recorded, and to contain as comprehensive a collection of a genus as is possible.

Now we come to the question which is the title of the talk—which genera need adoption?

If we look at the list of those collections in existence we will find there is a predominance of herbaceous groups which, in fact, in most cases, occupy the least amount of space and are therefore obviously the first to be taken up.

We are mainly in need of sites for the shrubs and trees but also some more herbaceous groups. It is always difficult to say exactly which genera because of variation in particular sites or the interests of individuals or nurseries, but we are always open to suggestions from interested parties. It must also be remembered that collections, like plants, may lay dormant while ground work is being done and therefore take time to mature. Lists of National Collections are available at the minimal cost of £1.00.

The National Collection scheme is actively supported by the Royal Horticultural Society, Royal Botanic Gardens at Kew, International Union for the Conservation of Nature and Natural Resources, and several overseas countries that are liaising or thinking of setting up similar schemes, e.g. New Zealand, Australia, Holland, and the United States.

CAREERS: ACADEMIC TO HORTICULTURIST

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Abstract. A personal view of various aspects of micropropagation. The costs of developing a commercial production process for a new subject. How can these costs be financed? The Heath Robinson approach. The need for follow-up development beyond the laboratory.

My first view of micropropagation was as an academic, when I was studying at the Nottingham University School of Agriculture for my Ph.D. During this time I began to realise the potential of microprop. and that it was not then being exploited commercially, or not in what I consider as the right way from a horticultural viewpoint.

The average "tissue culturist" is a scientist who considers that, in theory, anything and everything can be propagated using tissue culture. He can point to published research papers that list procedures for the micropropagation of plants X, Y, and Z, and which often describe how plants were transferred to compost, even if it was only 10 plants!

In our laboratories we, too, started trying to propagate everything that we were asked to try. We were asked to propagate many different types of plants—ones difficult to propagate as well as easy-to-root subjects. We succeeded in getting some subjects to grow in culture such as: *Prunus tenella, Saintpaulia,* and even tulip. Some subjects we even got into compost such as: strawberry, rubber plant, cherry, Boston fern and gerbera. It was not long, however, before we realised that few plants grow in culture as well as Boston fern and that developing commercial systems from research papers was not that simple. Successful development would require a lot of "Academics". The only problem with this is that such scientists are costly. The cost of setting up a microprop. laboratory has been well documented, but the major cost, the personnel, has often been ignored.

The costs of research and development (R & D) can be very high. The cost of developing a microprop procedure for a new plant type, even when there are relevant research papers published, can be approximately £3,000 and it can take two or more years. It is necessary to sort out not only basic techniques, but also the whole management of a new subject so that production can be efficiently planned to enable the regular production of plants at the right time and in the right quantities. This requires considerable knowledge of the subject in terms of how it grows in culture and its relation to changes such as temperature, handling method, rate of multiplication, etc. Even after all this development work and expense it may not be economically viable to produce the subject.

It can even be costly to introduce a new cultivar of a subject already in routine commercial production, e.g. for new rose cultivars approximately £250. The initial slow build-up of stocks of a new culture and the need for an initial cleaning-up period for the material means that it can take up to 18 months for a new cultivar to come on line.

Given all this development cost it is not very suprising that so many companies in microprop. have approached venture capitalists for finance.

Venture capital would at first sight appear to be the answer. Venture capitalists are keen to invest in "Hi-Tech" areas, are not expecting an instant return, and will provide money in high risk situations where banks panic. Microprop. is considered a high risk investment because it is considered a "non-proven" technology. The venture capitalist therefore requires: (1) high growth (looking for growth of a minimum of three to five fold over five years), and (2) high return (profit margin of say 25 per cent to 40 per cent). They will also want to be sure that there will be someone willing to buy them out so that they can realise their investment.

If we look at figures published in July, 1988, for the growth and profitability of horticulture overall (Table 1) neither of these requirements could certainly be met. However, in terms of growth rate microprop. can meet the desired levels, but I do not believe that it can do so in profitability terms and certainly not in the short term if past figures are anything to go by (see Table 2). The figures up to 1986 for the independent microprop. labs show an overall loss with few exceptions.

Table 1. General horticulture profitability & growth.

	Profit Margin	Average Growth
GROWERS (Average of 47)	2.7%	5.6%
GARDEN CENTERS (Average of 14)	2.9%	14.9%

Table 2. Financial history of micropropagation.

Year	Turnover (£)	Growth in Turnover	Loss (£)
1984	999,100	—	355,883
1985	1,683,900	1.7 fold	810,153
1986	4,323,026	2.6 fold	895,287

Totals for all independent micropropagation companies where information is available

My personal view is that in the short term (and probably in the long term as well) microprop. can only be successful if it employs the same approach as many industries including much of horticulture—i.e. companies must specialise. Much of horticulture is already specialised either by function: propagator, liner producer, container producer, field grower, garden centre, or by plant type: bedding, conifers, herbaceous, heathers, rhododendron, roses, trees, etc.

There are three main reasons why it is important to specialise:

1. To 'master the specialism' rather than being a jack-of-all-trades and to concentrate resources in a limited area.
2. Economy of scale—the efficiency of an operation can be improved simply by doing more with the same overheads and it becomes easier to justify the R & D costs when spread over a larger volume.
3. It is possible to provide better customer support by making use of accumulated knowledge. These days it is not good enough to sell a brand new product, take the money and walk away. If you want to develop repeat business you need to make sure the customer has the back-up to enable him to grow a good product which he can sell at a good price.

Our approach has been to specialise and to rely on banks for finance, even though their view of microprop. is somewhat nervous. By specialising it is possible to establish a profitable business and in our case we are now able to consider diversifying into woody plants other than roses.

With restricted capital we have had to be a little 'Heath Robinson'. This is an approach used by many other growers and propagators—find alternatives to scientific apparatus and don't spend £5 if 50p will work.

Like many other labs we use honey jars instead of expensive flasks or test-tubes, and our media is poured with a jug instead of a hi-tech media pourer—not so accurate but for production work quite adequate and quicker. Our media "cook" can fill 1600 jars in a couple of hours. Our lamina flow cabinets are made from kitchen units (obviously with high efficency filters) and have the added advantage of costing approx 80 per cent less than their scientific counterparts!

An important area largely neglected by the microprop industry is the follow-up once the plants come out of the lab. This does not include just the weaning, the light levels, humidity etc. (much of this has been looked at by various experimental stations such as Brogdale and Efford) but also the subsequent growing on. The compost required for potting, the optimum stage of potting on, how long it will take to produce saleable plants. We have been very fortunate that Luddington E. H. S. has done extensive trials on microprop roses and have produced recommendations for container compost controlled-release fertilizer etc. (See Table 3).

Table 3. Recommended compost formulations: free draining, coarse structure, with slow release fertilizer.

STAGE I—LINER		
Container Size:	7cm(2½") square or 9cm(3½") round or similar	
Compost	Irish moss peat	75% (3 parts)
recommendation	Cambark, fine	25% (1 part)
	Fritted trace elements	0.3 kg/m^3
	Ground magnesium limestone	2.4 kg/m^3
	Ammonium nitrate	0.25 kg/m^3
	Osmocote, 5–6 month, or	4 to 6 kg/m^3
	Ficote 140	6 kg/m^3 (with single superphosphate 1.4 kg/)
STAGE II—FINAL CONTAINER		
Container:	Usually 3-litre rigid (2-litre pot may suit requirements for miniatures)	
Compost	Irish moss peat	67% (6 parts)
recommendation	Cambark, 100	22% (2 parts)
	6 mm grit	11% (1 part)
	Fritted trace elements	0.3 kg/m^3
	Ground magnesium limestone	2.4 kg/m^3
	Ammonium nitrate	0.25 kg/m^3
	Osmocote 12/14 month, or	6–8 kg/m^3 *Osmocote*
	Ficote 140	(6–8 kg/m^3 Ficote) (with 0.75 kg/m^3 single superphosphate)

Specialising in roses has allowed us to put a lot of time and effort into determining the precise requirements for growing on the crop and into sorting out some of the problems. It has also enabled us to give technical back-up to our customers to help them grow a quality crop. In fact we now even circulate a regular information sheet to all our customers to suggest what they should be doing each month. It also includes information about problems they might meet and those previously met by others—so hopefully they can avoid them. We hope that by giving this back-up we can help our customers produce quality plants which will establish well in the garden of the final consumer and thereby create further demand for micropropagated plants.

PROPAGATION SYSTEMS IN THE 1980s: A PERSPECTIVE ON THE BEST AVAILABLE

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The aftercare of newly micropropagated plant material and the rooting of conventional cuttings share similar environmental requirements. Specifically, these are:

1. The need to conserve water in the plant tissues, since cuttings, whether from *in vitro* or conventional sources, readily suffer water deficits because they have no roots. In microplants already rooted *in vitro*, the roots often function poorly; their leaves, having developed in high humidities, have thin cuticles (1), little surface wax deposition (4), and relatively few stomata (5) with imperfect stomatal control (3).

2. It is nevertheless important to avoid excessive wetting of the plant material. In the case of micropropagated plants, the weight of water droplets can be physically damaging. In conventional cuttings there is need to avoid waterlogging of the basal stem tissues, which occurs especially in winter conditions and results in rotting.

3. Irradiance conditions must allow for the gradual redevelopment of autotrophic nutrition in micropropagated plants which have relied on sugars in the medium while in culture. Conventional cuttings of many woody ornamentals apparently require only low irradiance until they develop roots and begin to grow actively (10).

4. Temperatures should be moderate (18 to 25°C) but not excessive, i.e. below 40°C.