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MULTIPLE TRAIT IMPROVEMENT OF RADIATA PINE

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of the requirements for the degree of
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Abstract

This thesis explores the use of multivariate models in a tree breeding program with emphasis in radiata pine. It considers the development of breeding objectives, the efficiency of various strategies for subsampling trees to assess wood properties, and the analysis and exploitation of longitudinal data.

A model for a vertically integrated production system is developed — comprising forest production, pulp mill and sawmill — and evaluated for Chilean production and economic circumstances in each of three silvicultural regimes. The traits in the breeding objectives were volume at harvest age (m^3/ha) and average basic wood density (kg/m^3). Economic values for each trait were calculated as the difference in discounted profit for a unit marginal increase of volume or density. The objectives for different silvicultural regimes were similar, and a single objective — with relative weights 1:1.47 — appears to provide more economic gain than the use of specialist objectives.

Various subsampling schemes for wood property traits in progeny tests were studied through simulation in terms of reliability of estimates of genetic parameters, prediction of breeding values and expected genetic gains. Subsampling is subject to the Law of Diminishing returns, and measuring more than 15 trees per family did not provide large gains in accuracy of genetic parameters or in prediction of expected gain.

A unified view of multivariate analysis with longitudinal data from progeny trials is presented using a tree model. Several statistical models to deal with covariance structures are specified, the relationship between full multivariate analysis and random regression models is demonstrated, and model selection techniques are presented. Different models are compared for repeated assessments of basic wood density (kg/m^3). These models are further developed including additional random effects (block and plot) with an application to height (m) data using a Chilean radiata pine progeny test. Covariance structures reduce the risk of non-positive definite additive genetic matrices, while reducing computational demands for the analyses and providing a description of the genetic control of a trait over time.

Longitudinal data were used to predict breeding values close to rotation age, using either mass or combined selection. The method was tested under three covariance models and two breeding delays (time between selection and propagation of sufficient offspring for planting), to determine the best age — or combination of ages — for selection purposes. A combination of family information and repeated assessments provided the highest genetic gains.

*We do not receive wisdom, we must discover it by ourselves,
after a journey through the wilderness, which no one else can
make for us, which no one can spare us, for our wisdom is the
point of view from which we come at last to regard the world.*

—Marcel Proust

The journey is the destination.

—Anonymous

There is no intellectual exercise that is not ultimately useless.

—Jorge Luis Borges

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*Eres mi luna, eres mi sol,
mi dulce de mango, que dulzor.*

—Alma Rosa

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