ABSTRACT: Forestry restraints, in the form of reforestation rates, program implementation and past negative selection, limit tree improvement returns to modest Westwide gains in the short run. Long run prospects, or gains for the local landowner, are optimistic.

"How much more wood can the forests of our eleven western states, British Columbia and Alaska expect from tree improvement, say for the next half century?" This question would parallel asking the first corn breeder in the spring of his first season a half century ago, "What increased yields can you expect to provide the corn industry, say for the next half century?" No one would have been offended if he answered, "Why don't we wait at least until harvest and see?" However, with a crop that takes 50 to 100 times as long to grow, I doubt if I could get away with the same answer.

Yet, the parallel is strong. We forest geneticists are still in the early spring of our first crop. All we can do for you is to peek at the immature plants and estimate what they might be like at harvest time. I trust that you sensed this might be the kind of answer you would be getting today.

We know a bit more about some other forest genetics details than we know about how to predict growth. We forest geneticists feel rather certain that Douglas-fir and some other western conifers have at least the same magnitude of genetic variation in many traits, and perhaps more, than is common in improved agricultural plants because the population is still unselected. If we had a 1-year crop, or even a 10-year crop like Christmas trees, we would be producing tested, improved seed in quantity now. Our major obstacle is time, just like it is one of your major obstacles. It takes 5 to 20 years for first flowering of Douglas-fir; and as surely as one tree takes 5 years, the one you would like to cross it with takes 20. We can get hung up a decade waiting for seed-years to complete a crossing program, or wait even longer to produce seed from young trees in quantity. The major culprit with a tree, however, is that some traits like volume-per-acre return, long-term survival, and mature wood characteristics cannot be measured with complete assurance until harvest. We are forced either to guess too early or wait too long. Thus, even though the forest geneticist can, with luck, breed several generations in a lifetime, he can't test all traits of the first one for certain.

Estimates of Gains

Despite such time obstacles, forest geneticists over the world have ventured estimates of expected yields from tree improvement. Almost all such estimates are based upon young trees. The relatively few published estimates from other timber regions of the world range from 1 to 23 percent and tend to cluster in the 10- to 15-percent range. Our own estimates of Douglas-fir, somewhat influenced by having a 57-year old study of Douglas-fir from wind-pollinated parents, suggest that a 10-percent gain is reasonable to expect from selected parentage of the presently-employed types of tree improvement programs. Having the information is not the same thing as having seed with the assured improvement. What we are saying is that some portion of these parents, perhaps all, should give the 10-percent gain. It may take a decade or two of progeny testing to tell us which parentage will do it and which should be discarded for each ownership.

Although the potential may be much higher, we have hopes that second generation tree breeding, perhaps two decades away, will produce something near a 20-percent gain, but this is even more of a guess. Again, there would be a considerable time lag in actually producing such seed in quantity.

In all such estimates, one must be aware that higher yielding strains in the forest may encounter considerable natural selection pressure back toward the average stand volumes. Such selection pressures, though poorly understood, are obviously important in explaining known racial differences over very short distances. Japanese foresters are already reporting that their improved strains are depleting the fertility of the site. Man has substantially countered some natural selective pressures in agriculture with cultivation and fertilizer and future forestry may gravitate the same way.

Rather than struggling with imponderables to pinpoint a certain improvement at a certain time, the better concept for the individual landowner is to consider that a sound tree improvement program will be able to produce seed with successively more genetic improvement each decade. Hopefully, he will reach the 20-percent mark by the end of a half century and thus average about 10-percent improvement in his seed for the whole period. The concept of gradually improved seed is probably a lot more realistic than the figures, which at this stage could be off considerably in either direction. Many other improvements than better growth, such as better uniformity, form, resistances, early vigor, and wood quality, may also come during the same period.

Forestry Constraints and the Forester's Role

The discussion of yields would be incomplete without a consideration of how forestry constraints influence the amount of improvement, and of the forester's
responsibilities in determining the actual increases possible from tree improvement. Up to this point, the geneticist has had the ball. Now we toss it to the forester.

If we, for illustrative purposes, accept the rough 10-percent estimate as the average potential improvement contained in seed from tree improvement programs for the next half century, we can better understand some forestry constraints associated with any estimate of Westwide gains. Three of these should be highlighted here so that foresters will be aware of, and perhaps can ameliorate, them.

1. Having seed with a built-in capability of 10-percent gain doesn't mean foresters can start overcutting 10 percent in anticipation of future yields. If one planted with improved seedlings the 1 to 2 percent of his holdings cut over next year, one would still have 98 to 99 percent of his land growing wood at the normal rate. Foresters can only capture gains from tree improvement on the acres they actually have planted with improved seed. Most foresters today talk about rotations from 50 to 100 years. Some are less, some are longer, but if we assume a 75-year rotation as average for the 11 western states and Alaska, only 50 out of every 75 acres would be planted to 10-percent improved trees in a half century. The other 25 acres would still be growing at the normal rate. And if we computed our gain from tree improvement over the next half century, it would be based upon the midyear of the 50-year period when a third of the total ownership was planted. Thus, we have instead of a 10-percent gain the potential for only about 3-1/3-percent Westwide gain, more or less.

No simple way of circumventing this constraint suggests itself. Because each decade is likely to have seed with more built-in improvement than the last, there is little incentive to tamper with present sustained-yield plans to gain yields.

2. Increased yields from tree improvement, when considered for all of the eleven western states and Alaska, are dealing with an area of over 150 million acres of commercial forests, growing roughly 25 billion board feet per year. In order for tree improvement to have a full impact in the next half century, a large portion of western forests would have to be involved in tree improvement programs now. How rapidly can this be expected to happen? Western tree improvement programs have been in existence now about a decade yet programs on not more than a million acres have reached the stage of producing seed with some improvement for use in planting their cutovers. A straight-line projection suggests 5 million acres Westwide in the seed producing stage of the program in 50 years. This is an underestimate because parts of the West are already moving along more rapidly. For example, in Oregon about 1.2 million acres of new programs have been added in the last 3 years, of which about 100,000 acres have reached the stage where clearcuts are being planted with seedlings from the program. Although the pace is picking up, we would soon have to be adding millions of acres per year to achieve full impact of genetics Westwide.

A fair share of the West is occupied by species that have had no tree improvement research. A fair share are too low-site to justify sophisticated programs. Some landowners will use less costly programs or none at all. A portion of commercial forest land of the West is in ownerships that have no interest in either forestry or tree improvement. All these cut into the potential improvement. Without a deliberate countering program, it seems a fair estimate that over the next 50 years the potential number of acres in tree improvement plans will average only about half the commercial forest acreage. Hence, our 10-percent figure might well drop to 1-2/3 percent, more or less.

Here is certainly an area in which foresters can do something. The fact that two thirds of the growth occurs on the best one fifth of these commercial forest acres seems to be the key. Providing improved seed to these high-site lands early in the rotation could begin to add appreciably to Westwide yields in the next half century.

3. Another forestry constraint to increased yields from forest genetics over the West concerns past sins of negative selection. We conveniently ignore the fact that genetics works both positively and negatively. Up to World War II, much of the cutover land was regenerated by cull trees too sick to sell. Also for nearly two decades after World War II, our expanding planting program often employed off-site seed. Both practices provided strong possibilities for negative selection. The acreage involved and the percentage of loss per acre will never be accurately known. Our experiences indicate that such losses begin to show up in the 35- to 50-year period after planting when the forester is left with the unenviable choice between cutting his loss or riding out the rotation with poor yields. Since we are already down in our estimate from the initial 10 percent to about 1-2/3 percent Westwide, it's best not to make an estimate of loss from our sins of negative selection.

Obviously foresters can do something about further negative selection. It's still occurring, but most foresters and landowners are becoming aware of seed source problems. As long as average planting stock contains some negative selection, improved seed should look even more improved by comparison.

From these three forestry constraints over which geneticists have no control, the optimistic promise of good gains from tree improvement almost disappear as an important factor in Westwide yields in the next half century. The assumptions and computations I have used could probably be argued the rest of the meeting. This would be pointless. The figures are intended to be more illustrative than actual. The only point of being on a panel of this kind is to try to pinpoint problems and suggest where we can make progress collectively toward removing some of the constraints. I have done this for the foresters, now let us suggest some more work for the forest geneticists.

Forest Geneticist's Role

A first need among forest geneticists is that of updating some of the programs we initiated for forest landowners in the last decade, particularly seed orchard plans without provisions for progeny testing.
and future breeding schemes. Otherwise, the potential improvement may be lower than expected.

Our major time constraints involving the long breeding cycle, poor cyclic cone production, and earlier correlations between young tree and mature tree traits have already been recognized and are being studied. Few of us, however, really give these studies the sense of urgency they obviously deserve. A solution of any one would quite definitely add its increment to the timber supply. Sometimes, stratagems that somehow bypass the problems are as important to find as solutions.

We geneticists should also be looking at the problem of applying tree improvement to more of the West. Obviously several important species, now almost ignored, need genetics research to provide sound tree improvement plans.

Even within the species now studied, there is a real need for a variety of programs to fit the local situation. A good example is the vast area of all-aged ponderosa pine managed under various beetle risk salvage programs. I have seen some that have already had a considerable positive selection applied to the stands. Up to now, any suggestions for tree improvement involve clearcutting and planting, which usually involves loss of growing stock equivalent to several decades of growth. Tree improvement programs would probably not be able to recoup such loss in a rotation. It seems unimaginative that somehow we could not attain a fair level of tree improvement without asking for a change from all-aged to even-aged management.

The main long-range goal for the forest geneticist is to build a body of research for our western trees like the agricultural geneticists have built for crop breeding. The need for this, besides improving efficiencies, is to provide safe improved seed. Nothing would be a greater disaster than to find, after years of good performance, that our improved trees actually fell away in yield or showed shortcomings to climatic problems late in the rotation, as our oldest off-site stands are now showing.

Conclusion

The basic mood of sound tree improvement is optimistic. Only the temporary constraints of a Westwide picture have any pessimism. The local picture now, and the long-term picture Westwide, are optimistic. Over the West the time and forestry constraints which bedevil us in the first rotation almost disappear as we go into the second rotation. Yields should quickly climb to full expectations when all the acres in a program have improved trees.

There is a real contrast between the Westwide picture and the local picture. The local landowner in a tree improvement program is in an enviable position. If forestry programs lag over the West, his competitive position gets better and better. We should also stress that individual participants in a program lose nothing because of the listed constraints. For him, yields increase as rapidly as new information develops, a situation that can hardly be improved upon.

In closing, let's look again at the analogy used in my opening remarks about improvement in agriculture. The first generation of corn breeding was probably very disappointing and replete with problems. Yet genetic improvement later did become a major, if not the major, contributor to increased agricultural yields. This was done in many ways — cutting losses from pests, improvement in uniformity and quality, and finally improvements in yield itself. The genetic contributions were added on top of the best contributions of fertilizer and cultivation. Moreover, as a capital investment, genetic improvement does not need to be reapplied every year on each acre. Thank you. (applause)