with sprays of Zineb and Maneb or Benlate at three week intervals from about the middle of July.

For transport we use homemade lightweight trolleys with linked wheel axles which trail further trolleys in their tracks, thus saving space at the end of beds. In the greenhouse we always fill the last metre by the middle aisle with a fast growing plant which can be potted last and moved out first, which makes use of all the available space. The liners are moved out by means of tractor and trailers. For internal transport I had an engineer design a container with shelving to carry liners in 40 × 60 cm plastic flats. This container fits onto a Europallet and can be carried by two men when empty. It is made of very light steel which our men make during the winter. Each container measures 80 × 120 cm and has five shelves which take 20 flats in total. As it is up to 10 km between the nurseries this saves us a lot of time.

In a discussion of the wastage factor in liner production, the speakers estimated that of the total cuttings taken, 70 to 90% would make saleable liners. This took into account losses during propagation and establishment, outgrading of poor cuttings, etc., and a proportion remaining unsold.

MECHANICAL LIFTING AND COLD STORAGE OF FRUIT TREES AND ROOTSTOCKS

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Our nursery produces fruit trees and rootstocks and some ornamental trees. We are wholesale suppliers to the nursery trade and to the fruit grower establishing fruit plantations. We are, therefore, dealing with very intensive field production of bareroot material that necessitates autumn and winter harvest. The majority of our trees are sold as one-year (maiden) trees; this allows us to mechanically lift and store most of these prior to delivery to our customers. Following our tree lifting of around 150,000 trees we harvest ½ million rootstocks from stoolbeds. Due to the deteriorating weather we aim to have all the field work finished by Christmas as we know from experience that we rarely have uninterrupted working conditions in the field after this. This enables us to organise our labour force efficiently, having six weeks work under cover during January and February.

To enable us to stick to such a tight schedule we, firstly, needed machinery and the capacity to store trees and root-stocks in a suitable environment.

Field Lifting. In the West country we more often than not have a late leaf fall due to a late growing season. Our soil is reasonably heavy therefore retaining warmth for the late growth. We, therefore, aid leaf abscission by the application of copper oxychloride in late September. This gives us a reasonable lifting starting date around 15th October.

We uphold certain theories on the use of machinery in our job. It is possible to become too sophisticated and demanding of the machinery we use. This is particularly the case with machines designed to work in marginal field conditions. Our intention is purely to take the physical work from the operation still allowing due care and attention to the trees themselves. The root system, which tends to be the most neglected part of the plant in our trade, must have the best possible chance of surviving intact when released from the ground. Our machine for this job is a simple side lifter of Danish design that is aided with a shaker to help remove some of the soil. The trees, having been pre-marked into grades, are then bundled, palletised, and put into coldstore. This system enables us to lift a block of trees at a time, cutting out the problem of travelling constantly over the same gorund during the winter, selectively digging to order. This is of great advantage as we do not do unnecessary damage to the soil structure, we have less travelling time for the labour force during the winter season and, most important of all, the physical effort required by each employee is greatly reduced, which improves morale. All palletising and loading during this critical time is done early morning and evenings on a shift system under flood light so that the daylight hours are used in the field.

Cold Storage. The most revolutionary aid to our nursery work over the last 15 years has been the introduction of the jacket coldstore. This was built in 1967 by ourselves with the help and guidance of Mr. Paul Dufresne of Denmark who gave a talk at our 1970 Conference on the jacket coldstore system. I will not, therefore, go into technical details as these are already recorded for your reference but, as the name implies, air is circulated between an outer shell and inner wall, cooling the plants that are in a "still air" environment. This is exclusively used for our own planting material when dormancy is extended into the spring and early summer, if the need arises due to poor planting conditions. The temperature is held at a constant 0° to 1°C, keeping all our planting material in perfect condition. It is well known that coldstored plant material late-

planted is capable of catching up the early planting, even when taken out in the months of May and early June.

To enable us to harvest our trees as mentioned earlier, we needed to apply the same cold storage techniques to trees as we had to rootstocks. A far larger capacity was required but the construction cost for a jacket coldstore of such a size was not economically viable. We, therefore, opted for a direct cold store system that had been used by us quite successfully on a small scale to help with our hardwood cutting technique. Polyurethane foam sprayed onto the inside walls of an existing building created very simply an insulated building into which a refrigeration system was installed to circulate cold air. The only problem that we were aware of was the need to maintain a high humidity in a drying atmosphere.

We manage very well by hand watering the floor of the store twice daily and misting the tree roots twice a week, thereby maintaining the humidity required. As this coolstore is considered short-term and trees are coming in and going out constantly, very few dry out to any degree and after five years experience we seem to have had no problems or reports of desiccated material. In the latter part of the winter, when rootstocks from our stoolbed harvest are kept in these stores, we do then jacket the pallets individually with polythene, which is normal practise in a direct cold store. There are modern systems for creating humidity available now which could be of some use. All these systems produce very fine droplets that are circulated either by the refrigerant system itself or an additional installed fan. We believe that, although a jacket store coldstore is obviously the ideal system for bare root plant material, a direct cooled store with a modern built-in humidifier of accurate control is a very adequate substitute where capital investment is limited. Too high a humidity can create problems of ice deposition on the cooling equipment.

Fungal growth has always been a problem in the still air environment of a jacket store and generally it is best to treat all stock with a fungicide. This is unnecessary in the direct cooled store, therefore being one advantage in the day to day management of the store.

A stacking pallet system was necessary to enable us to efficiently fill the coldstore; these pallets were built by ourselves with manually lift-off tops to enable us to fill each pallet without any damage to the plant material.

Rootstock Harvest. During the three weeks leading up to Christmas we harvest our stoolbeds. An offset saw is used for this purpose as well as ground preparation machinery which has been designed and built by ourselves. Again all stocks are

brought into coldstore where grading and despatch can be done at will, uninterrupted by the weather, allowing prompt delivery to our customers.

In conclusion it is necessary to emphasise the importance of precise organisation where so many extreme situations can affect and disrupt a smooth running operation. At the same time, with so many mechanical and technical improvements as time goes on, we are open to more risks when faults in the system appear. Therefore, careful planning and precise calculations are necessary to make the most of our progress.

STANDARD STEMS FOR ROSES

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Stems for standard roses are expensive and for this reason some rose growers produce their own. The usual method is to propagate from hardwood cuttings. It is also possible to grow good stems on a stoolbed. A third method, which has been little used by growers, is to bud a "stem builder" on an ordinary bush rootstock and this is what I want to discuss here. At Shardlow Hall we have three years experience budding a range of species and cultivars that seem suitable, using *Rosa corymbifera* 'Laxa' as the rootstock throughout.

Good results have been obtained using *Rosa rugosa*, *R. multiflora* 'Dornloos', *R.m.* 'De La Grifferaie', and *R.* 'G278', an unnamed John Innes seedling, which has produced the best stems so far. *R. canina* selections have been rather disappointing. 'G278' is a very vigorous, upright shrub, and the stems are straight and almost thornless although cuttings do not root readily. The stem continues to thicken as the plant gets older.

Ordinary bush rootstocks are used at normal spacings, although it is important to leave sufficient interrow space to work in when tying up stems in the second year. Good rootstocks and good growing conditions are necessary to give a high proportion of good quality stems and a sheltered site is clearly highly desirable.

Budding is done in the usual way for bush roses. In the second year support is needed and we have used 2 metre canes for staking plus a post-and-wire system. If more than one shoot arises from the bud the best is selected. It is essential to tie in regularly to ensure straight stems (we use a Max