



Profert-Pine: A fertiliser tool for softwood plantations

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Outline of Talk

- Project description
- Background
- Description of ProFert
- New discoveries/ developments
- Testing accuracy and quantifying the benefits
- Introduction to using ProFert
- Next steps



Project description

- **Aim**

- Parameterize the fertiliser model ProFert using new data
- Make the model compatible with current systems

- **Partners**

- FWPA
- TPPL – Green Triangle
- HVP – Victoria
- Norske Skog - Tasmania

- **Outputs**

- New version of ProFert, parameterized for SE Australia
- Final report
- A user manual



Background – Need

- **Fertiliser response prediction can:**

- Help target most responsive stands
- Increase profitability of fertiliser use
- Increase wood supply
- Reduced need for more land
- Even out variations in supply

- **However there is still large uncertainty in:**

- Basic response prediction
- The effect of different rates and forms of fertiliser
- Interactions between different nutrients
- Translating short term predictions into long term product yield
- Calculating economic benefits



Background – Past work

- **1960's-80's**

- Fertiliser trials established across Australia
- Large short-term responses to N (Type 1 response).
- Demonstration of potential for long-term responses to P (Type 2)

- **1990's-2000's**

- Mid-rotation fertiliser experiments established across Australia
- Development of fertiliser response and profit prediction tools

- **Recent work**

- NP-Opt improved and parameterised for Tasmanian plantations
- Other in-house tools developed by plantation owners
- Recognition of the benefit of pooling results and knowledge



Description of Profert

- **History**

- Original model developed by CSIRO for Green Triangle
- Improved and parameterized for Tasmania

- **Improvements**

- Responses in young stands (< 15 years)
- Includes predictions based on soil type and visual assessment
- Estimates of uncertainty
- More robust response relationships
- Accounts for variation in harvesting and transport costs
- Includes log type breakdown and value

Only tool available to provide full economic assessment and include effects of fertiliser form + rate and nutrient interactions



Current project

- **Objective**

- Parameterize ProFert for use in softwoods across SE Australia

- **Method**

- Obtain data sets from collaborators
 - Analyse data and integrate with previous results from CSIRO study
 - Obtain outputs from existing growth and yield systems
 - Develop new interface compatible with existing systems
 - Assess accuracy of outputs
 - Trial model with collaborators
 - Revise as necessary and role out final version

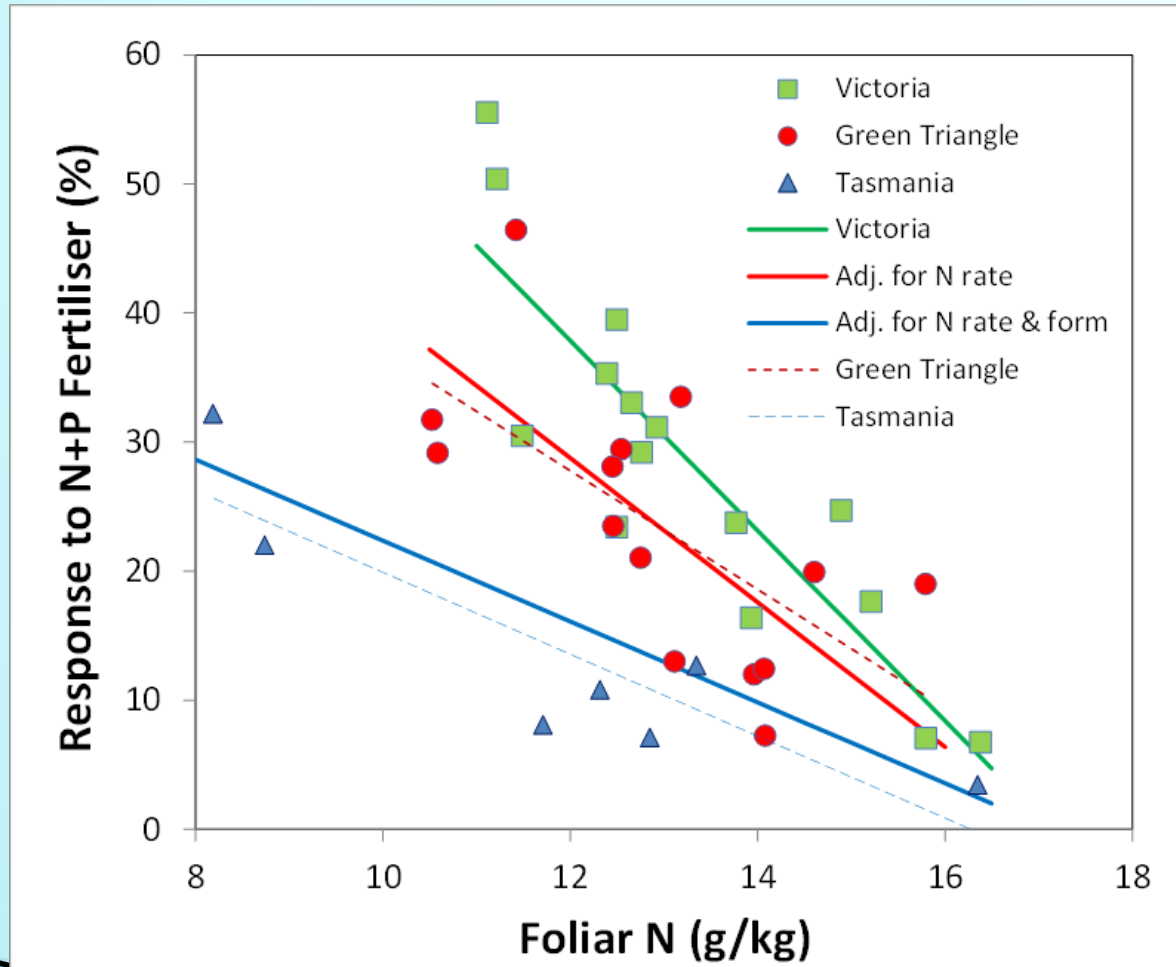
- **Future**

- Assess performance by comparing actual vs. predicted responses



New discoveries

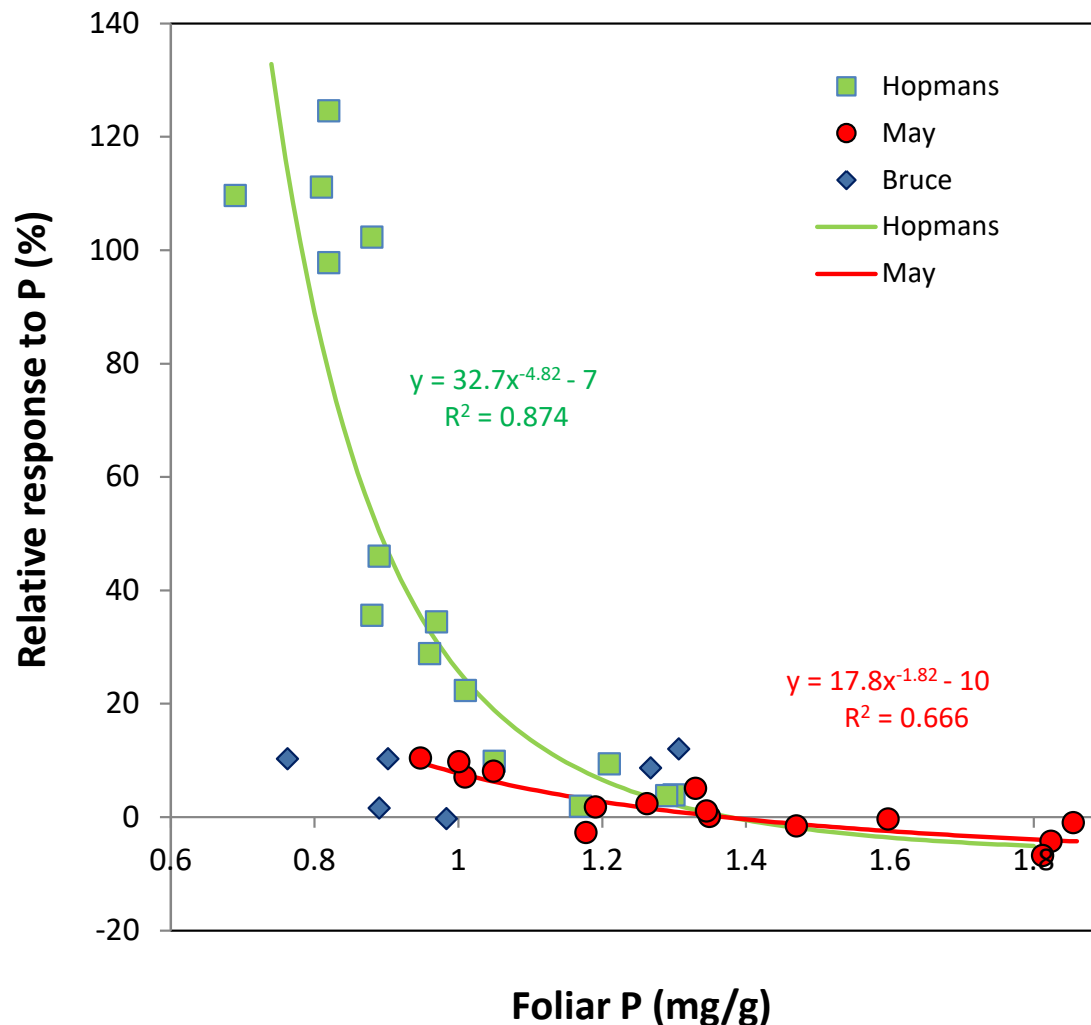
- **New response relationships: N fertiliser**



- Foliar N can explain up to 85% of variation in N response
- Apparent regional differences may be due to differences in rates and forms used

New discoveries

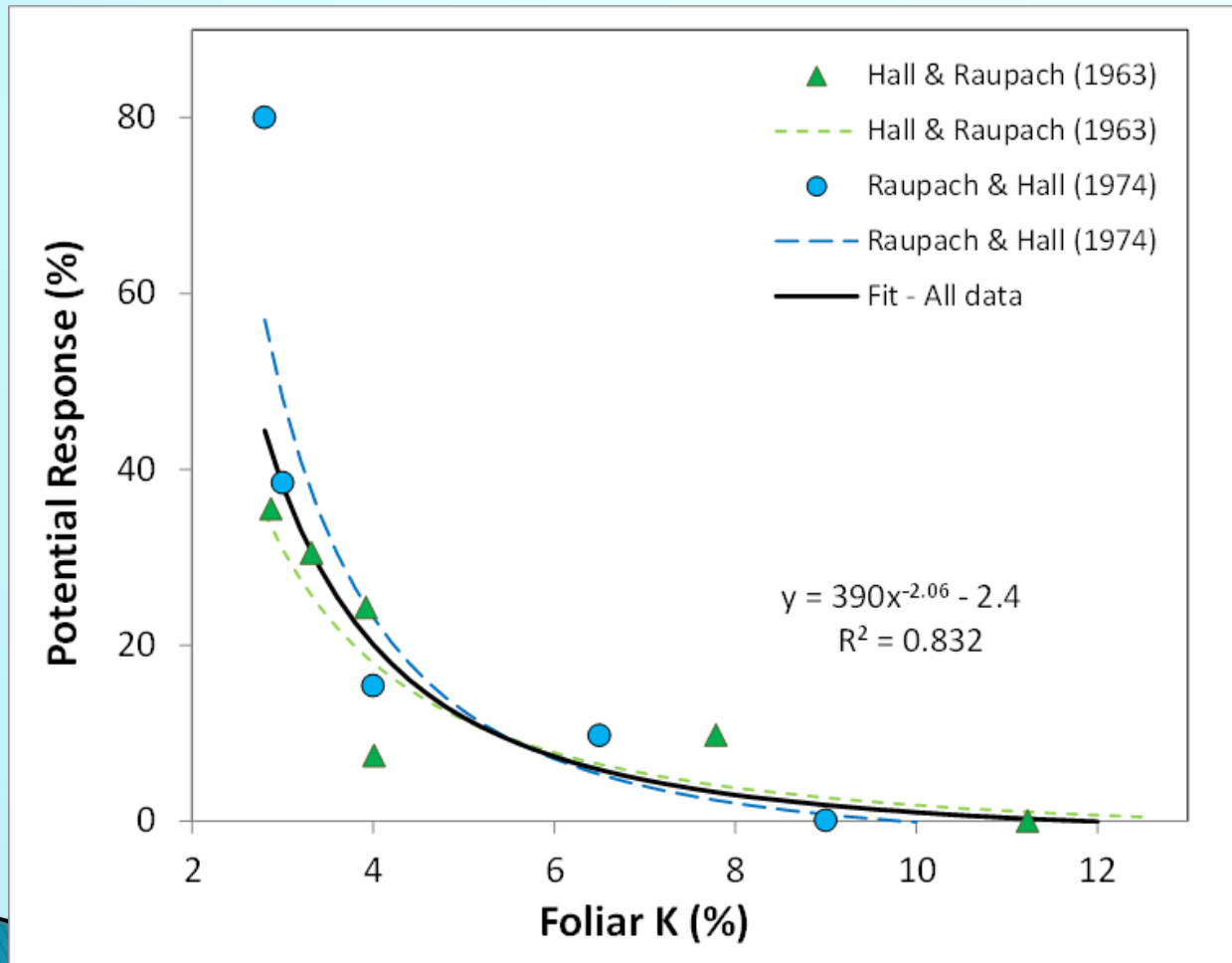
- New response relationships: P fertiliser



- Foliar P can explain up to 87% of variation in P response
- Responses in Victorian experiments greater than SA or Tasmania

New discoveries

- **New response relationships: K fertiliser**

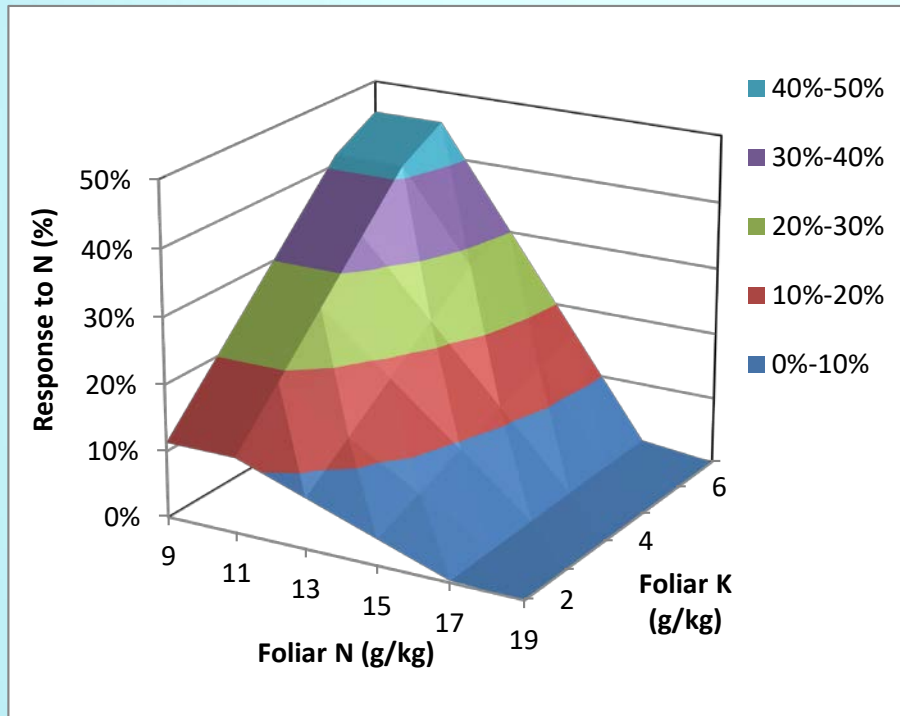


- Theoretical approach using results from Hall and Raupach (1960's)
- Similar relationships from two sets of trials by
- Needs to be varified

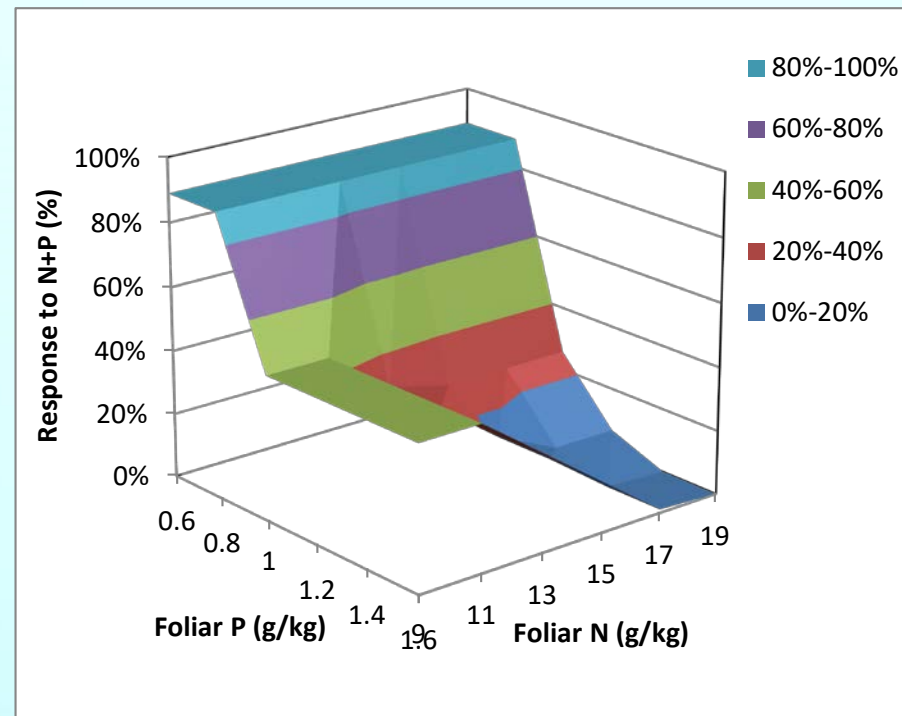
New discoveries

• New response relationships: Nutrient interactions

Response to N alone



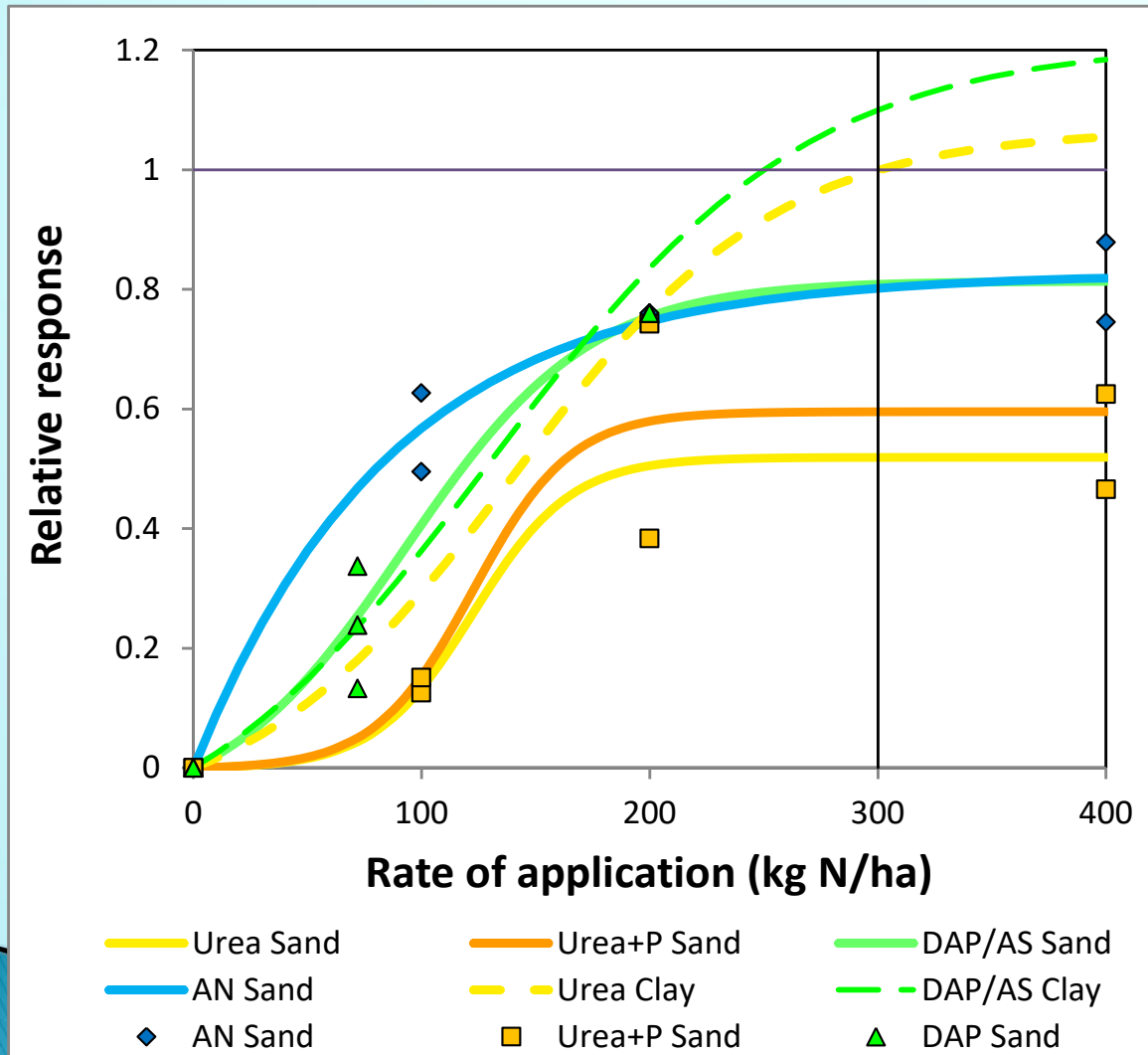
Response to N+P



- Based on the understanding that growth is limited by the most limiting nutrient
- Explains non-additive responses to fertiliser treatments

New discoveries

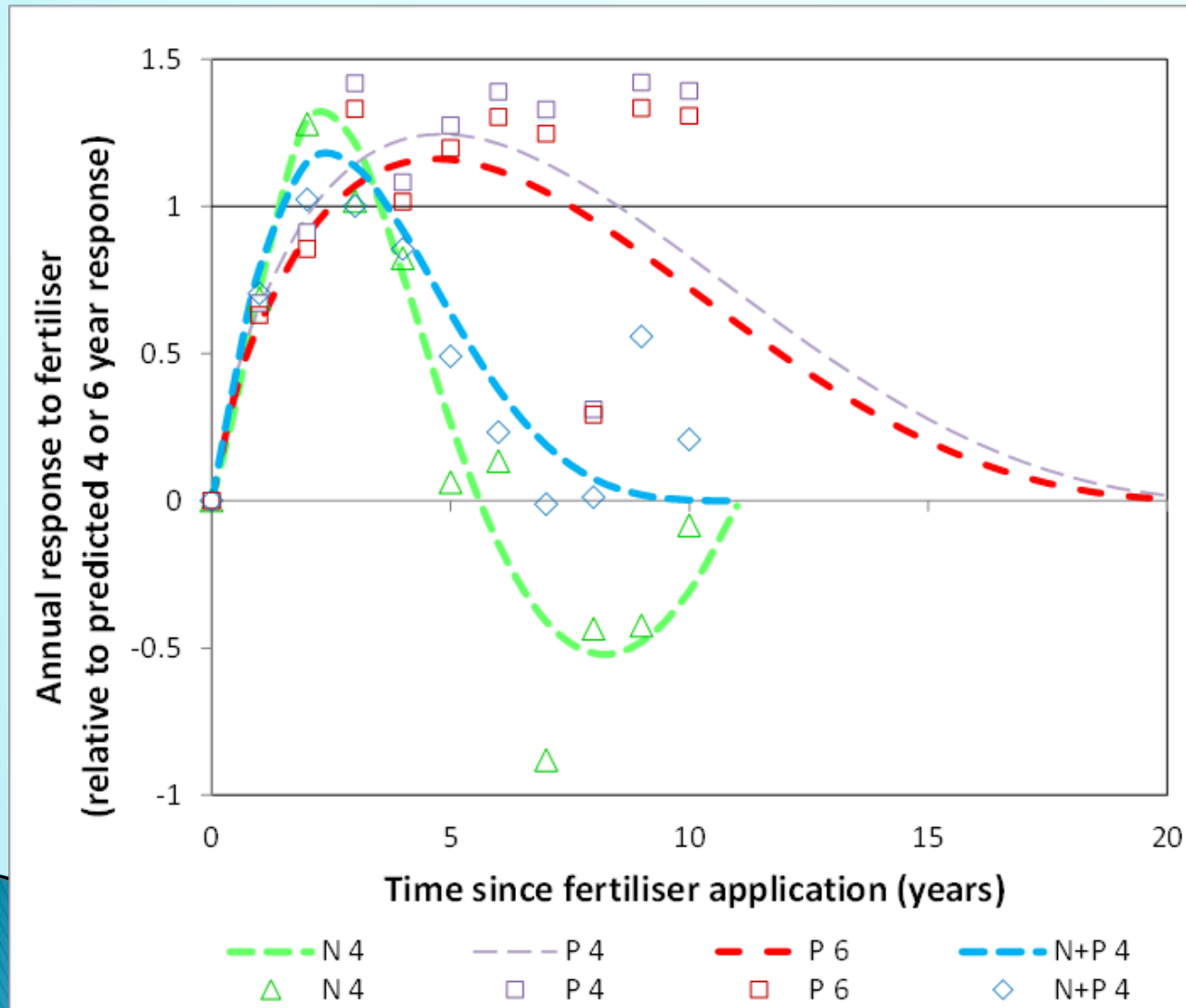
- Effect of N form and rate



- Based on 7 experiments in Green Triangle
- Similar results from Victoria

New discoveries

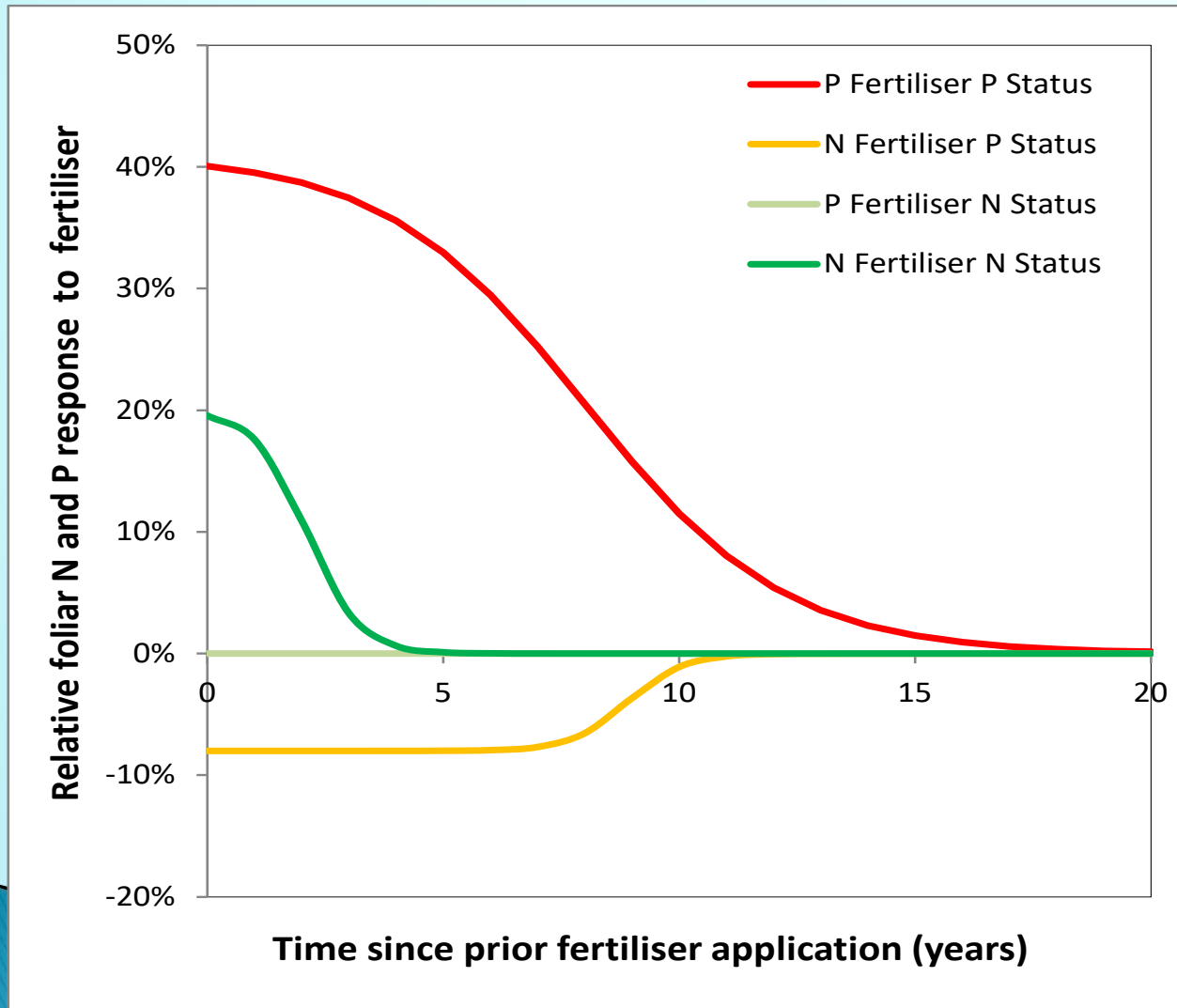
- Variation in response to N, P and N+P over time



- Averages from 10 stands across Green Triangle
- Negative longer term responses to N reported in other studies

New discoveries

- Predicting effects of fertiliser on N and P status



- Accounts for increases in nutrient status due to fertiliser.
- Also accounts for induced nutrient deficiencies e.g. N induced P deficiency.

Improvements – Economics

- **Including harvest and haulage costs in product value**

- Product net value (N) calculated as follows:

Net value = Gross value – Harvesting cost – Transport cost

- Gross value is calculated from:

- Value each product $\times$ % recovery of each product

- Product recovery:

- Relationship between tree size and product yield
- Accounts for the effect fertiliser on tree size

- Harvest and haulage costs:

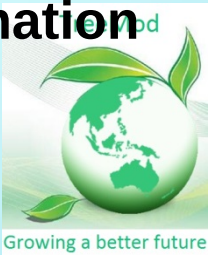
- Vary with operation (T1, T2, CF) location and product
- Account for differences in haulage distance and harvesting costs



Improvements – Compatibility

- **Can import outputs from growth and yield systems to calculate**
 - Growth of unfertilised stand
 - Growth of fertilised stand
 - Product yields at thinning and clearfell
 - Relates product yields to trees volume
 - Calculates % yields for unfertilised and fertilised stands
 - Product mill door values
 - Harvesting and haulage costs for different operations and locations
 - Calculates stumpage rates for each product based on stand and
 - harvest specific information

ProFert calculates economic response using same information as growth and yield system



Improvements – Flexibility

- **Includes four separate growth and yield interfaces**

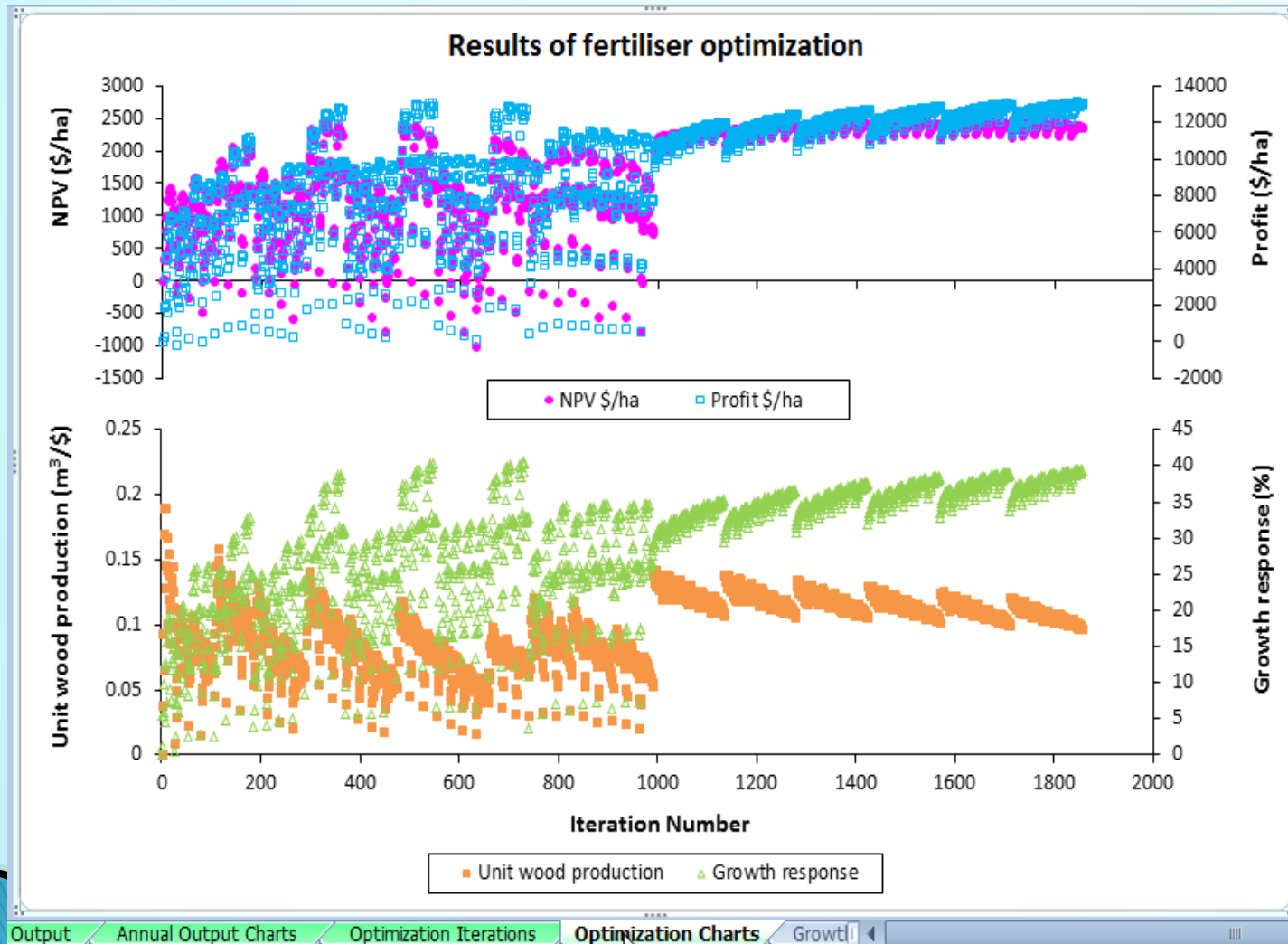
- YTGen – growth, yields, product values and harvesting costs
- YTGen – growth and yields only
- In-house growth and yield model
- Default growth curves and product yield relationships

Other interfaces can be readily included as required



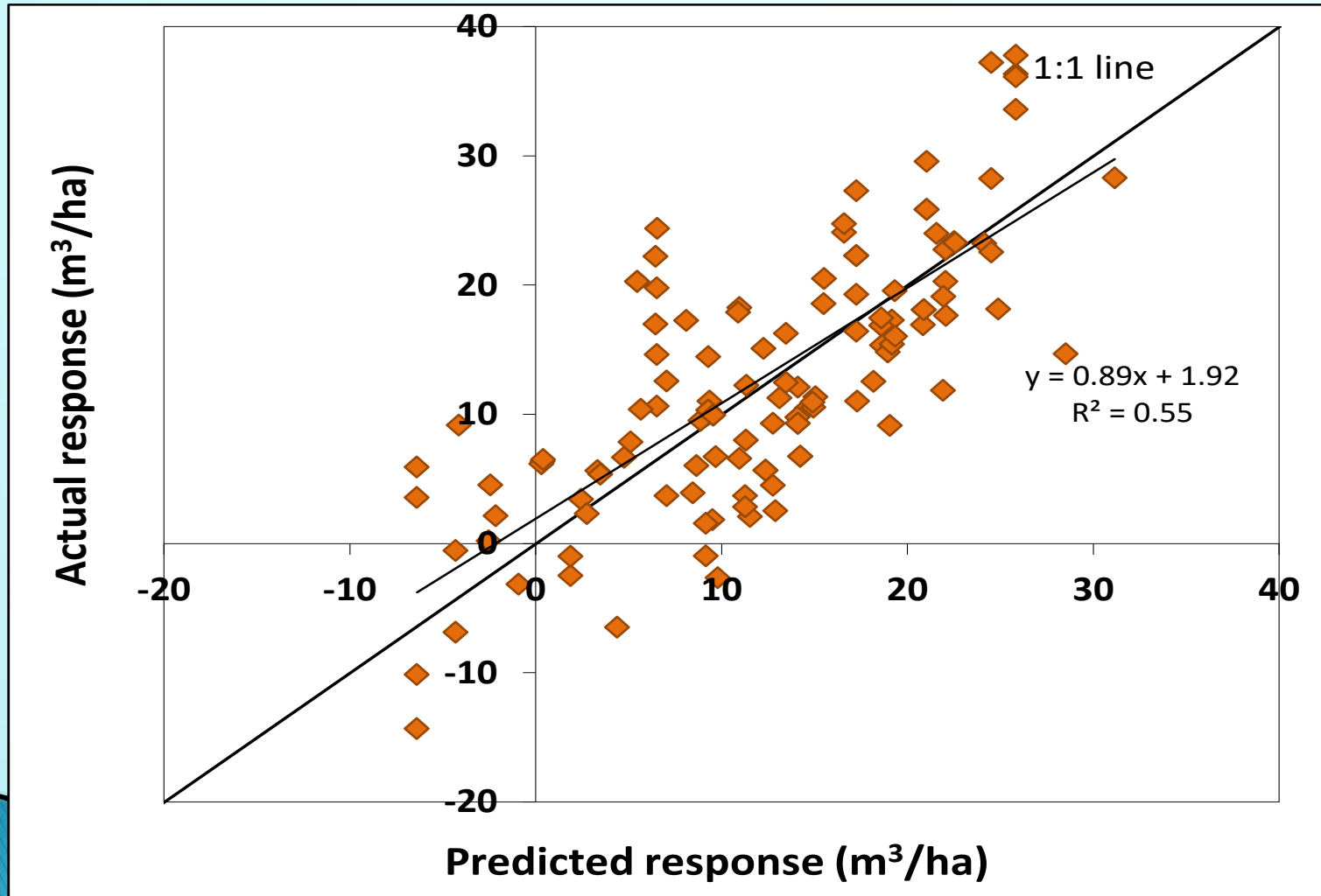
Improvements – Faster

- Improved optimizer procedure



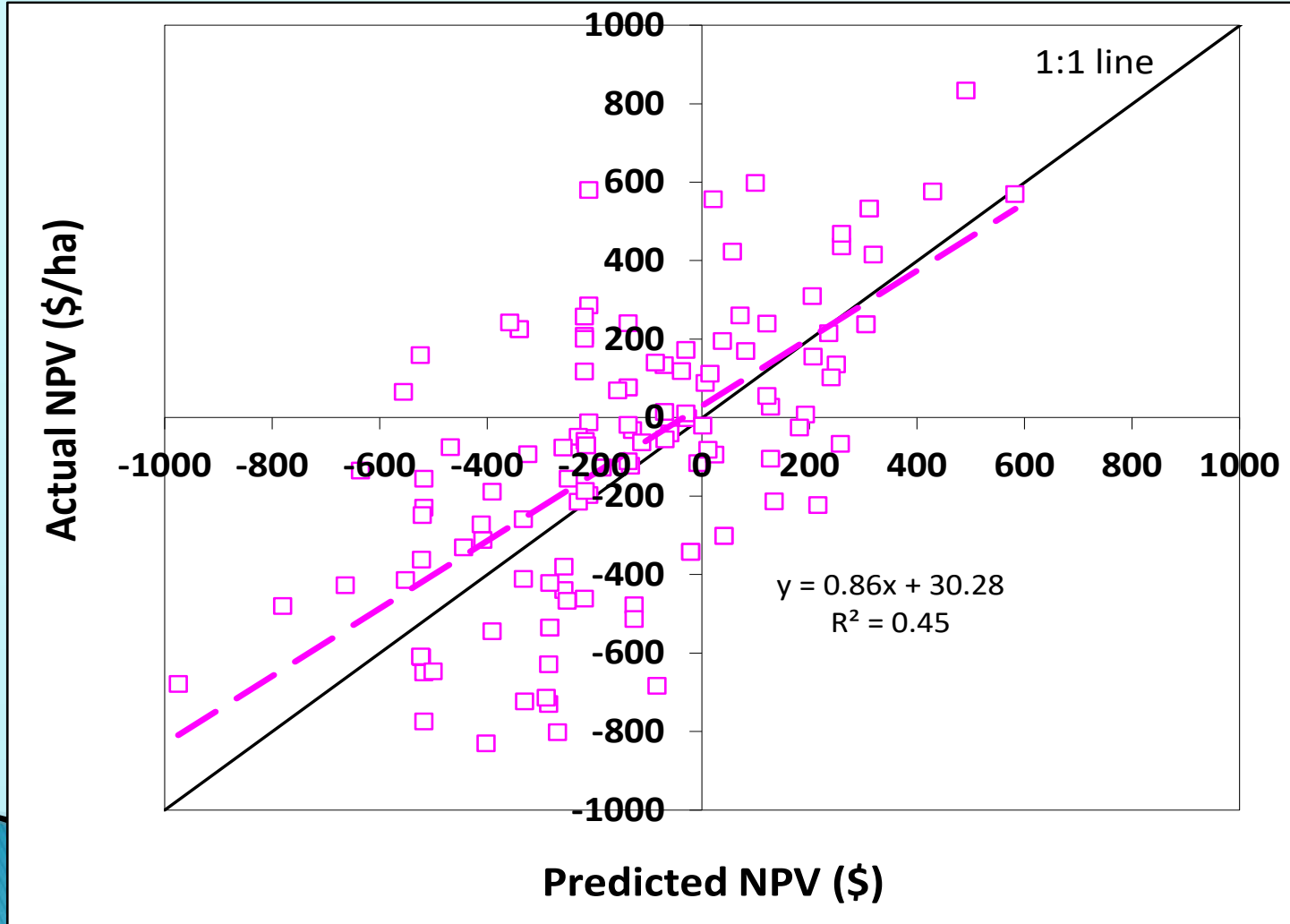
Testing accuracy

- Volume response: robust and unbiased



Testing accuracy

- **Profitability: reasonably accurate and unbiased**



Quantifying the benefits

- **ProFert site selection criteria**

- Positive NPV (with a 10% discount rate)

- **Alternative approaches selection criteria**

- All sites fertilised
- Lower than expected growth (<75% predicted)
- Moderate growth (site quality 3-5)
- Older stands (> 20 years)
- Foliar nutrients (N < 13 mg/g and P < 1.1 mg/g)

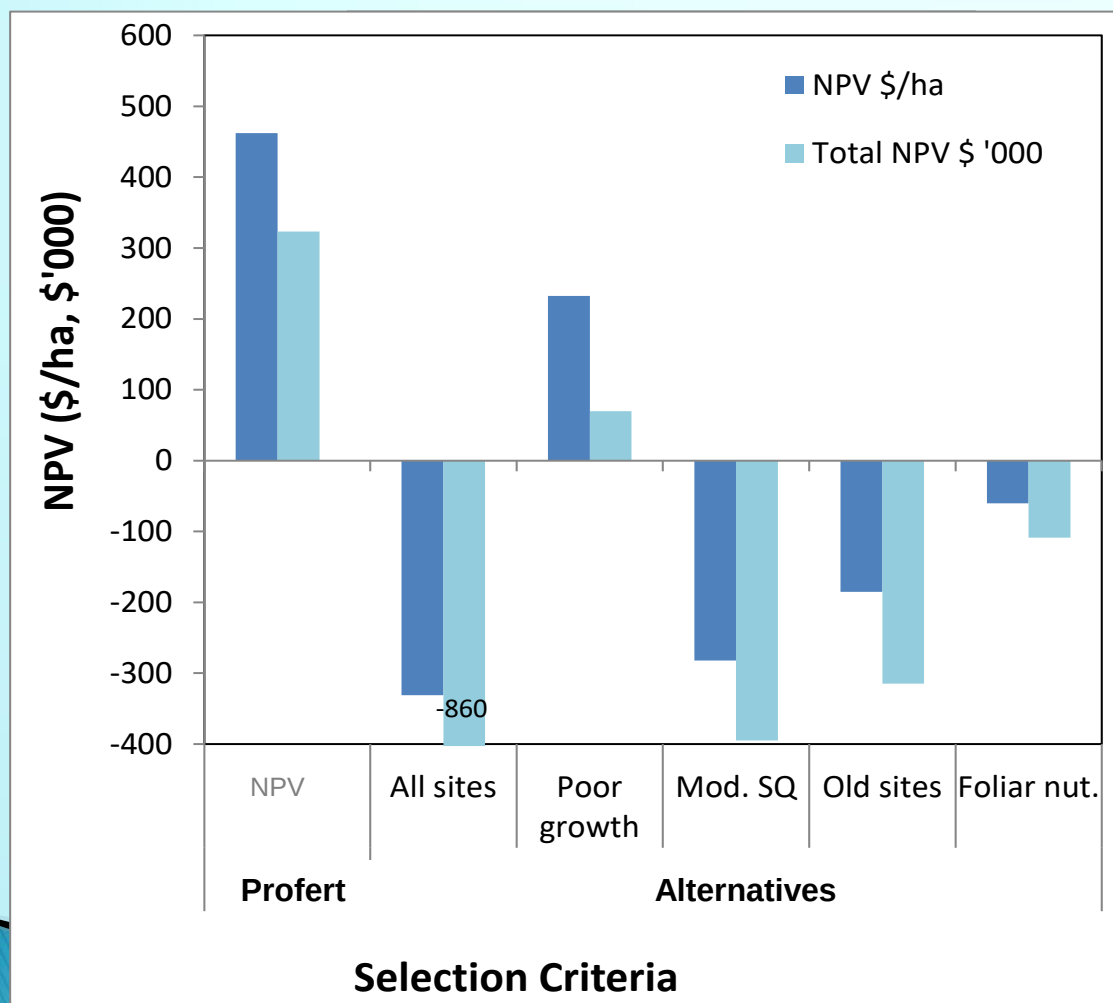
- **Method**

- Criteria applied to 10 experimental sites in the Green Triangle
- Profitability estimated using actual growth measurements, projected future growth and estimated product yields and values.



Quantifying the benefits

• Predicted NPV of different site selection criteria



- Poor returns for most current options.
- Using ProFert:
 - \$ per hectare profitability doubled.
 - Area fertilised doubled.
 - Total profitability increased by five-fold.



Introduction to using ProFert

• Overview

Stand Inputs:

- Stand age, site index, stocking and volume
- Foliar N, P, K
- Harvest regime
- Fertiliser regime

Global Inputs

- Harvest costs
- Product values
- Fertiliser costs



Outputs:

- Potential max % response
- Predicted response (% , m3/ha)
- Products (sawlog, pulplog, other)
- Costs and returns
- Profitability (NPV, IRR, unit wood cost)
- Optimal fertiliser regime

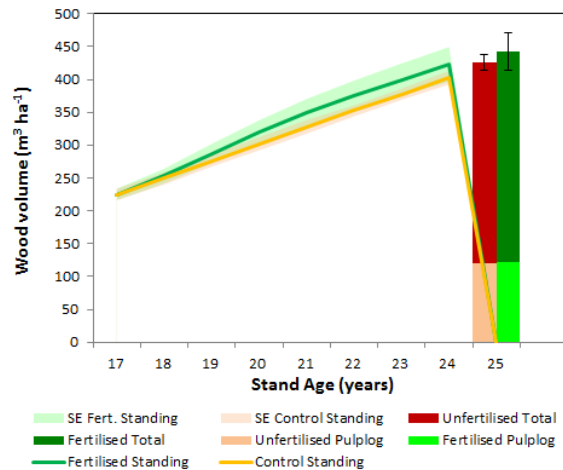


Introduction to using ProFert

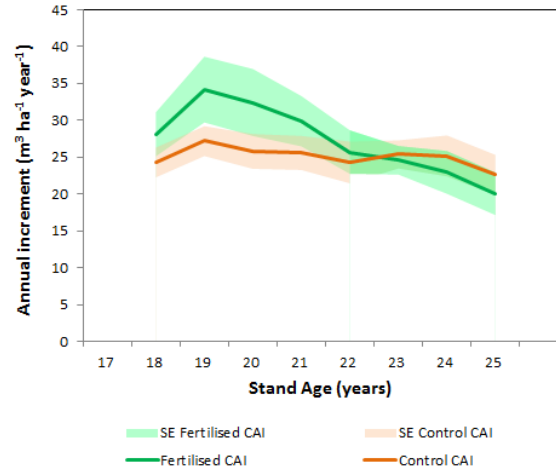
• Outputs

- Summary table: multi site
- Annual growth: single site
- Charts: single sites

Standing and harvested volumes



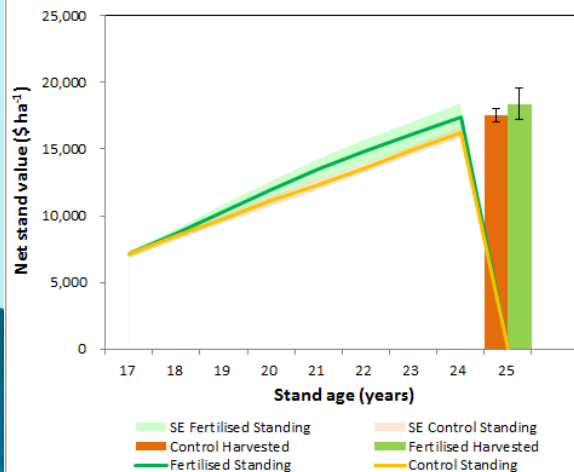
Annual volume growth



Age	Stems		Volume Growth							
			Control		Fertilised		Fertiliser Response			
	Standing	Removed	CAI	PAI	CAI	PAI	CAI	PAI	CAI	PAI
years	stems/ha	stems/ha	m³/ha/y	m³/ha/y	m³/ha/y	m³/ha/y	m³/ha/y	m³/ha/y	%	%
17	592	0								
18	590	0	24.30	24.30	28.13	28.13	3.8	3.8	15.7	15.7
19	588	0	27.20	25.75	34.20	31.16	7.0	5.4	25.7	21.0
20	586	0	25.80	25.77	32.44	31.59	6.6	5.8	25.7	22.6
21	583	0	25.60	25.72	29.90	31.16	4.3	5.4	16.8	21.1
22	581	0	24.30	25.44	25.71	30.07	1.4	4.6	5.8	18.2
23	578	0	25.40	25.43	24.60	29.16	-0.8	3.7	-3.1	14.7
24	574	0	25.20	25.40	22.96	28.28	-2.2	2.9	-8.9	11.3
25	0	571	22.60	25.05	20.05	27.25	-2.5	2.2	-11.3	8.8

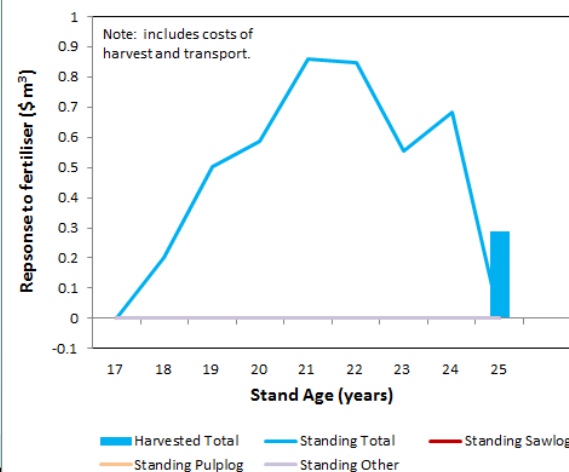
Stand value

Note: includes costs of harvest and transport.

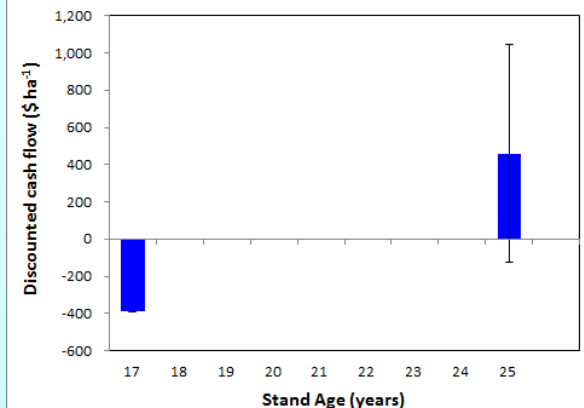


Increase in wood value due to fertiliser

Note: includes costs of harvest and transport.



Discounted costs and revenue



Downloading the model

- **Free FWPA version**

- Includes all response equations used in complete version
- Includes default growth curves for Green Triangle
- Requires user to input:
 - Product recovery vs tree size data
 - Fertiliser costs
 - Product values
 - Harvest and haulage costs

- **Model, user manual and report can be downloaded from: FWPA website**

- Expected to be available from mid-December



Model limitations

- **Knowledge gaps:**
 - Regional differences in responses
 - Effects of soil type
 - Effect of fertiliser rate and form
 - Responses in young stands
 - Nutrient interactions
 - Response longevity
 - Non foliage based predictors
- **Uses best data available for regions covered**



Next steps

- **Further testing and validation of ProFert**

- Using results from fertiliser experiments from other parts of Australia
- Understanding whether differences between response across Victoria, Tasmania and SA are real

- **Improving response prediction relationships**

- Analysis of data from other fertiliser experiments to improve response prediction relationships
- Establishment of fertiliser trials using a consistent set of treatments, prediction variables and measurement methodology



Thank you

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