Container Program In Alberia 1/

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Abstract. -- The Spencer - Lemaire book and the A.R.C. sausage containers are the only ones used in operational reforestation in Alberta. About seven million book container seedlings are planted this year plus about one million sausage containers. With a need for growing larger and larger container seedlings for difficult planting sites (severe competition and drought), costs per seedling for containers may well exceed costs for bareroots. The container concept is therefore constantly under review in Alberta to cut costs and to improve seedling quality by increasing production efficiency.

INTRODUCTION

The purpose of this report is to give an up to date progress report on the production and planting of container grown seedlings within the Province of Alberta. Information is given on programs carried out by both the Alberta Forest Service and Private Industry, but ex cludes work done by the Canadian Forestry Service and studies of costs for the Spencer/Lemaire book at the Provincial tree nursery.

The Alberta Forest Service has been involved in experimentation with container planting since 1962. Work prior to 1972 has been well documented by McDougall and Kennedy (1972), Glade (1972), Endean (1972), Mitchell et al (1972) and Mitchell and Kay (1972). In these first 10 years approximately 12.7 million container seedlings were planted.

A number of different containers were tested. Based on the experience with these, a decision was made in 1972 by the Alberta Forest Service to limit further testing and use to two container types, the 1" A.R.C. "peat sausage" (2.4 Cu. in. vol.) and the Spencer - Lemaire (3 cu. in. vol.) folding container (book). The peat sausage system is being developed for the Alberta Forest Service under contract to the Research Council of Alberta. The Spencer-Lemaire 3 cu. in. folding containers were developed jointly by Spencer-Lemaire Ind. Ltd. of Edmonton and North Western Pulp & Power Ltd. of Hinton. Details of both container programs are discussed separately in this report.

Mostly western white spruce (Picea glauca [Moench] Voss) and lodgepole pine (Pinus contorta Doug. var. latifolia Engelm.) are grown in these two container types.

Present and Future size of the container program:

The size of the Provincial container planting program for 1974 is 7.91 million plants of which 5.65 million are grown by the Alberta Forest Service and 2.26 million by North Western Pulp & Power Ltd. at Hinton. Of the 5.65 million plants grown by the Forest Service, 1.4 million are reared in the A.R.C. sausage containers and the balance of 4.25 million in the Spencer - Lemaire containers. All but approx- imately 500,000 seedlings grown by the Forest Service are produced in the Provincial Tree Nursery operated by the Department of Agriculture in Edmonton. The two satelite nurseries, one at

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Rocky Mountain House and one at Peace River, have a combined production potential of between 500,000 to 800,000 plants per year. The bulk of the 5.65 million seedlings is planted by the Alberta Forest Service on old and new cut over areas since 1966. Only 0.26 million is given to private operators free of charge except that the companies must provide their own seed for planting on quota license areas where the operator assumed responsibility for reforestation.

Demand for planting stock is increasing gradually in Alberta. Anticipated annual increases in container seedling production over the next three years amount to approximately 0.5 million, exclusive of production increases by North Western Pulp & Power Ltd. Thus, the annual seedling production by the Forest Service should reach a minimum of 7.5 million containers by 1977 or about 10 million including North Western Pulp & Power's stock.

In order to keep up with the increasing demand for planting stock, the Alberta Forest Service is presently planning for an entirely new nursery complex near Edmonton with a planned annual capacity of 10 million container seedlings (A.R.C. and Spencer-Lemaire containers) and 10 million bareroot plants (2-0 and 3-0). Production of planting stock for reforestation purposes will be discontinued at the present facilities in or about 1978. There is a possibility that both the A.R.C. and Spencer-Lemaire container types may be used for many years to come if differences in performance on different planting sites warrant this.

Size and quality specifications for container grown stock:

Relatively young (8-10 wks. old) and small (1"-2" tall) seedlings were planted prior to the late 1960's but these were not satisfactory for Alberta conditions. Because it took nearly 10 years to recognize this a number of planting projects failed. Indications are that, within the limitation of the container, the larger planting stock has better survival and growth potential following outplanting (subjective field appraisal) than smaller seedlings.

In order to produce a satisfactory see' ling, the following general specifications presently in use for botF and A.R.C. sausages:

a) Height of Seedling above root collar at time of outplanting : 3-5 inches.

b) Average total dry weight per seedling: 300 - 500 mgs.

c) Shoot to root ratio: less than 3.

d) Seedlings having sturdy, woody stems and fibrous roots before shipping to the field.

The above criteria have not always been met in the past but have been set as a target for future production.

THE SPENCER-LEMAIRE CONTAINER SYSTEM:

The basic unit of the Spencer-L:: container system is the folding book planter It is a vacuum formed plastic sheet containi both halves of the container. When folded, rectangular cavities are formed which have holes in their bottoms. In the case of the 3 cu. in. model, which is most commonly used in Alberta, each sheet forms six cavities, each of which is 3/4" X 1" X 4" deep. The usable rooting volume is between 2 1/2 and 2 3/4 cu. inches, depending on the amount of rooting medium placed into each cavity. Seventeen folded sheets, forming 102 cavities are placed into plastic trays measuring 13 1/2" X 7 5/8" X 3 1/2" (inside dimensions). The trays are usually manufactured of high impact styrene with open lattice bottom to accommodate air pruning of the roots. These tray units are convenient for handling and are maintained right up to the planting operation in the field.

Commercially available sphagnum peat moss of local origin is used as a growing medium (pH 4.5 - 5.5). The peat is treated with a non ionic wetting agent prior to filling the containers in order to improve the uptake of water along the entire depth of the cavity.

The first phase of the culturing, lasting from 6 to 17 weeks, takes place inside greenhouses where total environmental control is practiced. From the greenhouses the seedlings are placed under shade frames for periods of 12 weeks to 1 year depending on (a) seedlots (b) seasonal (ambient) weather, and (c) planting schedules. Only partial environmental control is possible at this location.

There are four crops produced from each greenhouse per year under the present culturing system. A typical set of schedules is shown in Table I.

TABLE I - 1974 CULTURING SCHEDULE FOR SPENCER - LEMAIRE CONTAINERS:

CROP NO:	SEEDING DATE:	TRANSFER TO SHADE FRAMES:	TOTAL GREENHOUSE TIME: (WEEKS)	READY FOR PLANTING:
1	Mar. 1	May 15	10.5	Spruce-Spring 76 Pine-Fall 75
2	May 17	June 30	6.0	Spruce-Spring 76 Pine-Fall 75, Spring 76
3	July 2	Aug. 30	9.0	Spruce-Fall 76 Pine-Summer 76
4	Sept. 1	Dec. 30 *	17.0	Spruce-Summer 76 Pine-Spring & Summer 76.

* Transferred to root cellar for over-wintering and transferred to shade frames in spring.

Nutrients and watering are varied from crop-to-crop in order to obtain satisfactory planting stock. High phosphate fertilizers (10-52-10) are used in spring, followed by high nitrogen (28-14-14) in mid-summer, and returned co high phosphate in the fall.

Over-wintering of Seedlings:

Table I shows that approximately 75% of any year's production is held in the nursery for planting during the following summer. On the average, therefore, it takes 12 months to grow a plantable container seedling under Alberta conditions.

Because of the adverse climatic conditions in Alberta and because the technology of over-wintering has not been fully worked out, success to date has been variable. The Alberta Forest Service has no facilities and staff at present to do exacting research into over-wintering and culturing in general. As a consequence we have largely relied on practical experience solving problems as we go.

The following general procedure is based on our experience and should help in reducing morality in over-wintering.

a) Ascertain that seedlings are fully dormant at the onset of winter.

Seedlings kept in shade frames usually go into dormancy naturally at the end of summer. However, the process can be hastened somewhat by reducing fertilization and watering regimes to minimal levels during the later part of summer. Do not subject the seedlings to drought conditions as such seedlings appear to be very sensitive to frost during over-wintering.

b) Treat seedlings with a suitable anti-desiccant in case the snow cover should melt during winter.

c) Maintain a generous snow cover over the seedlings if at all possible (The use of artificial snow machines is recommended if necessary).

d) Prevent air circulation under seedling trays. If trays are elevated on racks and the snow melts, such trays appear to sustain very high mortality the cause for which is not yet understood. The damage does not appear to be from low temperatures alone as seedlings from the same lot placed in a confined space under similar temperature conditions usually suffer no damage.

Field Planting:

Planting operations with contrainer grown stock are usually carried out during May to August, depending on local climate. Priority is given to planting conventional bare root stock during spring and early summer. The type of tools used for planting depend on site and soil conditions. Tools used are: light planting bars; light mattocks; and the Finnish planting tube (pottiputki).

Container grown seedlings are easier and therefore faster to plant than conventionals. Daily production rates vary from 800 to 1200 seedlings, depending on site preparation, soil types, and crew motivation. Corresponding production rates for conventional seedlings vary between 500 - 800 per day. The number of seedlings planted per acre vary from 300 in a fill-in operation to 600 on establishment projects.

The Spencer-Lemaire "plugs" have not been used long enough under operating conditions to permit final judgment on their performance. A few projects were established during 1971 but large scale plug planting commenced only in 1972. Feedback from the field indicate that initial survival is encouraging.

a) 94% survival 1 - 2 months after planting

b) 84% survival 1 - year after planting

c) 75% survival 2 - years after planting.

These figures are based on results from 15 survival plots in Central and Northern Alberta. More data will be gathered in the next few years to give long term survival and growth data.

Sources of mortality include inadequate soil moisture and use of the container seedlings on sites not properly prepared. Because of their relatively small size, container seedlings are sensitive to competition from grasses, herbs, and shrubs. Therefore, judicious site selection with low competition or site preparation to control competition are "musts" for container planting projects in Alberta.

SPENCER-LEMAIRE CONTAINER PLANTING AT NORTH WESTERN PULP & POWER LTD:

The present nursery facilities at North Western Pulp & Power Ltd.* have an annual capacity to produce up to 2.6 million seedlings. The gross greenhouse floor space used to produce this volume is approxi- mately 3280 sq. ft. yielding an average of 792 plants per square foot per year.

Species produced for operational planting are: western white spruce and lodgepole pine in a near 50 - 50 proportion.

The culturing regime is somewhat different from those employed at the Provincial Tree Nursery and in most other nurseries. Because of the intensive care given to the seedlings throughout the rearing process, lodgepole pine seedlings are usually ready for planting in 16 growing weeks. White spruce requires 20 to 24 growing weeks to produce a plantable stock.

The greenhouse period lasts only four weeks from seeding after which the seedlings are placed outside into elevated cold frames for conditioning and further growth. Shading (approx. 50%) is maintained during clear days for the first two weeks in the cold frames. At the end of the two weeks, the shades are removed and the seedlings are exposed to full sunlight. Continuous frost protection is offered by an automatic sprinkling system. Irrigation is carried out as required. Water soluble fertilizers are applied weekly in liquid form beginning in the third week after seeding. Typical formulations used are the 20-20-20 with micro nutrients added during most of the growing season. A high phosphate (10-40-15) fertilizer is used prior to outplanting and prior to onset of dormancy in the fall on all lots being held over winter.

Seedlings are normally produced in the greenhouse in weekly batches of 130,000 each, beginning in late March or early April. The maximum number of batches that can be produced in one year is 20 depending on climatic conditions. The last four seeding batches usually have an extended greenhouse period and these are hardened off and are kept inside the greenhouse

*- North Western Pulp and Power Ltd. is a subsidiary of St. Regis Paper Co. of New York. The Company holds 3000 sq. miles of forest land in the central Western portion of the Province under a 20 year renewable Forest Management Agreement. Primary products are: Bleached Craft Pulp and studs. Manufacturing facilities are located at Hinton, Alberta.

until spring of the following year.

The first 10 batches of seedings in each year are usually lodgepole pine, and these are ready for planting during the summer of the same year. The second half of the production may be spruce and pine, but these are held over winter and are planted the following year.

Seedling size for over-wintered lodgepole pine varies from 460 to 920 milligrams with corresponding S/R ratios of 2.3 to 3.6. Average seedling size in 1973 for one over-wintered white spruce was 610 mgs. with an S/R ratio of 2.8. Seedlings above 600 mgs. are too large for the 3 Cu. in. containers and are marginal for planting because plants are susceptible to desiccation following outplanting.

Planting is normally carried out during June, July, and August with breaks during periods of hot, dry weather. Monitoring of field performance in North Western's limits is carried out by the Northern Forest Research Centre - Department of Environment.

Cost of seedling production in the Spencer-Lemaire containers is shown in Table II.

A.R.C. SEEDLING CONTAINERS

The apparent shorcomings of the current container systems in 1968 led to the initiation of development of A.R.C. containers which originally used a biodegradable skin. The purpose of initiating development of the A.R.C. container was to (a) use compacted peat which seemed to give superior field survival, (b) develop a less expensive system of production than other contemporary systems and, (c) take advantage of the individual container concept to ease dudding, reseeding and handling.

After much experimentation it was decided to discontinue the use of biodegradable materials. It was too difficult to avoid premature degradation in relation to planting time. Polyethylene was then selected as the alternate material for its lower cost, flexibility, strength, and durability.

Production:

The A.R.C. sausage is produced by the extrusion of screened peat moss with 80-85% moisture content into 1" diameter plastic sausage skins 10 feet long. A recent development may make continuous extrusion possible. The sausages are cut into 3" lengths with a 15 blade gang cutter, drilled to a depth of

TABLE II. NORTH WESTERN PULP & POWER LTD. SEEDLING PRODUCTION COSTS FOR 1972 AND 1973:

Cost Item	1972 costs/1000 seedlings 16-20 wks old stock	1972 costs/1000 seedlings over-wintered stock	1973 costs/1000 seedlings 16-20 wks old stock *
1. Materials	$ 7.08	$ 8.30	$ 6.91
2. Direct Labor	8.52	12.66	12.09
3. Utilities (heat & power)	1.27	1.44	0.78
4. Repairs & Maint. of facilities	3.87	4.39	1.88
5. Depreciation	2.37	3.77	1.70
TOTAL	23.11	30.56	23.36

*) Based mainly on manual operations. Mechanization will be considered later once the container system has proven itself. Cost increases in over-wintering originate from (a) mortality and (b) from expenditure of additional labor and materials. The first increase is variable, depending on over-wintering success. The normal cost increase due to additional maintenance is between 22 - 25% of the cost of the 16-20 weeks old stock.

1/4" - 1/2'' to accommodate seed and grit, and placed 98 sausages to a tray. Trays have up to now been wooden with expanded metal screen bases.

The extruder, using 10 foot lengths of plastic, made it possible to produce 5,000 to 6,000 containers per hour on a test basis.

The continuous extrusion process was developed to reduce the labour component below 65% of total . This process eliminates manual threading of plastic onto nozzles and the changing of nozzles during extrusion. Pelletized resin is also less expensive than plastic sausage casing. In addition, an automatic cutter has been developed. These labour and cost saving devices make it possible to produce 50,000 containers per day for a 3 - man crew on a single machine.

Filled trays are placed in pallets and stored in coolers until seeds are to be germinated.

The cost of the filled container, including recycleable trays, ranges from $9.90/M to $13.00/M.

Roughly 30% of the total container seedling production for the Alberta Forest Service was reared in A.R.C. sausages in 1973 and 1974.

Rearing:

The rearing process is currently being studied in an effort to devise techniques that are effective in rearing a satisfactory seedling at minimum cost. Greenhouses are used in combination with shade houses to obtain the optimum number of cycles over a 12 - month period. Currently, five crops are grown per year started in early February, late April, late May, mid July, and early September.

Each cycle has its own rearing regime to counteract seasonal variations of natural day length and temperatures. During the early spring and summer crop cycles, the greenhouse duration is kept to a minimum of 6 to 8 weeks to produce a reasonably durable seedling for continued growth in the shade house. The late fall crop has an extended greenhouse period of 16 weeks or more. Each of the spring and summer crops is moved to the shade house where continued growth takes place. All crops have at least one cold period prior to planting. Near the end of the growth period fertilizer levels and types are adjusted, and the day length is reduced to less than 12 hours to induce bud formation. After the bud has been formed, the process of hardening the seedlings to cold storage is begun. This involves reduction of the temperatures within the greenhouse in late fall from 70°F to 60°F to 50°F to 40°F and finally to 32°F. All other crops harden off naturally under the shade frames. A 4 - week hardening cycle has been used for the winter or late fall crop but was found to be minimal for satisfactory survival. It should exceed 8 weeks for rapid and complete flushing in spring.

Generally, the process for a fall and winter crop is as follows: The containers are seeded and covered with about 1/4 - inch of fine sand, prior to movement to the greenhouse. After they have been placed in the greenhouse, the seeded containers are thoroughly soaked with water and then covered with polyethylene film to maintain high moisture and relatively even temperatures for germination and emergence. The film is supported at a level approximately 3 inches above the top of the containers. The film is left in place for 1 to 2 weeks, or until approximately 70 to 80% emergence is noted. The film is removed temporarily during this period to irrigate the containers if drying is noted. Temperatures are maintained at approximately 80°F during the day, and 70°F during the night. Lighting is used to give a minimum 12 - hour day period during the emergence stage.

After emergence has reached the 70 to 80% level, the film is removed, temperatures are reduced, and day length is increased to 18 hours. From this point on, the moisture level in the containers is maintained at approximately 85%. The irrigation system to maintain the moisture level is semi-automatic and is usually combined with fertilizer application. During the cooler periods it is necessary to irrigate only 2 to 3 times per week but the frequency of irrigation is determined by the container moisture level (trays are weighed to determine water content).

At about 3 weeks, the containers are thinned manually to one dominant seedling per container. Containers which are blank are removed, reseeded, and regerminated in order to meet committed seedling quotas. This usually produces a second seedling crop slightly behind the main crop.

Reseeding (dudding) is a time-consuming operation and has led to modification in our procedures such as drilling deeper holes to prevent seeds from falling out. It is less time consuming to remove excess seedlings than reseeding duds, using more seeds per container and taking greater care when saturating the containers with water before germination to ensure adequate moisture for germination.

Fertilizer application is cyclic in type and level. Approximately 2 weeks after emergence a higher phosphate fertilizer (10-52-17) is used for 1 to 2 weeks to assist root growth and establishment. This is followed by a higher nitrogen and lower phosphate type (28-14-14). A weekly rate of application of approximately 15 g of fertilizer per 4000 seedlings is used for the first 8 weeks after emergence, and doubled thereafter.

Just prior to bud initiation and growth, fertilizing switches back to the high phosphate material. It should be pointed out here that the fertilizers all contain the necessary micronutrients since peat is deficient in most.

The seedlings are given a coating of antidesiccant just before dormancy. They are over-wintered in three ways: (a) they are kept in a root cellar until they can be brought out to the shade frames as the weather warms after the snow has melted in spring or (b) they are left inside the cold greenhouse until spring or they are kept under snow outside (a snow blower is used to obtain an even covering). Over - wintering of A.R.C. sausage seedlings has not been too successful to date probably due to desiccation.

All seedlings put under shade frames in spring are treated similarly. They are irrigated to make certain desiccation does not occur during the early spring period when the dormant seedling is exposed to the hot sun. As seedling growth begins when the container has thawed, high phosphate fertilizer is applied, followed by applications of high nitrogen, until shipment to the forests is required.

Production and rearing costs:

The cost of the A.R.C. containers has been lowered as operations became more efficient. In spite of the rising cost of labor and materials over the past two years, filled and trayed containers, ready for seeding, have been maintained as follows:

		$/1000 containers
Labor-filling operations ($3.36/m-hr)		$ 5.58
Materials	- Peat	1.00
	- Film	0.68
	- Trays	1.80
	- Equipment and Overhead	0.75
		$ 9.81

Total seedling stock at planting age cost $27.24/M. Rearing costs therefore, account for nearly 72% of the finished seedling. It is hoped that the cost of the containers can be lowered below $7.50/M with the more automated process now considered.

Results of out plantings have been variable. In general survival is:

a) 99% 1 - 2 months after planting

b) 84% 1 year after planting and

c) 75% 2 years after planting based on data from about 10 outplanting test sites.

The container skin is normally removed before planting because it is of marginal value for retaining water and of definite liability for root egress and early normal growth.

Frost heaving may be a serious problem for seedlings with the skin still on.

COMMENTS FOR THE FUTURE

The container seedling concept is viable for Alberta because it permits planting of tree seedlings during the summer after the spring planting or before the fall planting of bareroot stock. The problems encountered in Alberta with the rearing of container stock have been biological and operational, but time will permit us to get to know the systems we use and thus will allow us to produce better and better seedlings.

Both the Spencer-Lemaire and the A.R.C. sausage containers may have a place in reforestation in Alberta. Experience has shown that:

1) The Spencer-Lemaire container seedlinc is easier to rear than the A.R.C. sausage seedling mainly because it is easiest to water and fertilize.

2) The A.R.C. sausage seedling has shown slightly better survival on droughtier sites than Spencer-Lemaire seedlings probably because of a more compact peat plug. However, this advantage may be imaginary more than real, only time will tell.

3) The container seedling planted today in Alberta costs nearly as much to produce as the conventional 3-0 bareroot seedling. The larger container and container seedling is

therefore not very likely going to compete with the planting of bare-root stock on sites where larger stock is needed to compete effectively with vegetative competition unless costs are to be ignored.

4) Some of the early reasons for using container grown rather than bareroot stock are questioned today such as:

a) Container seedlings can not be planted throughout the growing season in Alberta. Summer droughts make many parts of Alberta suitable for planting only in early spring and late fall. Indiscriminate planting has led to much of the mortality associated with earlier container planting projects in this province.

b) Container seedlings need to be at least 3 - 4" tall for outplanting in Alberta even on the best of sites with minimum competition. Soil splash, local soil movement down slope on scarified ground, leaf smother under aspen and grass, and reinvasion of scarified ground by grasses and herbs all suggest the use of larger seedlings than germinants. The early concept that 4-week-old seedlings were old enough has persisted almost to the present day.

c) Bareroot stock can be healed in on the planting site in late fall and is therefore ready on site when spring planting can proceed. This eases spring seedling lifting operations in the nursery, stock transport to planting site, timing of planting operations, and it allows for a longer period of bareroot planting than is possible with spring lifted stock. All of these considerations were thought to be specific to container systems in the past.

d) If one assumes that it costs as much to produce a plantable 4" tall seedling in a container as it costs to produce a 3-0 bareroot seedling 6 - 8" tall, then the advantages with the container concept are valid mainly in relation to speed of planting. If it were decided in the future that a 6" tall container seedling is really needed for planting, then this seedling would cost more after planting on site than the barerooted seedling.

The container seedling program in Alberta has grown mainly because bareroot seedling production has been inadequate. The failure of the bareroot program has been caused by severe weed problems, inadequate chemical control, and unsuitable nursery soils. Hopefully, these drawbacks with current facilities will be minimized at our new nursery site. It is therefore too early at this time to tell if the container program will grow faster than the bareroot program or whether the Spencer - Lemaire or A.R.C. sausage containers will be adopted for long-term operational use.

BIBLIOGRAPHY

Creighton, S. M., D. L., Mitchell, and W. C. Kay. 1974. Seedling Container, In: Canadian Patent, p. 939, 905.

Endean, F. 1972. Container Planting program at the Northern Forest Research Centre. In: Proceedings of a Workshop on Container Planting in Canada. Environment Canada, Information Report DPC - X - 2. pp. 26 - 28.

Glade, L. 1972. Container planting program in Alberta. In: Proceedings of a Workshop on Container Planting in Canada, Environment Canada, Forestry Service Information Report DPC - X - 2. pp. 10 - 14.

Kay, W. C. 1973. Greenhouse production of conifer seedlings, Paper No: 73 - 1550 ASAE 1973 Winter Meeting, Chicago.

Kay, W. C. 1974. Production Report - Alberta Forest Service Requirements, 1974 - 75 Seedlings Production, Internal Report.

McDougall, F. W. and L. L. Kennedy. 1972. The status and future of reforestation in Alberta. Pulp and Paper Magazine of Canada March issue, pp. 3 - 8.

Mitchell, D. L., D., Hocking, and W. C. Kay, 1972. Reforestation with tree seedlings grown in extruded peat cylinders: In: Part I - Mechanical aspects of the process, Trans. ASAE 15, p. 36.

Mitchell, D. L., D., Hocking, and W. C. Kay, 1972. Extruded peat cylinders: their physical characteristics as affecting tree seedling growth and greenhouse drought tolerance, In: Canadian Journal of Forest Research, 2 (4): 479 - 486.

Mitchell, D. L. and W. C. Kay, 1972. Reforestation with tree seedlings grown in extruded peat cylinders: In: Part III. - Evaluation of conifer planting trials, Proceedings 4th International Peat Congress I - IV Helsinki pp. 559-569

Question: Your slides showed planting on cutover lands that appeared unburned. Do you burn before planting?

Ferdinand: Very seldom. It is not the current policy of the Alberta Forest Service to use burning for site preparation, except for experimental work.

Question: Are container systems adaptable to production of woody ornamentals, fruit trees, or other agricultural crops?

Ferdinand: I think containers would be far more adaptable to those uses, because the end product would have a much higher value than forest tree seedlings. Therefore, you could afford to spend more on the container and the production system.