different so he brought his business expertise to the nursery business. Jim Cross has been a tremendous cooperator and he has some new insights on how to do things. I think you will enjoy the comments that he has to make.

PROPAGATION IS JUST THE BEGINNING

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This morning I want to talk a bit about that phase of programmed production which *immediately* follows propagation. It is the process of producing the so-called "liner" which will then go into the field, or a container of some sort, to be grown on to whatever size your particular market or needs require. My comments will be partial to container growing but the same process would apply if the plants were to be grown on in mother earth.

This initial phase of growing cannot and should not be separated from propagation — it should be a continuation, without interruption of the process begun in the propagation bench. Whatever you wish to call this phase, it should be associated in your mind with **Growing** — for all too often this phase is begun and even continued more as a holding process than as a fully managed growing operation.

We put in all that effort to get new plants started, so why lose the momentum achieved in the propagation house. I assure you that there is a form of momentum involved. For any of you who do not think in these terms, listen carefully to Dr. Krizek's presentation this afternoon, or tomorrow's panel on "Systems" for rhododendrons.

There is one prime characteristic of commercial horticulture which separates it from all other industries. This is the **very long lead time** between the decision as to what plants to propagate and grow and the point of eventual sale or other disposal. Try to think of another industry which even approaches commercial horticulture in this unfortunate respect. Even new passenger airplanes and large custom boilers have lessened their development and production period to less than ours.

This industry characteristic points up very sharply two aspects of plant production where application of more management time can pay off like no other.

1. First, the initial decision as to which plants to grow and in what quantities. With a 2, 4 or 6 year production cycle, it should be obvious that we need well-programmed production more than any other industry.

2. The second aspect which comes to mind is "How to reduce this production time?" This is the subject which I want to stress by looking at one simple method which produces good results for us.

As a starter, I would suggest that if you commercial growers have not reduced your production time by at least a full year over methods of 10 years ago, you have slipped up somewhere. All of the knowledge and materials necessary to do this have long been available. Moreover, you have had this subject will presented at earlier I.P.P.S. meetings. Dick Vanderbilt told us very specifically how with rhododendron in 1967, as did Richard Bosley last year. There have been many other papers which covered this subject in one way or another.

Let me mention a few of the plants where we have managed to reduce production time by at least 1 year.

Probably the ideal plant to make my point is the cotoneaster, because, once started in the propagation bench at the right time for your schedule, it is ready to grow and all one has to do is provide its modest needs.

Cotoneaster dammeri — Normal sized cuttings were taken in November 1971. At the end of its first growing season, the first halt in growth since it was rooted, it is at least a full 18-24" plant in an 8" or so-called 2 gal., container. Our cotoneasters are all sold as 1 year plants or less. About 1/3 of our crop is sold in late summer and fall with no winter carryover. A very wide variety of other plants respond well to the same simple management which produced these cotoneasters.

The brooms, *Cytisus* and *Genista* — Cuttings stuck mid-December 1971. All will be sold this coming spring and early summer as 1 year plants.

Even the very slow growing dwarf conifers respond well to this process. We generally grow these on for a second year but they have a good start for these particular plants and some cultivars can readily be sold for retail use at the first year stage.

Pachistima canbyi — A very nice, acid-soil, ground-cover, limited in availability and usefulness because it is so frequently sold only bareroot in the spring. These plants are finished for our purpose in their first year from a December cutting.

Rhododendron — We already know what is being done with large leaf forms. The techniques work as well with small-leaf dwarf forms, adjusting sizewise to their slower rate of growth.

'Purple Gem' — A well-budded and full 15-18" plant in a 8" container can be produced in 2 years.

'Dora Amateis' — A dwarf white. Full 18" plant, well-budded in 2 years. This past spring season we began to sell these last two varieties when 1 year old. They bloom heavily enough with nice 8" heads, to make good impulse items at retail garden centers. One-third of our crop went out this way with no fall promotion or catalogue listing and no customer had any plants left unsold. So even these might well be converted to a 1 year crop.

'Wilsonae' — With this variety we get only a few flower buds in the second year, but they are sold primarily as foliage plants, so no time has been spent trying to improve budding. These results apply to numerous other cultivars — all small-leaf — which we raise.

Leucothoe axillaris — Nice compact 12-15" plants, ready for sale in retail yards can be produced in less than 1 year.

Ilex glabra — In 2 years a good 15-18" full plant.

Calluna and *Erica* — Any of the many cultivars can be finished and ready for sale at retail in the first year.

In every case the elapsed time in achieving the desired size of these particular plants was one season (or 1 year in the Northeast) — less than that frequently required. This reduction was achieved by little more than continuing the momentum obtained in the propagation house.

Beginning about mid-December, we lift the rooted cuttings, starting with the fastest rooting varieties, cut back all tops hard and roots where elongated and coarse, and transplant them into a fertilized Cornell type mix (vermiculite and peat) in flatted 3" peat pots.

The flats are placed in a heated plastic house of simple construction and management — in this case, 22 x 180 ft.

The flats are kept well off the ground — if too low, not only will the plants not grow well but some will go into winter dormancy, even though there is a 2 foot perimeter insulation. Our heat is oil-fired hot air, distributed by off-center tubing. We originally ran these houses at 65° -75° F, but after listening to Dr. Krizek at our 1968 meeting, we have increased this to more like 75° -85° F with noticeably better results.

The center tube distributes fresh air from the wall fan. In January, and most of February, in our area this is used only manually to bring in dry air in late afternoon for a day or two after irrigation. As the days become longer and brighter this fan takes over at 85° F with a few simple safety procedures to prevent any chance of back draft of fumes from a hot furnace.

A peninsula arrangement of the flats permits ready access to all plants with minimum aisle space. We do keep a fairly wide center aisle for ease and comfort of handling plants and equipment.

Irrigation can be manual, or overhead with manual touch up. I would highly recommend manual irrigation by carefully trained personnel whenever time permits, particularly during the first month or two, as the houses are filling up and the plants are in different stages of growth and, therefore, of water consumption.

This house is filled gradually as plants are rooted and ready to move, with completion about the end of February. The last plants to go in are those in which the cuttings went into propagating space made available by the first entries into this growing house. We have the house set up so that a partition wall limits the protion which needs full heat.

By the time the first transplants have settled in and made additional root growth, the days are beginning to lengthen and we get more sunny days — so the timing works out about right with Mother Nature.

We have used incandescent light as a supplement on quite a few genera of plants but the results, in our case, did not justify continuance of this practice. We did get somewhat more growth, but too rapid elongation produced a taller, but lower quality, plant.

By mid-May, when the danger of frost is past in our area, we begin to move these plants out for potting into their larger containers. The first ones out are those such as rhododendrons and cotoneaster, which are the first to grow out of their peat pots. As they are moved outside in the spring of the year of propagation, you have a good, full, 1 year liner. These plants are ready to continue into the equivalent of their second year of growth, which will be achieved with ease their first summer outside in the normal manner for container growing, as long as this move is well-timed.

In my opinion, good timing at this point is determined by minimizing transplanting setback and getting the plant going into its new home well before the summer heat sets in. We go to the extra effort and expense of using peat pots in order to reduce disturbance in transplanting. It is easy to allow the other severe competitors for our time, such as filling orders and deliveries, to get in the way of transplanting at the prime time. After all, these plants are growing well where they are and need only be maintained. If we allow this year's sales activities to decide this timing, we pay a measurable price on next year's crop.

To go back to the heated plastic house — the management during those winter and early spring months includes nothing whatsoever unusual. Normal, though careful, irrigation and preventive spray programs are followed. Though we eagerly experiment with new chemical growth regulators, we are using no chemical accelerator or inhibitor on a regular program. I would, however, be remiss if I did not stress one type of growth regulator which, if used on a well-timed basis, does a spectacular job. There is still nothing available that I am aware of which produces equivalent results in quantity and quality to the pruning shears.

The frequent pruning done in our growing house is valuable for two reasons in particular.

1. It is done in the off-season when we have fewer interruptions and a much better chance of the best timing.

2. The time to do the pruning, which is the key to quality, is when the plant is starting to build its future base. You waste less growth and get the best response with the least space and effort. Some genera can never be brought back into a really good branching structure once they reach a certain point of elongation or, at best, it takes a long time.

Incidentally, another obvious but important point might be mentioned here. The timing of this pruning is not only right for the plant, but also the nursery manager who is always looking for productive work to justify keeping on desirable personnel in the off season. Moreover, any man who generally works at the far end of the production cycle will benefit greatly, in attitude and interest, from seeing first-hand, and being a part of the full variety of processes which the nursery has to offer.

The objective in these comments is not to argue for faster growth or higher quality for its own sake, but rather to try to show the importance of reductions in production time.

In my opinion, the economics of this particular process for cutting 1 year from production time is very strong. I am certain that costs of this simple process can be reduced — from what we show — by most any astute nursery manager, by finding the always available better ways to do the same thing and from lower costs which come from working with larger quantities. Our costs include some bad mistakes. Our incremental costs for this growing phase are as follows:

Incremental costs of one season's growth in mid-winter in controlled environment

Capital Costs	Est. Life		Cost/yr.	Cost/plant
House frame	20 yrs.		$ 88.	
House cover-fiberglas	10 yrs.		260.	
Heater	8 yrs.		165.	
Oil tanks	25 yrs.		11.	
Ventilating equipment	5 yrs.		45.	
Misc. fittings, etc.	10 yrs.		10.	
Labor — construction	10 yrs.		31.	
		Total	$ 610.	$ .0173
Annual Operating Costs				
Fuel			$ 830.	
Heater maintenance & repair			55.	
Electricity			39.	
Poly liner & tubing			108.	
Labor — preparation			70.	
Shading — mat'l & labor			52.	
Misc. materials			5.	
		Total	$ 1159.	$ .0328
Other				
Flats — amortization & annual treatment			$ .0068	
Peat pots			.0176	
Mix — incl. labor			.0195	$ .0439
		Total incremental costs per plant		$ .094

These are not **total** costs, for I have tried to exclude those cost items which clearly would be incurred in most any approach to carrying on production or even just holding the rooted cuttings.

Nor are they entirely incremental for it might be argued that some of the costs shown overlap those which would be incurred in other methods. I have attempted to stay conservative with these figures. I do not know how you respond to the 9.4 cents cost, as I have not had the opportunity to discuss this with you. By my methods, this figure tells me that our little plastic house is the most efficient thing we do — far and away our best investment of capital.

Keep in mind that it cuts a full year from production time. Our average plant going through this process sells at wholesale for $2.00. If we took the 2 years formerly needed to produce this same plant, I know that our maintenance costs for that second year, including losses and winter protection would be several times this 9.4 cents. However, I do not need to look this far to see the economic benefit. That $2.00 which I received and had use of a year sooner is worth 10 cents at the local bank's lowest savings rate, 12-14 cents in most any good bond these days, probably 16 cents or more if I had to borrow from the bank and 20 cents if we are able to achieve an unspectacular 10% return on the investment of our nursery.

Whenever you can program your production so as to reduce the long production time for woody ornamentals, you are making real progress by most any measure.

HAROLD TUKEY: Jim, that was tremendous and you have done so well we are going to have to ask you back again soon.

G. STROOMBEEK: Do you allow for any dormant period on these broadleaved cuttings?

JIM CROSS: Not as such, though there is some rest as a result of the low light conditions we experience at this time of the year. Also, I do not turn my temperature all the way up when the plants are first put into the houses, it does take a while for the heat to get into the root area and start growth activity — so there is in a sense some rest period but it is not intentional.

PETE VERMEULEN: Would you comment on your fertilization proceedures, timing, etc.?

JIM CROSS: As I mentioned, there is nothing unusual; we use the Cornell Mix and have gone to vermiculite rather than perlite because we can manage it easier — particularly the irrigation. We used two different pH's, the lower one for the ericaceous material and the higher one for euonymus, cotoneaster etc. We add 5 pounds of limestone and 5 pounds of superphosphate plus 2 tablespoons of iron per yard of medium. For the ericaceous material, gypsum is substituted for half of the limestone. Bareroot material that has been in sand or perlite, we pot in the medium with no nitrogen at first and then use a 1 ½ gram Agriform tablet. For those cuttings which have a little rootball we add the nitrogen to the medium. At present we are using 6 pounds of Acid Electra per cubic yard. When they are moved into the larger containers we go to all slow-release fertilizer — Osmocote on the faster growing plants and Agriform tablets on the ericaceous and other slow growing materials.

HAROLD TUKEY: Our next speaker is Dr. Andy Leiser and he is going to tell us about some interesting experiences with plant propagation for highway planting[1].

We have no time for questions and so we will move on to our next speaker, Dr. Hudson Hartmann. Dr. Hartmann has not been on our program before but he is probably well known to all of you. He is the co-author of one of the best books we have on plant propagation and is the International Editor for the Society. Dr. Hartmann is going to discuss some aspects of the present rootstock situation for fruit crops in California.

THE ROOTSTOCK SITUATION FOR TREE FRUITS AND GRAPES IN CALIFORNIA

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For most of the major fruit crops in California, the plants are propagated by budding or grafting on rootstocks. Very large acreages and high crop values are involved; the proper selection of scion-rootstock combinations is necessary or tremendous financial losses can occur.

The bulk of the deciduous fruit acreage in California is in the Central Valley — the Sacramento and San Joaquin valleys — where considerable emphasis is on the stone fruits — peaches and nectarines (110,000 acres); almonds (254,000 acres); apricots (35,000 acres); prunes (100,000 acres); and plums (27,000 acres). The English walnut is also grown in the Central Valley with smaller amounts in coastal valleys and Southern California, giving a total acreage of 198,000. The vinifera grape is a major and dramatically increasing crop in the San Joaquin valley with lesser amounts in the coastal valleys, making a total of almost 500,000 acres now planted. The San Joaquin valley and, to a lesser extent, Southern California, is the big producer of table oranges with 224,000 acres. The coastal region south of Santa Barbara and, to a lesser extent, Southern California, grows 56,000 acres of lemons. California is the sole producer of olives in the U.S. with 42,000 acres, grown mainly in the San Joaquin and Sacramento valleys. Pears, mainly Bartletts, are grown in the Sacramento valley as well as in the foothills of the Coast Range and Sierra Nevada, with a total acreage of about 46,000.

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[1]Dr. Leiser discussed his studies of plant materials used along new highway construction