DECISION-MAKING IN PROGENY TEST LOCATION USING GIBBS SAMPLING

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Abstract : The manner in which progeny tests are deployed affects genetic gain in production populations in the presence of genotype x environment interactions (GE). The conventional method of determining the site to locate progeny tests is to estimate the efficiency of selecting at one site for planting at another site. Since early selection is normally practised in tree breeding, efficiency of early selection across sites is important. In order to estimate the efficiency of selection, heritability and genetic correlations are estimated using standard methods such as REML. A major limitation of this approach is that the variance of the efficiencies of selection are unknown, adversely influencing efficiency of decision-making.

An alternative method is to use a Bayesian approach such as Gibbs sampling. This approach, is attractive because the sampling distribution of the efficiency of selection can be obtained and expected efficiency and variance of the efficiency of selection can be derived and futhermore, the probability that the efficiency of selection lies between certain values can also be estimated, thereby producing considerably more information on which to base decisions on compared to the point estimates from REML.

Data for the Gibbs sampler were heights assessed at ages 9.5 years and 22.5 years at two sites in Zimbabwe. The analysis was done using Multi Trait Gibbs Sampling for Animal Models program (MTGSAM, Van Tassell and Van Vleck 1995). The four traits were analysed simultaneously and a total of 1000 samples of genetic and phenotypic covariances were stored. From these, heritability, genetic correlations and efficiencies of selection were calculated for each sample, and inferences about efficiencies of selection were made by computing directly summary statistics from the distribution derived from the 1000 samples. These efficiency estimates were compared to the point estimates from REML. The efficiency of lower than 0.70 was assumed to justify extra costs of establishing separate progeny tests.

The estimated selection efficiencies are shown in Table 1. While the efficiencies of early selection across site showed little variation, those for selection at maturity across sites did. The probability that the efficiency of early selection at site C for planting at site A was greater than 0.70 was 0.93, indicating that early selection at site C would result in little loss in gain at site A at harvest age, compared to early selection at site A. In fact, the probability that more gain would be obtained from early selection at site C compared to site A is 0.2.

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Table 1. REML and Gibbs sampling estimates of efficiencies of selection for height and their standard deviations (SD), and the probabilities that the selection efficiencies (E) are greater than 0.7 and 1.0.

	REML estimate	Posterior mode	Posterior mean	SD	P(E>0.7)	P(E>1.0)
E_{A2c4}*	0.84	0.80	0.70	0.18	0.57	0.01
E_{c2A4}	0.75	0.75	0.89	0.15	0.93	0.20
E_{A4C4}	0.49	0.50	0.46	0.22	0.12	0.00
E_{C4A4}	0.53	0.63	0.48	0.23	0.17	0.01

*E_{A2C4} = efficiency of selecting at site A at 9.5 years for planting at site C compared with early selection at site C at 9.5 years.
E_{c2A4} = efficiency of selecting at site C at 9.5 years for planting at site A compared with early selection at site A at 9.5 years.
E_{A4C4} = efficiency of selecting at site A at 22.5 years for planting at site C compared to direct selection at site C.
E_{C4A4} = efficiency of selecting at site C at 22.5 years for planting at site A compared to direct selection at site A.

The efficiency of early selection at site A for planting at site C was greater than 0.70 was only 0.57, and only 0.01 that early selections at site A would result in higher gain at site C at harvest age than early selections at site C.

The results suggest that site C is a better progeny test site since selections made here will result in [ittle loss in gain at site A, and may even result in higher gain at site A at harvest age whereas early ;election early at site A would severely reduce progress at site C. If selections are to be made at maturity, results indicate that separate progeny tests should be established for the sites since ;elections at alternative sites would result in substantial losses in gain at the sites.

The decision regarding selection at maturity is consistent with that obtained using point estimates From REML, but Gibbs sampling allowed the efficiencies of selection to be interpreted with more onfidence.

The decision regarding early selection differed from that based on point estimates from REML. Jsing REML, the efficiencies of early selection at both site A and site C were greater than 0.7 ndicating that any of the two sites could be a suitable location for progeny tests, while with Gibbs ;sampling it was clear that site C was a better site to locate progeny tests. The results indicate that, ven in this simply decision problem, Gibbs sampling can be an attractive approach to decision-making as more information to make inferences about the parameter of interest can be derived from the analyses than possible from REML. The benefits might be expected to be even greater in more complex decision processes.

REFERENCES

Van Tassell, C. P. and Van Vleck, L. D. (1995). A manual for use of MTGSAM. A set of fortran programs to apply Gibbs sampling to animal models for variance component estimation. US Department of Agriculture, Agricultural Research Service.