Seed Orchard Management Strategies for Deployment of Intensively Selected Loblolly Pine Families in the Southern US

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Operational family block planting with loblolly pine (*Pinus taeda* L.) was begun by Weyerhaeuser Company in the mid-1970's (Gladstone 1981) and has been one of the most significant forest management decisions made with southern pines. After more than 30 years, planting of individual open-pollinated families, and more recently full-sib families and clones, has become standard practice in the southern United States. In the early 2000's, 59% of the loblolly pine plantations were established as single open-pollinated (OP) family blocks (McKeand et al. 2003). About 80% of the regeneration on company lands was with OP families, and 48% of seedlings used for market sales were as OP families. Fourteen companies used family blocks for deployment of loblolly pine. On average, a company deployed 47 different families on its own land, but there was tremendous variation in the number of families deployed in a region, ranging from as few as 4 to as many as 90.

Although these survey results have not been updated since 2002, the percentage of plantations established with individual families as opposed to seed orchard mixes has increased. Companies sell very few mixed seedlots, and state agencies have begun to sell individual OP families. We believe that about 75% of the loblolly pine plantations are now established as single open-pollinated (OP) family blocks.

In our opinion, nothing has had a greater impact on operational genetic gain than deployment of individual families of loblolly pine to specific sites. With loblolly pine, deployment is fairly straightforward; plant the best families on the best sites to realize the most genetic gain (Duzan and Williams 1988). The best families tend to be the best on all sites within broad adaptability zones, so more wood production is realized from the combination of the best families, sites, and silvicultural practices (McKeand et al. 1997, 2006; Li and McKeand, 1989). Even with the availability of many tonnes of loblolly pine seed available each year (Figure 1), foresters don't plant the best family everywhere, since seedlings of best genotypes are always in short supply and because of diversity concerns.

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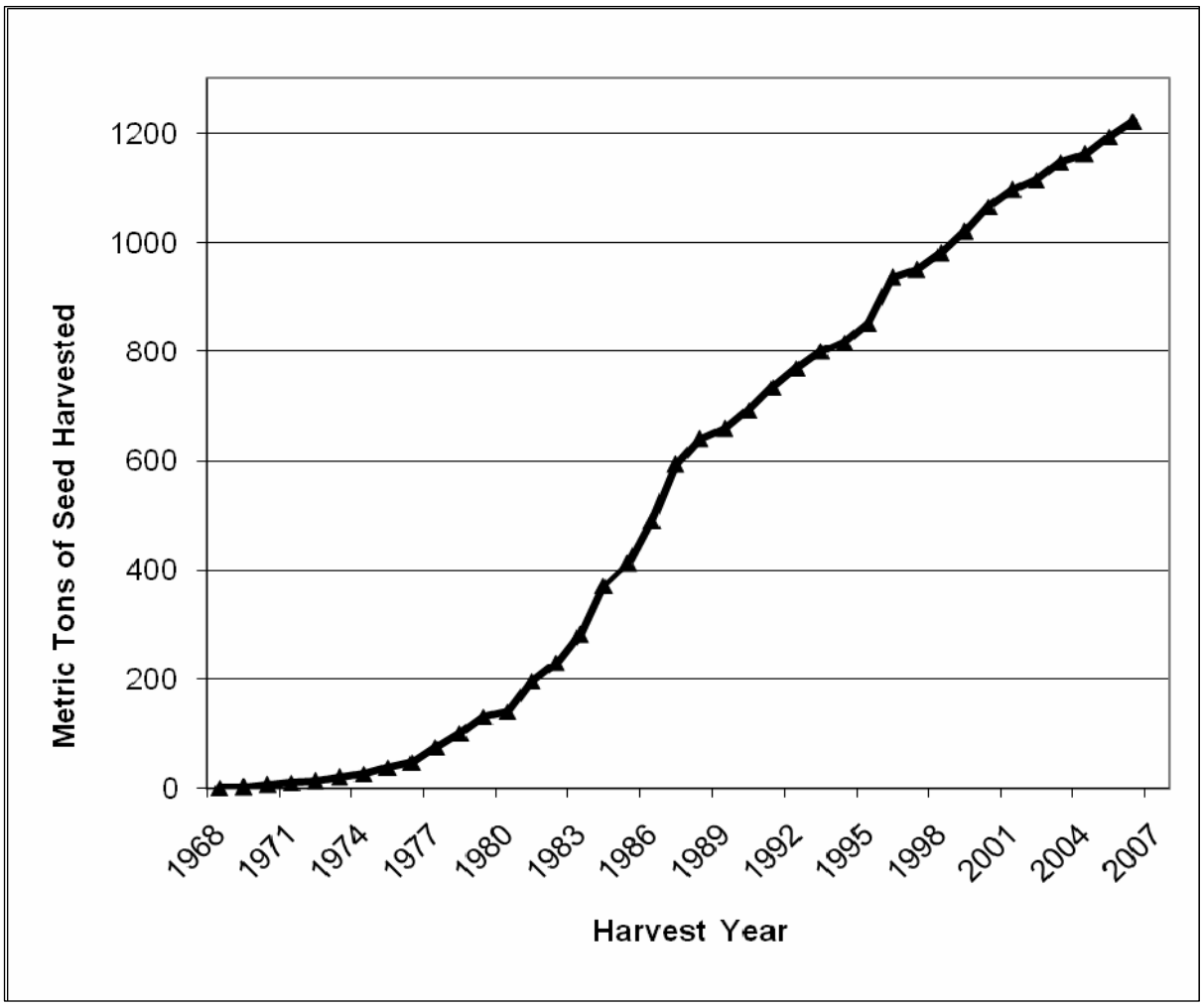

Figure 1. Cumulative production of loblolly pine seed by members of the NC State Tree Improvement Cooperative. Enough seeds have been produced to plant over 30 billion seedlings in the last 40 years.

Over the last 10 years, seed orchard managers have had great success in developing methods to mass produce full-sib families for operational planting. The gains from improved quality and yield are very impressive when both the female and male parents are selected (e.g. Bramlett 1997, Bridgwater et al. 1998, Jansson and Li 2004). Figures 2 and 3 show gain estimates in the MeadWestvaco / ArborGen tree improvement program due to different levels of selection. The gains in productivity, fusiform rust resistance (caused by the fungus *Cronartium quercuum* f. sp. *fusiforme*), and stem straightness are most impressive when both the male and female parents are controlled. As forest managers in the southern US move almost exclusively to silvicultural regimes to promote sawtimber production (Figure 3), the improvement in stem quality from lower levels of rust and better stem straightness have exceptionally high economic value.

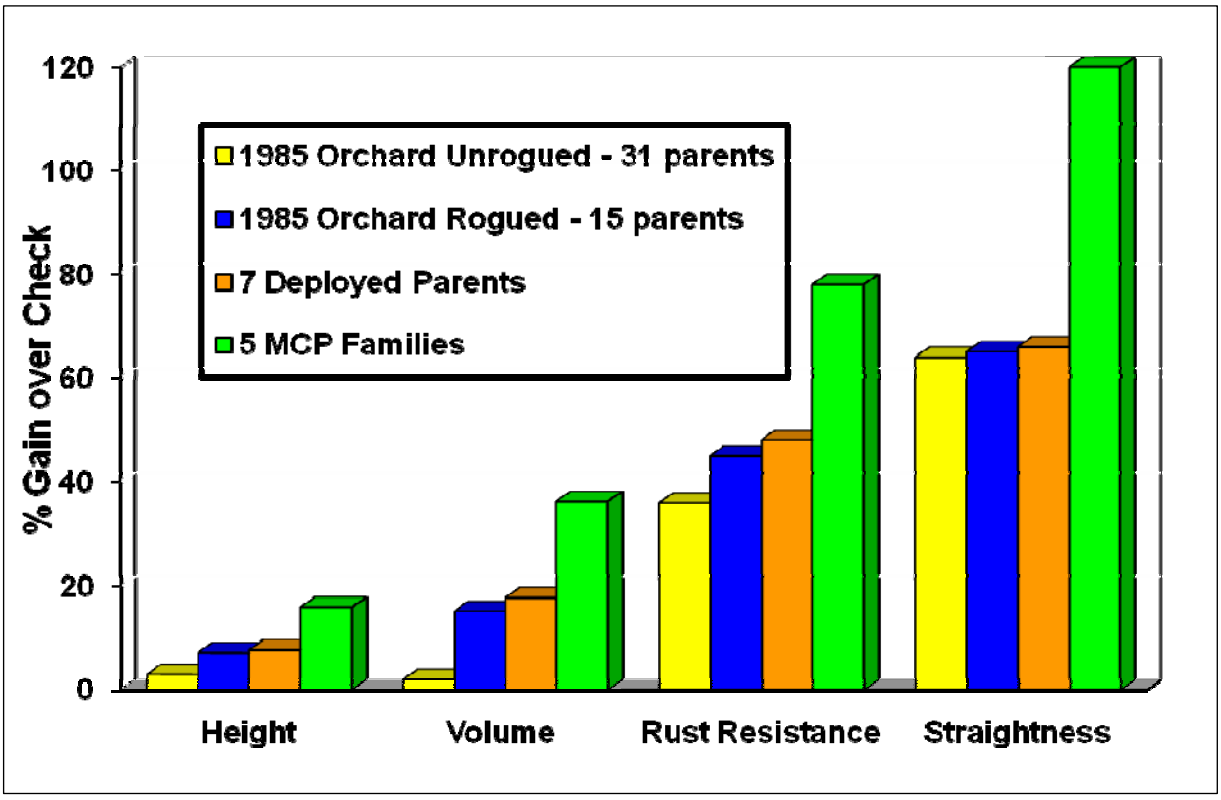

Figure 2. Estimates of genetic gain over unimproved checklots for different levels of genetic entries from the MeadWestvaco / ArborGen tree improvement program in the Atlantic Coastal Plain in South Carolina, USA. The yellow bar is for the average of all 31 parents in the unrogued orchard. The blue bar is for the average of the 15 parents in the rogued orchard. The orange is the mean of 7 OP families that were operationally deployed in the 1990's by MeadWestvaco. The green bar represents the mean of the 5 MCP families now planted.

Since production costs for mass control pollination (MCP or CMP) are large, production characteristics of the parent selections can be overwhelmingly important. When orchard managers are pollinating 40,000 to 80,000 bags each spring, production efficiency is critical. While the genetic quality of the parent trees used for MCP is critical, the morphological, physiological, phenological, and yield characteristics of the trees are extremely important. Virtually everything in a seed orchard is clonal; flowering, susceptibility to insects, drought, diseases, animal predation, and even hurricanes damage varies tremendously among parental selections. For an orchard manager to make MCP cost-effective, he or she must understand these differences and manage the orchard and MCP production efficiently.

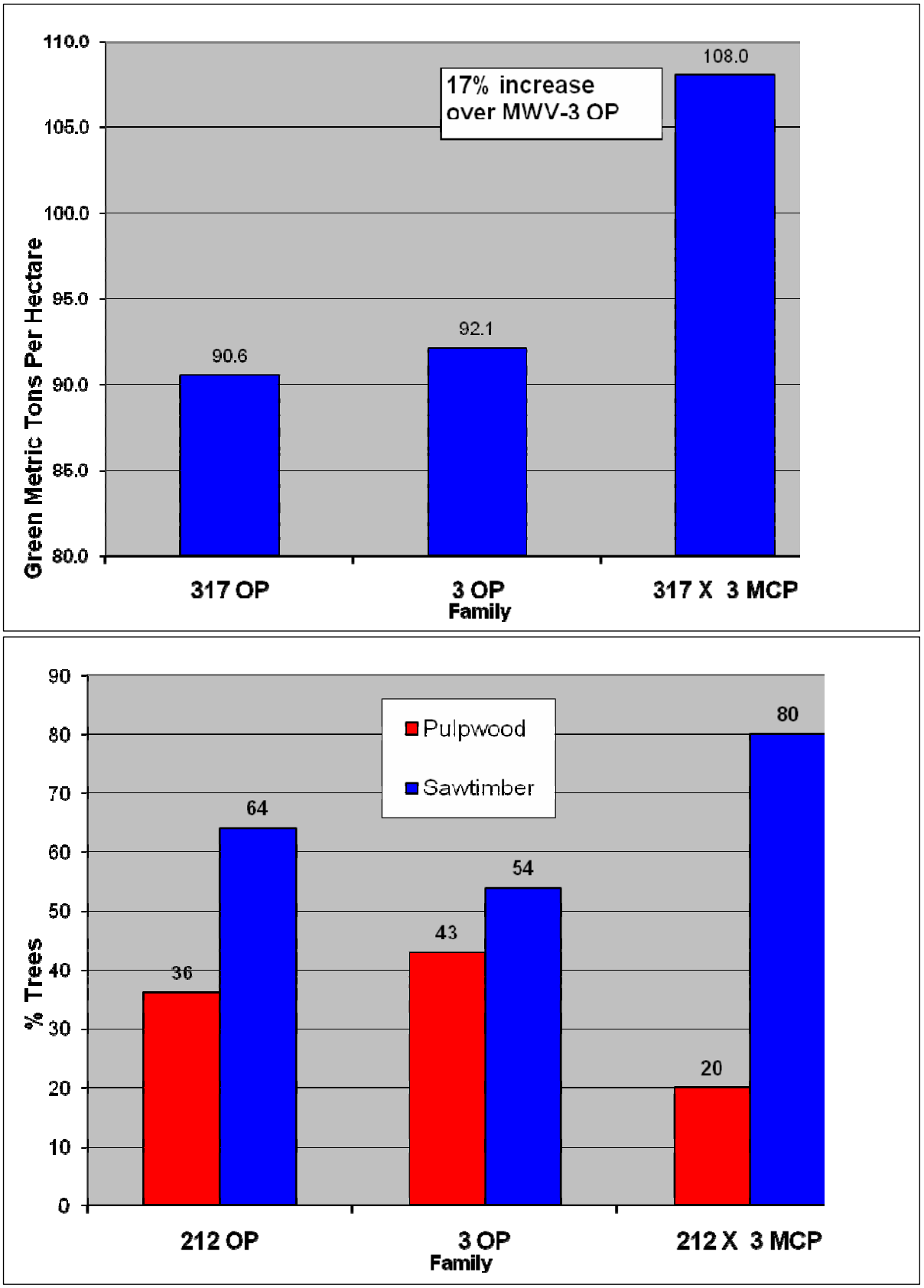

Figure 3. Comparison of yield per hectare (top) and percentage of trees producing sawtimber (bottom) of the full-sib cross compared to open-pollinated offspring of both parents. The gains from controlling both parents are most impressive in MCP families through age 8 years.

In 2007, the companies that have been mass producing full-sib seedlings for operational planting were surveyed to determine how many Mass Control Pollinated (MCP or CMP) seedlings have been produced. Since 2000, over 94 million full-sib family seedlings have been planted in the South (Figure 4). While the current annual production of full-sib seedlings is only about 3% of the total seedling production of the 800,000,000 to 1 billion loblolly pine seedlings, we anticipate that full-sib seedling production will become a much more significant component of the seedling market in coming years.

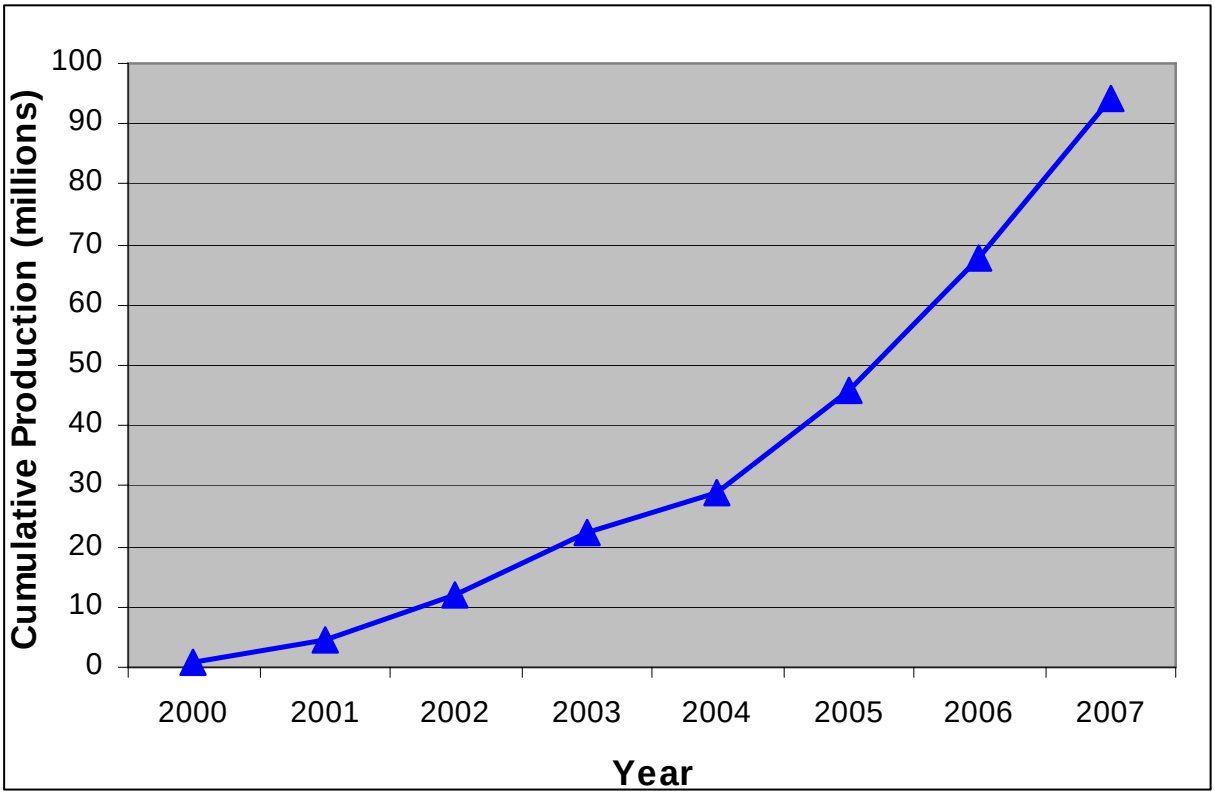

Figure 4. Operational planting of full-sib families of loblolly pine has become a reality. Since 2000, over 94 million full-sib family seedlings have been planted by landowners in the southern United States.

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