PINE TREE IMPROVEMENT TO DATE AND TOMORROW

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Abstract. Within the framework of broad-based recurrent selection programs, fine-tuning of genotype-site relationships will maximize genetic gains. Straightness and form characteristics will assume greater importance as log diameters diminish. Vegetative propagation will become operational and forestry operations will become more labor intensive. The nature of forestry, with its basic assets, the soil and the tree, provides an unparalleled opportunity for its practitioners to develop the code of personal ethics necessary for survival in the future.

"The fit are those who fit their existing environment
and whose descendants will fit future environments."

Thoday (1958)

TO DATE

Where is southern pine tree improvement today? For details, I'll refer you to the North Carolina State Cooperative's 19th Annual Report (1975). The generalities are as follows:

. We're in an embryonic state of development when compared with genetic and cultural programs of other plants and animals, however we can profit and will profit by the mistakes and success of these other programs.

. Natural genetic variability at three major levels is being utilized to provide the best planting stock available for regenerating harvested acres. For a given region or broad management area:

A. The proper species is selected.

B. The best source(s) within that species is selected. We lean heavily on local material where seed orchards are involved, but are rapidly researching the movement of material.

C. The best individuals within sources are being used as seed orchard parents. Through seed orchards we concentrate and perpetuate populations

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of good genotypes.

What are "best individuals"? The major goal of pine improvement, and thereby the ultimate selection or fitness characteristic, combining all others, is the maximum production of wood in some specified form and/or with some specified properties. Any selection criterion which can contribute to production directly or indirectly, independently or in concert with other criteria can be useful. Volume growth, disease resistance, and straightness are examples of obvious and very important traits.

The most visible tree improvement activity occurs at the individual selection, or seed orchard level, where we are, for the most part, breeding broad-based populations which are regionally specific. First generation orchards represent somewhat narrower geographic ranges than do 1 1/2 and second generation orchards, since the latter contain the best clonal material available from regional cooperators. Volume gains of 20% and 35%, respectively, are anticipated from 1 1/2 and second generation orchards, dramatic contributions to the South's Third Forest.

The seedlings produced from the output of the orchards are being planted on relatively diverse sites and microsites, the broad genetic base of the bulked material insuring improved performance but perhaps not optimum attainable performance. The question arises ..... "How site specific can we afford to be?". Genotype-site interactions apparent in progeny test results suggest that there are growth gains to be made by matching families and sites. How closely can or should we machine that fit? Specialty orchards have been established, concentrating on disease resistance, adverse site conditions, and wood properties. I foresee more effort devoted to specialty orchards.

Insofar as operational planting is concerned, we are not yet able to cash in on those extra-good specific combinations (full-sib families) which have been identified in progeny tests. Two clone orchards are coming in and mass pollination techniques will be developed to increase the production of excellent crosses. Vegetative propagation of individual genotypes for operational planting would provide the means for testing and using that apparently rust resistant individual from a very susceptible family or those gun-barrel-straight individuals from families which are already represented in the next generation's orchard by other family members.

Despite my inclination toward site-genotype specificity, I recognize the need for inter-company and inter-regional crossing. By planning and implementing these programs now, we're insuring that the descendants of our current pine populations will be able to fit future environments. We face the universal breeding dilemma -- long range needs for adaptability to diverse and changing environments versus short term desires for specificity and maximum immediate gains.

Is it conceivable, however, that by working diligently with first, 1 1/2, and second generation material, carefully matching genotype to site and product needs by such methods as

- Segregating and planting half-sib families,

- Producing and segregating full-sib families, and

- Operationally propagating selected individuals

that overall gains could be equivalent to the gains achieved by the broad-based approach to the third generation? (Unsafe levels of genetic homogeneity would be avoided.)

I can't answer that question unequivocally. But while I certainly advocate that we produce our third and fourth generations as rapidly as possible, the long range spectre of limitations on the amounts of suitable breeding material suggest that a more intensive examination and utilization of what we have at hand is in order. At this point we run up against economics. Most organizations haven't the resources to manage tree improvement this intensively.

That's generally where we stand today, with a few thoughts on where some emphasis should be added in the near future.

TOMORROW

A Broad Perspective

What does the distant future look like? Let's examine it on a broad scale and then return to the forest and to pine tree improvement.

If you've been reading *The Limits to Growth* (Meadows, et al. 1972), *Mankind at the Turning Point* (Mesarovic and Pestel 1974), or *How to Get to the Future Before it Gets to You* (Mead 1974), then you're probably as confused as I am about the prospects for solving our national and international problems. Is technology the answer? Or should our by-word be "Natural is Beautiful"?

William W. Harman of the Stanford Research Institute (Critical choices as the United States enters its third century-1973 mimeo) states that the dilemmas of the whole industrialized world appear to be unresolvable in any satisfactory way. "The basic tradeoffs between environment, life styles, personal freedoms, amenities, international stability, high energy cost and high cost of goods, public health, unemployment and economic recession, and other social costs, are growing more intolerable and it is not clear what could be done to make them less so." Life styles, international stability, high energy cost, unemployment, economic recession are particularly critical right now. We have entered the inevitable era of scarcity ahead of schedule; inevitable because of the finiteness of non-renewable resources, and ahead of schedule because of impending worldwide redistribution of resources and wealth. Witness the oil and bauxite cartels and expect others.

My own inclination is to be moderately pessimistic about our material standard of living but optimistic about other less tangible but important qualities of life. I think that Dennis Meadows' (co-author of *The Limits to Growth)* comments in *Business Week,* May 12, 1975, are not far wide of the mark:

"We will not be able to provide the same flow of materials and energy through the households of America in 10 to 15 years as we can today. The material standard of living will have declined sufficiently by the end of the 1980's to pull the rug out from under a lot of mass consumer markets. I think it is likely that the U.S. economy is going to deteriorate very seriously." I'm not so sure of the time scale, but I think that the trend is already becoming apparent.

This assumes, of course, that we and other developed nations do not indulge in wars of 'preemptive seizure', a morally bankrupt policy of taking what we want if we can get it militarily.

According to the authors of *Mankind At The Turning Point* (Mesarovic and Pestel 1974), an individual's new code of ethics must include:

- A world consciousness and a sense of common human destiny.
- A harmonious attitude toward nature.
- A life style compatible with limited resources. This requires a new technology of production based on minimal use of resources rather than maximal throughput.
- A sense of identification with future generations. We should be ready to relinquish benefits for ourselves in favor of future generations. (Are we "fit"?)

Idealistic, perhaps, and not in accord with economic precedents, but the problems which we must solve are also unprecedented.

A Forestry Perspective

All of this suggests to me that industrial and public forestry operations should and probably will become more labor intensive. The idle hands will become available; the challenge will lie in assuring those hands a sense of dignity, accomplishment, and satisfaction.

Aside from reserving energy and capital equipment resources for manufacturing operations, many silvicultural benefits from labor intensive management can be enumerated. Foremost would be the establishment of relatively small management blocks with permanent working forces which have a commitment to the land, a personal identification with the complete forest. Minimize contractual, absentee operator arrangements and thus minimize the "I don't care what happens after my phase of the operation is over" attitude. The harvester becomes the planter, the weeder, the thinner, the pruner, and finally, the harvester again.

Decrease the mobility of the professionals involved so that they can acquire an intimate knowledge of their particular soils, their plant material, and the subtle and not-so-subtle interactions between the two. A more favorable balance of mechanical and selective thinning will be achievable with a larger labor force and should result in a better disposition of individual phenotypes in a given plantation. It'll still be a clear-cut and plant proposition, however the cutting and regeneration units can be better regulated to the advantage of

environmental concerns. Harvesting and site prep machines which are absolutely indispensable should be precisely scaled to fit their jobs.

One of my major concerns, based on the forecast that energy will become a scarce, more expensive commodity, is that it will be desirable, if not mandatory, to minimize the amount of reconstitution necessary to fully utilize the wood available to us; i.e., the value of solid wood products relative to that of reconstituted products will increase in the future. Short rotation plantations mean diminishing log diameters and consequently lower yields, per cubic foot of raw material, of sawn products and veneers. It is important to note that losses of yield due to sweep and taper are proportionally greater as log diameter decreases.

Questions dealing with planting densities, thinning regimes, rotation ages, diameter distributions, and log quality come up daily in the South, but, critical as they are, I'm afraid we procrastinate in dealing with them. Our efforts to maximize cubic volume or weight per acre per year will have the effect of pushing the fractionation of our raw material back into the woods and materially increasing the necessity of gluing it back together. As an industry, we foresters are fortunate that one of our basic resources is a solar energy converter. Solar energy puts wood together ..... we should leave as much of it intact as possible. Creating specific surface, mechanically or chemically, consumes energy. Even companies which traditionally have been totally fiber oriented may find it profitable to recover solid wood products.

A Tree Improvement Perspective

What implications do labor intensive management and pressures for small log quality have for tree improvement?

Increased emphasis on form and straightness. Vegetative propagation in some form will permit the replication of near-perfect genotypes. This may be the primary contribution of tissue culture to pine forestry. Regular distribution of stems in properly planted, well stocked plantations should help to minimize sweep and eccentricity caused by unbalanced competition. Thinning and control of non-crop vegetation will have to be executed with care to preserve the competitive balance of a plantation.

Custom matching of species, provenances, families, and individuals to site conditions. Our ability to do this will be greatly improved by continued trial and observation by permanent field personnel. Single family plantations of limited size will permit close matching. Furthermore, recognizing that there is considerable between family variability in straightness and branching characteristics, some attractive management alternatives may be available at harvest, these same alternatives being lost if families are bulked. Somewhat longer rotations for straight, small-limbed families may be justified by the prospect of increasing grade volume (maximizing value increment), for example, while rougher families are harvested on the basis of mean annual volume increment, and wind up contributing heavily to chip supplies. I should include here an intensification of breeding for marginal sites. Agriculture will be competing for our most productive sites.

Orchards and nurseries will become more labor intensive. Mass, or controlled, pollination will be more manageable with more people and will make orchard design more flexible. Specific combining ability will be utilized to a greater extent. Good selections which are out of phase phenologically can be useful if artificially pollinated, adding to our genetic base. Harvesting, extraction, and stratification of seeds will be customized by family, as will nursery culture.

Intensification of breeding for resistance to or tolerance of disease and insects. The objectives, of course, are to improve plant efficiency, however reducing pesticide-energy requirements and minimize environmental impacts are side-benefits.

Creation and testing of new variants. Accelerated selection and breeding programs will reduce the generation lag, expediting the appearance of more efficient trees. Inter- and intra-specific hybridization, and mutagenesis (including chemical, radiation and nuclear fusion) will provide new genotypes.

Continued efforts. Cone and seed insect research, orchard cultural treatments, containerized breeding orchards, frost damage control, and a myriad of other research and development activities will continue to improve our efficiency and lower our costs and losses.

SUMMARY

Within the framework of broad-based, recurrent selection programs, fine tuning of genotype-site relationships and genotype product relationships will maximize genetic gains. Straightness and form characteristics will assume even greater importance as log diameters continue to diminish. Both genetic and intensive environmental controls will be brought to bear on log quality.

Vegetative propagation in some form will permit us to replicate excellent genotypes on an operational scale and thus take advantage of very specific gene combinations.

At some point in time forestry operations in the orchards, the nurseries, and the field will become more labor intensive, providing the manpower needed to accomplish a general increase in management intensity.

The nature of forestry, with its basic soil asset and its renewable asset, the tree, provides an unequalled opportunity for its practitioners to develop the code of personal ethics which will be necessary for survival in the future. Our pines may be "fit", but are we?

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