Fruit growing in 2060... will be a big cover-up

By Mike Nichols
When I arrived in New Zealand as a raw—very raw—horticultural graduate from Nottingham University in 1958 I was not impressed with the standard of fruit production which I saw.

In the UK there was already an awareness of the advantages of dwarfing root stocks, higher density planting and renewal pruning. None of this appeared to be in commercial practise when I first arrived in New Zealand.

In fact the pip fruit industry at that time was based on a very simple formula. Trees were planted in a 20 ft x 20 ft square pattern, grafted onto Northern Spy rootstock, and were mainly varieties of Cox’s Orange Pippin, Golden Delicious, Red Delicious, Jonathan, Granny Smith or Sturmer. All the orchards were clean cultivated with discs or harrows, irrigation was only present in Central Otago by the use of flood irrigation methods, and spur pruning was the norm. Pest and disease control was by regular calendar-measured sprays with pesticides such as DDT to control codling moth. This then posed the problem of how best to control spider mite, due to the DDT killing off the spider mite predators.

We have come a long way in the past 50 years. Grassed orchards and irrigation are now the norm, as are high density plantings and dwarfing rootstocks. Any relationship between yesterday’s varieties and today’s is purely coincidental. As far as pest and disease management is concerned an awareness of the importance of reducing pesticide use has led to an acceptance by the industry of IPM and biological control methods.

The reason behind the New Zealand horticultural industry being so far behind in 1958 is probably due to the uncooperative UK weather. It was necessary to work hard to get the right technology to produce crops, whereas in New Zealand the superior climate made horticultural production an easier task. This trend is apparent in North America, where the Eastern states have to strive much harder to obtain good crops compared with the Western states. Another reason is that horticultural training in the UK was more advanced than in New Zealand. Whatever the reason was, the difference is now history, and New Zealand’s international reputation in terms of horticulture innovation is equal to the best in the world.

WHERE TO FROM HERE?

Growers must tread a delicate line between conservatism and innovation. One bad decision can easily remove the efforts of a lifetime. Nevertheless conservatism has its disadvantages. In the mid 80’s I spent two months in the city of Quetta in Pakistan evaluating a high density, dwarfing root stock, drip irrigation apple project for the United Nations. It was an interesting project because traditionally in Baluchistan apples were grown on their own roots at a very low number of trees per hectare. Each tree would produce a very high yield per tree on extremely large and tall trees, but a low yield per hectare. This is very different from the modern philosophy of having a large number of dwarf trees per hectare. This provides relatively low yields per tree, but high yields per...
hectare, with the added advantage of the trees being easy to manage in terms of height. The UN proposal went down with the locals like a lead balloon, due to innate conservatism of the local growers, and even when grafted onto dwarfing root stocks, they tried to overcome the dwarfing effects of the rootstocks by moulding up the stems to ensure scion rooting and consequently large trees!

2060
What will the New Zealand fruit industry look like in 2060? My view is that it will have become a “protected cropping industry” similar to how tomatoes have become over the past 20 years.

The greenhouse industry in Europe was originally established to produce fruit. The first “greenhouses” were developed in the 17th and 18th Century in order to produce oranges for the rich and famous. These greenhouses — actually called orangeries — were primarily stone built buildings containing a small stove, with small glass windows, that provided some light for the plants. It was essentially a basic method of frost protection for the sensitive citrus, as the plants were grown outside in pots during the summer and only transferred into the orangeries in the autumn at the onset of cold weather.

In the 19th century many rich landowners developed large walled gardens to produce fruit and vegetables for their own consumption. They then found that the walls could be used to support lean-to greenhouses for the production of out of season fruits. There were even greenhouses developed specifically for growing pineapples! In 1850 the Great Exhibition had as its centre piece a very large glasshouse named the Crystal Palace, and as a result the potential for production of ‘cheap’ out of season vegetables was established. In the 20th Century the production of fruit under protected cultivation virtually disappeared, although in New Zealand I can recall a few desert grapes being grown in greenhouses near Oamaru for the ‘hospital trade’ at least into the 1960’s. Of course there is always the very large grape vine in a greenhouse at Hampton Court near London, as a remainder of times long past.

In recent years there has been worldwide production of high quality fruit under protective cultivation but not really here in Australia or New Zealand. This is somewhat surprising considering the supermarket dominance in both countries, and the interest that supermarkets and consumers have in high quality product being available on the shelves year round. However in horticulture things change rapidly. In New Zealand we saw a decline in the 90’s of fresh outdoor tomato production with the development of corporate greenhouse tomato production. A similar trend appears to be occurring in Australia, while in Europe we are seeing a swing away from the field production of strawberries towards greenhouse production. This grows better quality fruit and provides a more stable supply. Such results are seen even in such climatically favoured countries as Spain. For countries with a difficult climate and summer rains such as UK, New Zealand or even Australia, the writing is on the wall for high quality fruit production — adapt or disappear.

In many countries weather sensitive crops such as cherries — see my recent article — have been grown under high plastic tunnels. Even in the drier areas of North America there is considerable interest in the use of protected cultivation to produce top quality cherries and other stone fruit.
There are some very real advantages of growing in protected cultivation. Biological control methods are more reliable, pesticides are not washed off the plant by rain, harvesting is not weather dependant, and fruit quality is vastly improved. I am currently involved in a greenhouse strawberry study which by Christmas had produced the equivalent of 40t/ha of first grade fruit without any pesticides and with only three rotten fruit out of a total of some 6400.

I believe that berry fruit will initially show the way, but it will only be a question of when, not if, summerfruit and later pipfruit producers appreciate the many advantages of producing in a semi controlled environment.

Moving from the field into a protected cropping greenhouse environment will not be straightforward. It will involve additional capital, and a complete change in the production methods we are currently using. To some extent this has already been signalled by Dr Stuart Tustin from NZ Plant and Food. He has suggested that the current tree training methods might be considerably improved by using the “Future Orchard Planting System” where trees have two axes rather than one, and will be grown like horizontal cordons trained along wires to allow the development of vertical stems, in a planar arrangement much like a candelabra. Tustin has suggested that productivity might be increased by as much as two to three times using this growing system. Suitable dwarfing rootstocks already exist for apples, and it is only a question of time before a range of dwarfing root stocks become available for other tree fruits. Other training systems might be considered, for example the two axes system combined with a “Tatura trellis” system. This may even be better.

The New Zealand kiwifruit industry is currently going through some considerable trauma due to Psa. A complete re-think regarding production systems could prove relevant at this time. Water appears to be a major factor, and this poses the question of whether a totally new production system might be the future. High tunnels would reduce the water problem and presumably the Psa, but the training system would have to be greatly modified. Kiwifruit training in the past has been limited to two training methods. If dwarfing rootstocks could be developed, then the potential to look at a horizontal main stem / planar arrangement might allow easy production in a protected and rain free environment. It could also enhance productivity with both yield and quality. The use of “high tunnel” greenhouses for kiwifruit would also introduce the potential for using bumble bee hive colonies for pollination.

The UFO system, a permanent single layer espalier system with the fruiting wood held upright, might be a solution for cherries. Pruning each winter would comprise of cutting the fruiting wood back to the permanent espalier, or horizontal cordon, framework. Rows could be much closer together, and spraying would be by means of a permanent set of nozzles. Pollination should be improved as bumble bees would be effective in the tunnels, and the need for pollen imports would be eliminated. The male pollinator plants could be grown in containers and introduced into the high tunnels. >>
for pollination, and then taken outside for the rest of the growing season.

There would almost certainly be a need for the kiwifruit industry to follow the lead of the apple industry, and develop dwarfing rootstocks. This could play a useful role in developing high tunnel production systems.

It goes without saying that the quality of fruit produced under tunnels would be superior to that from outdoor crops, and this might include higher brix, earlier maturity etc.

HYDROPONICS

It is generally acknowledged that soil is not a good medium to grow high value crops. In a classic paper Professor Lim Ho. (Fig I) showed that in the UK, over a 30 year period, greenhouse tomatoes in soil increased in yield by an average of 1.7% per year. Those producers who used hydroponics, which became popular first in the 1960’s, had annual yield increases of 6.4%. This was not due solely to the use of hydroponics, but because the yield from the hydroponics was higher; it became economically feasible to invest in other improved technologies. In this case automatic greenhouse temperature control, supplementary carbon-dioxide, IPM, etc.

In the 21st century the two scarce resources are likely to be water for irrigation and fertilizer. Hydroponics using recirculating systems offers considerable efficiencies in both. Horticulture on a per hectare basis is a major user of fertilizer, and much of this is leached through the soil and finds its way into the rivers and lakes. Recirculating hydroponic systems minimize this environmental hazard.

Apart from strawberries most greenhouse berry fruit crops are still grown in the soil. The recent developments in cherry production in North America and elsewhere using high tunnels have all assumed soil as the growing medium of choice. This poses the question of whether it might be advantageous to grow many types of the dwarf fruit trees hydroponically in containers, in order to provide a superior root environment. As an extension of this concept, there is potential to extend the production season for berry fruit such as strawberries, raspberries, blackberries and blueberries; and produce stone fruit such as cherries, peaches apricots and nectarines out of season. It would then not be too difficult to transfer the plants into a cool store in the autumn for winter chilling. They would then be transferred back into a greenhouse for fruiting. If the trees were trained using the UFO (espalier) training system they could be placed very close together in the cool store. In the case of berry fruit – excluding strawberries – new production systems would need to be developed, but this should not be beyond our capacity.

In the case of kiwifruit it is worth considering growing the male pollinators in separate containers, and only moving them into the all-female planted greenhouse just for the pollination period. This would be more efficient use of the greenhouse space.

Fruit size is dependent on cell numbers and cell size. Cell numbers are generally determined soon after pollination,
whereas cell size is determined much closer to harvest. It may be possible to manipulate fruit cell number by modifying the growing environment in a greenhouse grown fruit crop at a critical stage - something which is totally impossible in the field, where we have to accept what nature throws at us.

Cell size also depends on the plant environment, i.e. adequate moisture and nutrients. It will also be modified by the grower with control of fruit load, thus the source/sink relationship. However this is mainly controlled by the environment close to harvest. Possibly "Controlled Deficit Irrigation" will have a part to play? A strategy far more feasible in a recirculating hydroponic situation than when growing in the field in soil!

There is little doubt that growing fruit using protective cultivation systems will result in better quality fruit both in terms of size and appearance. An added bonus might be improved pest and disease management - because pesticides will not be washed off growing surfaces, such as foliage and fruit due to rain. More effective biological control will be possible.

When I worked for the Department of Agriculture in Nelson in the early 60's there was a trial planting of dessert grapes on the DSIR "Appleby Research Orchard". It was not very successful, because the birds played havoc with the ripening grapes, and this opened up the fruit to the wasps. Rain close to harvest was also a problem. The potential of using high tunnels to produce high quality dessert grapes would appear to be excellent and might even have some possibilities for early production in Australia. It would reduce the need to import dessert grapes from USA, South America or South Africa. Birds would be eliminated simply by spreading a net over the high tunnel greenhouse. An added advantage of local production would be the elimination of any biosecurity risk, and, of course the fruit would be much fresher!

Whether this approach might have potential for wine grapes is also worth considering. Protected covers would clearly have an advantage in a cool/wet autumn, and it might be possible to produce a wine grape hydroponically on any site, with a similar quality to that grown on the very expensive "Gimblett Gravels".

Quality fruit is an essential component of any export endeavour, and there is likely to be a significant domestic market for high quality fruit. It should not be too difficult to develop production systems for growing apples, pears, kiwi fruit, apricots, peaches, nectarines and nashi using systems similar to those currently used for high tunnel cherry production.

It is difficult to foresee the shape of the fruit industry in the future, but one thing is clear: it will be very different from the present.

In my next article I will look at the potential of producing fruit in "plant factories" - very much a look into the future, but one that comes nearer every day. Could the Wright Brothers ever have envisaged planes such as the Airbus A380 transporting 500 people at 800km/hr over distances of 15,000 km?

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