The Status of Container Planting in Western Canada¹

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"Container systems, or for that matter, any other new reforestation technique must yield biologically acceptable results as well as be amenable to mechanization."

Abstract

Canada's western provinces must develop new reforestation techniques if forest management is to be intensified, and if forest renewal is to keep pace with the accelerated rate of harvesting. The challenge can be met if labor productivity is significantly increased through mechanization of planting. Container planting methods can improve manual planting performance and provide the basis for ultimate mechanization.

Container planting methods as developed in Canada may be defined as reforestation systems whereby tree seedlings are grown, transported and planted in small containers. Several types, sizes and shapes of containers are being investigated but, for reasons of economy in bulk and weight, all are characterized by a tiny soil capacity usually not exceeding three cubic inches. The small size and uniform shape of container-grown seedlings permits manual planting rates two to three times faster than those possible by mattock planting conventional bare-root nursery stock. The principal biological advantage of container methods is the capability of protecting the seedling and delivering it to the planting site with all of its roots intact and viable.

Large-scale container field trials are underway in all four provinces, but few conclusive results are yet available. Deficiencies in containers or techniques that have come to light are being overcome. As biologically acceptable methods emerge, efforts should be channelled toward developing equipment for automating and mechanizing both the nursery and planting phases.

La plantation en godets dans l'ouest canadien

Résumé

Pour intensifier la mise en valeur des forêts, et assurer leur renouvellement au même rythme

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que leur exploitation, les provinces de l'Ouest devront développer de nouvelles techniques de reboisement. Cet objectif ne pourra être atteint que si la productivité de la main-d'oeuvre est accrue par une mécanisation des techniques de plantation. Les méthodes de plantation en godets peuvent améliorer le travail manuel et servir de base à une mécanisation plus poussée.

Les méthodes de plantation en godets mises au point au Canada peuvent être définies comme des systèmes de reboisement qui consistent à produire, transporter et planter des semis dans de petits godets. Des godets de divers genres, dimensions et formes sont à l'étude, mais pour des raisons d'économie, de quantité et de poids, tous ces godets ne contiennent qu'une faible quantité de terre n'excédant pas 3 pouces cubes. La petite dimension et l'uniformité des semis plantés en godets permet un rythme de plantation manuelle de 2 à 3 fois plus rapide que par la méthode traditionnelle de plantation des plants de pépinière, à l'aide de la pelle-pioche. Le principal avantage biologique des méthodes de plantation en godets est d'assurer la protection de toutes les racines du semis lors du transport et de la transplantation.

Des essais sur une grande échelle de la méthode de plantation en godets sont en cours dans les quatre provinces de l'ouest, mais jusqu'à présent on ne possède que peu de résultats concluants. Certains défauts des godets et certains problèmes techniques, portés à notre connaissance sont en voie d'être corrigés. A mesure que l'on conçoit des procédés qui améliorent le facteur biologique, les efforts devraient être dirigés vers l'automatisation et la mécanisation de toutes les phases de la plantation.

The Challenge

The rate of forest harvesting in Canada's western provinces is expanding rapidly. If present harvesting levels are to be sustained or increased, forests will have to be renewed at a rate far exceed-

ing present-day operations. Trends of mechanized harvesting and of intensified forest management in the foreseeable future indicate that more and more of our cutover lands will have to be restored promptly by artificial means. Renewal by planting can ensure adequate stocking of preferred species at controlled spacings. Conventional planting practice has remained virtually unchanged for decades. Manual planting of the usual bare-root stock produced by forest nurseries is a labor intensive operation which offers little scope for increasing labor productivity. But significant gains must be achieved in labor productivity if planting programs are to be expanded commensurate with forest resource needs. Rising labor costs and the scarcity of social capital available to forestry operations only accentuate the urgency for developing planting methods with the potential capacity for huge gains in productivity.

In many other fields, including forest harvesting, productivity has kept pace with costs through mechanization. If tree planting operations are to be even sustained at present levels, let alone expanded, they too must be mechanized.

Container planting systems can quickly increase manual productivity, and can provide the basic technology required for mechanizing the whole planting process. Container systems, or for that matter, any other new reforestation technique must yield biologically acceptable results as well as be amenable to mechanization. Biological performance can be somewhat compromised if productivity gains are large enough, but it cannot be ignored.

Most of the container research and development activity in the western provinces is presently directed toward devising biologically acceptable methods. Few trials have reached the conclusive stage, but preliminary results are encouraging enough to continue further development.

The Methods

Characteristics of Canadian container systems

Container planting is a broad term covering various methods of growing trees from seed in containers and transporting and planting them with the container still shielding the root mass. A slight, but significant modification excludes the last step where the container is removed immediately before field planting. Many plants, including trees, have been grown in containers of many kinds for centuries; this aspect is not new. What is new, particularly in Canadian forestry, is the exploration of acceptable means of growing and transplanting large numbers of trees in tiny containers having soil capacities of from one-half to three cubic inches. The reason for this approach relates wholly to economic considerations rather than biological desirability. There can be no doubt that a larger tree can be grown in a larger container, but the tiny containers are dictated by factors of soil cost and weight, transportability and plantability. By this very definition one finds that most Canadian containerized systems have two features in common: trees produced are easily and cheaply planted, but their size is small compared

with that produced in conventional nurseries. It is this smallness in stock size that conflicts with the trend in conventional planting practice of growing and planting a larger and larger seedling. Although the stock is young and small, container-protected seedlings can be delivered to the planting sites with all of their roots intact and healthy.

Basic systems

The interest in the use of small containers in reforestation programs was stimulated over a decade ago when Walters devised a bullet-shaped container designed for mechanizing the planting process, and McLean demonstrated that tube-protected germinants could survive as well as much older and larger bare-root planted trees. McLean's method was quickly developed by the Ontario Forest Service into a full-scale operational program. A number of other container types and sizes are being studied, but most testing under way uses one of three basic container approaches.

Ontario tubelings

The container is a simple extruded and slit styrene tube measuring 9/16 inch in diameter and three inches in length. After loading with soil and sowing, successive crops of young pine and spruce are grown in greenhouses during the summer months. Seedlings are from six to ten weeks old when planted. Planting is usually continuous throughout the frost-free season.

Walter's bullet

This container is specially designed and manufactured to aid planting. The rigid casing permits a one-step planting process. The bullet is manufactured by injection moulding of styrene. Several sizes have been tested, but the one in common use is 4½ inches long with an inner diameter of ¾ inch. Seedlings can be grown in this type of container for at least one growing season without excessive root binding. Various tools called planting "guns" have been devised to increase planting speed and to demonstrate the mechanical potential of the system.

BC/CFS Styroblocks

Containers protect and shape seedlings for ease of handling and planting, but there is no evidence to show that the container is of any benefit to the seedling after the tree and container are in the ground. By contrast, most evidence demonstrates that the container is deleterious to the tree after planting. Styroblocks are simply modular tapered cavities for protecting and shaping the roots. The seedling or root "plug" is extracted and planted free of any container constraint. Seedlings must be large enough to form a firm, but unbound root "plug", to permit efficient dibble planting. The method is relatively new; the first large-scale trials were only started on the west coast in 1970. It can be anticipated that potential planting productivity gains will be somewhat less than those provided by bullets or tubeling methods, but the system does have greater biological acceptability than most other methods.

Only one size of foamed styrene has been manu-

factured. Each tapered cavity is one inch in diameter at the top and 4½ inches in depth; its maximum soil capacity is 2½ cubic inches. Seedlings approaching the size and quality of two-year-old conventional nursery stock can be grown in this soil volume.

Growing methods

The small size and close spacing of containers allows the whole nursery operation to be compressed, compared with conventional nurseries. The nursery can be located wherever climate and water supply are suitable. A compact nursery permits the use of relatively expensive facilities such as greenhouses. Thus growth rates can be maximized through control of environment and nutrition. Crops can be scheduled more precisely and flexibly. Soil used in most container trials are various blends of sterilized peat, vermiculite and sand. Reproducible soil media are desirable. Optimal nutrition is maintained throughout the growing cycle by supplying soluble fertilizers through overhead watering or sub-irrigation systems.

Strict adherence to good sanitation procedures, and environmental manipulation can reduce weed, disease and other pest problems to a minimum.

Although container growing can reap the benefits of precise controls, many old, and some new problems have to be solved. If problems arise in a compact nursery, their effects can be much more disastrous than in an extensive conventional nursery. Many of the problems developed are the result of inexperience. Even where precise care can be prescribed, the native skill, or "green thumb" ability of the nurseryman can mean the difference between crop success and failure.

Often container plantation failures can be ascribed to deficiencies in the size or thrift of seedlings rather than to container characteristics, planting techniques or site quality. The importance of stock quality to plantation success cannot be overstressed.

Regional Progress and Status

Alberta

The Alberta and Canadian Forestry Services, in cooperation with North Western Pulp and Power Limited and the Provincial Department of Agriculture, have been engaged in testing, developing and producing container stock since 1962. The program has progressed to the stage where approximately three million seedlings are planted annually on public and company lands.

After testing a wide variety of containers, including Walters' first 2½-inch bullet, a system was developed around a ¾-inch version of the Ontario tube, and growing and planting methods similar to the Ontario system. For the most part, ten-week-old seedlings are greenhouse grown, cold frame hardened and outplanted from June to September. All tubelings are manually dibble-planted.

The company operation is an excellent example of the progress possible in adapting new technology to a specific operation when free enterprise is provided with tenure incentives, technical support, and corporate leadership.

The scale of the combined Alberta programs is large enough to provide the most realistic container cost and productivity data in the west. Productivity gains in the Provincial projects are not as great as anticipated, but improvements are being made as experience accumulates. The company has minimized costs by using pay incentives made feasible by container methods.

Survival results have been considered satisfactory at levels between 60 and 80 per cent. However, growth rates during the first several years after planting have been slow. Lodgepole pine has performed well on some sites, but the growth rate of white spruce on low quality sites has been unacceptable. As a consequence, foresters associated with both the industrial and the public container programs are searching for means of improving growth performance. Approaches investigated include design of a more biologically suitable container, and improvement of nursery techniques to produce seedlings with maximum survival and growth characteristics.

Saskatchewan and Manitoba

Both the Saskatchewan and the Manitoba Forest Services have patterned their container methods after the Ontario and Alberta tubeling systems. Trials in Saskatchewan have been underway since 1967, with close to one-half million trees now in the ground. The Manitoba testing program was begun in 1969 when the first 100,000 eight-week-old tubelings were grown and planted. On the basis of acceptable survival levels, it is expected that testing programs will be expanded in these provinces.

British Columbia

The program underway in British Columbia differs from that in the other three western provinces in two basic respects. Firstly, with the lead provided by Walters, evidence continues to mount supporting his contention that bullet-grown and planted seedlings are not only capable of high survival rates, but that initial growth rates can be very rapid on highly productive coastal sites. The second difference is the greater age and size of container seedlings being planted in west coast projects compared with most other tubeling practices. The mild coastal climate reduces the need for expensive growing facilities; shade houses and the normal growing season are used as much as possible to produce container seedlings comparable to one-year conventional nursery stock. New techniques make it possible to grow seedling of this size and age without excessive root binding in the container.

Besides Walters' experiments, the first extensive outplanting trial was attempted in 1965, when weeks-old germinants were outplanted in mid-summer. Survival was so poor that more extensive testing was deferred until 1967-1968, when Provincial and Federal Forest Services cooperated with the Forest Industries and the University of British Columbia in growing and planting 100,000 coastal seedlings. Since 1967, trials have been replicated and expanded to cover a greater variety of sites and species. The survival and growth rates of over 200,-

000 individually identified trees are being followed. Over 100,000 seedlings have also been used to gather planting productivity data, and to test new planting tools and techniques.

Tubelings were tested in the 1967-1968 trials along with 2½-inch and 4½-inch Walters' bullet containers and 2 + 0 bare-root stock. A further comparison was added to determine the effect of the container on the seedling after planting. Trees grown and transported in 4½-inch bullet containers were extracted and dibble-planted free of any container-restraint. For want of a better term, these container-free seedlings have been indelicately described as "plugs". In order to keep the program manageable, the tube and short-bullet container comparisons were dropped after the 1967-68 trial. By contrast, the performance of "plug" seedlings, and the acceptability of the container-grown — container-free concept has been so favorable, that full-scale testing of seedlings grown in the specially designed "styroblock" was initiated in 1970.

It has been demonstrated that manual container planting rates can be at least doubled compared with mattock-planting of bare-root stock under similar conditions. But at this stage, cost and productivity considerations are secondary to biological performance. Stress is being placed on developing methods of growing high-quality container stock, and learning where and when it can be successfully planted.

Although initial results from the expanding results in British Columbia are encouraging, acceptance of containerization as an integral part of Provincial planting practice is contingent upon replicated survival and growth measures over a wide variety of conditions.

Synthesis and Forecast

Even considering the Alberta production level of some three million trees per year, all container programs in Canada's western provinces must be considered developmental in nature. In every province, the **potential** advantages of containerization are recognized — potentials in terms of reduced labor input, of cost per surviving tree, of extended or compressed planting seasons, of crop flexibility, and of improved growth performance. But major deci-

sions involving vast expenditures and the future quality of planted forests must be taken on the basis of **demonstrated** advantages of a new reforestation technique. At this juncture every container testing program should be contributing valid information on which to base future decisions. Although there now seems to be a plethora of container systems, each has its advantages and shortcomings. Competition and proliferation in techniques can only accelerate the synthesis of a system applicable for most conditions in western Canada. Although the variety of approaches can be stimulating, it may also lead to confusion and needless duplication unless several essential features of an optimal container system are kept clearly in view. Some characteristics of a system consistent with contemporary and future Canada can be forecast as follows:

- 1) The system must reduce manual labor input to a minimum:
 - container configurations will be precisely modular,
 - nursery care will be automated,
 - mechanization of the transportation and planting phases will be maximized.
- 2) The system must permit production of consistently uniform and high quality clonal, or seedling crops:
 - nursery environment will be controlled within the dictates of climate and the limits of economics.
 - nutrition, disease, insect and weed control methods will be prescribed in detail.
- 3) The container must be present when needed but must be effectively eliminated when it may become a hindrance:
 - the container will shape the root system without detracting from its ultimate structure or its capability of free egress.
 - the container will protect the root from nursery to the planting site.
 - immediately upon planting, the container will effectively cease to exist with respect to free and balanced root egress.

These specifications are demanding, but they can be met, provided that forest management policies continue to support vigorous development technology.

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