REDUCING COSTS IN PLANT PROPAGATION

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One difficulty in discussing the subject of reducing costs is that we are dealing with so many species and cultivars, propagated in so many ways, on so many nurseries. Every nursery is a unique situation. Every nursery has a different programme. Contrast this to the situation in the glasshouse industry where the yearly programme may only involve one or two crops, so that very precise control is possible. The hardy nursery stock industry is, in contrast, highly flexible; this makes it much more difficult to suggest where costs can be reduced. Every nurseryman must, therefore, examine his own situation and decide for himself on how he can make his production more efficient in terms of costs and returns.

Glasshouse food crops have reached fantastic levels in input costs. To counterbalance this the cultural parameters, such as temperature regimes, nutrition, and so on are quite clearly defined so that culture can proceed to blueprint specifications. The propagator of hardy nursery stock, on the other hand, concentrates on saving by minimum input costs. His parameters include percentage rooting, percentage 'take' in grafting, or percentage germination of seed, followed by time to reach saleable quality. Personal technical efficiency is paramount to maximise rooting of cuttings, "take" of grafts, good growth of seed, and the steady growth to uniform size of the finished product.

The human element is still crucial. Is the operator as up to date as possible in his procedures? Is he applying the results from Efford, for example, in mother stock management? Is he as up to date as possible in the use of hormones, wounding, rooting composts? These are factors in attaining high percentage success. Unnecessary application of rooting substances can be wasteful. Wounding can be a relatively slow and costly operation if it is not needed or, to the contrary, may be vital for success. If the final rooting percentage is not high the collection of the material, the application of hormones, the operation of wounding, aftercare, etc. etc. are all to a high degree wasted. I would also emphasise that such factors as wounding or the use of hormones may not be effective if other conditions are not right. In other words they are not a cover-up for inefficiency.

This may be obvious enough, yet most textbooks discuss hormones, wounding, etc. in a general way, and it is left to the nurseryman to learn by experience. It is suggested that more research, and far more published results, are needed on these fundamental operations in relation to individual species.

To quote an example: We have recently been involved in the propagation of alders from cuttings. At first sight this may seem a strange operation to the practising nurseryman, so a few words must be said in explanation. It is part of a research programme into short term forestry rotation for energy production by burning a woody crop. Alders are of interest as they fix nitrogen. This reduces the energy input in terms of fertilizers, their manufacture, and their application. It may become necessary to propagate special clones vegetatively, so we were asked to investigate the rooting of hardwood cuttings of three species. As alders were to us an unknown quantity, we tested the use of hormones, with and without wounding. The results are shown in Table 1.

Table 1. Rooting cuttings of three *Alnus* species under four treatments.

Treatment[1]	Species		
	A. incana	*A. glutinosa*	*A cordata*
No H, No W	2%	0%	0%
No H, W	5	0	7
H, No W	5	12	2
H, W	65	64	25

[1] H = Seradix 3, W = Wound

In general terms, most operators would accept that the application of root-promoting substances as likely to be beneficial, but in the absence of published information, how many would have considered the relatively time-consuming operation of wounding? Yet the hormone was much less effective in the absence of wounding.

A contrary result can be quoted for *Magnolia* × *soulangiana* 'Amabilis'. Here wounding had no effect, even in conjunction with hormone. (Table 2).

Table 2. Rooting of *Magnolia* × *soulangiana* 'Amabilis' cuttings under four treatments.

Treatment[1]	*Percent rooted*
No W, No H	11
W, No H	17
No W, H	91
W, H	91

[1] H = Seradix 3, W = Wound, Effect of H significant at 0.1% level

In this instance, the hormone was very effective, whether or not wounding was done.

These results are quoted as examples of the need for the publication of basic information as an aid to reducing costs through greater technical efficiency. Such knowledge is accumulated by every experienced nurseryman, yet there is need for published standards against which individuals can measure their own performances. The demand for such information is shown by the success of a little booklet published at Kinsealy, giving tentative results under our own conditions.

Efforts to reduce costs in plant propagation fall into two categories.

1) Operational efficiency

2) Direct manipulation of energy input.

The examples I have been quoting fall under operational efficiency as distinct from direct energy input. The full exploitation of natural resources of the nursery come under this heading. For some growers this includes climatic advantages, such as the rooting of outdoor cuttings over the winter. At Kinsealy, for example, we can root outdoors not only deciduous spp. but also evergreens like *Hebes, Garrya, Laurus, Olearia, Escallonia,* and others which might be too risky in inland areas. Where cold frames are used we have been asked whether costly glass can be replaced with plastic. Trials with 44 different species and cultivars over the period of September-May indicated that glass could be replaced with 500 gauge polythene. If opaque polythene was used there was no need to use shading slats. In almost every case, rooting percentages under plastic were as good as, and often better, than under glass. A few examples are shown, covering conifers and broad-leaved plants.

Table 3. Cold Frames — Percent rooting under 3 types of cladding.

Species	Opaque plastic	Clear plastic	Glass
Chamaecyparis lawsoniana			
'Fraseri'	86	70	63
C. 'Castlewellan Gold'	93	76	70
Escallonia 'Apple Blossom'	76	96	56
Hebe 'Headfortii'	100	96	100
Pittosporum tenuifolium 'Silver Queen'	26	43	43
Viburnum davidii	73	93	70

A further trial the following winter with 18 species confirmed that satisfactory results could be obtained under opaque plastic and that further economy in structural cost could be obtained by using a single sheet of plastic over the whole frame. It was necessary to ensure that the plastic was stretched tightly with an adequate slope to ensure run off of rain as well as slats at intervals to support the plastic. Otherwise there were problems due to pools of water weighing down the plastic.

A previous paper (1) by one of us (J.C. Kelly) at the 1977 (Norwich) meeting demonstrated the losses that could arise from crowding *Chamaecyparis*, especially the harder to root cultivars. Further results with broad-leaved species support these findings (Table 4).

Table 4. Cuttings rooted at three densities

Species	Month Cuttings inserted	No. of cuttings per tray (37 × 22 cm.)		
		24	40	60
Cotoneaster		*Number and percent rooted*		
'Hybridus Pendulus'	Sept.	16(67)	26(65)	35(59)
Pyracantha				
'Mohave'	Oct.	20(83)	29(72)	38(63)
Chamaecyparis pisifera				
'Boulevard'	Feb.	23(96)	30(75)	25(42)
Prunus aurocerasus				
'Otto Luyken'	Feb.	13(54)	19(47)	28(47)

Although by inserting more cuttings per unit area a greater number of rooted cuttings may be obtained, if these are expressed on a percentage basis it is seen that in some cases there can be waste of materials, labour and time. In *Cotoneaster* and *Prunus* there is not really much difference in the percentage rooted. In *Pyracantha* there is more, but in *Chamaecyparis* there is quite a substantial difference, indicating that rooting of conifers can be strongly influenced by the spacing. These are but preliminary observations but they do indicate that spacing of cuttings could be investigated in relation to species and season. One of the difficulties of advising on the results of such an experiment is that conditions vary so much on nurseries that one propagator may get better results at a closer spacing than the next owing to all round better conditions or facilities. Nevertheless these figures focus attention on overcrowding as a factor in reduced yield. The figures suggest that, under the conditions of this experiment, a fair compromise would be approximately 40 cuttings per tray.

The grower will be alert to improvements in basic technology that will lower costs by giving more reliable results in propagation. One aspect we have begun to consider at Kinsealy is the moisture level in the compost when cuttings are under plastic, especially where bottom heat is used; there could be effects from the combination of warmth and moisture — conditions conducive to decay at the base of the cutting. In *Chamaecyparis*, for example, we often find rot at the base of the cutting with roots emerging higher up. Insertion of cuttings shallowly on the assumption this would improve aeration did not indicate the cause. Next we tried applying water to the moss peat — sand (2:1) rooting mix at three levels before inserting the cuttings. The trays remained under plastic, with rod-type thermostats set at 20°C until rooting, without further watering. Results are shown in Table 5. The moisture levels were arbitrary — 300 cc was arrived at by adding water to the dry compost and at saturation point it represented 300 cc per litre of compost; the remaining amounts are a half and a quarter of this.

Table 5. Compost moisture — effect on rooting of *Chamaecyparis* cuttings

Cultivar	Water added per litre of compost		
	75 cc	150 cc	300 cc
	Percent rooted after 10 weeks		
'Allumii'	44	28	17
'Kilmacurragh'	73	34	32

A different pattern of response was obtained from summer cuttings of *Cotinus coggyria* 'Royal Purple' (Table 6)

Table 6. Compost moisture — effect on rooting of *Cotinus* cuttings

Cultivar	Water added per litre of compost		
	300 cc*	150 cc	75 cc
Cotinus 'Royal Purple' rooting	53%	37%	20%

*Approx. saturation point.

These are but preliminary results, but they indicate the effect of the levels of water in the compost; by improved results this could contribute towards reduction in costs other than by direct energy input.

DIRECT MANIPULATION OF ENERGY INPUT

The saving of energy input at the expense of time and space is a decision that will be governed by the circumstances of the individual grower. In other words the choice is between spending money to get quicker rooting and greater throughput or having the cuttings root slowly, occupying bench space for longer periods. More than ever before careful forward planning of the propagation cycle is needed.

The propagation of heathers from hardwood cuttings is an example. By inserting hardwood cuttings under the warm bench and plastic in February they will be rooted in seven to nine weeks, hardened off, and grown on in a cold frame, initially with glass or polythene lights. By September nice plants 10 to 15 cm across will be produced.

The alternative is to substitute the cold frame and plastic method for the heated bench. This necessitates taking hardwood cuttings in October, lifting them in April for planting out in further frames, to produce saleable plants by autumn. The respective time scales of these two methods are 7 to 8 months and 11 to 12 months. The traditional method of summer cuttings requires 15 months. Nevertheless, the use of bottom heat may be justified in certain propagation programmes, e.g. vacant space or catch cropping.

Another example of a cold frame method is the rooting of cuttings of Japanese azaleas. When energy was cheap we regarded July as a convenient time to root cuttings under the warm bench and plastic system or under mist, when rooting will have occurred six weeks later — in September. Instead cuttings can be inserted under plastic in a cold frame to be rooted by the following March. Though with bottom heat the cuttings will be rooted by autumn, any slight advantage in having them rooted then, rather than in spring may be unimportant.

Table 7. Percent rooting of azalea cuttings by two methods.

Cultivar	Method	
	CF & P	WB & P
White Lady	78	72
Addy Wery	62	82
Hinomayo	60	50
Vuyk's Scarlet	80	48
Queen Wilhelmina	46	50
Amoena	62	40

CF & P = Cold frame and plastic
WB & P = Warm bench and plastic

Apart from such possibilities in the substitution of no heat methods for bottom heat, there is the possibility of manipulation of the temperature regime. At a previous meeting (1977) an account (2) was given of experiences at Kinsealy on: a) rooting at lower base temperatures, and b) heating during night hours only. Work at Luddington and Efford has shown the possibilities of manipulating not only the base temperature, but also the base temperature in conjunction with the ambient temperature. The cheapest electricity cost at Efford was where a low ambient temperature (6°C) was combined with a low (15°C) day-only base temperature, but the cuttings occupied the bench space for longer.

The rod-type thermostat is a relatively insensitive instrument for controlling the base heat in the propagating bench. A semiconductor sensor control unit gives a much more instant and accurate control of base temperature, resulting in much reduced electricity consumption. Over a 40-day period (11th Nov. to 27th Jan.) the following results and consumption were recorded. The figure for mist (from an adjacent house) is included for comparison.

Table 8. Economy in base heat for cuttings 40 days (11/12/77 - 27/1/78).

Species	Method (WB & Pl) and percent rooting			
	Control	on/off	Sensor	Mist
Elaeagnus pungens 'Maculata'	58%	50%	66%	44%
Prunus aurocerasus 'Otto Luyken'	60	70	66	80
Mahonia japonica	38	57	50	57
Chamaecyparis lawsoniana 'Columnaris'	100	70	70	84
Ceanothus 'Southmead'	52	18	10	74
Ilex 'Mme Briot'	60	50	80	54
Viburnum davidii	75	95	80	90
Consumption (units per m²)	66	60	50	93
Cost	£2.64	£2.40	£2.00	£3.72

These figures show the high cost of the mist system during the winter months. It may well suit nurserymen to use mist during the summer months, especially in warm sunny districts. Nevertheless, some figures we collected during the past month are interesting. We estimated that the mist unit was costing us 104p per square m per month in electricity consumption compared with 53p per sq m per month for a warm bench and plastic inside a general glasshouse. Insulated frames on the ground within a plastic structure were running at a cost 20p per month. The cheapness of an insulated frame inside a plastic growing house indicates that a raised bench in a general growing house is not the most economical arrangement. It is better to have a separate propagating house which does not have to be ventilated to the sâme degree as a general purpose house.

At the risk of stressing the obvious it may be well to mention the need to keep a heated bench covered all the way with plastic. Yet an operator not conscious enough of cost might well overlook this if using only part of the bench for striking cuttings.

Another consideration is the effect of reducing the period of bottom heat either at the beginning or end of the rooting period. At Kinsealy a preliminary trial was carried out during investigations on the rooting of *Chamaecyparis* (Table 9).

In this trial covering seven cultivars cuttings inserted in September rooted better without bottom heat. In October rooting was poor unless bottom heat was given, but not continuously. Better results were obtained when the cuttings were left cold for the first month. We need to do more trials on this aspect, but these first results do indicate an interesting field for investigation, perhaps in combination with different levels of moisture.

At a previous meeting (1977), Ward showed how a double tunnel (a low tunnel within a plastic structure) could be used for

Table 9. Effect of four temperature regimes on rooting of *Chamaecyparis* cuttings.

Cultivar	*Inserted*	21°C *(Continuous)*	21°C *(1st month)*	21°C *(after 1 month)*	*Unheated*
'Minima Glauca'	Sept.	3	4	1	36
'Minima Glauca'	Oct.	2	1	8	3
'Tharandtensis caesia'	Sept.	6	15	17	25
'Tharandtensis caesia'	Oct.	30	40	40	2
'Erecta viridis'	Sept.	4	29	21	72
'Erecta viridis'	Oct.	7	15	70	18
'Fraseri'	Sept.	1	9	11	31
'Fraseri'	Oct.	8	23	50	35

summer and for late autumn cuttings. Is there a case for using bottom heat in a plastic structure over the winter? At Kinsealy we constructed frames as fully insulated as we could make them with polystyrene lining and placed bubble type plastic over the cuttings. Table 10 shows the results in percentage rooted.

Table 10. Cuttings in plastic house. Percent rooting. Inserted 25/10/79.

	Min. bottom heat		
Species	20°C	10°C	Unheated
Chamaecyparis lawsoniana 'Columnaris'	80(20)*	74(11)*	95(0)*
× *Cupressocyparis leylandii*	32(53)	20(20)	60(0)
Juniperus communis 'Hornibrookii'	3(97)	67(0)	93(2)
Pittosporum tenuifolium 'Silver Queen'	10(43)	44(15)	55(6)
Ilex 'Mme Briot'	60(5)	69(12)	69(6)
Thuja occidentalis 'Boothii'	40(60)	95(5)	73(0)
Lifted	8/4/80	19/5/80	20/5/80
Units used per 3.7 sq m	721	563	-

* Percent dead in parenthesis.

By applying the conventional base temperature of 20°C, the cuttings inserted in October were ready to lift six weeks in advance of those in the frame heated to 10°C, and the latter gave little or no speeding up of rooting, compared with the cold frame. At a cost of, say 4p per unit these six weeks cost £29 per frame (3.6 m × 1 m) or a little over 2p per cutting. Since the cuttings heated at 20°C were lifted in April, a time when there are not many cuttings to be inserted, most growers would be more interested in waiting until May when the cold frame cuttings can be lifted in advance of the summer batches of cuttings. The generally larger numbers of dead cuttings where heat was given is in line with our general experience that bottom heat is not favourable to most cuttings covered with plastic during the winter months.

To sum up: In the present anxiety to save energy we should not think of reducing heating input as the only way to reduce costs. Although investigation into temperature regimes can be rewarding, other aspects of propragation technology are important also. More research is needed to define in a more precise way the mode of action of hormones, wounding, compost moisture levels, and other factors promoting high efficiency.

LITERATURE CITED

1. Kelly, J.C. 1977. Effect of spacing on the rooting of *Chamaecyparis*. *Proc. Inter. Plant Prop. Soc.* 27:67-69.
2. Lamb, J.G.D. 1977. Effect of two temperature regimes on rooting cuttings. *Proc. Inter. Plant Prop. Soc.* 27:35-37.

J. ANSTEY: Why does putting conifer cuttings further apart lead to better rooting?

J. LAMB: I suggest that conifer cuttings are commonly rooted at periods of the year when the light conditions are poor. They are relatively dense cuttings and they shade each other.

B. MACDONALD: Have you done any work with relation to the compression of composts?

J. LAMB: No, but in experiments on moisture levels in composts we try to keep them as equal as possible.

J. CLAYTON: In relation to water regimes what composts were you using; was it a peat/sand mix or a peat/grit mix?

J. LAMB: We used two parts moss peat to one of sand (non-limestone sand), the standard compost we used for everything except ericaceous plants, for which we use peat only.

B. RIGBY: When you combine wounding and hormone on, for instance, *Alnus* cuttings, can we assume you still only apply the Seradix at the base of the cutting, not to the extent of the wound?

J. LAMB: It was along the length of the wound; whether or not this was significant or not I don't know. We are all aware when using liquid quick-dip hormones, work at East Malling has shown that you should only dip the very base of the cutting.