in a washing machine on a larger scale though I have not attempted it.

A. R. CARTER: I have not tried that technique, but other workers have tried washing the seed.

JAMES WELLS: If seed is picked immaturely would it improve germination?

A. R. CARTER: We are trying different stages from green to deep red; we may have more information next year.

JAMES WELLS: I am surprised to hear that *R. multiflora* is not hardy. It is the basic understock in the USA, where temperatures are much lower than here.

A. R. CARTER (and other speakers) stressed that the depth of cane dormancy may depend upon autumn ripening and emphasized that it was the new growth that was damaged.

WORK FLOW IN THE PRODUCTION DEPARTMENT OF THE NURSERY

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Before production efficiency and rationalisation can take place, a number of basic factors to any business must be considered. Production must be related to the type of business in which the nurseryman is engaged; for example, the requirements of a retail company might be quite different than those of a wholesale company and a company engaged in both wholesale and retail trading would again vary from the previous two. The basic marketing techniques of garden centres and mail orders may profoundly influence the approach towards production. It is scarcely necessary for me to expand further upon these major factors.

Production for our retail trade is geared towards the propagation of a vast range of plants, generally in fairly small numbers, whereas the wholesale grower is normally engaged in the production of a fairly small range of plants in vast numbers. If the business is entirely orientated towards a garden centre, or more than one garden centre, or if it is a wholesale business which is aiming to produce garden centre type products, then containerisation will be involved, resulting in a quite different production chain or flow pattern than that of an open ground plant. The production cycle in the nursery will be profoundly influenced by management policy towards production, whether or not home production is favoured or whether plants are purchased at some stage in their development.

The factors which I have mentioned so far mainly come under the jurisdiction of nursery management at its highest level; in other words, the owner or the directors. The question of management policy towards production, once the basic principles of the type of outlet have been settled, is often in-

fluenced by the propagator and his department. If the propagator is able to convince management that he is a man of ability and is able to produce plants efficiently and economically, then obviously they will be more likely to give him the opportunity of producing more within the nursery. This means that the propagating department assumes considerable importance in the company; obviously, from the propagator's point of view, this is all to the good. There will be other factors which influence the attitude towards home production which are outside the control of the propagator and the management; for instance, the influence of seasonal labour variations and availability of labour may have a profound influence on the company's attitude towards home production. There might, for example, be a good in-flow of student labour in the summer months. There might be financial considerations which affect the availability or the use of labour; the cash flow position could have an effect here. In many mail order businesses there is a good in-flow of cash in late spring and summer which slowly reduces to a mere trickle in autumn and early winter. Often managements are unwilling to aggravate the cash position by increasing staff when the in-flow of money is small.

Having decided on the type of business and the general approach towards nursery production, it is necessary to get down to more precise details and to make decisions regarding the range of production which will be undertaken. It might be appropriate at this stage to characterise a few different types of production and their influence on the labour situation in the company.

Sometimes, a simple production set-up, often associated with wholesale nurseries, occurs where most of the plant material in the nursery has been bought in and the staff are used generally as planters, cultivators, lifters and packers. The company often undertakes simple propagation, such as hardwood cuttings, possibly root cuttings, and simple seed production of the large-seeded plants like oaks or maples. Usually, under this set up the nursery also produces some plants by budding and field grafting. The type of labour used for this is a general nursery worker and not strictly a propagator, and obviously this type of worker has his advantages and disadvantages. He is versatile, but not so specialised as the propagator, usually not so technically capable and he is unlikely to produce material of such great monetary value as the full-time propagator.

Another type of grouping occurs in many nurseries where the general workers, lifters, cultivators, etc. still frequently take on such operations as budding, but parallel with them is a production department of full-time propagating staff under one or more head propagators. The type of worker which you find in these departments is usually, though not always, of course, a more technical type of man; often he is the most competent craftsman type.

Generally speaking, many of the more highly trained horicultural nursery workers tend to gravitate towards the propagating units; whether this is always desirable is another matter, but it is a factor of the nursery world. Assuming that the right type of staff is available, the decision regarding the range of production will take the next step and this is very much a question of capitalisation, the availability of glasshouse space, of mist propagation facilities, and of the considerable capital involved in producing this type of facility.

One propagating house which we have in use at the moment cost no less than 30/- per square foot to erect in 1967 and 1968; it might rightly be argued that this figure is rather excessively high; with the use of cheaper structures, polythene houses etc., figures of something like 10/- or 12/- per square foot or less might be possible. Nevertheless, compared with £300. or £400. an acre for nursery land — all that is necessary for the production of hardwood cuttings — the capital investment and business risk in sophisticated propagating facilities have to be considered.

The factors which I have mentioned up to now — the availability of labour and the type of business — will, as I have said, profoundly affect decisions regarding the range of production. They will also affect the approach towards given pro- is more possible for us to have a fairly large labour force in the summer, our cash flow position is best at this time, and we are able to get good quantities of student labour who work for us during their summer holidays. In the winter we like to substantially reduce our staff, partly because we are anxious to conserve our funds, and also because we favour a low labour force during bad weather due to the problems of finding productive work for a heavy labour force under adverse weather conditions. Because of this labour situation, we have tended to be rather strong on propagation by summer cuttings and our production by hardwood cuttings has not figured very largely in our schedules; we do insert 30 or 40 thousand hardwood cuttings, but this, compared with our summer production of half a million or so cuttings, is obviously very small.

In order to make proper decisions regarding production range and the feasibility of carrying out production schedules, it is vitally important that data be collected. Available data is something which is lacking in most British nurseries, including our own; we are still far from satisfied with our data collecting.

Organization — Data collection forms into two major groups — firstly, the requirement of production and the data necessary to predict this requirement, and secondly, the assessment of the possible output from a given labour situation. Requirement predictions are obtained from the data collected by sales records and from questionnaires and also, of course, from personal visits to customers. We use all three of these techniques to obtain our predictions. An assessment questionnaire was

circulated to over 250 public authorities this year, and one of the Directors and myself visited some 50 or 60 public authorities throughout the country, discussing with them their requirements.

An assessment of the output per labour unit (normally calculated as a 'man-hour') is obtained from the date collected over a number of years by the propagator or by a special staff in a work measurement section. Measurements of the number of cuttings collected per hour for a given type of plant, or the number of scions collected or the number of seeds collected, as appropriate, are required. The number of items processed per hour, grafted, stratified, prepared into cuttings, the number of cuttings struck and so on are all relevant and necessary to provide accurate schedules.

The production schedule needs to be broken down into numbers of separate components, normally the most convenient way of doing this is by dividing it into crops. There is often no need to split it into genera as items may be grouped together; for instance — a number of genera may form the sun frame crop or hardwood cutting crop. What is important is that groupings are made with genera which are treated in a similar manner. Sometimes it is more convenient to treat with a genus individually, for example, the rhododendron. In this example, however, it would be advisable to split these into three items — early, mid-season and late production from cuttings. Rhododendron grafting would need to be treated separately. I have circulated to you a sheet showing a possible break down of crops for a given period from May until September, giving some figures as examples (Example Sheets 1 and 2). Then I have carried out an exercise which is based mostly on our own data and our own predictions for labour output and I have shown you how this can then be calculated into the man-hours per month required. This was used as an assessment for a given labour situation on one of our production units.

If we look at the two sheets, you will see that the crops are itemised on the left, the total number of cuttings involved is shown in the next column, and the period of propagation and the method of propagation is also shown; from this data an assessment of the crop area taken up by the given figures can be made and this can be balanced against the availability of propagating facilities. By simple multiplication and division it will be seen that a figure for the number of man-hours required to collect and make a given crop is also calculated (labour assessment) for each particular item, and by adding these figures together, an overall labour assessment is made and planning of staffing levels can then take place (see Sheet 3).

The next phase of the job is to decide the flow pattern or sequence of events which go towards the final production of the crop. This pattern can profoundly influence the efficiency and the utilisation of labour so that an assessment can give a

Example — Sheet 1

NO. VII UNIT PRODUCTION SCHEDULE, JUNE — SEPTEMBER, 1968

CROP ANALYSIS — LABOUR ASSESSMENT IN MAN-HOURS

Crop		Quantity	Period	Position	Collecting	Making and inserting
Syringa vulgaris hybrids	0.75 [1]B C [2]B	2100	May	Glasshouse Mist	10	14
S. species	0.75 B C	2000	May	Glasshouse Mist	9	12
	1.3 B		May	Glasshouse Mist	7	8
Azalea, deciduous	B C	2000				
Corylopsis	0.75 B C B	2000	June	Glasshouse Mist	10	23
Chaenomeles	0.75 B C B	3000	June	Glasshouse Mist	14	20
Cotinus coggyria	1 3 B C 1.3 B	10,000	June	Open Mist	25	40
Magnolia	0.5 B C 0.75 B	20,000	June/ July	Glasshouse Mist	40, June 95, July	50. June 120, July
Buddleia	0.75 B C B	4000	June/ July	Open Mist	14, June 5, July	20, June 7, July
Sun-frame cuttings	B C 1.3 B	91,000	June/ August	Open Mist	66, June 200, July 33, August	110, June 350, July 55, August
Cytisus	1.5 B C 1.5 B	8000	July	Open Mist	20	35
Elaeagnus	0.75 B C 0.75 B	2000	July/ August	Glasshouse Mist	2½, July 7½, August	5, July 15, August

[1]BC = basic collecting rate of 300 per hour
[2]B = basic making and inserting raate of 150 per hour

Example — Sheet 2.

CROP ANALYSIS

LABOUR ASSESSMENT, MAN-HOURS

Crop			Quantity	Period	Position	Collecting	Making and inserting
Cotoneaster		[1]B C [2]B	10,000	July/ August	Open Mist	23, July 10, August	46, July 20, August
Azalea, evergreen	1.3 1.5	B C B	5,500	July/ August	Glasshouse Mist	25, July 2.5, August	25, July 2.5, August
Berberis, deciduous	 0.5	B C B	25,000	July/ August	Open Mist	23, July 60, August	94, July 240, August
Erica	1.5 1·5	B C B	34,000	August	Heated Frame	75	170
Calluna	1.5 1.5	B C B	6,000	August	Heated Frame	13	30
Hebe	 1.3	B C	5,500	August	Heated Frame	18	22
Rhododendron	0.75 1.2	B C B	60,000	August/ September	Glasshouse Mist	125, August 175, Sept.	120, August 170, Sept.
Ilex	0.75 1.3	B C B	12,000	August/ September/ October.	Glasshouse Mist	60	48
Berberis, evergreen	 0.5	B C B	80,000	September/ October	Open Mist	200, Sept. 66, Oct.	800, Sept. 266, Oct.

[1]BC = basic collecting rate of 300 per hour

[2]B — basic making and inserting rate of 150 per hour

Example — Sheet 3.

NO. VII UNIT PRODUCTION SCHEDULE, JUNE - SEPTEMBER, 1968

STAFF ALLOCATION

	Total cuttings to insert per month.	No of working days per month	Total hrs collecting per month	[1]Staff allocation per day	Total hrs making, and sticking per month.	Staff allocation per day	Total hrs. collecting, making, and sticking per month.	Total staff per month
JUNE	44,000	19	169	[2]1 man @ 9 hours	263	2 men @ 7 hours	432	3 men
JULY	102,500	23	394	2 men @ 8 hours	682	4 men @ 7½ hours	1076	6 men
AUGUST	115,500	22	404	2 men @ 9 hours	722	4 men @ 8¼ Hours	1126	6-7 men
SEPTEMBER	95,000	20	375	2 men @ 9½ hours	970	6 men @ 8 hours	1345	8 men
TOTAL	357,000	84	1342		2637		3979	

[1]For convenience the figures are rounded off

[2]Where hours per day exceed statutory hours, overtime is assumed.

Example Sheet 4.

PRODUCTION RECORD SHEET 19

Genus — Cytisus

General Remarks: —

Dept. .....

Propagation by .....

S (young stock); R (number required to produce); T (number of plants produced)

NAME	S	R	T	S	R	T	S	R	T	S	R	T
'Burkwoodii'												
'C. E. Pearson'												
'Cornish Cream'												
'Daisy Hill'												
x *dallimorei*												
'Donard Seedling'												
'Dorothy Walpole'												
'Fulgens'												
'Garden Magic'												
'*Golden Sunlight*'												
etc. etc.												

high output per unit of labour or a low output, according to the pattern of work which is chosen. There are certain basic rules in any flow pattern which must be followed if efficiency is to be obtained.. The flow starts with a sales prediction, which is then related to the existing stock position for previous production schedules, and the period of saleability for the particular crop is taken into account — (for example, a *Buxus* might stay saleable for ten years, whereas, a *Buddleia* in a pot is saleable for, at the most, two or three years). These factors are balanced to arrive at an annual production requirement for a given plant in a given year. This is then transmitted to the propagator by some means or another, sometimes verbally or better, in my opinion, on paper. In our company we have a system of what we call "production record sheets", copies of which I have circulated; I will describe one of these very brief-

ly. In one column is the existing stock position, the middle column shows the requirements and the 'T' column shows the "takes", which are filled in by the propagator; he retains one copy and one copy is sent back to me for filing in the office. The "takes" column tends to become the stock position for the following year (see Sheet 4).

Having received his production record sheet, the propagator is then in a position to get on with the job and firstly, of course, decide how he is going to propagate the plant and the sequence of events which he is going to follow. We have a system in the company in connection with these production sheets, in that they are grouped into production methods. Peter Dummer or Graham Adcock will get from me the batch of production sheets for genera just before the time they will be propagating the plant.

The question of the sequence of events of production is a very difficult one. The responsibility of the propagator will vary; it may extend from rooting the cutting, grafting the plant, or sowing the seeds to the stage where the plant leaves the nursery as a saleable product.

It is most important that the propagator considers the sequence of events which take place in the production chain, and it is important to take the long term view regarding this, and not just the view which relates to the propagator's own sphere of activity. It is the responsibility of the propagaotr to provide the plant in the form required by the field cultivation department.

When deciding upon a particular flow pattern, the propagator should have in mind the final product, and how this may be most efficiently obtained with the labour at his command. There are, I believe, a few "golden rules" which should be observed.

If the item is to be container-grown, select a production flow which gets the item into a container as soon as possible. For example, if production is by cuttings, then consider rooting the cuttings in Multi-pots, Vaca-pots or Jiffys; if from seed, consider sowing the seeds individually in pots or Multi-pots; for grafting, graft onto potted stocks rather than bare-root or field stocks.

For field production the aim should be to get the crop into the field as quickly as possible; for example, root the cuttings in the field by using hardwood cuttings or by a "Phytotektor" type of system. If it is necessary to root under glass in boxes, or on the mist bench, as with difficult subjects, bed out the cuttings straight into the field rather than potting them first, if possible.

The propagator who wins in the profitability race is the one who cuts most corners; every production unit should experiment on corner-cutting with a small percentage of its crops each year. Missing out one transplanting or one potting sequence on a production schedule can mean a big cash saving,

with a resultant increase in the profitability of the crop. The expertise in organisation of the staff will have a profound influence on the success of a given "corner cutting" scheme.

"Corner cutting" often leads to a greater saving in labour, but not generally to greater labour flexibility; for example, careful timing is necessary for a crop which is field-planted from the cutting beds and not potted. One must have labour available at the particular crucial time when field planting takes place. A production chain involving containers (that is, boxes or partitioned boxes, such as Vaca-pots, Multi-pots, Jiffys or some similar item), involves more capital, both of cash and labour, than a production chain concerned only with bare-rooted plants, but can give greater flexibility of labour use and a higher quality product, because it is possible to get better control of the environment.

It is possible to increase production considerably by thinking carefully about various factors in the production schedule. One of the major factors which has affected propagation in the last decade is mist propagation; this has brought many benefits, advantages, and gains in propagation techniques. Unfortunately, some features of mist are not so desirable. One of these is the concept of a fixed bench with a mist line above. From a management standpoint, the conventional glasshouse mist propagation layout with fixed equipment is rather inflexible. Crops must be brought into the glasshouse, subjected to mist until they are able to withstand a harsher environment, and then they must be moved out to make room for subsequent crops. In practice, most propagators insert cuttings into suitable containers to facilitate package handling and to speed up the number of crops which may be "run through" the misting process over a given period of time. For crops which have a low market value, such as *Weigelia, Deutzia, Physocarpus, Stephanandra, Berberis,* etc., the economics of production by this sophisticated means, involving high cost installations and frequent handlings, is questionable.

In an attempt to tackle the economics of production of the low price-reurn species, we reviewed alternative production methods. The traditional so-called "sun-frame technique" commends itself in many ways. With this system, low cost installation, such as simple temporary cold frames are used, this being coupled with rooting the cuttings directly onto the nursery bed. Using the sun-frame system, the cuttings, once rooted, are left to grow, *in situ,* and produce excellent liners for machine planting some 18 months from the time of insertion. An additional bonus is the suitable cutting material which may be collected from the beds of young plants approximately 12 months after the original cuttings were inserted.

All that was necessary was to up-date the sun-frame technique for acceptance under the present conditions prevailing at the nursery. After four years evolution, we have reached a point where our system closely resembles the "Phytotektor"

system, I imagine still in popular use in the States. We use white opaque polythene stretched over wire hoops let into side planks of 96 inches x 8 inches x 1½ inches soft wood. Under the polythene tunnel a mist line is fixed in position and the cuttings are placed into a 2-inch deep layer of coarse sand which is put on top of the nursery soil. Once the cuttings are rooted, the mist line and polythene are removed for subsequent re-use the same season if conditions are suitable.

With this system we gain the advantage of mist and the advantage of sun-frame cuttings simultaneously and we are able, by correct spacing of our cuttings, to economically obtain an ideal liner. This system is by no means unique in this country and, of course, it is well established in the USA. It is an example of a system which has been obtained by thinking round the subject, deciding that mist is good, but the technique which has arisen as the result of the use of mist is not the most efficient way of producing the easily-rooted type of cutting.

Another crop worth discussing is the hardy hybrid rhododendron. Here we have used a number of "corner cutting" systems which have resulted in what is quite an efficient method of producing many such plants. These systems were slowly built up by trial and error.

Cuttings are cut to length from stock plant bushes with secateurs, and normally no further trimming is required. We ignore the presence of nodes, and do not make cuttings with a heel; the chosen length is simply what is convenient for our Dutch Tomato Tray containers.

With suitable varieties the lower leaves are torn off and not cut away with knife or secateurs. The remaining leaves are cut to a convenient length with secateurs. We do not give our rhododendron cuttings a heavy wound; this is because we are now using a rooting hormone, indolyl butyric acid dissolved in 50% methylated spirits, and our trials indicate that there is little effect by wounding on rooting percentage. The cuttings are inserted into Dutch Tomato Trays fitted with the rooting medium and then placed under mist.

The next item in the production flow for this crop is bedding out the rooted cuttings straight into open air beds in a woodland soil with a high organic matter content. There is no need to pot the rooted cuttings. Ideally the young plants should be bedded as the terminal bud is swelling — just before it breaks.

If conditions indicate irrigation of the cutting beds, this must be given priority and good cultivation is necessary. The young plants are bedded into raised beds at a plant density of 4 inches square and remain, *in situ*, for approximately one year. After this, the young plants are lifted from the beds and planted on raised beds at a distance of 22 inches square.

We are considering "cutting another corner" with our rhododendrons; we suspect our young rooted cuttings will

stand full exposure provided adequate irrigation is available and we are going to try and bed a trial number of plants straight out into the final bed which, if successful, will save us several weeks work.

Unlike some nurseries, we grow ericas as bare-root plants and ball them in hessian for despatch. Our ericas are rooted in Dutch Tomato Trays, and because we use a fairly sandy rooting medium, we place a half-inch deep layer of peat on the bottom of the box with a slow-release fertiliser, such as Mag-Amp or En-Mag incorporated into it so that, once rooted, the roots are able to grow down into this layer and maintain the young plants in good health until the boxes of young plants are transported straight to the field and planted into final saleable positions from the cutting boxes.

These cuttings should be planted before the middle of June to ensure that they are large enough to over-winter in the open ground in the south of England; planting them in mid-August is too late as the young plants do not make sufficient growth to survive the winter. This year we planted in early July and the cuttings are doing well and by good cultivation, we shall successfully over-winter them, though not without some worry.

Another item which responds very favourably to open ground bedding, straight from the cutting boxes is holly (*Ilex aquifolium*). Here we root our cuttings in Dutch Tomato Trays, which are then taken to beds, planted in soil at 4 inches x 4 inches as done with rhododendrons. They are grown on in these beds for a year, and then machine-planted on our normal bed system at 22 inches x 15 inches.

I trust that the above comments will assist my fellow propagators in their attempts to increase efficiency by the consideration of "Work Flow Patterns."