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DRAFT

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Strategy for Growth and Wood Properties Modelling

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Research Provider:
Scion

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EXECUTIVE SUMMARY

The development of empirical prediction models has been fundamental to running forest businesses and providing investor confidence in forecasting forestry yields and understanding regime effects. The current tools have come from the strategic thinking of past custodians of this science (both researchers and practitioners) by the development of robust trial designs, data collection programmes, and new modelling methods. The current plan is born out of the need to rationalise a plethora of models and data sets, and to test and deploy what has recently been produced. Confidence in the new collaborative models (primarily the ITGM and 300 Index) has not been high and needed to be addressed.

The FFR Radiata Management Technical Steering Team (TST) has undertaken a series of reviews, validation, and stock takes before carefully considering the future investment and direction of growth and wood properties modelling in the IFS programme. In input has been received by the wider theme membership via workshop session at the 10 March 2009 Theme meeting at Christchurch.

The strategy proposed is high level with some of the tactical detail on measurement programmes and timing still to be developed. In summary the strategy is to:

- Complete the validation of 300 Index Growth Model for use on any site and over the full tree crop rotation.
- Complete wood property modelling for key properties that influence product performance and account for variability within the stem and across the stand.
- Complete Blossim Branch model validation and implementation
- Development all models iteratively, beginning simply, and adding complexity only if justified.

Provide for delivery within a system framework that receives continuous improvement and updated models.

To implement and deploy what is available as soon as possible. To review the strategy regularly and modify or improve as we learn.

INTRODUCTION

Over the last two ears a number of reviews and validations studies have been completed for growth models, branch models and wood property models. These are documented in FFR reports numbers R001, R009, R0016, R016, R017, R027, R030.

After a series of long meetings of the TST a proposed strategy was presented to the Christchurch meeting of the FFR Radiata Management Theme, (10 March 2009). A workshop session was then run to enable members input through discussion in small groups. A number of useful points were raised for consideration; a response to these is included in Appendix 1. The major issues raised that were not in the strategy or current work programme are summarised as:

1. Focus on extracting value from existing crop
2. Environmental issues should be included
3. Control level of detail, apply 80:20 rule, concentrate on wood quality attributes with impact on product performance
4. Improve delivery of current tools
5. Balance modelling with knowledge development

The majority of the suggested strategy seems to be supported by members although there are indications by some (verbally or in their feedback sheets) that they did not fully understand it and further effort to elucidate is needed. Cross linkage with the Environment Theme programme needs further development.

BACKGROUND

New Zealand has had a long history of collaborative development of empirical growth models for radiata pine, primarily within the Stand Growth Model Cooperative, Plantation Management Cooperative, and Wood Quality Initiative. The development of these tools has been fundamental in providing investor confidence in forecasting yields and understanding silvicultural regime effects. However the development of robust: trial design, data collection, and modelling methodology, has come from the strategic thinking of past custodians of this science (both researchers and practitioners).

The current plan is born out of the need to rationalise a plethora of models and data sets, and implement and test what has recently been produced. Confidence in the new collaborative models (primarily the ITGM and 300 Index) has not been high and needed to be addressed. The ultimate goal of this research must be kept in mind, ie to be used to add value or make a difference.

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STRATEGY

In developing this plan the thinking has often wandered between strategic, tactical, and operational levels. To help with this, it may be clearer if we at least deal with some of the tactical issues, so that important ideas are recorded. The following table 1 is a collation of what was presented to Members on 10 March at Christchurch, the feedback received from the workshop, and further TST discussions.

In brief, the strategy for growth modelling is to complete the 300 Index model so that users have confidence in using for any site over the full rotation length. This will also leverage off the work linking environmental variables to productivity indices to make it more universal. New ideas will be tested and new modelling methods trialled, so that the future growth projections are even better. In the near term the Weeds decision support system (DSS) VMAN will be linked to the 300 Index growth model in Forecaster. There are plans to add a fertiliser DSS and a genetic gain DSS.

Wood property modelling will be primarily focussed on achieving an intermediate step toward predicting final product performance, ie properties that lead to or combine to predict appearance, stiffness, strength, and stability. As shown in figure 1, there are three approaches suggested toward achieving the product performance prediction. Each approach has strengths and weaknesses. Because of the high uncertainty in science and the need to deliver annual results to the industry, the three approaches will run concurrently.

The short term direct approach is to link stand and environment factors to a end product measure, eg stem slenderness to wood stiffness (MOE). The empirical modelling of a wood properties (density, spiral grain, MFA, etc) that can be combined to predict product performance, is also useful as it identifies linkages between reasonably easily measured and well understood properties to end use performance. A third, long term, approach (as part of Objective 2) is to the model wood formation in a simulation process that allows detailed knowledge to be developed on biomechanical relationships that drive differing wood properties.

Table 1: Summary of Growth Modelling and Wood Properties Strategy

	Growth	Wood Props	Delivery
Strategic Goals	• Accurately model the combined impacts of varying site, silviculture and genetics from year 0 to rotation end for yield, and wood quality. • Improve understanding of the fundamental parameters influencing tree and stand growth and incorporates this into the modelling capability. • Develop the ability to predict and model the crown architecture of individual stems in stands. • Identify the impacts of crown architecture on growth and wood properties.	• To identify what influences/determines wood properties and develop a modelling capability to ascertain the combined impacts of site, silviculture and tree stock genetics on both physical and chemical properties on individual stems in 3 dimensions. • Identify the influences of G*S*E on end product performance.	• Development of modelling systems that implement FFR output.
Objectives and Priorities	Further develop the 300 Index model so that it: • Is capable of modelling from age 0 on bare sites using environmental variables and tree stock genetics to determine the appropriate index value. • Can model from any point in the rotation without knowledge of prior silvicultural history. • Can accommodate the impacts of establishment management. • Can accommodate the impact of varying genotype. Provides a platform for incorporating further developments in understanding and modelling branching/wood properties and genetics. • Complete validation and implementation of Tree Blossim.	• Develop empirical models iteratively. • Iteration 1: uncoupled growth overlaid with wood properties by ring number/age and branches. • Iteration 2: weakly coupled growth and wood properties via DBH growth indices. • Iteration 3: Strongly coupled growth, branching and wood properties.	• Current and future models will be implemented in commercial software • FFR Radiata Calculator will be maintained and enhanced where possible with stand level models but will not include tree level models. • Integration Frameworks further developed to link Weeds, Fertiliser, and Genetic deployment.
Tactics	• Continue to remeasure PSPs (see PSP Review and rationalisation given in report FFR RO ##.) Where possible include: ○ Geo locations ○ new site variables ○ wood properties • Add methods to better account for stand history if absent. • Major hypotheses are tested with current data. • Collaboration is sought with RPBC on genetic gain modelling.	• Review GxExS impacts on wood properties. • Major site and Genotype types are identified and sampled for wood properties to fill important gaps. • Look backwards from mature tree crown shapes – correlate stem wood properties and product performance with indices of crown shape or architecture taken from aerial photography or Lidar. • Major hypotheses are tested with current data.	• Updates of models are delivered early and often. • Issues with software IP to be resolved to provide access for all members.

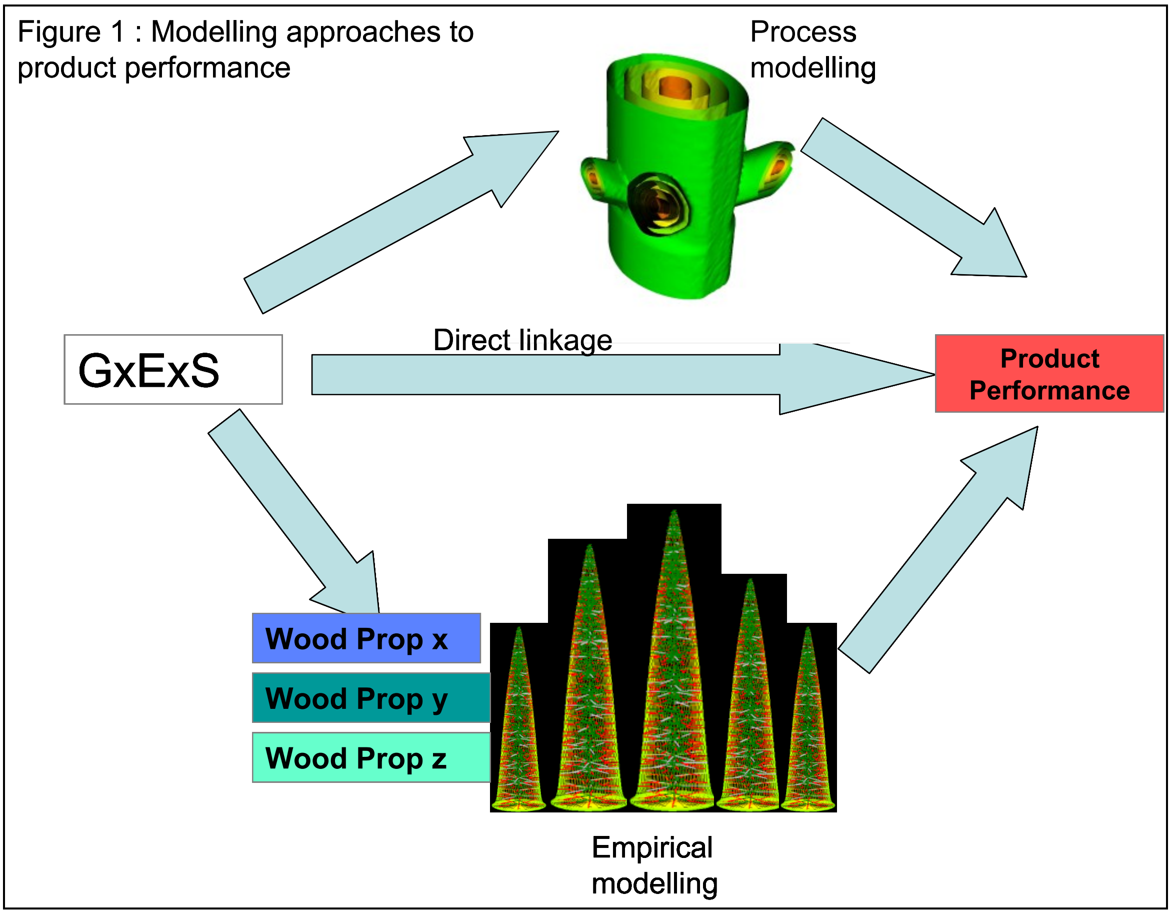

Figure 1: Modelling approaches

VISION

A strategy in someway should fulfil a vision or a goal that those involved want to achieve. Forestry as a land use or investment option faces severe challenges and competition from other more successful land uses and product substitution from aluminium, plastic, steel, and concrete. While plantations may be proven to be sustainable and may help with a range of environmental issues, the current trend is retrenchment based on profitability or perceived risk.

This research programme coupled with several others in FFR aims to address this issue by growing a better product in a sustainable way.

Perhaps the development of a vision of what may be the outcome of the programme may help consolidate the thinking, eg
The result of the strategy for an integrated Growth and Wood Property modelling Framework and associated science programme may lead to better decision support tools that give new insights on how to intensively grow and manage tree crops.

As a result, future forests of radiata pine may be harvested at age 15 -20 yrs by using genotypes selected for specific sites and end products, managed with appropriate intensity to achieve the best trade-off of cost, growth rate and wood quality, and providing wood that performs better than the benchmark material for that use.

CONCLUSION

A strategy that is pragmatic, consolidates on current models and yet delivers on the goals of the IFS FRST contract is proposed. The resulting modelling system and knowledge should lead to a new level of predictability and confidence to grow wood better suited to end users needs. As with all strategies, this one should be reviewed annually and changed or updated as new results and knowledge emerge.

APPENDIX 1

The following are suggested actions in response to the members' workshop findings.

1. Focus on extracting value from existing crop.
    a. The strategy is augmented by greater effort using the approach of "looking backward from existing external characteristics" and by using models that account for GxExS effects, "back project" internal wood properties in mature stands.
    b. The programme in Objective 4 (Resource monitoring) is reviewed by the TST to help focus and accelerate the timetable to give greater value to members.

2. Environmental issues should be included.
    a. Synergies with the Environment Theme will be explored; some of that themes' outputs could be built into the Virtual Forest Framework.
    b. Work from PEEF2 I/O1 (sustainable productivity) could be included.
    Carbon is planned to go into Forecaster. Root biomass could be added.

3. Control the level of detail, apply 80:20 rule, concentrate on wood quality attributes with impact on product performance.
    a. The iterative development cycle suggested in the strategy allows a level of control to be achieved over the effort expended on detail.
    Rather than launching into an attempt at a very complex 3D model from the start, take the best available data each year and improve current models and take a step up in the complexity of the modelling approach. At each step, evaluating if we have reached a sufficient level of explanation of the variances and allowing new approaches to be tried and tested.

4. Improve delivery of current tools
    a. Resolve the issues of; increasing complexity, cost to access tools, setting priorities, by rapidly progressing the proposal to resolve IP ownership by forming a JV company that manages this for all parties.
    b. Set regular software user meetings where the competing needs and expectations of FFR, End Users, and Scion, are better communicated and rationalised.

5. Balance modelling with knowledge development.
    a. An empirical modelling strategy will implicitly demand very large data sets to provide confidence in forecasting within a reasonably constrained matrix of GxExS factors. While this may be achievable, it is unlikely to advance our knowledge of why these relationships occur and how far they can be extended before they mislead.

To balance this risk, a component of knowledge development or hypothesis testing could be considered prudent. Testing hypothesis each year could lead to significant shifts in the modelling approach as indicated in 3 above.