AN INTEGRATED INDUSTRIAL SYSTEM
FOR THE PRODUCTION OF TREE SEEDLING CONTAINERS

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Abstract.--A new type of container was developed as well as the process and machines required for its industrial production. Last winter, 3.5 million tree seedlings were produced and grown in the greenhouses of the Ministere de l'Energie et des Ressources du Quebec. Productivity, quality, reliability and costs are discussed and new challenges are outlined for future development.

Résumé.--Un nouveau type de récipient, ainsi que le procédé et les machines nécessaires pour sa production industrielle, ont été mis au point. L'hiver dernier, 3.5 millions de semis d'arbres ont été produits et cultivés dans les serres du Ministère de l'Énergie et des Ressources du Québec. La productivité, la qualité, la fiabilité et les coûts sont discutés et des nouveaux défis pour l'avenir sont exposés.

INTRODUCTION

A strong trend toward the use of containerized seedlings in reforestation started in the early 1970s and all provinces of Canada have now implemented container planting programs of varying complexity. Many types of container have been considered and tested by different organizations since then and a great deal of research and development work has been accomplished.

The program in Quebec was one of the few that sought a container system amenable to integration of the production process. Such a process was seen to include not only such operations as peat treatment, filling, sowing and packaging, but also forming of the container itself (Bonin 1972).

A long-term project was initiated by the Ministere de l'Energie et des Ressources du Quebec (MERQ) in the mid-1970s to develop the above container program. The Centre de Recherche Industrielle du Quebec (CRIQ) received the mandate to investigate the mechanical aspects of the program, *viz.:*

- to define an appropriate container in terms of its configuration, components, rooting medium and package;
- to develop an integrated industrial process for producing the containers;
- to design the necessary specialized machinery.

At the end of the fifth year of the project 3.5 million seedlings were produced in the East Angus greenhouses of the Centre de Culture des Plants en Recipients. This paper reviews the principal developments to date and outlines the challenges for the future.

Although the different objectives of the development activity are interdependent, for ease of discussion it is convenient to divide the program into three distinct parts, viz.: the product, the process and the machinery. What follows disregards the intermediate steps.

THE PRODUCT

The configuration, dimensions and components of the container as defined by the project are illustrated in Figure 1.

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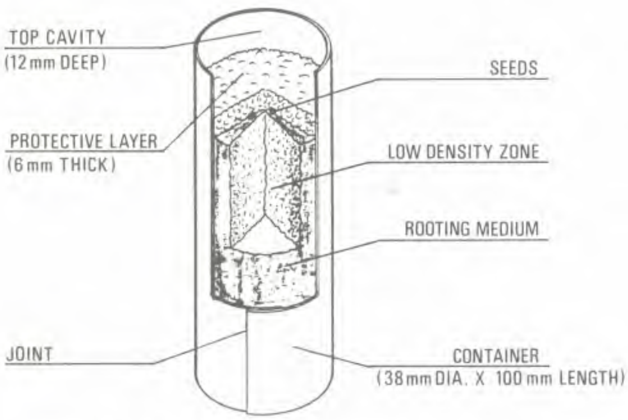

Figure 1. Schematic representation of container.

The container consists of two layers of disposable paper, the innermost being a synthetic material that resists the effects of water in the greenhouse. The tube is formed by joining the two edges of a continuous sheet and lap-sealing them with a quick-drying glue. The container is removed before planting.

The rooting medium is normally a wet peat with a moisture content (wet basis) of about 80%. However, the manufacture and mechanical handling of the containers can be accomplished equally well at moisture contents (wet basis) ranging from 70 to 85%.

The quality of the peat is a critical parameter for seedling growth (Helium 1975). There are certain guidelines which should be followed in order to avoid crop failures, viz..

- best results are obtained with a sphagnum-type peat (e.g., Pointe aux Peres, coarse A);
- peat has to be clean and free of all material larger than 8 mm;
- density of the rooting medium should be kept at about 0.1 g/cm^3 of dry material;
- a reduction in the particle size of the peat (e.g., during peat preparation) should be avoided as much as possible in order to keep the hydraulic permeability at a minimum of 500 cm/day (Bernier et al. 1978).

The container is filled with peat to within about 12 mm of the top of the tube. This is found to aid moisture retention, thereby improving the growth of the seedlings. The central zone has a lower density which may facilitate aeration and wetting of the rooting medium.

Once the tubes are filled, one or more selected and treated seeds are sown in the centre of each filled cavity. The seeds are then covered with a 6 mm thick layer of sand to stabilize them and protect them against adverse external factors.

The filled containers, as described above, are packed on a tray in groups of 48 units (Fig. 2) for easier handling. They are subsequently placed in wooden pallets for the duration of the growth period in the greenhouse.

Figure 2. Package of 48 containers.

THE PROCESS

The discovery that a mixture of peat and water can be stored at 80% moisture content (wet basis) and more was a turning point in the project, and resulted in the division of the manufacturing process into two separate phases: peat treatment and container production.

The main operations involved in the container production process, including treatment of the growing medium, are illustrated in Figure 3. A general view of the equipment installed at East Angus is shown in Figure 4.

Peat Treatment

The peat is fed into the process in 0.17 m^3 bags that are opened manually above a grating, at which point the largest sticks and foreign particles are removed. Lumps of peat are always present in the bags, and these are broken up in a rotary delumper-sifter which also serves to separate any foreign particles larger than 8 mm.

The sifted peat is then wetted in a custom-built double-shaft mixer with adjustable paddles. Water is metered through sprinklers directly onto the peat which is fed by a belt elevator into the mixer. The peat and water must be blended until the peat is uniformly moist. The wet peat is then stored in a live-bottom bin for later use.

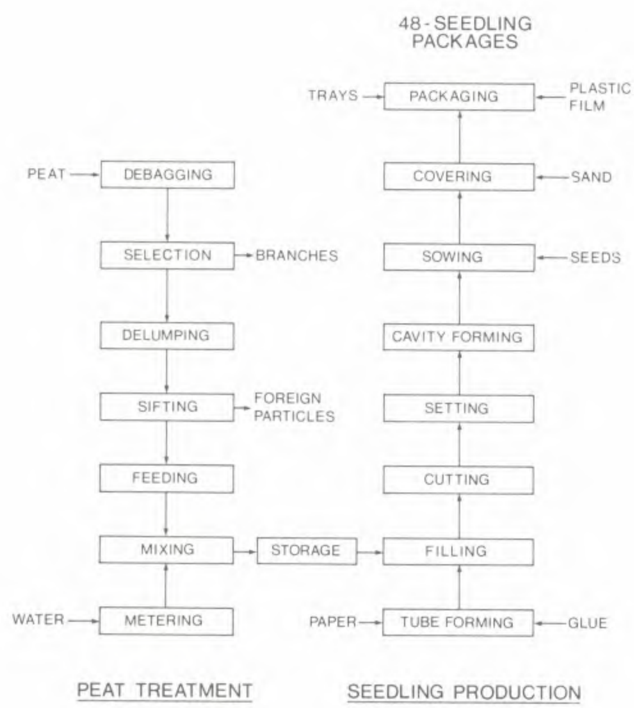

Figure 3. Flow chart of production process.

Container Production

The containers are formed from a sheet of paper that is fed continuously around a pipe, connected to the filling device, to shape it. A bead of glue is then applied between the edges of the sheet to seal them and thus form a tube.

The previously stored peat-water mixture is fed into the filling device, which consists of screw conveyors with unequal pitch, diameter and speed. These are arranged in series so as to fill the tubelike container that is being formed around the pipe. The resultant continuously filled container is cut with a rotary cutter into a series of cylinders of predetermined length. The radius of the cutting edge of the spiral blade increases gradually during each revolution, so that the blade penetrates progressively into the container. The continuously delivered horizontal cylinders are finally separated into eight rows by a distributing conveyor, after which a chute mechanism guides them toward a supporting conveyor in a vertical position, ready for seeding.

The cavities in the upper 12 mm of the containers are formed as the containers pass under a rotating drum, the external surface of which is fitted with appropriately sized dibbles. The forward velocity of the feed conveyor and drum are synchronized accordingly.

Sowing is carried out by a device arranged above the conveyor, which consists of a rotating cagelike drum with peripheral, longitudinally perforated tubes. The tubes are alternately placed under suction and pressure so that they pick up seeds from a receptacle and discharge them into the cavities in the containers. The seeds are then covered with sand. The sander consists of a rotating drum with scoops around its circumference, which is designed to pick up an adequate amount of sand from a reservoir to cover the seeds in each container.

The final operation, packaging, is carried out automatically by a machine at the end of the conveyor. It consists of (i) a pusher that moves a batch of 48 containers from the conveyor onto a tray, (ii) a mechanism that closes and welds polyethylene film around the package of containers, and (iii) a mechanism to move the packaging unit along at the same speed as the supporting conveyor and to bring it back as the cycle is finished. The transfer of the packages to pallets and subsequently to the greenhouse is a manual operation at present.

THE MACHINERY

In developing the process we have endeavored to use as many commercially available components as possible (e.g., standard screw conveyors, belt elevators, paddle mixer, flow meter, live-bottom bin, gluing unit, transmissions, controls, etc.).

Nevertheless, several specialized devices had to be designed and built in order to complete the production process, viz.: paper-forming device, filling screw conveyors, rotary cutter, distributing conveyor and vertical chute mechanism, supporting conveyor, cavity-forming drum, sowing drum, sanding device, packaging machine. Patents for the various features of these machines and devices have been either applied for or obtained (Barbulescu et al. 1981).

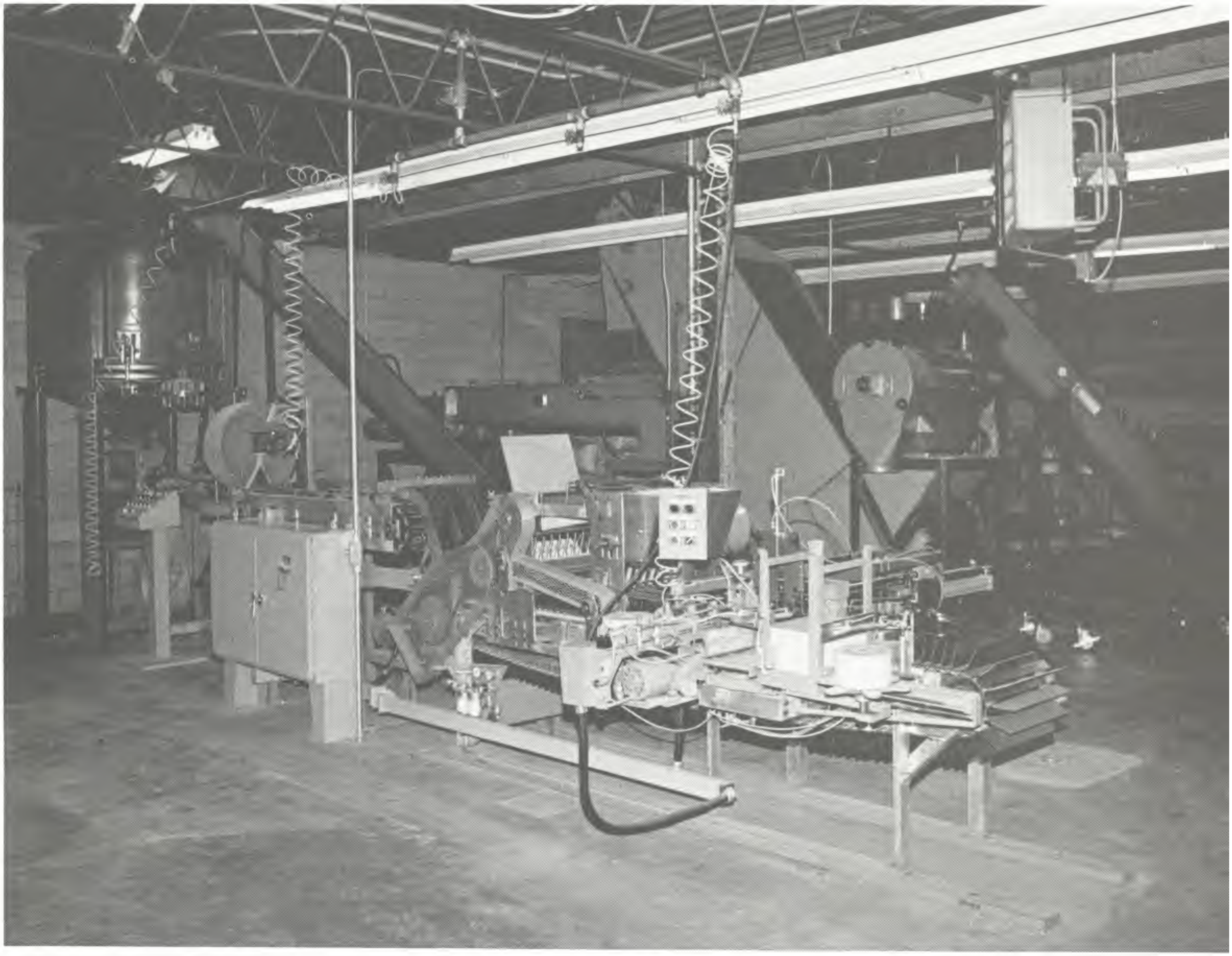

Figure 4. General view of equipment.

INITIAL PRODUCTION

In the fall of 1980, it was decided to proceed with a first operational production of containerized seedlings using the newly developed process and related machinery.

The delivery of filled containers to the East Angus greenhouses began on 15 December 1980, and the whole task was completed by 15 February 1981. In all, 3.5 million containers were produced in about two months.

Some average performances of the filling line were as follows:

- Daily production (two shifts) - 120,000 containers
- Number of operators required - 4
- Peat consumption - 0.08 m^3 (3 ft^3)/1000 containers
- Energy consumption - 3 KWh/1000 containers

Seedling growth in the greenhouse as well as overall survival were comparable with those of other containerized systems. A tendency to root spiralling was noted in some instances, but appears to be inherent in this type of container (Bergman et al. 1973).

Average production costs calculated by Czobor (1981) were found to be significantly better than those for other containerized systems.

CONCLUSION

There are now 53 container filling lines in Canada, and they delivered nearly 130 million units in 1980--an average of 2.5 million containers per machine. The one developed in Quebec compares favorably with the others, and in its first operational use produced 3.5 million container units. In summary, the new process offers the following advantages:

- The production process is continuous.
- Container forming, peat treatment and packaging are integrated into a single process.
- Filling and seeding operations are almost completely mechanized.
- Labor and production costs are significantly better than those for other container systems.

Some areas requiring further improvement were noted during the first operational production, viz.:

- Root spiralling in the containers should be thoroughly investigated and the most promising solutions tested.
- Higher productivity should be pursued by increasing the speed and reliability of the machinery.
- Machine parts subject to rapid wear should be improved by redesign or the use of more appropriate materials.

Despite these difficulties we are encouraged by the results obtained to date.

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