FRIDAY AFTERNOON SESSION

December 6, 1968

The session convened at 1:15 in the Ontario Room, Royal York Hotel. Mr. Peter Nielson was moderator.

MODERATOR NEILSON: Our first talk this afternoon is entitled "Propagation of Trees by the Tube Technique" which will be presented by Malcolm McLean.

PROPAGATION OF TREES BY TUBE TECHNIQUE

MALCOLM M. MCLEAN
Ontario Department of Land and Forests
Dorset, Ontario

This presentation is intended to convey the past and present objectives and ideas in using tubes for tree propagation. I hope that the inclusion of some of the particular problems encountered so far in Ontario will provoke discussion and thus generate new thoughts which can be applied in future development of the basic technique.

The following rather cursory introduction is to set the scene, so to speak, indicating how the tube came to be used as an integral part of Ontario's expanding forest regeneration program.

In brief outline, the tube-grown tree is one which has been established by sowing seed in a small tube containing soil. The plant must be tended and protected until it has developed to a stage where, it is judged, it may be transplanted with a reasonable hope of survival and satisfactory subsequent development. This paper deals with the tubes being used by the Ontario Department of Lands and Forests as part of its reforestation program. These tubes are three inches long and approximately one-half inch in diameter. They are made of extruded high impact styrene-latex, white in colour to ameliorate high temperatures, and are slit down one side to allow the seedlings to grow without restriction.

Of course, the ultimate purpose for which the tree is grown and the environment into which it is to be planted, will influence the size of tube or other container which is used. Thus, the rearing of plants having value in horticulture or other special purpose would justify the use of larger containers than are used in normal reforestation work. Similarly, when dealing with especially difficult planting sites, or where planting is especially urgent for, say, aesthetic purposes, one would have to consider whether larger containers with larger plants might be more suitable.

The essential purpose of the container, whatever the size, is to minimize disturbance of the root environment during transplanting. The ancillary advantages of ease in handling, segregation of individuals, plantability throughout the growing season, and possibilities of mass production and mechanized planting may or may not be important considerations for a given program.

As for the Ontario reforestation work using tubes, the technique was seen originally as a method of producing stock for reforestation of burned cut-over lands. In many cases, wildfire through logging slash has destroyed most of the seed upon which natural regeneration must depend. Although conventional nursery seedlings may be used with good success under such conditions, there are instances from time to time, when devastation from wildfire is so widespread as to preclude dependence on older nursery stock. Such stock is not available in sufficient numbers simply because we are unable to predict when the very large burns will occur. Unfortunately, any lengthy delay in reforesting such areas allows non-crop vegetation to become established. This creates a barrier to tree seedlings because of competition for light, moisture and nutrients.

An obvious thought, under these burned conditions, is to reforest the area by sowing tree seed. Such action has been taken in numerous instances in the past, but with variable success. In recent years, a developing understanding of the requirements for seed treatment and site preparation has led to more acceptable results from seeding operations. We look with some measure of satisfaction towards future seeding efforts.

Many of the losses to naturally or artificially disseminated seed in forest areas, occur before seedlings have grown past the cotyledonous stage. The causes of such early losses include depredation by birds or mice, lack of suitable seedbed for germination, surface drought conditions and extremes of temperature.

The tube was conceived as a method of creating a miniature growing area in which the seedling could be started, protected and conditioned against these common early hazards, and to facilitate transportation and transplanting of the seedling.

With this background, let us examine some of the growing pains of the program which has evolved in Ontario.

The technology of production and planting has been shaped, of course, by the container itself. We aimed at developing a container of the smallest size that would encourage survival and growth for the conditions and times under which plantings would be carried out. You will understand from this, that the present tubes are not judged to be the optimum that could be devised for all conditions.

The small size is desirable because of cost and space considerations. The effect of size on cost applies not only to the tube itself, but to all phases of production — soil loading, transportation, carrying and handling in the field.

The experimental work in the past included the use of paper tubes, waxed cardboard and painted cardboard tubes, polyethylene tubes, both one-half and three-eighth inch in diameter, and a variety of organic and inorganic soils. These experiments provided the following empirical information upon which the pilot trials and large-scale program were based:

a. Paper, cardboard, waxed cardboard and painted cardboard tubes deteriorate too quickly to enable individual handling during the planting operation. Furthermore, moisture loss and consequent drying of seedlings was attributed to the tube material giving up moisture to the atmosphere by a wick effect.

b. Polyethylene tubes, slit on one side to allow for growth of the seedling, give excellent results, whether one-half or three-eighth inch in diameter. In the smaller tube, however, loading the tubes with soil, sowing of seed, and covering with sand are difficult to accomplish. More important, polyethylene is too expensive for large-scale use, costing approximately one half of the cost of producing conventional nursery stock.

c. Inorganic soils give poor results. No fertilizers or other ameliorative treatments were provided in the trials. However, because of excessive weight and the better results obtained with organic soils, the use of mineral soils was discontinued.

d. Organic soils derived from hardwood litter give good results when using white and red pine, but poor results when using white and black spruce.

e. Shredded peat moss gives poor results, attributed to the fact that the material does not pack well into tubes, moisture retentiveness thus being adversely affected.

f. Peaty muck, crumb-structured mucks and peat from which coarse woody material has been removed, give generally excellent results with respect to moisture-retentiveness and, yet, tend not to become waterlogged.

g. Consistently poor survival and growth after planting are to be expected if the seedlings are poor when they are set out.

h. Good survival and growth may be anticipated if the seedlings are in good shape when planted, if the forest site is reasonably productive and in a good physical state; that is, having some humus cover, yet free of vegetation which competes directly with the tree seedlings.

i. Good stock may be set out at any time during the the growing season in the expectation that, barring catastrophic climatic conditions, survival will be good, providing of course, that reasonable spots have been selected for planting.
j. Small seedlings are subject to smothering by leaves if planting is done where broadleaved species exist.
k. Frost heaving is apt to occur if planting is done on bare mineral soil.
l. Although it is possible to raise stock in tubes outdoors, large-scale continuous production usually must be accomplished using greenhouses, because of the vagaries of climate.
m. Excessive sand cover will reduce germination, especially of small seeds.

The reference to "good" seedlings in this context should be explained. The seedling should be as large and healthy as it is feasible to grow it, considering the size of container being used. In addition, it should be sufficiently hardy to withstand the cold, heat and drought conditions that it is likely to have to endure in the field. The main root should be at or near the bottom of the tube and branch roots should be well developed. The size to which one may grow a seedling in a small tube, such as we have been dealing with, is rather surprising. Some examples are on display, to illustrate what may be achieved.

One of the early questions posed when the program was expanded was: "Why don't you grow larger seedlings to give better results after planting?" The answer was rather simple, we thought — "Because the roots of the trees grow out of the tubes if they are held too long, so are damaged when we try to take them out of the flats." Our experience to that time was that only a small measure of control over root growth can be attained. We did this by adding or withholding water. To encourage main root extension, withhold water. To inhibit main root extension, keep the soil wetter. Conversely, to encourage branch root growth, give more water. This was a rather unsophisticated approach, we learned, but it was the best we had. To some extent, it is still a useful procedure.

It appeared for some years, that the best seedlings we could grow would, of necessity, be small ones, otherwise physical damage would be done during transplanting, or else the roots would be rotted because of excessive water introduced in an attempt to hold back root extension. We considered the possibility of root pruning but were unable to devise a method of getting at the roots when the tubes are in the flats. At the same time, we were uneasy about introducing an imbalance in the top-root ratio just before planting was to be done.

I would refer you at this time to the paper by G. H. Saul of this Department, in 'Tree Planters' Notes, Volume 19, Number 1, March, 1968, in which he describes the use of copper on the bottom of containers to limit main root extension and hasten branch root development.

This technique has given some rather remarkable results in initial trials. Whatever the reason for this action of copper on root development, it appears that the inhibitory effect on a root which grows down to the copper, does not apply to any other part of the plant. Branch roots develop quickly, turn down towards the bottom of the tube, and each in turn ceases to develop in length. However, each does increase in diameter. In the meantime, one is able, by suitable fertilizer application, to build a bigger top. The most salutary effect of this treatment is seen very shortly after the tree in the tube has been transplanted. The roots which had been held back in longitudinal extension, upon being removed from the copper, grow at a tremendous rate — of the order of an inch or more per day, apparently depending on species, for at least several days. One can imagine what this would mean in terms of rapid establishment of a seedling in the field. It would appear that fertilizer treatment and the big top developed, have allowed the accumulation of much stored food in the root mass within the tube, the reserves then being mobilized for root growth immediately after transplanting.

It has been postulated that the effect of the copper is to kill the new root cells as they touch the copper, but that the meristematic tissue is uninjured and continues to produce new cells, which in turn are killed, until the copper is no longer part of the environment.

The early trials by Saul were small greenhouse trials, using copper plate, copper-armored fiber (a building material) and several different copper paints. Of these paints, one was more reliable than the others. These materials, with the exception of the copper plate and the less reliable paints, have been used on a pilot-scale field test in the field production greenhouses, and it is now confirmed that copper does inhibit root extension as in Saul's trials. It is a matter now of determining for certain that there are no deleterious effects and that root extension does proceed rapidly after transplanting.

One important feature of seedlings in tubes — plantability throughout the growing season, has led to the adoption of the method as an annual effort to supplement the existing reforestation program. Planting crews who previously were laid off at the completion of the spring planting operation, now can be employed on planting from spring to fall.

A good deal of discussion has taken place regarding the tube material. It has been argued that a product which would break down physically and/or chemically, would be desirable, in that there would be a better opportunity for lateral feeding roots to exploit the, upper few inches of the ground. Also there would be less likelihood of frost-heaving if the container had disintegrated.

The problem has been to find a material which would maintain its rigidity during the growing and planting periods, thus facilitating these operations, but which then would break down.

Investigations into this aspect are being carried out by a number of different groups. We are hopeful that one of the products to be tested this coming year — a paper impregnated with a non-toxic, water-resistant material, will prove to be satisfactory. We would hope eventually to be able to program the rate of breakdown to any desired length of time.

A continuing problem, notably with white spruce, has been in obtaining uniform and complete germination of the seeds sown within one flat. Research is being undertaken to determine the means by which undesirable germination characteristics can be overcome. Promising avenues of investigation are separation of seed on the bases of size and density, and pre-germination treatments involving the freezing of seed.

Some of the special operations and procedures of our Tree Breeding Unit are being modified to take advantage of the tube technique. In the greenhouse, production of seedlings for testing purposes normally fills the available space to capacity, thus limiting the amount of material which can be produced. The use of tubes has markedly reduced the time and effort required to raise the stock. In addition, much space has been gained.

The Tree Breeding Unit is concerned too with propagation by the use of cuttings. A recent innovation has been to start the cuttings in tubes. It has been observed that a superior configuration of roots can thus be obtained, in that there tends not to be developed, a single, long-trailing root, but rather a well-balanced and contained system of more but smaller roots, up to the time transplanting is done. Previous to using tubes, much damage occurred to the stock during transplanting, due to the root breaking away from the cutting. This breakage has been virtually eliminated by using tubes.

Work has been undertaken in recent years to develop a suitable nursery technique for raising poplar species from seed. This has been in anticipation of a demand for such a technique, which could be used to further the work of tree breeders.

Mr. Peter Jaciw of this Department has used the tube technique successfully for growing large-toothed aspen from seed. He reports that it appears to be advantageous to remove the tube from this kind of stock at the time of transplanting for the reason that better growth has been obtained in the first two years when the tube is removed. The better seedlings in his trials were about eight feet high, compared with only six feet for the best seedlings with tubes left on.

I hope that the material on display and this outline have given a good idea of the scope of our activities to date.

We will be glad to furnish you with more detailed information if you are interested in any particular aspect of our program.

MODERATOR NIELSON: That certainly is a new and revolutionary technique which you have devised Mr. McLean. Are there any questions?

HUGH STEAVENSON: On out-planting the tube grown seedlings, how old are they, about 1 year from time of seeding to out-planting?

MALCOLM MCLEAN: This has been variable; originally the system was intended for the planting of young seedlings, perhaps 1 month old. Currently planting, in the case of pines is done at 6-7 weeks and with spruce at 10-12 weeks.

HUGH STEAVENSON: In terms of growth how will this tube-planted transplant compare in growth during the succeeding 2-3 years with say a 2/1 transplant?

MALCOLM MCLEAN: We would never expect the tube grown stock to out-perform the conventional stock but we don't know what the ultimate will be. In the case of pines we get 6-8 inches of growth and on conventional stock about 12 inches or more of growth the year following transplanting.

BRUCE BRIGGS: How long have you had conifers treated this way planted out in the field and what has been the survival rate?

MALCOLM MCLEAN: We set out the first ones in 1956. Survival has been terrible to excellent depending upon many factors the primary ones being the planting site and its hazards and the condition of the particular stock.

HOWARD BROWN: Why were you using only 3″ tubes?

MALCOLM MCLEAN: We were trying to find the smallest tube size that would be acceptable because of cost. Cost increases with respect to the square of the diameter on the basis of the space needed for growing the plants.

BERT HENNING: Are the tubes available in Canada, what are their cost and are many other sizes available.

MALCOLM MCLEAN: The tubes are available in Canada and the current cost runs about $2.25/M. Larger containers are available but I can't give you any details right at the moment.

MODERATOR NIELSON: Our next speaker is W. A. Cummings whose topic is "Trimmed Versus Untrimmed Cuttings under Mist."

TRIMMED VERSUS UNTRIMMED CUTTINGS UNDER MIST

W. A. CUMMING

Canada Department of Agriculture, Research Branch, Research Station, Morden, Manitoba, Canada

Introduction — There is nothing profoundly new in the evidence which has been collected over a three year period and is presented in this paper. Propagators have argued the pros and cons of trimming cuttings for many years and indeed some of you have already discontinued this laborious and meticulous