6. More flexibility in subsequent handling/potting-on procedures
7. Possible reduction in disease, especially in propagation phase
8. Higher percentage out-turn of saleable plants from initial number of receptacles produced.

Disadvantages of Direct Sticking

1. Substantially more propagation facilities required (× 3 to × 15)
2. More labour involved at propagation phase
3. Materials cost higher at propagation phase
4. Care in nutrition (feeding) required
5. Care in spacing to maintain quality
6. Rooting-through can be a problem
7. Because of the high A.F.P. final pots dry out readily
8. More winter protection required the first winter

VEGETABLE PLANT RAISING USING SPEEDLING TRANSPLANTS

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My objective as a plant raiser, is to enable my customer, the intensive vegetable farmer, to reduce his unit cost of end product; for example, a crate of cauliflowers. In order to do this, the system I use has to be economical but, above all, has to give a high percentage yield of uniform, marketable produce which brings the unit cost down.

Traditionally, vegetable growers have direct-seeded into their fields, or thickly sown in one field or greenhouse then pulled the plants and transplanted them into their final position in the field.

When I became involved in plant raising, growers were starting to use the first form of module — the peat block — which was having some success, especially with lettuce. This technology had come from Holland where the system was well developed, albeit mainly for glasshouse growers. Production of peat blocks in Holland was highly mechanized and was a large industry. However there were disadvantages in this system when used by outdoor vegetable growers in the U.K. mainly because of the slow development of roots into the field soil and the peat block's inability to re-wet if it dries out.

On looking around for alternatives, we found the "Speedling System" in the United States. This had been developed for the outdoor grower and had eliminated many of the peat block's disadvantages. The peat block had been developed for the glasshouse grower with his ability to control the environment.

The heart of the "Speedling System" is the tray the plants are grown in and, more specifically, the shape of each module or cell (Figure 1). The tray is about 1 × 2 ft and has differing numbers of cells, with as many as 595 cells in our mini-cell tray. The cell is the shape of an inverted pyramid and, when the seed germinates, its roots are guided by the corners and shape of the cell to the large drainage hole. As the cell has no bottom, as in a flower pot for the roots to run around, the roots grow out of this drainage hole and, because the tray is supported off the floor of the greenhouse with a good flow of air under it, the roots die in the dry air. This process is called "air pruning" and it releases the dominance of the root, allowing a number of secondary roots to develop. This process is repeated with each root that grows out of the cell and results in a root system with a large number of young, vigorous roots mainly on the outside of the module, ready to establish into the field soil. This system avoids root balling as the roots are not allowed to run around the base of the module as in a flower pot, and results in more rapid establishment.

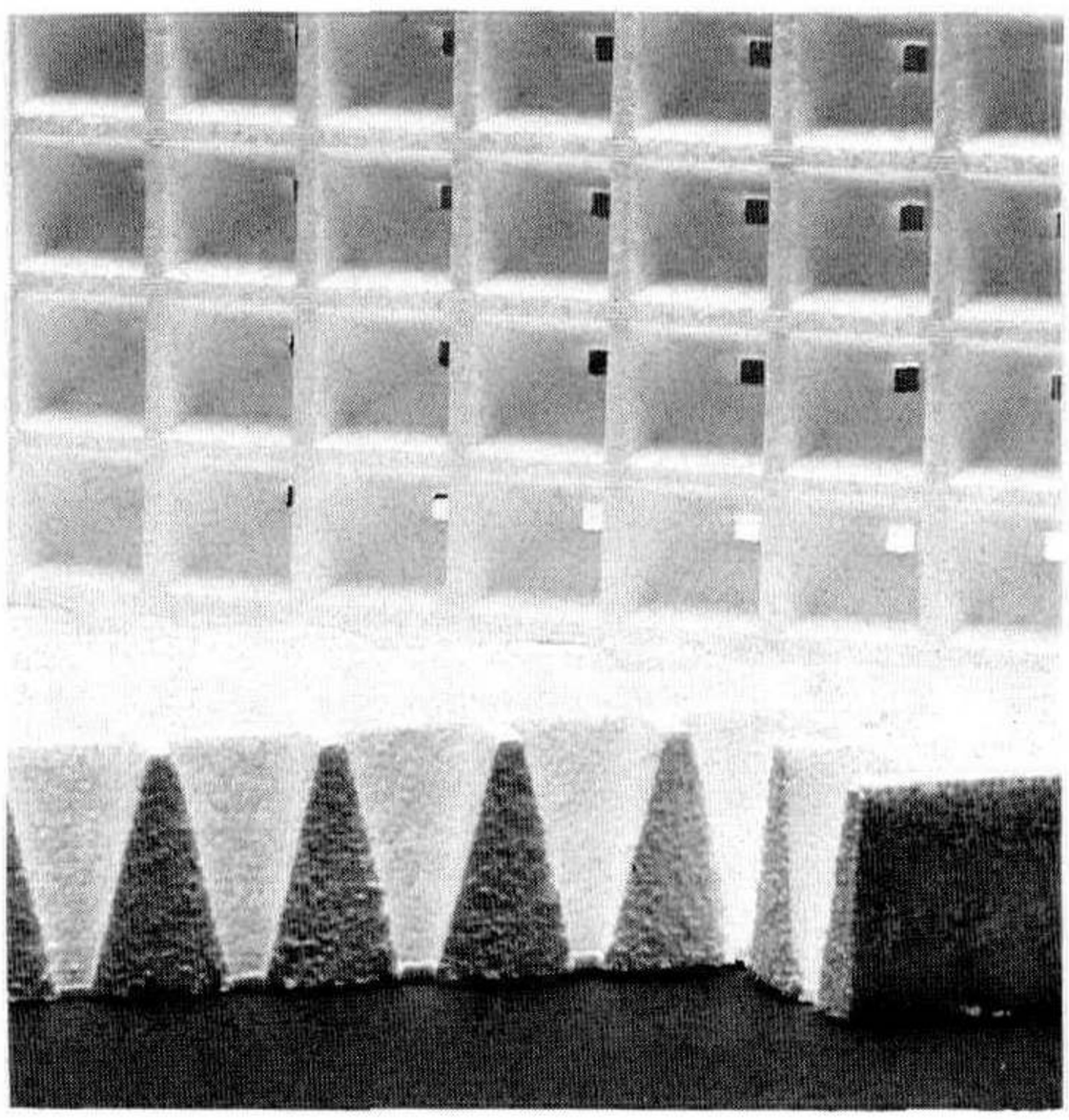

Figure 1. Speedling System trays. *Above.* View looking into tray. *Below.* Side section showing inverted pyramid shape of cells.

The "Speedling System" has now been adopted in many countries and we in the U.K. have, perhaps, been a little slow

to adopt this method, possibly because of the peat block's presence. This initial slowness has, however, been made up for by the now rapid uptake, with probably over 1 billion vegetable modules being planted in 1985.

On our nursery, the first process is the compost mixing, tray filling, and seeding which is all done in one line, and has an output of over 1 million cells per day. We mix our own compost with a low nutrition and the incorporation of vermiculite. The trays are then palletized, "cling filmed," and moved into a germination room, where the temperature is controlled to create the ideal environment for seed germination.

After the appropriate length of time the trays are laid out in the greenhouses on benching of a good working height which allows air to pass under the trays. In order to water the trays and keep each cell with the same moisture content, one needs a very uniform method of applying water, especially as each cell is unconnected to its neighbour and above the ground, so there is no water movement at all. To achieve the desired accuracy, we use a moving gantry, which waters in a band fashion moving across the entire greenhouse and applying water very accurately — and certainly a lot more accurately than spraylines or sprinklers.

Once we have this ability to apply the water accurately, it also gives us the scope to control plant growth by feeding through the gantry and only applying little nutrients at a time in such a way that one gets the type of growth desired, which is strong and stocky. This contrasts strongly to the peat block where the plant gets excessive nutrients which are not controlled, hence growth is often weak and soft.

The result of this method of growing is a plant that has strong foliage, that will stand up to the rigours of the transplanting shock, and also will pass through the planting machine in a trouble-free manner. The roots are so trained that in a very short period a large number will grow out into the field soil and gain water and feed from the field rather than from the module. In short, we are trying to grow a plant which is suited to its ultimate environment and the rapid establishment into this environment.

Our range of plants produced is fairly large, but the most important crops are brassicas (cauliflower, brussel sprouts, calabreze, chinese cabbage, cabbage, etc.), lettuce, and leeks.

In the U.S.A., where plants have to travel a long distance, they are pulled out of the tray and placed into cardboard boxes and shipped to the farm. In the U.K., we send the growing tray to the field and here the trays are placed in a

palletized racked bin, which permits easy handling by forklift. These bins are taken to the field and then the trays are placed on the planting machine. Some plants are planted in the field by hand, but mainly they are put in by a machine of some sort.

The slowest machines are the traditional planters as used for the old bareroot plants; these plant about 1500 to 2000 plants per row per hour. However, much faster machines which have been designed specifically for planting the module are now available. Our sister company specialises in the sale of propagation equipment and sells such a planter, which is capable of planting at 3000 to 3500 plants per row per hour, with a less skilled workforce than the older machines. The plants are simply taken from the tray, which is held on a rotating carousel, and placed into one of a series of moving cups, which at the appropriate times opens and drops the plant into a shoe, which is travelling through the soil. At the correct time for the plant spacing, the plant is pushed out of the shoe by a kicker mechanism, which places it into the soil, hopefully green side up.

The plant is then suddenly and instantly taken from the protection of the greenhouse and its neighbors in the tray, into what is often a hostile and demanding environment and it is then that the plant raising and the system itself are tried and tested.

To date, we have been happy with the results and, as illustrated by the use of the system, so have the farmers. For example, with cauliflowers, the farmer gets between 80 and 99% establishment, as opposed to 30 to 90 percent with bare-root plants. Furthermore, the plants are more uniform and crop over a shorter period, thus allowing the farmer to pass over the field fewer times. We are looking to improve the system in many ways but, in principle, feel we have the correct system for our specific application.