CONTAINER-GROWING MECHANIZATION AND COSTS 1/

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Abstract.--Mechanization of growing coniferous seedlings has been implemented to some extent by the Provincial Tree Nursery, Alberta Agriculture. Mechanical filling of the container has reduced man hours from 2123 to 323 for 1 million production run of Spencer-Lemaire 6 cell book containers. Seeding time has been reduced from 1056 to 476 with "speed seeding." Cost of production has decreased from $30.81 per thousand to $28.54 per thousand, even though costs for labour and material have increased substantially.

INTRODUCTION

The Alberta Department of Agriculture, Provincial Tree Nursery (PTN) has been involved in the production of containerized coniferous seedlings for 8 years. Production throughout this period has consisted primarily of Picea glauca and Pinus contorta var. latifolia, in addition, a limited quantity of shelterbelt deciduous material has been started.

Since the program started the nursery production has risen from a few hundred thousand a year to 6.0 million in 1974. Many types of containers, mixes and production methods have been tried. As a production nursery the PTN has the task of increasing seedling size, lowering costs and increasing overall production, therefore, only the most successful methods have been adopted and the rest were scrapped.

In the past year changes within the container program have been rapid, with some improvements having a substantial impact on the program.

The production system adopted by the PTN uses the Spencer-Lemaire 3/ 6 cell hook planter (37 c.c. capacity) filled with a sterile peat growing medium.

Our greenhouse complex consists of 2 sets of 3 ridge-and-furrow type (Ickes-Braun) 1,300 sq. ft. units. Each unit is 36' x 60' with a rigid fibreglass covering, each is equipped with 2 Modine 400,000 BTU forced air furnaces which are equipped with dehumidity, freezstat and maximum temperature controls.

Photoperiod is controlled by a timed incandescent lighting system, cooling is achieved by the use of 2 'Swamp-coolers' in each greenhot unit. There are twelve 8' x 16' benches, 32" high covered with # 14 expanded metal (to give root pruning) in each unit. All floors in the greenhouse complex are gravelled for maximum drainage and minimum heat reflection.

The greenhouse unit costs approximately $35,000.00 complete and has a life expectancy of 20 years. Each unit has a capacity of 200,000 seedlings per cycle with 4 cycles planned over a 10 month period for Alberta Forest Service production demands for coniferous seedlings. As production aims are set, one new greenhouse will be added each year for 3 years.

From the greenhouse phase the seedlings are placed into shade frames for further growth. Winter crops are placed into 'root cellars' which are equipped with incandescent light. The shade frames are of 2" diameter aluminum frame construction with a 'Saran*' shade cloth covering. The shading is approximately 43 - 47% of available sunlight. The same shade cloth covers the greenhouses.

The aim of the PTN is to produce a 4" seedling with a shoot/root ratio of 1:1 in

1/Paper presented at North American Containerized Forest Tree Seedling Symposium, Denver, Colorado, August 26-29, 1974.

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3/The use of specific company names is not intended to be a recommendation of that brand of equipment or manufacturer.

20 - 30 weeks. We hope to achieve this by lengthening the greenhouse phase and other production improvements.

Our containers are mechanically filled with a density aim of .09 - .10 gm./c.c. as shown on the attached sample sheet (Courtesy of W.C.Kay). We are approaching this density figure on a more uniform basis as operators become acquainted with the filling procedure.

Fertilizer application for our production is as follows: Following germination: High Phosphorus (10-52-10); Growth Period: High Nitrogen (28-14-14); Hardening Off: High Phosphorus (10-52-10).

The rate of application of fertilizer is 1/4 lb. per 1,000 sq. ft. every second day (Monday, Wednesday, and Friday).

MECHANIZATION AND IMPROVEMENTS

In the past the program required an extensive labour pool and with raising labour rates this became a very costly way to operate. As well, other costs, such as plastic, have increased so dramatically that cost saving became a must. It required 6 people 8 hours to fill 6,000 cavities. Following are some of the ideas we have put to use and others we hope to incorporate, a cost comparison is also included.

With the shape and construction of the small Spencer-Lemaire containers it was relatively simple to mechanize the filling, seeding and moving. The old method involved filling the cavity by hand by pushing moist peat into individual cavities. This was not only time consuming but gave us uneven densities within the container. In the fall of 1973 the Nursery felt it was necessary to decrease the labour requirement in view of increased production demands for 1973. Over the winter months we devised a slurry method of filling the container.

The 'slurry' method consisted of mixing the peat to the consistency of wet cement. The peat then flowed through a tube (by gravity) to a vibrating table. The table vibrated quite slowly (100 - 150 c.p.m.) to allow time for the operator to break up large peat pieces. This method had the advantage of washing out the 'fines', or very small peat particles. However, there were two major disadvantages;

(1) the operation was quite messy and dangerous because of the volume of water required.
(2) the density could not be regulated sufficiently as it still required the Operator to push bulky peat into the cavities. There was also a certain settling as the containers were moved about. However, this method cut the filling time in half.

The filling technique finally adopted (see attached diagram) was to incorporate the 'vibrating table' at a higher vibration and lessen the water content. The shaker table speed was increased to approximately 450 c.p.m. The peat is supplied by conveyor to the table from the batch mixer where it is moistened to 80% water content. The peat is brushed onto the containers and then is vibrated down. The excess peat falls through the meshed bottom onto a conveyor where it is returned to the batch mixer. The vibrator operates for a short period only and is switched on 2 - 3 times for each filling of 10 trays. With this system 1.5 people can fill 55,000 cavities per 8 hour day. The cost of developing this system was approximately $1,500.00.

The gritting operation has also been mechanized to save time. This involves the trays travelling on a conveyor under a hopper containing the sand. (The hopper operates off the conveyor pulley). As the trays move under the hopper the seed is covered by a 1/16" layer of sand.

Another method of cost and time saving, although not mechanized, was to overseed or 'speed seed'. This involves overseeding of each cavity, instead of 2 - 3 seeds per cavity we put in 5 - 7 seeds per cavity and thin. This has resulted in a saving in man hours for seeding but has increased man hours to thin. With the variance in germination of some seedlots this method works quite well. Once we have completed present renovations to seed laboratory and new equipment purchased we will be working on a higher volume of viable seed. The over seeding will be decreased as germination percentage increases on an overall basis and fewer seeds will be applied.

In the past, 6,000 cavities per day were filled, seeded, gritted, and put into storage. With these new methods 55,000 per day are filled, seeded, gritted and put into storage by 4 people.

Improving our irrigation system has resulted in a more efficient operation. Previously we hand watered our greenhouse facilities. Now we have introduced Chapin* no-drip spray nozzles which give an excellent coverage. As well we now are working on having installed an irrigation injection system for fertilizer application.

We are installing an incandescent lighting system into our lath-house to lengthen day light applied to northern seed sources.

COSTS

The costs shown on table 1 following are based on production runs of 1 million seedlings. By necessity some costs can only be estimated but are based on comparable figures from other greenhouse facilities.

Table 1.--Cost components per million seedlings

	1974	1973
Containers (Cavities)	$ 5,830.00	$ 3,984.00
Trays	** $ 3,500.00	$ 3,400.00
Container Assembly	$ 1,000.00	$ 1,000.00
Peat	$ 720.00	$ 962.80
Container Filling	$ 969.00	$ 5,647.18
Seed	$ 1,750.00	$ 1,750.00
Seeding	$ 1,428.00	$ 2,808.96
Grit	$ 45.00	$ 36.00
Fertilizer	$ 193.00	$ 136.00
Container Maintenance (Watering, Fertilizing, thinning, reseeding, and miscellaneous duties)	$ 5,994.00	$5,043.36
Supervision (Technicians Salary)	$ 2,000.00	$2,372.00
* Deliveries (pickup and delivery of containers)	$ 75.00	$ 94.68
Handling Costs (Filling and emptying greenhouses and shipping)	$ 2,940.00	$1,568.40
Depreciation (1) Greenhouses	$ 900.00	$ 804.00
(2) Lath-houses	$ 320.00	$ 322.00
* Maintenance Costs	$ 435.00	$ 434.00
* Fuel Costs (1) Gas	$ 400.00	$ 400.00
(2) Electricity	$ 40.00	$ 42.00
TOTAL	$28,539.00	$30,805.38

* Estimated Costs
** 1 return = $1,750.00 Case for trays
MM = 1 million
M = 1 thousand

Table 2.--1973 Supply Costing

	Man Hours	Labour Cost
Labour costs $2.66 per hour including 6% holiday pay		
Filling	2,123	$5,647.18
Seeding	1,056	$2,808.96
Watering, Fertilizing & Miscellaneous duties	1,180	$3,138.80
Filling Greenhouses	144	$ 383.04
Emptying Greenhouses	244	$ 649.04
Loading Trucks (Shipping)	202	$ 537.32
Thinning and Reseeding	752	$2,000.32

Cost of Supplies

Ferdinand Cavities 1,000,000	$3.984/M
Plastic trays 10,000	.34¢ each
Peat 335 bags	$2.884/bag
Grit 30 bags	$1.20 /bag(80lbs.)
Fertilizer	660 lbs. @34¢/lb.
Seed	35 lbs.@$50.00/lb.

Cost per thousand seedlings leaving the nursery:

1974 - $28.54
1973 - $30.81

The 1974 production figures are based on higher labour figures than the 1973 costs. However, the comparative cost for man hours used is lower per thousand seedlings, which shows that even the smallest improvement can lead to lower overall production costs.

The cost of seeding shows a drop in labour man hours whereas, because of overseeding, thinning costs are higher. There is a net lowering of the costs as a result of the technique of 'speed seeding'.

Some equipment changes that are being installed or contemplated are:

(1) Complete time controlled irrigation system.
(2) A metered fertilizer injection sytem for the entire complex.
(3) Frost sensing devices for an improved detection system.

The contained program generally is expanding and being modified at a tremendous rate. New techniques and methods of production are constantly being introduced and evaluated. No industry especially such an expanding one can stand still, methods must be improved or containerization will not be as great as the future indicates.

Table 3.-- 1974 Supply Costing

	Man Hours	Labour Cost
Labour costs $3.00 per hour including 6% holiday pay.		
Filling	323	$ 969.00
Seeding	476	$1,428.00
Watering, Fertilizing & miscellaneous duties	900	$2,700.00
Filling Greenhouses	200	$ 600.00
Emptying Greenhouses	400	$1,200.00
Loading Trucks (Shipping)	380	$1,140.00
Thinning and Reseeding	1,098	$3,294.00

Cost of Supplies

Seeding-Rate of seeding - 2.1 M/hr.
Filling - Rate of filling - 3.1 M/hr.
Containers -1,000,000 @ $5.83/M cavities.
Trays - 10,000 @ .35¢ each
Peat Moss - 180 bags @ $4.00 each
Fertilizer - 660 lbs. @ 34¢/lb.
Seed - 35 lbs. @ $50.00/lb.
Sand - 30 bags @ $1.50 each

Table 4.--Density of Spencer-Lemaire container media

	Height From Top	Tare Wt.	Dry & Tare Weight	Dry Wt.	Wet Volume	Dry Wt. Wet Vol.	
Container No. 1-1	0.8	4.408	7.389	2.981	35.24	0.0846	
1-2	0.7	4.389	7.609	3.220	35.65	0.0903	
1-3	0.6	4.399	7.868	3.469	36.05	0.0962	
1-4	0.8	4.410	8.055	3.645	35.24	0.1034	
1-5	0.8	4.413	7.858	3.445	35.24	0.0977	
1-6	0.5	4.181	7.558	3.377	36.45	0.0926	
1-7	0.7	4.098	7.180	3.082	35.65	0.0865	
1-8	0.7	4.178	8.071	3.893	35.65	0.1092	
1-9	0.4	4.170	8.428	4.258	36.86	0.1155	
1-10	0.7	4.118	7.550	3.432	35.65	0.0963	
				Mean		0.0972	-- Density of S/L container media taken from tray #1
				Stand Dev.		0.0098	
Container No. 2-1	0.8	4.031	7.369	3.338	35.24	0.0947	
2-2	0.6	4.022	7.338	3.316	36.05	0.0920	
2-3	0.6	4.082	7.453	3.371	36.05	0.0935	
2-4	0.6	4.118	7.542	3.424	36.05	0.0950	
2-5	0.7	4.122	7.567	3.445	35.65	0.0966	
2-6	0.8	4.364	7.761	3.397	35.24	2.0964	
2-7	0.8	4.103	7.298	3.195	35.24	0.0907	
2-8	0.5	4.054	7.590	3.536	36.45	0.0970	
2-9	0.4	2.292	6.101	3.809	36.86	0.1033	
2-10	0.5	2.239	5.819	3.580	36.45	0.0982	
				Mean		0.0957	-- Density of S/L container media taken from tray #2
				Stand Dev.		0.0035	

(Courtesy of W. C. Kay)

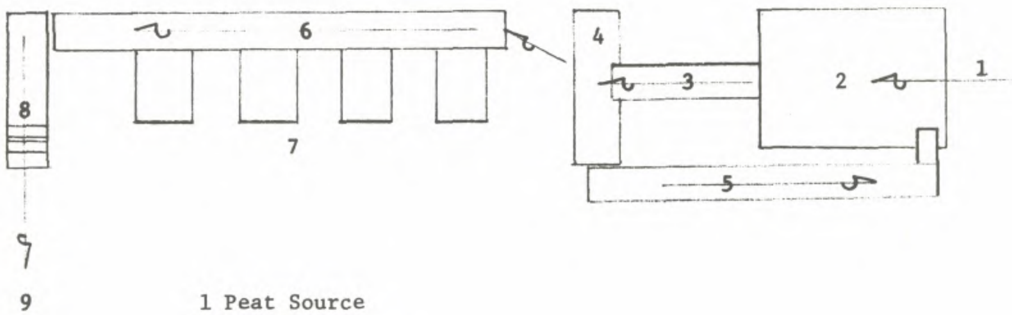
Table 5.-- Seedling Analysis

SEEDLOT	DATE STARTED	SAMPLING DATE	ROOT WT. (gm)	SHOOT WT. (gm)	SHOOT LENGTH (cm)	TOTAL DRY WT. (gm)	SHOOT/ROOT RATIO
DG 3-1-71 (Pl)	10/5/73	9/9/73	.06	.08	3.65	.14	1.38
DG 3-7-70 (Pl)	10/5/73	9/9/73	.06	.09	3.87	.15	1.44
NCFI 63-5-6-72 (Pl)	3/3/73	20/8/73	.08	.11	5.17	.19	1.31
DE 1-4-71 (Pl)	10/5/73	9/9/73	.07	.11	4.22	.18	1.53
DE 2-1-68 (Pl)	10/5/73	9/9/73	.08	.11	4.01	.19	1.40
RB 5-2-5-72 (Pl)	23/11/72	28/6/73	.03	.07	3.97	.10	2.83
DS 4-3-70 (Sw)	15/4/73	20/8/73	.03	.04	1.99	.07	1.41
DG 5-8-70 (Sw)	29/6/72	20/8/73	.01	.04	1.84	.05	2.80
DS 4-3-70 (Sw)	8/6/72	5/7/73	.03	.04	1.99	.07	1.41
DS 4-3-70 (Sw)	8/6/72	5/7/73	.04	.07	3.83	.11	1.94
DS 4-3-70 (Sw)	24/7/72	13/7/73	.03	.06	3.18	.09	1.76

All production in Spencer-Lemaire book planters.
Pl - *Pinus contorta* var. *latifolia*.
Sw - *Picea glauca*

(Courtesy Systems Design and Data Analysis - Alberta Agriculture).

Table 6.--Container Assembly System



1 Peat Source
2 Batch Mixer
3 Loading Conveyor
4 Vibrating Table
5 Peat Return Conveyor
6 Conveyor
7 Seeding Stations
8 Gritting Conveyor
9 Containers go into 40" x 48" x 36" pallets to be stored in Cooler (@ 34°F).

Question: How many times can you reuse the Spencer-Lemaire container?

Grainger: We hadn't planned on reusing any, but because of scarcity we had to, and found we could reuse about 30 percent of them. Ultraviolet light makes them brittle. Treatment to prevent UV degradation would probably make the container reusable, but I doubt that it would be economical to do so.