Forest & Wood Products Australia

Executive Summary

A TOOL TO PREDICT FERTILISER RESPONSE & PROFITABILITY IN SOFTWOOD PLANTATIONS ACROSS AUSTRALIA

Component 1: South West WA

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A tool to predict fertiliser response and profitability in softwood plantations across Australia

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Improved nutrient management has the potential to increase wood production and profitability of softwood plantations. However, uncertainty persists regarding the responsiveness of different stands to different fertilisers applied at different ages as well as the overall profitability of fertiliser use.

A fertiliser prediction tool – **ProFert** – developed in collaboration with FWPA and softwood growers in SE Australia, enables managers to predict increases in wood production and the profitability of fertiliser use. The use of ProFert has been restricted to plantations in south-eastern Australia across regions where the data used to develop the underlying relationships used in the model were sourced.

There was interest from growers in other regions to better understand the fundamental drivers of responses to fertiliser in their plantations and in parameterising ProFert for use in softwood plantations in other parts of Australia. This project addressed these needs in Western Australia.

This project was a component of a national initiative to develop fertiliser prediction systems for softwood plantations across Australia, with a parallel project undertaken in eastern Australia to extend the regional coverage of ProFert. Download full project report here.

Project objectives:

The primary objective was to improve the capacity of plantation growers in south-west Western Australia to understand and predict the responsiveness of their plantations to fertiliser. This was to be achieved by:

- Synthesising data from an extensive series of completed fertiliser experiments to understand the responses to fertiliser and the impact of climate on these responses.
- Using the understanding developed from these analyses to parameterise the ProFert fertiliser Decision Support System for use in WA softwood plantations.

The project was based on data from long-term trials in Western Australia which included:

1. **A series of mid-rotation thinning x fertiliser trials** across the climatic gradients in south-west WA, which provided the opportunity to define the nutrient responses in relation to plantation density, water availability and level of water stress experienced by trees.

2. **Nitrogen by phosphorus interaction trials and application timing trials.** This provided data on the responsiveness of stands to N and P across a range of climatic and soil conditions with soils ranging from lateritic gravels/loams through duplex sand over clay to deep costal sands. Information on the impact of split fertilizer applications and the timing of fertiliser applications was also available from these trials.

3. **N rate and P rate trials**. These provided data on the magnitude of responses to N and P fertiliser and were used to develop rate response curves for these elements applied pre-canopy closure and allowed the calibration of relationships between responsiveness to fertiliser and soil nutrient concentrations. They also provided information in longevity of responses to P applied at establishment and young stands.

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The response relationships developed from the extensive trial network were used to parameterise ProFert for use in WA. The comprehensive understanding of the relationships between water supply and responsiveness to fertilizer available from the WA work will also be useful in improving the calibration of ProFert in other Australian regions.

Project achievements:

- The limit to plantation productivity in the relatively dry and seasonally variable environment of southern WA is determined by ***water availability***. In order of influence, water availability (measured as the ratio of rainfall to evaporation: *R/E*, and expressed as *Climate Wetness Index: CWI*), ***phosphorus supply*** and then ***nitrogen supply*** are the major influences on productivity and responsiveness to fertiliser. Plantation density also has a strong influence on the responsiveness to fertiliser as it influences the availability of water.

- The ***largest responses to fertiliser occurred in situations where there was little restriction on growth due to water supply and the soils were relatively infertile***. For the higher rates of N and P applied, plantations in the higher rainfall areas have the potential to grow at more than 30m3/ha/yr. Where water supply is more restricted the responses to fertiliser are more modest. On drier sites, plantation density was critical in determining the magnitude of responses to fertiliser with the greater water stress experienced by higher density plantations limiting the response to fertiliser.

- There were ***strong relationships between concentrations of phosphorus and nitrogen in soil and response to fertiliser***, with the response to additions of both nutrients decreasing as the concentrations of these nutrients in the soil increased. The strong relationships between soil nutrient concentrations and fertiliser response demonstrated that soil analysis can be used as a predictor of response. The Olsen bicarbonate extractable phosphorus provided a useful index of phosphorus status while total soil nitrogen provided a good estimate of nitrogen status.

- The ***duration of the responses to both phosphorus and nitrogen were estimated from the time course of responses***. The longer residual effectiveness of phosphorus contrasts with the relatively short-term responses to applied nitrogen which only lasts between four to six years depending on the application rate.

- The ***interactions between the availability of water and nutrient supply were defined and used to create multi-dimensional relationships*** that are included in the ProFert model to predict the impact of water supply on the responses to phosphorus and nitrogen. The revised version of ProFert includes the effect of fertilizer rates and the duration of fertilizer responses under WA conditions.

- ***The key stand parameters for predicting fertiliser responses in WA plantations include total soil N, soil Olsen P and climate wetness index as well as the amount and type of fertiliser to be applied***. These last two factors can be input manually by the user or, alternatively, the model can automatically identify the optimum combinations and amounts of fertilisers to apply at different times throughout a rotation to maximise either profitability or the amount of wood produced at a given site.

Benefits to the forest and wood products industry :

The knowledge developed through these analyses have provided a rational basis for fertiliser recommendations in softwood plantations in WA. This is delivered through the ProFert decision support system that has been calibrated for conditions in Western Australia.

The updated version of ProFert now incorporates the results of fertiliser experiments across SW WA from the past 40 years. This model is expected to help forest managers improve the effectiveness of stand nutrient management across WA softwood plantations by tailoring fertiliser regimes to specific stand needs, boosting profitability, avoiding unnecessary fertiliser use and increasing stand growth.

The recalibrated version of Profert, which accommodates the influence of water supply on fertilizer responses, has been tested operationally by the Forest Products Commission WA (FPC).

Detailed report available for download here

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