Nanotechnology

Nanotechnology is the scientific term for the engineering and technology of the very, very small.

And the world of the very small is going to make a very big contribution to horticulture in the years ahead. Nanoscale science involves the understanding of the physical, chemical, and biological properties of matter at the length of scale of approximately 1 to 100 nanometres.

And a nanometre is really small. A sheet of paper is about 100,000 nanometres thick. A pin head is one million nanometres across. A human hair is approximately 50,000 to 100,000 nanometres in diameter.

In horticulture, nanotechnology has the potential to enhance the quality and value of food and non-food crops. It has a contribution to make in pest, disease and weed control and improvement of soil processes.

Preharvest nanotechnology could provide bio-sensors and diagnostic instruments for monitoring plant disease and environmental stresses enabling sustainable and precise production methods.

Other examples are micro sieves for separation and fractionation which can also improve emulsification processes in food processing.

This would allow the use of drug delivery concepts for nutrient delivery and the enhancement of the nutritional quality of food products.

Postharvest technology improvements from nanotechnology could include better waste management and improved permeability characteristics in packaging materials. Such packaging could combine printable electronics and low cost sensors to inform the customer about the product and its quality.

These new instruments will enable much faster measurements in or near production lines by non-expert personnel. Nanotechnology will also result in new concepts for food production processes. It could even give rise to totally new products that at present we can only imagine.

Automation and robotics in horticulture

Robots and automation processes are finding many uses in horticulture.

Automation and robotics reduce overall labour costs and increase the consistency of quality and safety during production and postharvest cycles.

Mechanical harvesting is currently largely restricted to products destined for processing such as grapes for wine, olives, sour cherries, tomatoes and citrus. This is because of the physical damage that can occur during harvest.

Robots in horticulture are widely used in some nursery industries for producing transplants, especially with vegetable plants for grafting, and for planting vegetable seeds and plantlets in both greenhouses and open fields.

Labour costs

Use of robots in the developed world is driven by the cost of labour and its availability. These two factors threaten to make many crops uneconomic. In the USA, labour costs have increased in the past decade from 38% of the net value of the farm economy to 58% currently. If the trends continue some farms will become uneconomic.

Many of the tasks associated with horticulture, such as picking, pruning, pest, disease and weed control, are repetitive and arduous. Such tasks seem ideally suited to robots.

The fruit industry in the USA is recognising that if it is to survive economically, it is fundamental that their costs are lowered significantly. Robotics and automation seem the only options to achieve this reduction in costs.

What robots can do

Robots can contribute to the early detection of pests and diseases through the application of remote sensing technologies, in the monitoring of plant health, assessing crop value, reducing the amount (and cost) of sprays and nutrients (through the imaging of micro stresses caused by localised infections), increase in the efficiency of labour (by providing mechanical aids to humans) and to the reduction of damage to crops at harvest.

Challenges of using robotics in horticulture

Designers of robots for fields and orchards face a daunting task. Robots have to 'see' the paths between the produce and they need to 'know' which areas have already been harvested. They need eyes to see the trunk of a tree and to separately identify fruit, flowers and leaves. Their arms need to be able to pluck, prune, spray and pollinate.

They have to be strong enough to handle rough terrain, sloping ground and mud. They must also be able to handle fragile fruits and berries which bruise easily. After avoiding all the people, poles, wires, stumps and rocks, robots need to be able to work near other robots without getting in their way.

Their economic use poses a number of problems. Some horticultural tasks such as fruit picking last for only a few months of the year. It simply is not profitable to use a robot for such a short period. Robots may have to be multifunctional and be able to pick, count buds, prune, and pollinate to ensure a reasonable return on their cost.

Fruit picking robots

Examples of fruit picking robots in development and/or in early stages of use:

Oranges

Italy: System that uses GPS way points to navigate in the orchard; 8.7 second picking cycle, fills bin.

USA: A scout robot forms a 3-dimensional map of the location of fruit and an eight-arm picker robot gathers the fruit.

Apples

Belgium: Robots that pick 85% of crop at a 9 second cycle.

USA: Developing and testing technologies including navigation and augmented harvesting of fruit.

Strawberries

Japan: Operates in a greenhouse; 10 second cycle – provided fruit is trained to grow over the edge of the container.

Kiwifruit

New Zealand: autonomous visual navigation of orchard rows; pick rate 0.25 seconds (1 fruit per second for each of four 'hands'), gentle fruit handling and bin filling; automated bin replacement.

Top: Mechanical harvesting of cherries; experimental unit in Michigan, USA.
Above: Automated tray transfer in greenhouses. PHOTO: WAGENINGEN UR GREENHOUSE HORTICULTURE, THE NETHERLANDS