# RES-FOR HIGHLIGHT #10

## November 2020

*Assessing and Communicating Uncertainties of Genomic Selection in Forestry*

## Overview

Genomic selection (GS) is a relatively novel breeding tool that consists of predictive modeling based on associations between genetic and phenotypic data, intended to help breeders select superior parent trees based on genetic information, thus reducing the need for field-testing of progeny for at least one generation. As with all novel technologies, there are uncertainties associated with the application of GS, which involves sophisticated genetic sequencing technologies and statistical algorithms. Future applications may be best pursued when uncertainties are broadly acknowledged, discussed, and incorporated into decision-making. Attention to and communication of uncertainty has been fruitfully applied in other fields in which genomic technologies are already deployed, such as medicine and forensic science, with benefits in the form of enhanced transparency, better decision-making, and improved public trust. The uncertainties associated with the application of GS for forestry have received comparatively less attention. Therefore, the objective of this study was to assess approaches to uncertainty among experts engaged in GS research and tree breeding more generally.

## Defining Uncertainty

Uncertainty is not the same as risk, which refers to an assessment of outcomes based on known probabilities of occurrence and outcomes. Rather, uncertainty refers to limited knowledge of future, past, and current events. Those limits may be a product of our methods of observation, and they may be inherent to complex, dynamic ecological and socio-political systems. Adding to this mix is the fact that different people approach uncertainty in different ways, based on their values, norms, and 'ways of seeing,' including disciplinary methodologies. Importantly, while in some ways uncertainties can be reduced through research and new methodologies, uncertainty is an inherent feature of complex systems, and by extension, an inherent feature of scientific research and decision-making, and an important feature of public engagement. This is particularly the case when introducing novel technologies.

## Research Questions

1. How do forestry experts view the uncertainties associated with genomic selection?
2. What are the implications of these views of uncertainty for shaping expert perceptions about the role and purpose of public communication of genomic science?

## Methods

Qualitative data was collected from 38 semi-structured interviews with forestry research professionals. Interviewees were asked to share views on how they assessed uncertainty in their disciplines generally, and in GS research specifically. The international community engaged in research on GS applications in forestry is quite small and highly specialized. Professional experts provide a unique vantage for identifying the range of informed perspectives at play in early stages of technology development and implementation. Participants included individuals with considerable experience in genomic applications in forestry or tree breeding. Institutional backgrounds included professionals across university, government, and industry, with disciplinary backgrounds including molecular and quantitative genetics; plant, tree and medical genetics; silviculture, engineering and ecology; chemistry; computer science; and economics. Interviews were conducted at three international forest research conferences between May 2017 – October 2018; and secondly, members of the RES-FOR interdisciplinary research team ( https://resfor.ualberta.ca/) of which the authors are a part. To minimize potential interviewer/response bias, the latter set of interviews were conducted entirely by a graduate assistant. The project was reviewed and approved by the research ethics boards at the University of Alberta and the University of Calgary.

## Key Findings

Findings revealed striking contrasts. First, respondents expressed varied assessments of the uncertainties that exist in GS, yet focused primarily on aspects of uncertainty that could be identified quantitatively and reduced through statistics. Most respondents acknowledged that uncertainty is inherent to scientific research, particularly in emerging technologies intended to respond to future-oriented events, yet remarked that uncertainty is often assumed but not explicitly discussed within their research communities. Some approached uncertainty positively, as a way to enhance research, learning, and progress. Most positioned uncertainty within the quantitative language and logics of statistics, including the expectation that uncertainty would be reduced with further research, while a few highlighted that uncertainties are introduced, rather than minimized, by genomic sequence data and the statistical techniques used to analyze this data. One person explicitly acknowledged the centrality of statistics in genomics research and the lack of attention to other forms of uncertainty such as ignorance. Others were concerned about the accuracy of predictive models, questioning whether these models would work across generations of trees. A few highlighted the importance of empirical, field-based testing to validate the accuracy of predictive models. Numerous references were made to uncertainties associated with climatic change.

Second, most respondents acknowledged the importance of public engagement, but tended to assume that the publics are deficit in knowledge and require education. Most respondents acknowledged the importance of enrolling lay publics in decision-making. Some elaborated that the successful implementation of GS requires public acceptance. Although public engagement was deemed important, we encountered repeated emphasis on the need to educate and inform the public about scientific views. For most respondents, engagement and education appeared to merge. Concerns were expressed about the capacity of lay publics to distinguish genomic selection from genetic engineering. One interviewee acknowledged that the multiple uncertainties associated with genomic selection might necessitate democratic forms of decision making that involve multiple stakeholders and perspectives: “What we need to do as a management community is to acknowledge these uncertainties and be open and frank to that with the general public because there will be a lot of scrutiny in what we will be doing in the future.”

## Discussion and Implications

Our findings suggest that, in this expert community, overall uncertainty was viewed statistically, alongside a deficit view of publics and their anticipated reception of GS. Two implications follow from these findings:

1. Approaching uncertainty through a statistical and quantitative register can favour the tendency to overlook the presence and relevance of other forms of uncertainty. This might engender a lack of attention to important limitations of knowledge perceived by policymakers, industry actors, and interested publics, and marginalize the voices of stakeholders who lack the technical expertise required to assess statistical probabilities;
2. Assumptions about public knowledge deficits and prescriptions for education, viewed in tandem with quantitative statistical approaches to uncertainty, can diminish opportunities for social learning and deliberation. Broadening the communication of uncertainty to include qualitative dimensions may mitigate this possibility.

Given that uncertainty is an inevitable feature of GS science and decision-making, social scientists can assist in broadening-out discussions of uncertainty to enhance social learning, stakeholder relations, and decision-making.

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