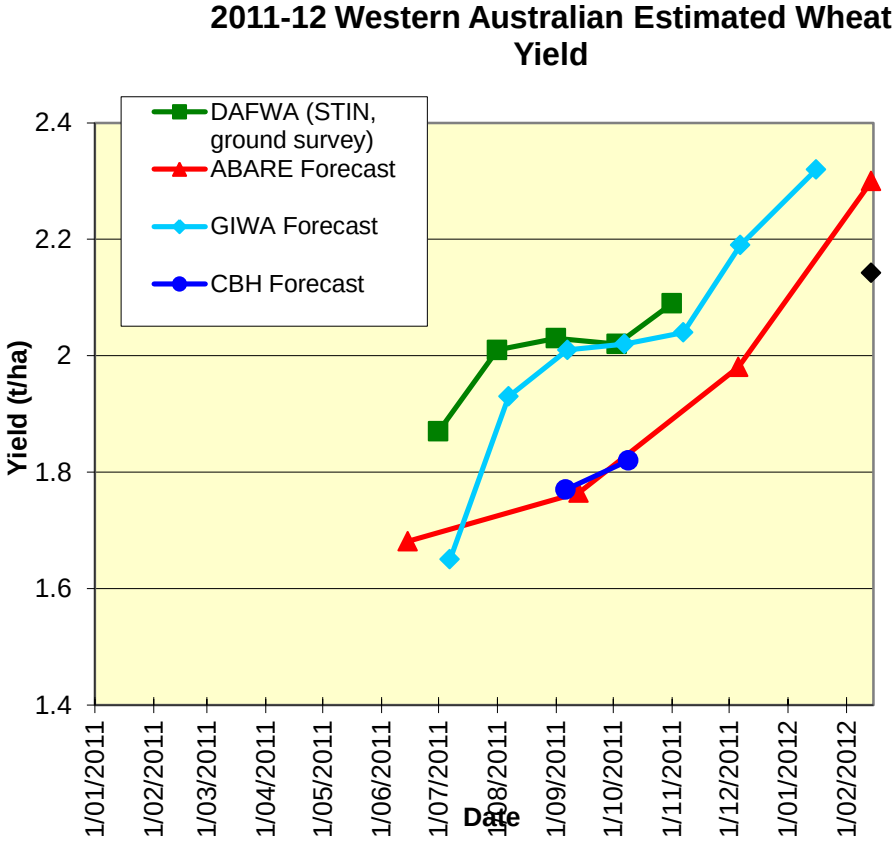
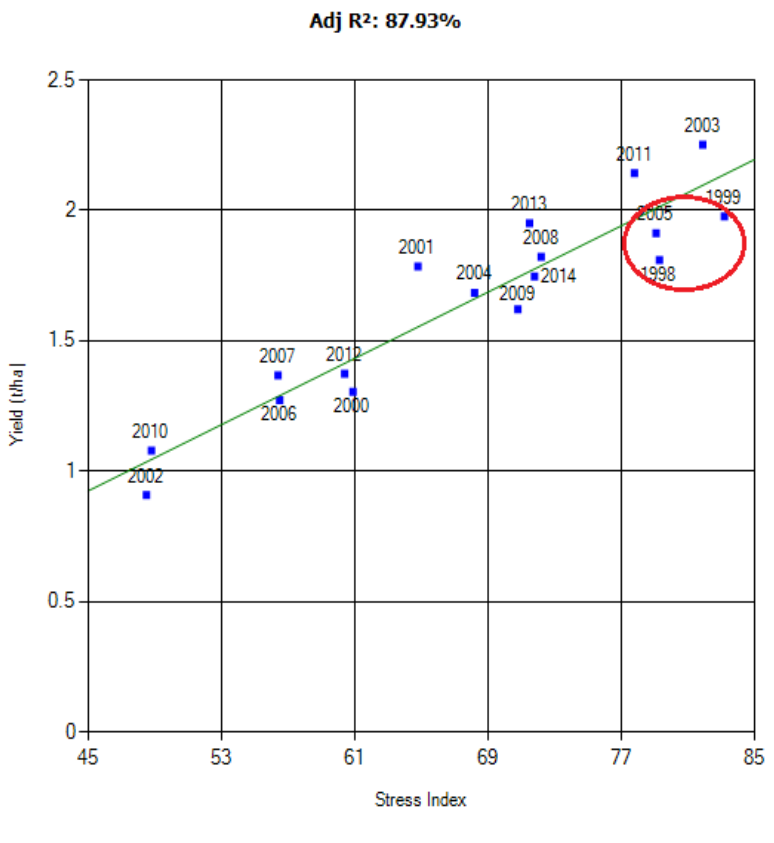
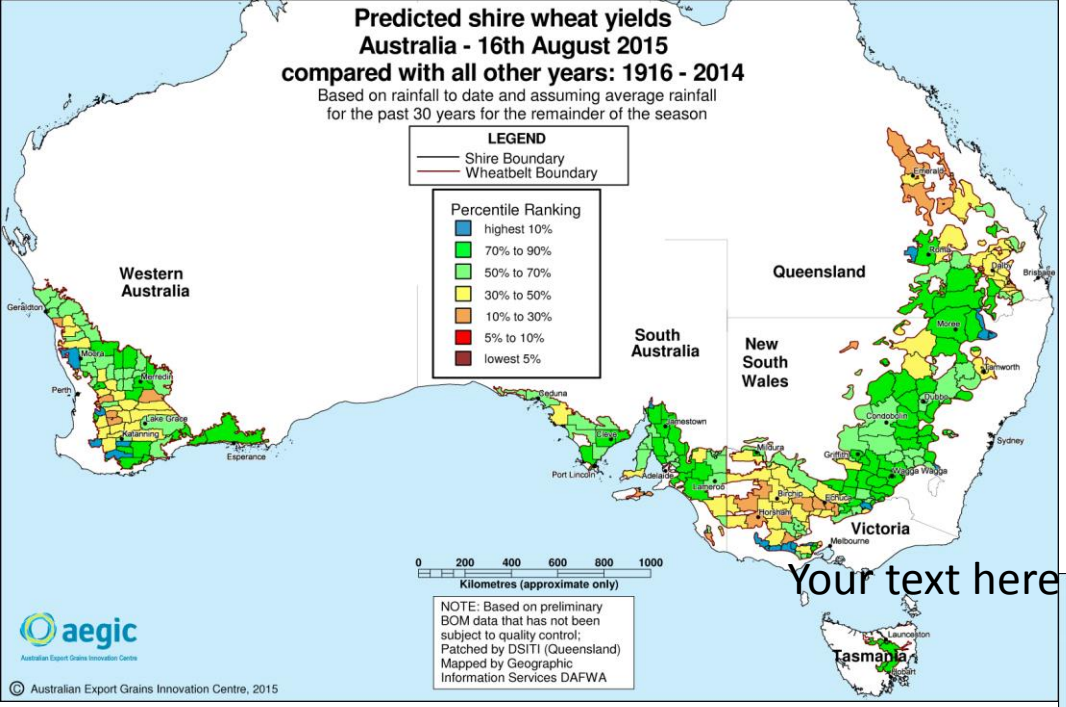
Crop Monitoring

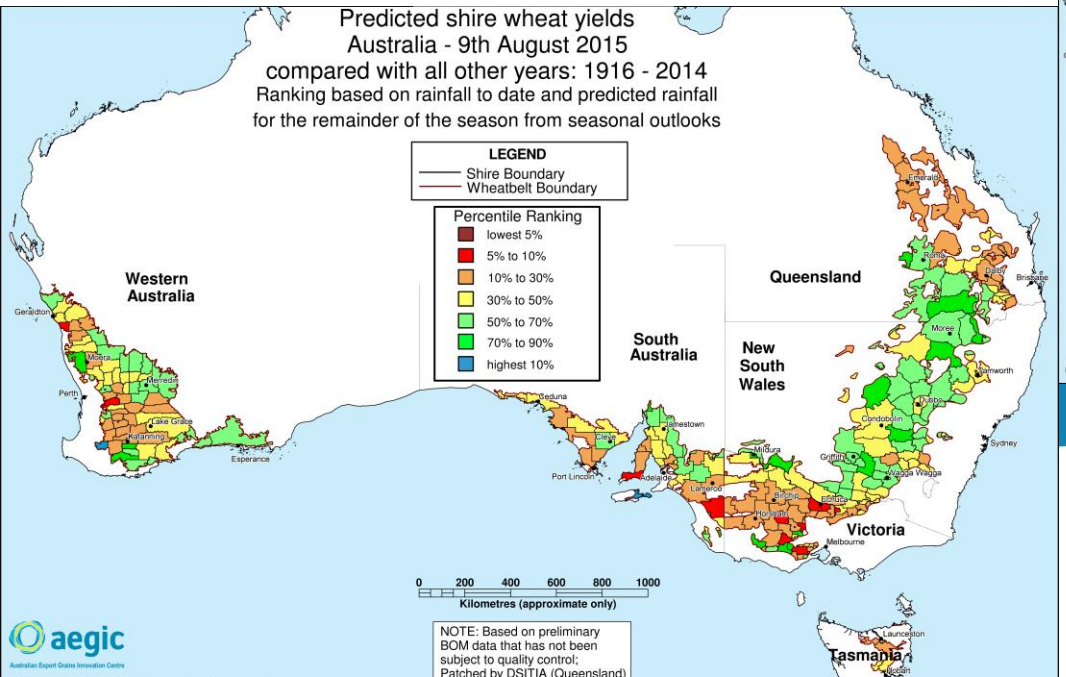












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Integration of seasonal forecasts - 2015 Forecasts final (right)

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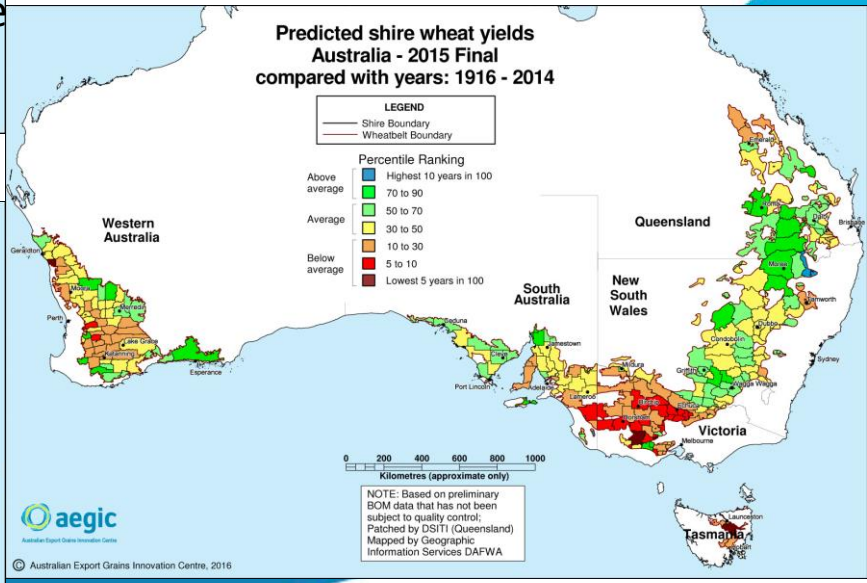

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Yield Forecasting
Water balance + Satellites

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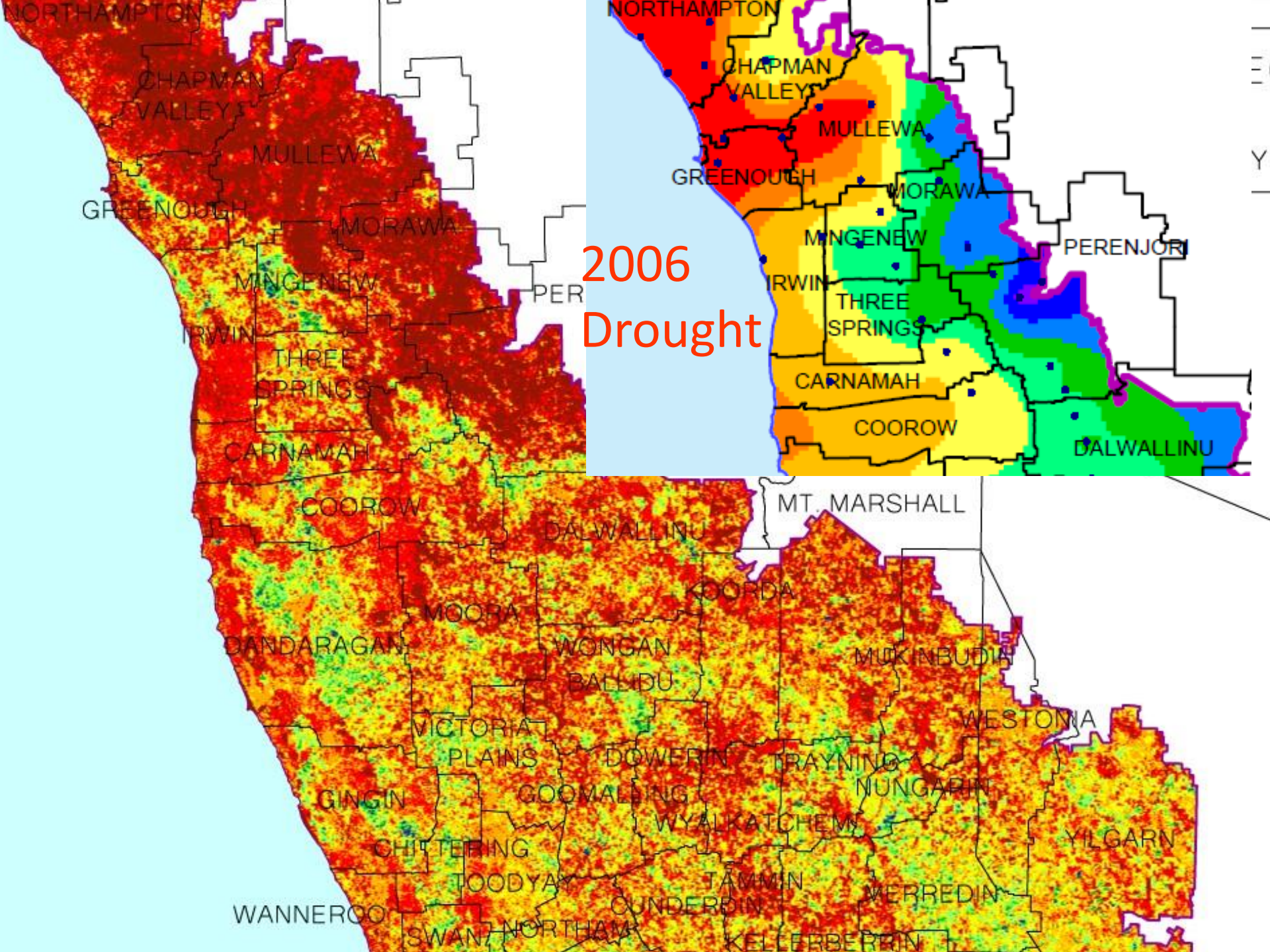
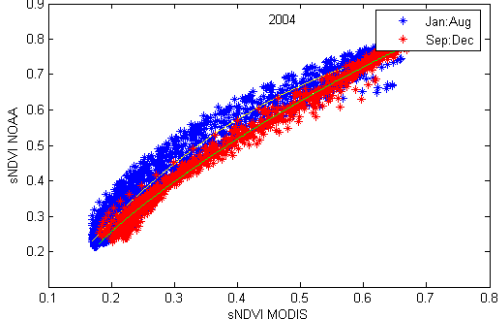
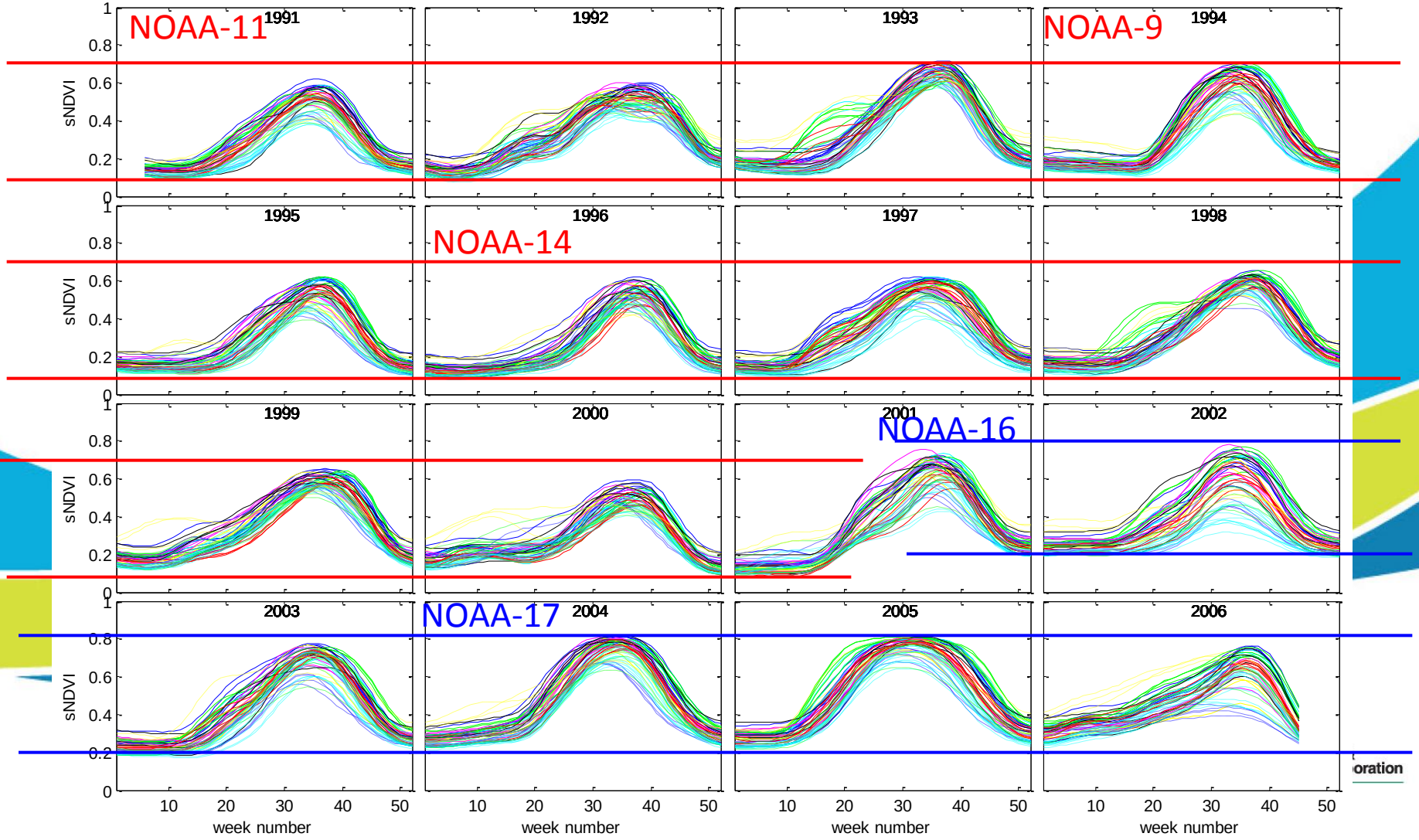

NORTHAMPTON
CHAPMAN VALLEY
MULLEWA
GREENOUGH
MORAWA
MINGENEW
IRWIN
THREE SPRINGS
CARNAMAH
COOROW
DALWALLINU
PERENJORI
2006 Drought
MT. MARSHALL
KOORDA
MOORA
DANDARAGAN
WONGAN BALLIDU
MUKINBUDIN
VICTORIA PLAINS
DOWERIN
TRAYNING
NUNGARIN
WESTONIA
GINGIN
GOOMALLING
WYALKATCHEM
YILGARN
CHITTERING
TOODYAY
TAMMIN
MERREDIN
WANNEROO
SWAN
NORTHAM
CUNDERDIN
KELLERBERRIN

Time-series of AVHRR in Western Australia





Regression analysis

- **One model for all shires**
- **Validation with leave-year-out procedure**
- **Partial least squares (PLS) regression**

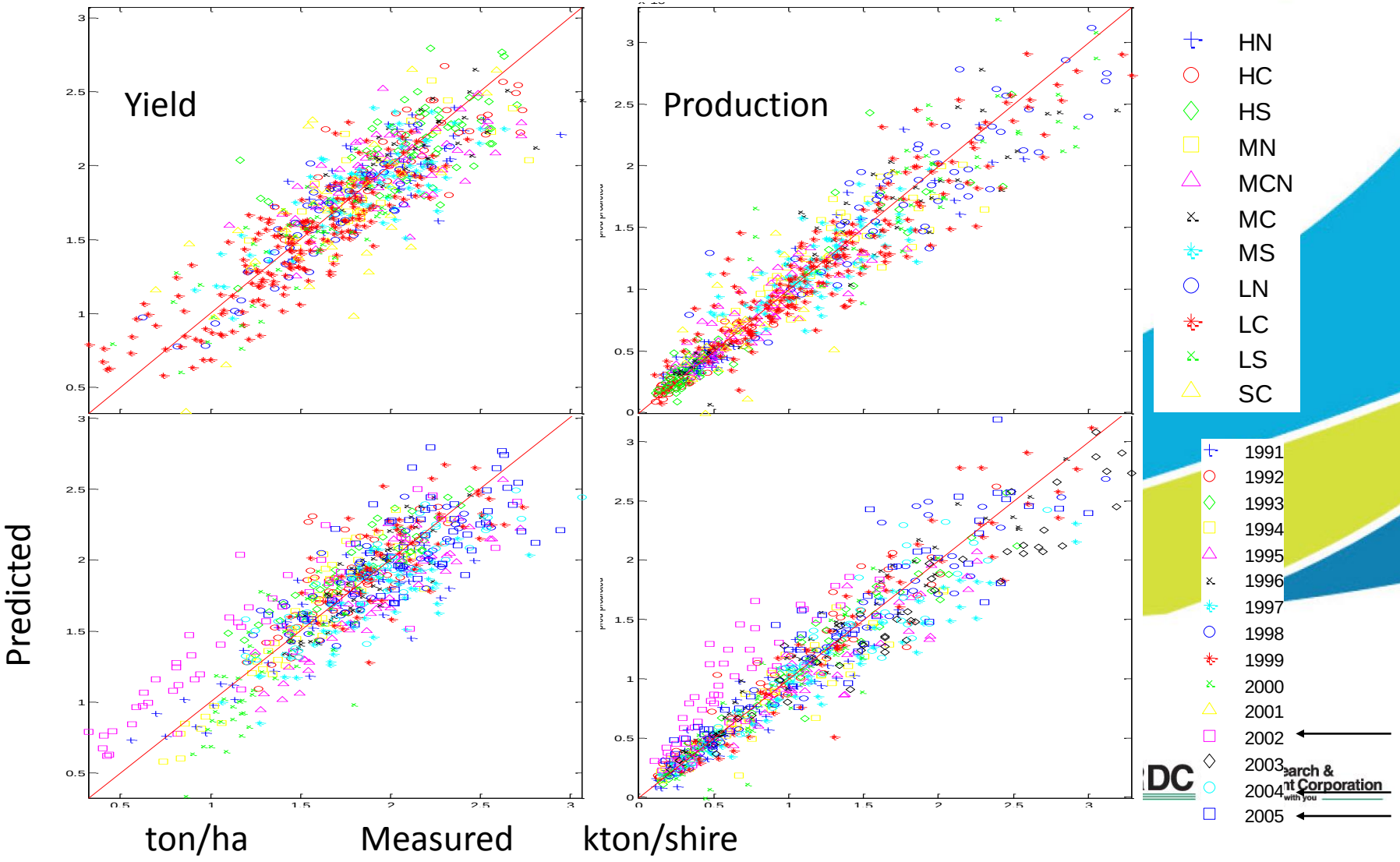
$$X = [Yr, SI, sNDVI, CR, SI \times NDVI, SI \times CR]$$

$$LV = f(X, Y)$$

$$Y = A \times LV$$

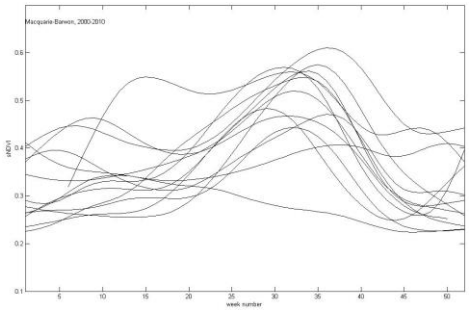
- **Maximum of 10 Latent Vectors in model**
- **Data normalization**
  - **Zero mean and unit variance per shire**
  - **Each column of X and Y separately**

Validation results for best model



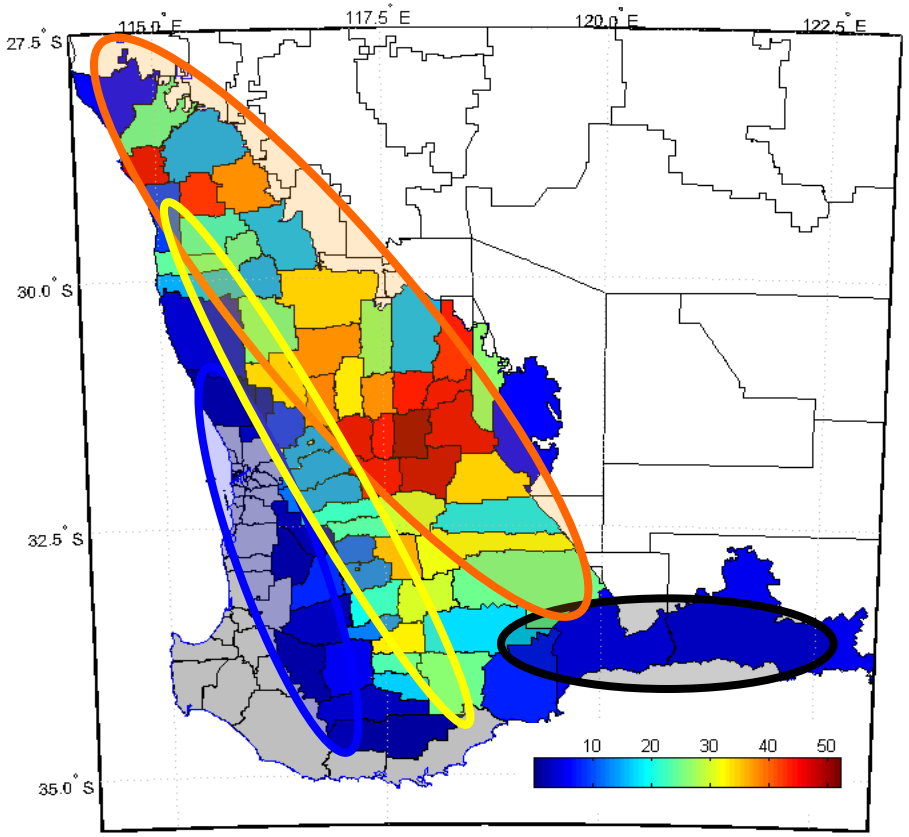
Aggregated to climatic zones

Rainfall	Q^2	RMSEP (t/ha)
High	0.5-0.8	0.11-0.18
Medium	0.8	0.11-0.14
Low	0.9-1.0	0.06-0.11
Southern coast	0.7-0.9	0.11-0.18

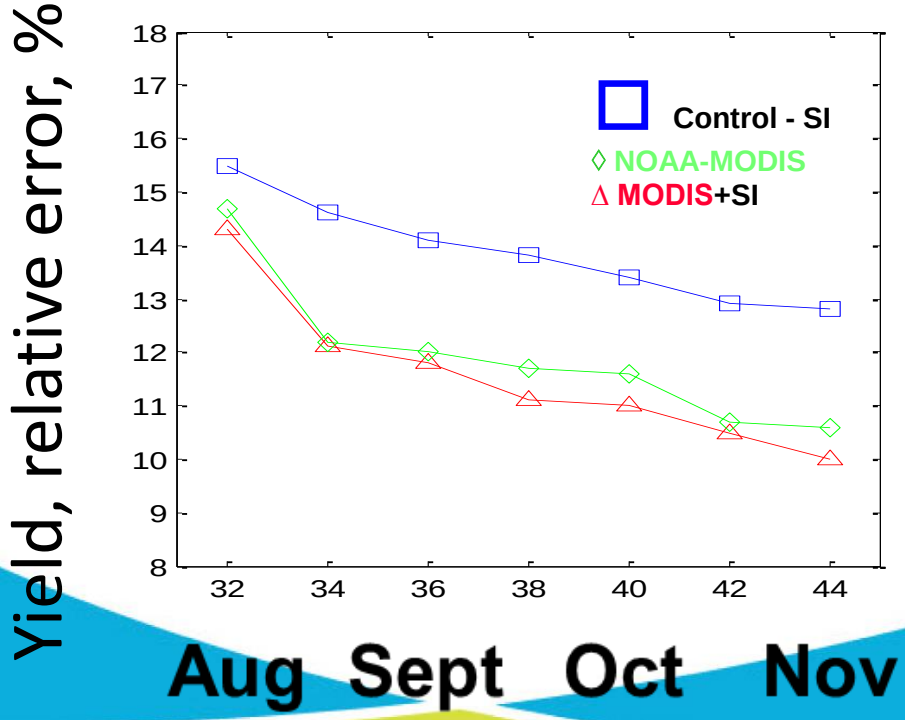


Model struggled
Where mixed crops

Area under wheat, %



MODIS data improves water balance model predictions



Total error for WA

	Sep	Nov
Current	0.98	0.75 Mt
Improved	0.55	0.46 Mt

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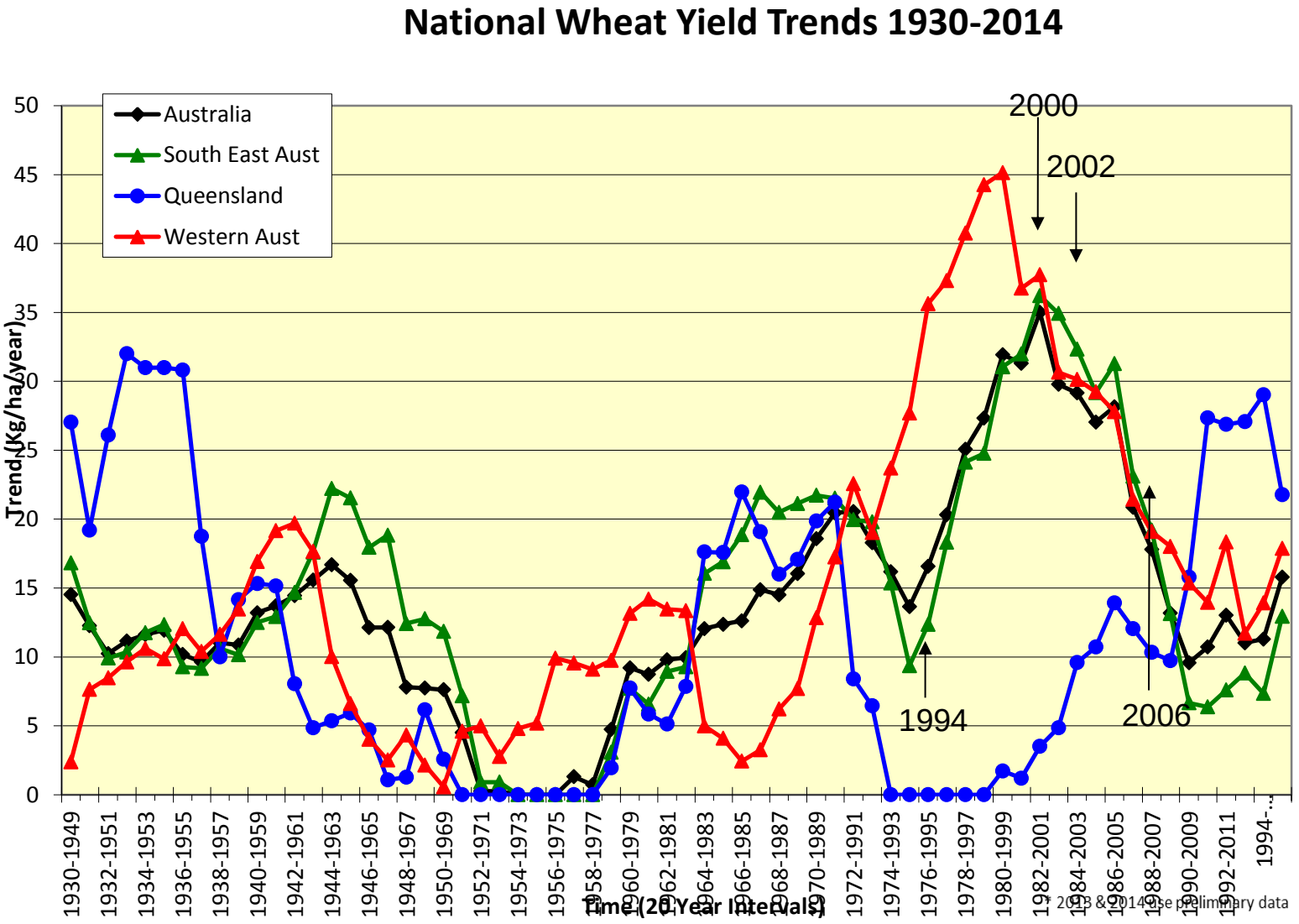
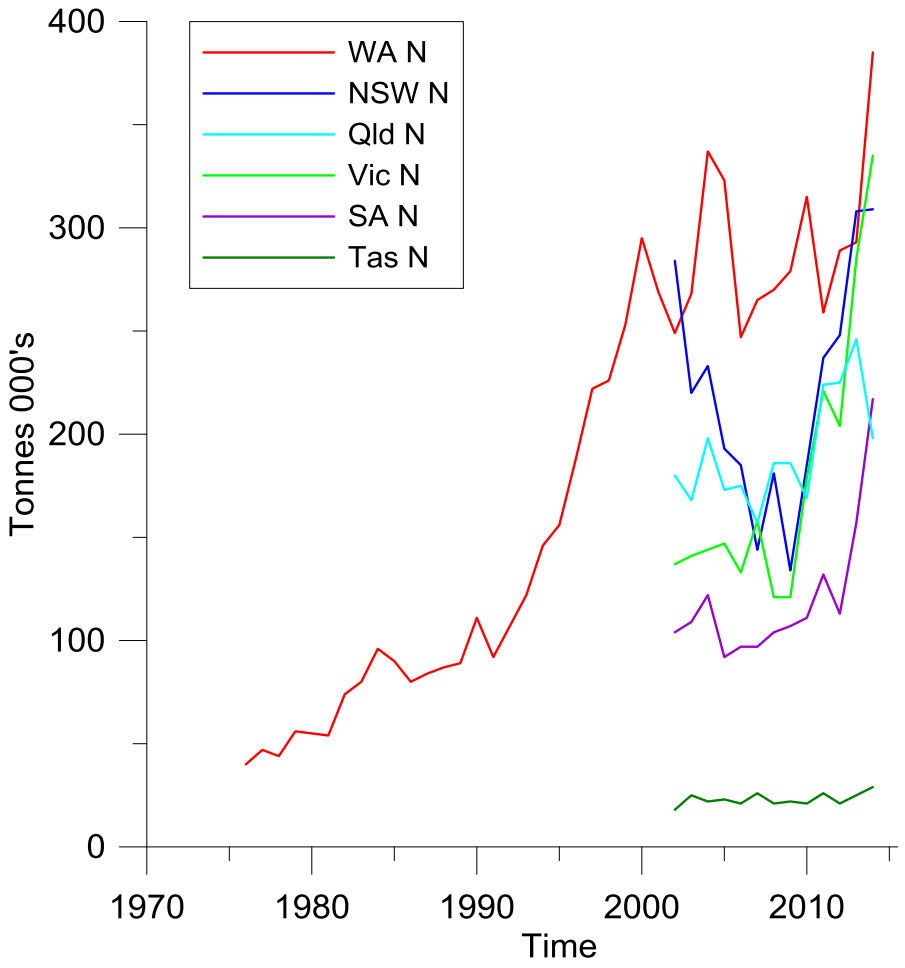
Wheat Yield Trends

Y = a + b (SI) + c *(year)



Adding fertilizer to model

$$Y = a + b^* (SI) + c^*(year) + d^*N$$



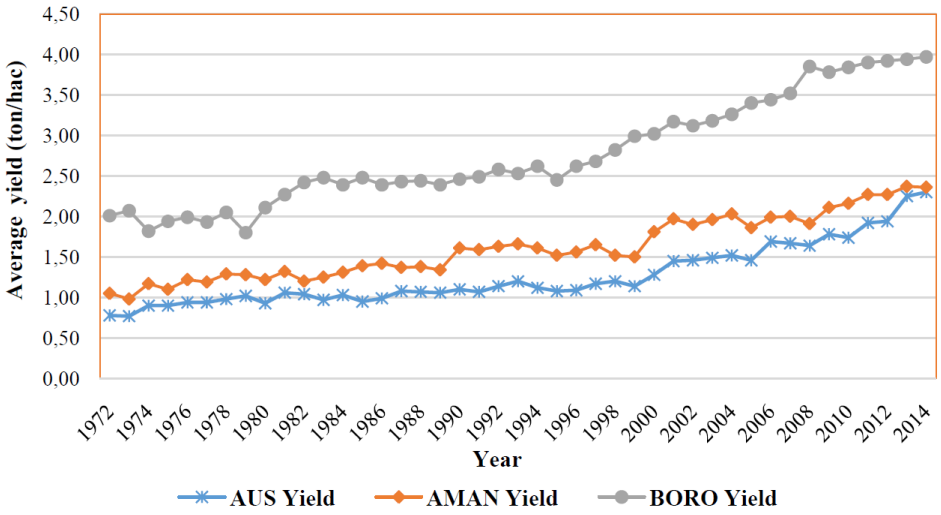
Adjusted R*2 for NSW/VIC (1993-2011)

NSW Current 0.92 new 0.95

VIC Current 0.92 new 0.94

However, difficult to get present season application (at this stage)

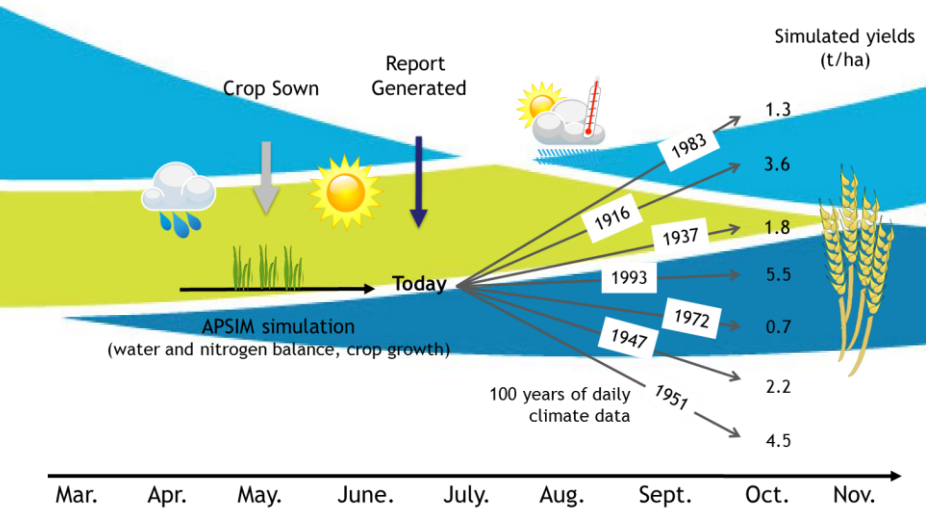
Bangladesh Rice yields



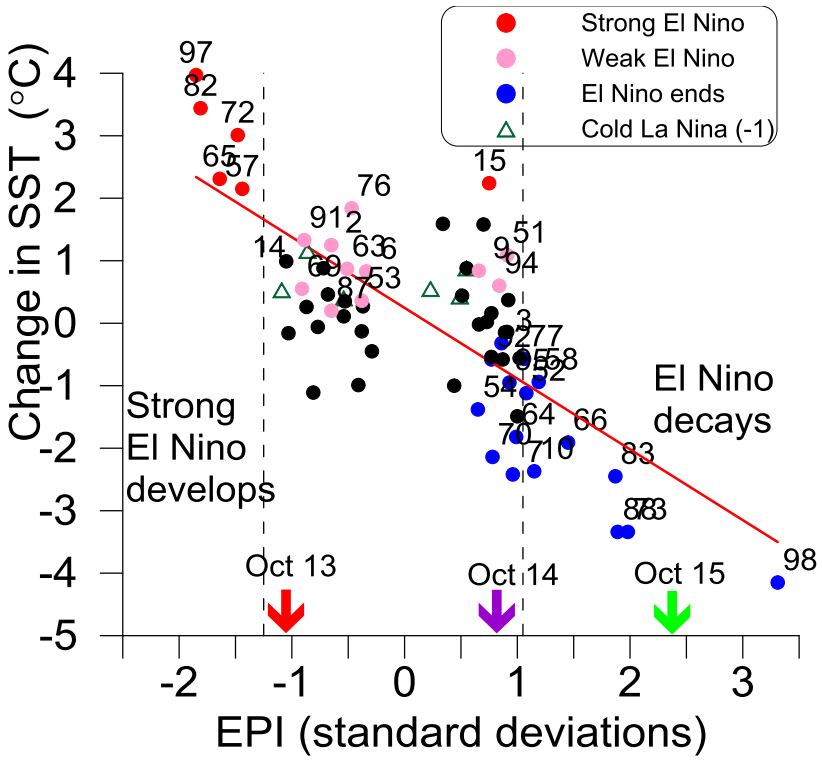
Simulation Model -Yield Prophet Modelling Framework

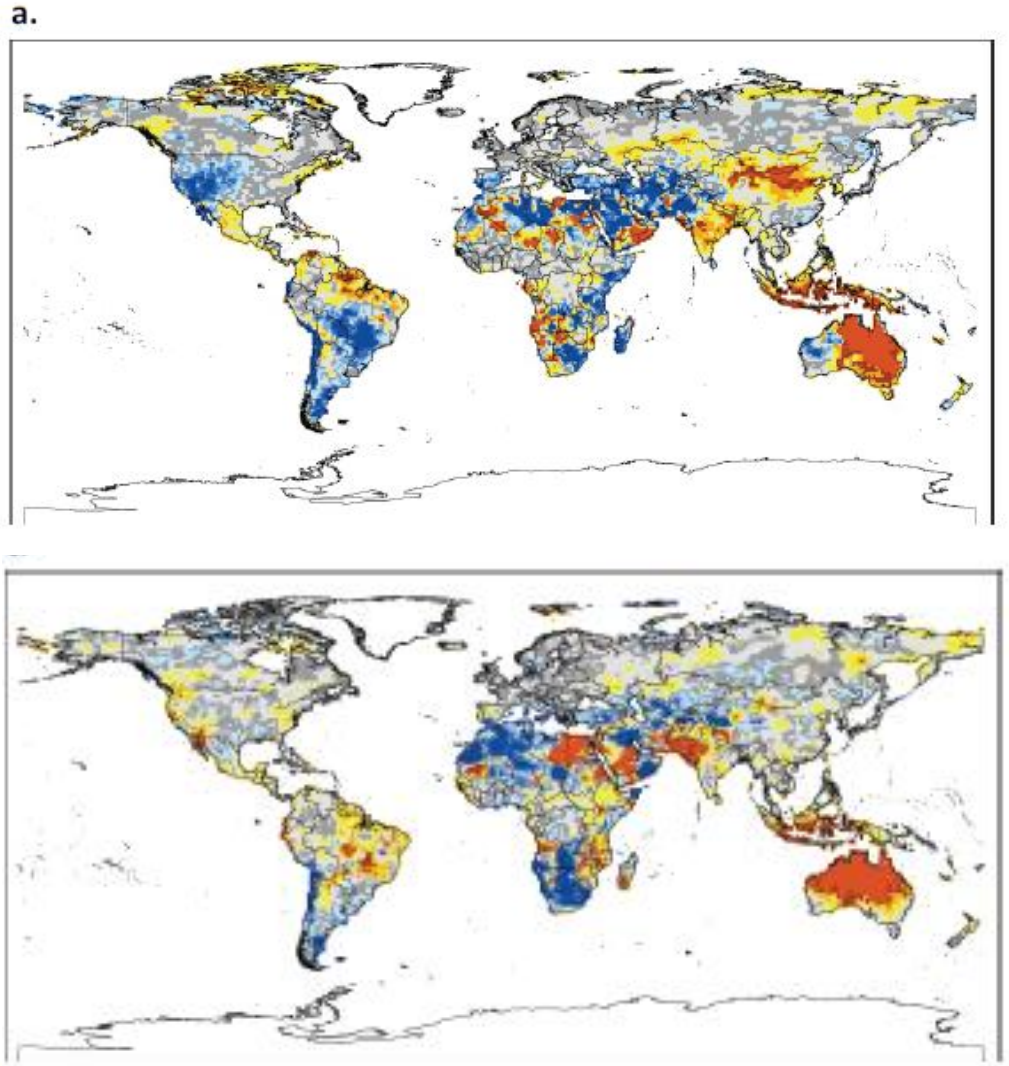
APSIM adapted by Donald Gayman (CSIRO) – works very well rice, well - wheat, maize, legumes over large majority Bangladesh.

ACIAR “Cropping system intensification in the salt-affected coastal zones of Bangladesh and West Bengal, India”. Project LWR/2014/73.



Opportunistic Early warning System for Climate Extremes –EPI predicting May-October rain in year (+1)





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Thankyou

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Canadian Wheat Board model

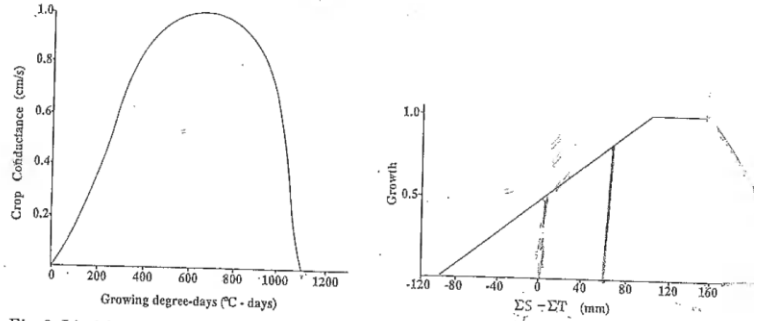

Fig. 2. Limiting crop conductance as a function of growing degree days.

Fig. 3. Growth (G_w) as a function of the cumulative difference between supply and demand variables

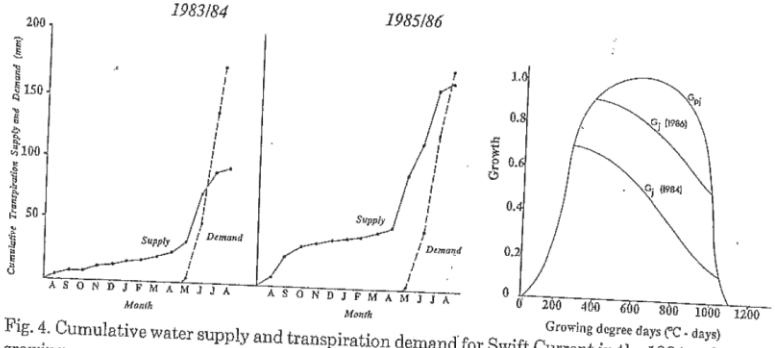

Fig. 4. Cumulative water supply and transpiration demand for Swift Current in the 1984 and 1986 growing seasons.

Fig. 5. Limiting growth values as a function of growing degree days and the curves of growth values calculated for Swift Current in 1984 and 1986.

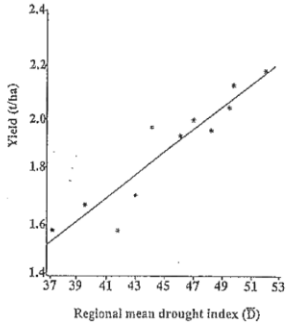

Fig. 6. Western Canada average wheat yields for 1976–86 vs. corresponding calculated drought index values.

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