GRAFTING CULTURE AND EXPECTED PRODUCTION

A. H. Gregory, Continental Can Company

My role on the panel this afternoon is to discuss with you the expected production of an orchard, and certain aspects of grafting. It may be well if I present some background comments on our Company's experience in tree improvement work.

Our major research effort is carried out through industry-university cooperative programs. We began our work **in** 1954, by joining the University of Florida group to work on slash pine. When the N. C. State Cooperative was formed in 1957, we became a part of that to concentrate our efforts in work with loblolly. The recent formation of the Western Gulf Tree Improvement Cooperative gave us a chance to complete the coverage of our holdings in work on tree improvement. We are concerned with slash and loblolly as our primary species, but are carrying out limited research studies on all the major commercial species, hardwood as well as pine.

We have established seed orchards in all our major land-owning territories. These total 165 acres, exclusive of isolation zones. Our orchards are all grafted and we used a variety of grafting methods which I will discuss a little later. The progeny testing of these orchards is well underway. We are using the 4-tester system of control-pollination in assessing the genetic work of over 250 parents in the orchards. All of the orchards have accompanying nurseries for the care aid maintenance of planting stock and progeny test material.

The age of the trees in these orchards is quite variable except for one or two of the more recent expansion units, which are relatively even-aged. As the trees were selected in the field, scions were collected and grafts made. Searching for and selecting our present clones covered a period of about 10 years so the age of the trees in the orchards reflect this same time span.

We are definitely encouraged by the early results of our progeny testing. Even though our oldest planting is only now in its fifth growing season, we are already noting significant improvement of the select material over the controls. The information on disease resistance, for example, has led us to establish a small orchard made up only of those clones that indicate resistance to Cronartium while maintaining above average growth rates. We plan to use the seed produced from this orchard for planting in so-called "hot spots" of Cronartium infection on our company lands.

I hope that my comments reveal to you our enthusiasm and support of tree improvement as a basic arm of our management program in the company. We need now to get on with *my* assigned task.

I don't believe it necessary to outline to you the basic ABC's of grafting. Most of you have done grafting and are more knowledgeable than I as to the basic procedures. I have accepted as my job here to review with you what is being done in the South in the way of grafting techniques. I will try to sort out the pros and cons of each grafting method and allow you to form your own conclusions.

Vegetative propagation or grafting is a short-cut scheme that has wide use in forest genetics. If a strain of tree looks good, it can be propagated at an early age by vegetative means. In other words, numerous offsprings (in this case seedlings) can be produced within a year after the decision is made that a tree has good qualities. It is not necessary to wait for the normal period of 15 years for flowering and cone production to obtain additional plants that have the same qualities as the parent. Grafting is an essential tool of the forest tree geneticist.

It is difficult to make enough grafts to completely establish a seed orchard in any 1-year period. The ,?vailability of scion material, funds, and/or space may delay the completion of an orchard for 2 or even 3 years. Graft and scion incompatibility often make grafting results extremely variable. Graft failure, while important in seed orchard establishment, is not the only reason for voids. Often after grafts are planted in the orchard, failures occur which may be due to many things. Transplanting shock, lack of after-care, and failure of the graft to adjust to field environment are but a few of the causes for failure. Even after growth starts, grafts may still die from any number of factors. For these reasons, continued attention should be given to learn as much as possible about the various grafting techniques.

When I learned of the subject for this discussion from Dr. Jones, I was hard pressed for a source of comprehensive information on the various forms of grafting in use today. In an effort to expand my awn knowledge and gain information for this presentation, I polled a few of the members of the tree improvement cooperatives for their comments on the basic grafting techniques which they were using or had used. The response and information was particularly gratifying. I am indebted to these men for their help, even though I will not single out any contribution by name or company.

No matter what method or technique is used for grafting, one of the most important points to remember is the vigor of the rootstock and the condition of the scion. Most people have found that healthy rootstock will result in a much higher grafting success and the grafted plants will grow much faster after transplanting or grafting (in the case of field grafting). Scions should be fresh. It is not a good idea to store them longer than 2 days. They must not be allowed to dry out. Scions from young trees generally graft better than scions from old trees.

Grafting should be done in cool weather during periods of high humidity. If grafting is done in an uncontrolled environment, it is best to wait until the danger of severe frost has passed. A prime rule to remember in grafting is "don't hurry." Skill will come with practice. The graft should always be protected from injury or heat. After-care to grafting is just as important as making the graft itself.

Grafting is done throughout our area on all species of pine and some hardwoods. The general results indicate that loblolly is more difficult to successfully graft than slash. The techniques of grafting longleaf still elude many people working on the propagation of this species. The cleft graft seems to be the most widely used in the South; however, many companies employ the side graft technique.

The first form of grafting I want to comment on is pot grafting. This method was widely used in the early years of tree improvement work but is now limited to use with certain species or in special cases. The general recommendations for pot grafting are that seedlings for rootstock should be grown at wide spacings in the nursery bed. This allows for the development of a vigorous plant to be used in the grafting. The plants are then potted as 1-0 stock in a suitable container for further development. They should be well watered and fertilized. Grafting should be done in the spring for outplanting during that same summer. Grafting stock should never be kept in the pots more than a year. There are reported instances of root-binding taking place after only 11 months in a pot.

The advantages of such a method of grafting are:

1. The grafting can take place in a controlled environment.

2. Care and supervision is easier since workers and plants are concentrated in a small area.

   The efforts of the grafters are more fully utilized.

4. Record keeping and possibility of error are minimized. Each clone can be kept separate in blocks during the grafting, cutting down the possibility of an error in labeling.

5. Transplanting is accomplished with a minimum of effort. There is some indication that transplant shock may be less than that of nursery bed grafts.

6. There is generally good survival of the transplanted grafts if proper care is given to the cutting of the roots to prevent root-binding.

The outstanding disadvantage of this system is the danger of the trees becoming root-bound. The vigorous growth of the root system in the enclosed space of the pot causes the roots to curl in on themselves and completely strangle the tree. There is also a tendency for the tree to be more susceptible to windthrow. This condition may be alleviated by cutting the tangled root systems vertically at the time of transplanting. The cutting allows the root system to then develop normally. Some operators use overly large containers for potting, but this adds to the inconvenience of handling.

Nursery bed grafting is the second method I wish to discuss. One of the comments I received defined this procedure as a compromise between pot and field grafting. The procedure for growing of the stock is much the same as for pot grafting except that a series of

thinnings reduce the spacing of the trees in place on the bed to about a 1- x 1-foot. All the grafts, using either cleft or side graft methods, are made in place on the beds. Successful grafts are then moved to the orchards. One of the recommended methods for transplanting is to lift the tree from the bed, maintaining a good ball of dirt around the roots. This ball is then wrapped in burlap to aid in holding moisture and to maintain soil around the roots during movement to the orchard. The burlap may or may not be removed when the graft is planted. This method is often the most efficient for use when the orchards are some distance away from the grafting site, Some operators use mechanical devices for digging or lifting the grafts to prepare them for transplanting.

Several advantages of this method are:

1. Growing stock is easier to care for. It may be fertilized and irrigated in place. No movement necessary.

2. Conditions of control and supervision are the same as for pot grafting. Record keeping is minimized.

3. Ideal for mass production. This method appears to be the best for establishment of an even-age orchard over extensive acreage.

Disadvantages are:

1. Many cases of transplanting shock. There is a period of adjustment for the transplanted grafts and careful attention must be given to the trees in this period.

The use of field grafting by all those contacted has diminished somewhat since most orchards are pretty well established and many are using other techniques for replacement of lost grafts and for expansion. As the name implies, the grafts are made in place in the orchard on previously planted rootstock. The usual method is to plant two vigorous seedlings at each potential graft location. During the grafting season, scions are grafted on each stock to assure successful establishment of as many grafting positions per clone as possible. Extra grafts may be removed or transferred to fail spots if both grafts, at a single position, are good "takes." Most of the contributors to this discussion were high in their praise for this method of grafting.

The advantages are:

1. No transplanting problems. There is every indication that earlier flowering of graft is accomplished by this method due to the fact that the tree is in place a year longer than transplanted grafts.

2. It is an excellent method to start new orchards on an even-age basis.

3. Good rootstock development for healthier graft.

Some disadvantages that were noted:

1. Requires more care and supervision during grafting. Space between plants and random location of clones may create problems in proper identification if extra care is not taken.

2. A great deal more after-care is required due to space covered by grafting project and exposure to environment. May be hard hit by dry spells if orchard is not irrigated.

As a final note on grafting, I must comment briefly on some miscellaneous methods that are used in special situations. In-arching has been used as a method for extending the grafting season. Success with this method has been spotty. Grafts generally exhibit poor survival and show poor early growth. The graft is generally weak mechanically. Cuttings and air layering have not been used too much for our southern pines due to extensive work and cost problems. One advantage to air layering is that it produces an exact replica of the tree. It often grows well if successful; but may be slow to flower and produce cones.

All of the preceeding notes and comments tend to point out some of the methods of grafting and possibly some of the advantages or disadvantages of each. All of you know, with careful and skillful grafters, any method can be made to work. The important point is that the advantages of any method are relative depending on local situations such as funds, size of grafting program, urgency of establishment, weather conditions, and many other factors. If you have a method that works, stay with it unless you can be assured of significant improvement in a change.

The second major portion of my subject is the expected production of an orchard when the grafting methods we have discussed are brought to fruition by time. There are many factors effecting the cone and seed production in an orchard, and I will try to cover many of them, based upon our own experience in seed orchards.

The methods of cone collection in an orchard vary mainly according to species. Slash cones are readily removed from standing trees by the use of poles and hooks manipulated from the ground. Many orchards are beginning to use a tree shaker to get the cones to the ground where they can be picked up for processing. Such is not the case with loblolly. The cones on this species display a tenacity with the stem that resists the most vigorous shaking or knocking.

We have employed clippers to remove the cones from the stems. We feel that clipping each cone instead of trying to pull it off prevents damage to the stem and subsequent loss of a portion of the next year's production. We have used hand clippers and pneumatic shears for this job. It has been quite effective for us. Perhaps the answer to our problems in loblolly cone collection lies in the work done by members of the North Carolina State Tree Improvement Cooperative on a machine to retrieve the loblolly seed from the ground in an orchard. This machine works on a vacuum pickup principle and literally sweeps the orchard after the cones have been allowed to mature, open, and discharge their seed. This is aided by shaking the trees with a vibra-sonic shaker after the cones have opened. This machine shows excellent promise.

Generally, our cone collection crews are made up of five men, and they work as a team from tree to tree in the orchards. They use ladders and climbing to get well up into the trees for collection. Our costs for these collections have ranged from 51.25 to S1.50 per bushel for slash and about 53.00 to $3.50 per bushel for loblolly. The added cost for loblolly, of course, is for the extra time required to cut each cone. The variation in costs for a given species is due to per tree production as well as overall production. We generally average about a bushel or more of cones per tree after the tree reaches cone-bearing age. I mentioned earlier, not all of the trees in any of our orchards are in full production yet.

The yields from an orchard have been predicted on the basis of certain spacing and age criteria. Using these predictions, which I believe to be well within reason, we should expect 40 to 50 pounds of seed per acre of orchard when nearly all of the trees are in full production. We have noted in our own orchards that it takes about 6 to 8 years for a tree to begin flowering well, and by the time it is 10 to 12 years old, it is in full production. On a spacing of 30- x 30-foot, there would be about 50 trees per acre, and each tree should produce about a bushel or more of cones. Our experience has been that slash pine yields 1.00 to 1.25 pounds of seed per bushel of cones, and loblolly yields 1.20 to 1.40 pounds of seed per bushel. With these yields, it is entirely possible to exceed 50 pounds per acre in some years. Another prediction generally used is that an acre of seed orchard in full production should yield about 300 thousand plantable seedlings. This yield gives a generous loss to germination and nursery survival. We have considered as an index that a pound *of* seed will provide enough good seedlings to plant 10 acres. We have found that seed orchard seed are generally larger, that is, fewer seeds per pound, but the average seedling is usually more vigorous and exhibits better survival in planting. We have found that slash seed generally run about 9 to 11 thousand per pound and loblolly

seed number about 14 to 16 thousand per pound. Variations in spacing, tree age, and general vigor of the orchard will affect the production rates in terms of cones or seed.

The expense of establishment, care, and maintenance of an orchard can be returned to the investor by the gains realized in production of improved trees. We are convinced that our investment in tree improvement is a good one. I thank you for your attention and I thank LeRoy for inviting me to participate in this panel.