MAXIMIZING GENETIC GAIN IN LOBLOLLY PINE BY APPLICATION OF ACCELERATED BREEDING METHODS AND NEW CONCEPTS IN ORCHARD DESIGN

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Abstract.--Despite advances in cloning, seed orchard seed as a significant source of genetically improved loblolly pine will be of importance indefinitely. Increasing genetic gain per unit time can not only be accomplished by decreasing the time needed for breeding and testing, but also by improving the yield of existing seed orchards, both in terms of quantity and genetic composition. Clonal orchard blocks as a means to this end should be seriously considered on an experimental basis.

Additional Keywords: Improved seed, juvenility, pollen contamination, supplemental mass pollination.

INTRODUCTION

Borlaug (1983) points out that there are still tremendous gains to be made by conventional breeding of essential food crops, and that genetic engineering combined with large-scale multiplication by tissue culture still faces formidable technical and biological obstacles. I suggest this is even more true in forestry, where we have only begun to plant the progeny of our first-generation selections, most of which derive from totally wild ancestry. Despite promising results in the field of woody plant tissue culture (e.g., Farnum et al, 1983), woody perennials that root poorly are probably the hardest plants of all to clone. In addition, woody perennials (including loblolly pine, Greenwood, unpublished data, 1983) undergo phase change, or maturation, which must be dealt with if cloning is to capture the gains considered theoretically possible. While I support research in cloning forest trees, the numerous obstacles facing clonal propagation must be dealt with patiently and thoroughly, to avoid the risk of forcing premature implementation of flawed technology.

Even if cloning were available today, it probably would not be cost effective or wise to regenerate a given company's acreage with only clonal material. Seed orchard-produced seed will continue to provide significant quantities of seed for regeneration purposes, perhaps indefinitely. Therefore, we must not neglect efforts to extract all the gain possible out of our current sexually-based seed production systems since our seed orchards represent a large investment.

This paper will briefly review some ways that genetic gain increment per

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Table 1.--Time periods (in years) for critical steps in a loblolly pine breeding and seed production program, assuming three different levels of implementation of new technology. Assume minimum of thirty clones for a new production orchard.

	Technology	•Traditional Field Breeding & Testing	•Accelerated Breeding Facility	•Accelerated Breeding •Earlier Selection •Clonal Blocks
A	Selection Age	8	8	2 - 8, avg. 5
B	Breeding period from grafting to test establishment	12[+]	5	5
C	Gen. Turnover (A+B)	20	13	7 - 13, avg. 10
D	Time to full production (includes gap for selection period)	15	15	12[*]
E	Comparison Factor $\frac{A + B + D}{35}$	1.0	0.77	0.63

[+] Includes 1 y for grafting, 4 y until both ♂, ♀ produced, 5 y for breeding and 2 y for cone maturation.

[*] Three years saved because new clones can be established immediately, instead of waiting until enough selections have been made for a new orchard.