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The Mechanisation of Cherry Production and Harvest

Written by:

Richard Copas NSch

March 2025

A NUFFIELD FARMING SCHOLARSHIPS REPORT

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A NUFFIELD FARMING SCHOLARSHIPS REPORT (UK)

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"Leading positive change in agriculture. Inspiring passion and potential in people."

Date of report: March 2025

Title	The Mechanisation of Cherry Production and Harvest
Scholar	Richard Copas
Sponsor	Malcolm Isaac
Objectives of Study Tour	To study the current and future availability of new technologies and techniques in terms of plant physiology, machine capabilities and robotics to determine the options available for the mechanisation of cherry production and harvest and the effect of this on the structure of cherry orchards of the future.
Countries Visited	United Kingdom USA France Germany Italy Holland Chile
Messages	Sweet fresh cherries are possibly one of the hardest crops to mechanise due to the small fruit size, clustered fruit, dense foliage and complex tree canopies. Advancements in robotics offer medium to long term potential, however trees will need to be grown on single plain growing systems. Mass harvesting techniques with shakers are possible now on a Y trellis growing system. This will result in a stem-free product that might not be acceptable in all international markets.

EXECUTIVE SUMMARY

The UK sweet cherry sector is reliant on seasonal foreign labour and, with rising minimum wage levels, the pressure to find alternative harvesting techniques is ever-increasing to secure home-grown production against importation from lower labour cost areas of the world.

The convergence of agricultural technologies in the form of machine capabilities and improved biotechnological knowledge has the potential to change cherry production systems.

This study looked at the current and future availability of these new technologies and techniques in terms of plant physiology, mechanisation and robotics to determine the options available for sweet cherry production and harvest.

The current sweet cherry industry around the world is a paradox between the industry leading technology in the packhouses and a labourer with a bucket and ladder in the orchard. The reason for this inconsistency is that harvesting cherries is possibly one of the most difficult crops to mechanise due to the small fruit size, clustered fruit, dense foliage, and complex tree canopies.

The report reviews two potential future harvest solutions - individual fruit removal with robotic technology and mass harvest techniques.

In terms of robotics, systems are not currently being developed specifically for the cherry industry. Significant investment is being made in other fruit sectors, but the commercialisation of these systems remains elusive. The technology continues to develop at a rapid rate and could potentially be transferable to the cherry industry.

Overall commercial robotic harvesting of cherries is unlikely to be possible in the short term. The main hurdle to overcome is that the current prevalent cherry growing systems with complex canopy structures are not suitable for robotic harvesting as the robots cannot easily access the fruit. Therefore, the industry should move towards single plain growing systems and work with robotic companies as the technology continues to develop.

For the mass harvesting of cherries, the technology is currently available to detach sweet fresh cherries with mechanical vibration. The reason these systems have not been adopted is the high percentage of fruit damage as the fruit falls through the tree. By using innovative single plain growing systems on a Y trellis, it should be possible to reduce fall distances and harvest losses.

The mass harvesting of cherries will result in a stem-free product with a comparable shelf life. Initial indications suggest that a stem-free cherry will be acceptable in European and North American markets however less suitable to Asian markets.

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DISCLAIMER

The opinions expressed in this report are my own and not necessarily those of the Nuffield Farming Scholarships Trust, or of my sponsor, or of any other sponsoring body.

Please note that the content of this report is up to date and believed to be correct as at the date shown on the front cover

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CHAPTER 1: INTRODUCTION

I grew up on a mixed family farm in Cookham, Berkshire spending all school holidays working with my brother on the farm in the arable and fruit businesses in the summer, and turkey business in the lead-up to Christmas.

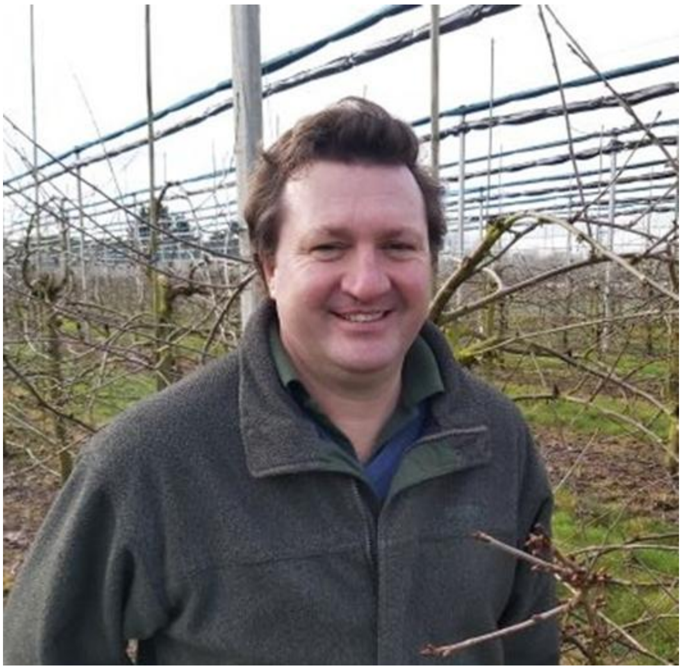


Figure 1: The author, Richard Copas. Photo: Author's own.

After school I completed a BSc Hons in Agricultural Business Management at Wye College in Kent before returning to the family farm which I now manage with my brother and father. Our farm is heavily diversified into property; however we have maintained our deep roots in agriculture operating a successful arable business and fruit business based on two Pick Your Own sites.

Whilst working on the farm I have gone on to complete my ACCA Accountancy Professional Qualification, MSc in Real Estate Management at Oxford Brookes University, and an MBA from Hult Ashridge Business School.

I have been happily married for 18 years and we have two teenage children. In my spare time I have enjoyed playing sociable hockey and 5-aside football but, due to advancing age, my sporting activities are now restricted to cycling and pursuing country sports.

CHAPTER 2: BACKGROUND TO MY STUDY

The focus of this report is on sweet cherry production for the fresh market and does not consider the processing or sour cherry sectors.

The Copas family have grown cherries for three generations. We currently have six hectares in production on dwarf root stocks which are all harvested by Pick Your Own customers for whom they remain a firm favourite.

In 2022, in the UK, 759 hectares of cherries where grown, producing 4,100 tonnes with an estimated farm gate value of £21.8m. In addition, the UK imported 15,000 tonnes, making the UK only 21.5% self-sufficient (DEFRA 2023). Compared to other horticultural crops, UK cherry production is very much a niche or specialised industry, however there is a strong consumer demand for homegrown quality cherries.

Traditionally the UK horticultural sector has relied on seasonal foreign workers to supplement its workforce, with European Union workers accounting for as much as 99% of seasonal labour recruited by the edible horticulture sector (House of Lords 2022). Following Brexit on 31 January 2020, the UK Government has pursued a high skilled, high wage economy and has sought to restrict immigration. This, coupled with an increase of 39.3% in the National Living Wage between April 2019 and April 2024, has put significant pressure on the UK horticulture sector, including UK cherry producers, leading to crops going unharvested.

It is widely believed that worldwide agriculture is in the middle of a fourth agricultural revolution with the advent of new technologies like artificial intelligence, robotics, gene editing, vertical farming, and increased understanding of plant physiology.

I hope that by undertaking this Nuffield Farming Scholarship I can understand the potential for these new technologies to benefit UK cherry producers and to develop a profitable blueprint for the cherry orchards of the future.

CHAPTER 3: MY STUDY TOUR

Due to the restriction on travel for the Covid19 pandemic, my study tour was conducted over an extended period. The countries I visited during my study tour are listed below. For a full list of the visits undertaken please see Appendix 1:

England & Scotland Apr, Jun 2021 Jun, Aug 2022	I wanted to review where the UK was with current harvest technologies for different crops in the horticultural sector and the likely pipeline for the introduction of the technologies under development.
USA Jun 2022	I visited the states of California, Oregon, and Washington. These are large cherry production areas close to the technology centre of Silicon Valley. There is also significant research undertaken in cherries at the Washington State University and the Oregon State University.
France & Germany Nov 2022 Feb 2023	I wanted to visit the following trade shows to review the availability of new technologies in Europe: Fruit Logistica (Berlin); SIMA (Paris); FIRA the Global Event for Agricultural Robots in Action (Toulouse).
Italy Jun 2023	I was following up on a contact made at Fruit Logistica. Northern Italy is also a significant centre for horticultural production and the manufacture of production and packing machinery.
Holland Sep 2023	Holland is one the leading countries in glass house technologies and has a niche cherry sector.
Chile Dec 2023	Chile is the largest producer of cherries in the southern hemisphere and has a rapidly expanding profitable industry suppling mainly China for their New Year celebrations. It is one of the leading countries in the adoption of new growing techniques.

CHAPTER 4: INFORMATION, OBSERVATIONS, AND INSIGHTS

When traveling with the Nuffield Scholarship I aimed to undertake four categories of visits:

1. Cherry farmers to understand what production techniques are currently being used in the field and packhouse, and to understand the general approach taken towards new technologies and the opportunities for mechanisation.
2. Growers of other fruits and vegetables that had either mechanised their harvests or were looking to introduce new technologies to assist with harvest.
3. Robotics and general machinery developers and manufacturers to see what equipment was currently available or in development.
4. Research institutions.

I have summarised my findings in the following chapters.

4.1 Observed current cherry growing systems

Through my travels I visited a wide variety of farms producing cherries. Some farms were solely dedicated to cherry production while others grew a variety of complementary horticultural crops and others were mixed farms also undertaking arable and livestock production. The range of farm sizes visited was from under 1 ha to over 4,000 ha in cherry production.

In the tables that follow, I have summarised the main varieties of cherries grown, the root stocks used, and a summary of the growing systems used.

Table 1 - Summary of cherry varieties grown

Country	Varieties
UK	**Stead Nicolle** – *Sweetheart, Georgia*
US	**Ralph Santos** – *Coral, Bing, Lapins, Sweetheart, Benton*. Blush Varieties - *Rainer* **Tim Dahle** - *Bing, Chelan, Sweetheart, Regina, Skeena, Kordia, Benton, Staccato* – Blush Varieties – *Rainer, Early Robin* **Orchard View** – *Bing 40% (stopped planting) , Chelan, Lapins, Black Pearl, Burgundy Pearl, Ebony Pearl, Sweetheart, Regina, Skeena, Kordia* - Blush Varieties– *Rainer, Early Robin* **Mt Adams** – *Lapins, Skeena, Regina amongst others*

Holland	**Djuke Smith** – *Merchant, Kordia* **Erik Vernooij** – *Stoppel 2.1, 2.3, 3.2, Sweet Aryana, Merchant, Areko, Henretta, Kordia, Tamara, Stoppel 10.4, 11.3, 12.1*
Chile	**Garces Farm** – *Santina (Early), Regina, Lapins, Sweetheart, Bing (stopped planting in 2014), Rainer.* **Agricola Entre -** *Santino (early by the coast), Sweet Aryana, Lapins, Regina, Kordia (late by the mountains). Sumitt, Sylvia, Skeena (as pollinators)* **Antonio Bunster** – *Bing (stopping growing) Lapins, Regina, Sweetheart, Staccato (not good, removing) Summitt only a pollinator.* **Rose** – Early Varieties – *Santino, Pacific Red, Sweet Aryana,* Mid-Season – *Kordia, Lapins, Skeena, Bing (stopped planting)*

The choice of variety is primary determined by the target market and consumer preferences with some of the observations being:

- Export-focused countries like the USA and Chile prefer firmer fruit varieties like Bing for export as there is less damage in transport.
- Early season production areas (closer to the equator or lower in altitude) will choose earlier fruiting varieties like Santino to take advantage of early season premium.
- Later season production areas (further from the equator or higher in altitude) will choose late fruiting varieties like Sweetheart to take advantage of the price premium at the end of the season.
- In Holland customers pay a premium for Kordia.
- In China, preferred varieties are Regina which attracts a premium.
- Skeena picks 25% faster than Bing due to less leaf cover.
- With climate change and global warming, growers are looking at varieties for the future that require fewer chill hours.

Table 2 - Summary of cherry root stock varieties

Country	Root stocks

US	**Ralph Nicolle** - *Colt* **Tim Dahle** – *Gisela 3, Gisela 5, Gisela 6, Gisela 12, Maxime depending on soils.* **Orchard View** – *Gisela 6, Gisela 12* **Mt Adams** – *Gisela 12*
Holland	**Erik Vernooij** – *Gisela 5, Gisela 6*
Chile	**Garces Farm** – *Colt, Gisela 8, Gisela 12* **Agricola Entre** – *Maxima 14, Colt* **Antonio Bunster** – *Colt, Meridier, Gisela 5 – roots to shallow for Chile.*

The selection of root stock is primarily determined by the climatic condition in the area with more dwarf root stocks like Gisela 3 and Gisela 5 used in more fertile areas and stronger root stocks used in less fertile areas.

Table 3 – Brief description of growing systems used

Country	**Growing systems**
UK	**Stead Nicolle** – *Upright Fruiting Offshoots (UFO) under plastic*
US	**Ralph Santos** – *Steep Leader (not covered)* **Tim Dahle** – *Wide variety of canopy structures, including UFO, Central Leader, and a developmental four branch UFO. Aiming for all pedestrian orchards.* **Orchard View** – *Steep Leader - trailing a V trellis UFO.* **Mt Adams** – *Steep Leader and Central Leader 2m by 4m spacing.*
Holland	**Djuke Smith** – *Central Leader tied down on a trellis 3 to 4m high. All under permanent plastic structure* **Erik Vernooij** – *Most orchards are on a Central Leader under plastic. Sweet Aryana and Kordia grown under covers to bring forward (can gain 10 days in enclosed tunnels). Looking to develop a double tabletop system by creating two horizontal H from central leader, one layer to be picked from the ground level and one from platforms.*

Chile	**Garces Farm** – *Currently use a multitude of growing systems – Central leader, KGB, UFO etc. All new planting on Central Leader with horizontal branches tied to a trellis on vertical spacings of 40cm. 2m tree spacings. Stopping KGB, branches collapse, plus hard to pick.* **Agricola Entre** - *All Central Leaders with no support systems. trees height 2.8m* **Antonio Bunster** – *Central Leader, tree height 2.6m*

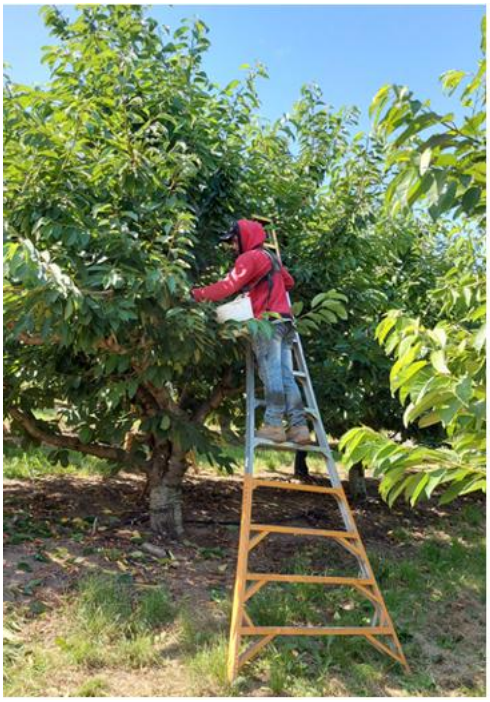
In the countries visited I saw a larger variety of differing growing systems. Individual countries tended to have their preferred system which is linked to climatic conditions and traditions. For example, the Four Leader system was the predominant system used in the USA accounting for roughly 70% of the orchards seen. In Chile, the predominated system was the Central Leader which still accounts for over 80% of the orchards in Chile.

In northern Europe, which has more adverse weather conditions, it is common to cover newly planted orchards. In the USA and Chile, which have more settled weather in the main growing areas, orchards are very rarely protected with plastic, giving a considerable cost advantage.

When planning new orchard planting all growers were conscious of improving picking times to reduce production costs. Due to this there is a trend towards high density orchard planting with more trellis-based systems. There were generally two schools of thought on orchard heights. For example Tim Dahle was planning to only plant pedestrian orchards to improve picking speeds and improve worker safety (no need to use ladders). Mt Adams wished to keep orchard heights between 3 to 4m as they believe too much productive growing area is lost with pedestrian orchards.

4.2 Observed current harvest systems

On all the farms visited all the cherries produced where harvested by hand, either from the ground or from a ladder. The source of the labour was generally from overseas, for example, Mexico in USA, Bolivia, Peru & Venezuela in Chile and Eastern Europe in Holland. The level of technology was very low and would not have changed in the last 100 years. This generally consisted of a ladder and a bucket which would be manually emptied into a larger bin for transport to the packhouse. See photo below.



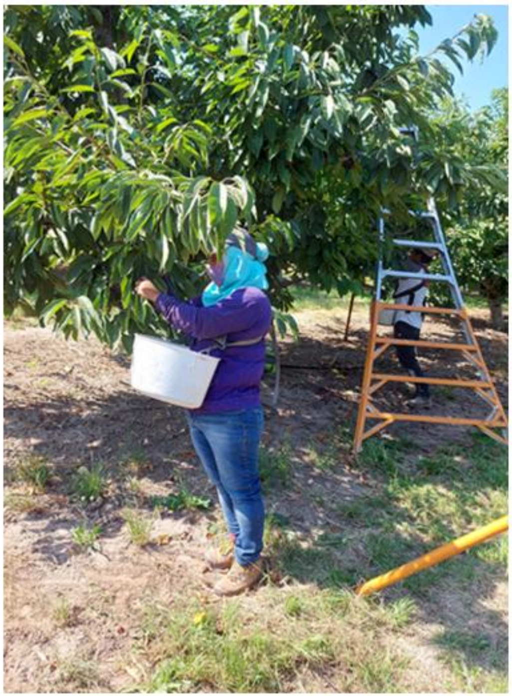


Figure 2: Cherry harvest at Orchard View, The Dalles, US. Photo: Author's own.

Harvest labour on all the farms visited was the largest single cost in the production of cherries accounting for between 40 and 60% of all costs. The table below shows the relative picking costs in the countries visited.

Table 4 – Comparison of labour costs

Country	Minium Wage 2024	Equivalent £/hr	Picking Costs $/kg
USA California Oregon	 $16.00/hr $13.20/hr	 £12.64/hr £10.43/hr	 $0.65 - $0.88/kg
Holland	Euro 13.27/hr	£11.41/hr	
Chile	460,000 Peso/month	£1.95/hr	$0.25 - £0.33/kg

There was also concern about the future continuality of the labour supply and future costs with some of the observations being:

- The average birth rate in Mexico has dropped from 6 to 2.6 children per family. Population demographics are changing which will not allow the current system to continue.

- The Mexicans and Central Americans will keep coming, the risk is political, and the fear is the US-Mexican border will be closed.
- In Chile we are starting to see tension between the immigrant workers and the local population.
- Labour price increased by 7% last year.
- A crew of 120 pickers plus a supervisor will pick 3-acres per day.

There was also considerable concern about the health and safety risks of using ladders, with one farmer observing that: "We have had five accidents with ladders so far this year, one serious injury where the person is still on light work."

Due to the risks associated with ladders in Holland, Erik Vernooij uses 10 work platforms for picking the tops of the trees which also helps with picking speeds. At Mt Adams in the US, they were reviewing the use of platforms but at the time of visit they were currently just using them for pruning.

Currently the focus on reducing picking costs was to improve the growing systems used. The view that pedestrian orchards saved labour had to be balanced against the reduction in growing area. Dr Matthew Whitting has observed that the harvest efficiency of pickers in a Steep Leader System was 0.53kg/min compared to an Upright Fruiting Offshoots System (UFO) of 0.94 kg/min.

4.3 Grower insights and attitudes to future mechanisation

When discussing potential for mechanisation of the cherry harvest with growers there is a common view that the mechanisation will be difficult. Growers tended to be pessimistic about the potential for future technologies. Some of the insights discussed were:

- "My markets demand a cherry on a stem. Picking by machines with a stem on is tough. I do not believe in my lifetime a robot will pick with a stem on."
- "For the last 30 years there has been talk of mechanical apple harvesters, tree structures changed accordingly but still this is not achieved, plus a lot of money has been wasted."
- "The first robot will be very expensive and slow, only the 4th to 5th version might work."
- "You need to start with pickers then look to make them more efficient. For example, buggies to follow pickers, automated trucks to drive fruit to the packhouses, tractors to cut the grass or do the spraying, robots are just not for picking."

- "Mechanisation will be very hard; I do not think shaking will work for a fresh market as the damage will be too high. Labour is not currently an issue."
- "My Grandmother never thought milking a cow would be possible with robots, now it is commonplace."

4.4 Observed current packhouse technologies

The comparison from the immigrant picker with a bucket and ladder, to the packhouse technology currently used could not be starker. The cherry packhouses or cherry lines I visited were state of the art with multimillion pounds invested in the labour-saving technologies.

Generally, a cherry packhouse and line will consist of the following process:

1	Arrival hall where field bins (220kg) are hydrocooled, and initial fruit quality checked
2	Fridge storage at 1 to 2°C with high humidity before fruit is processed
3	Automatic Box Tippers where the cherries are submerged in water and any leaves and branches are removed. Cherries then flow on a water flume down the line.
4	Cluster Cutter where the stalks of clusters of cherries are cut to singluate all cherries.
5	Photo sorting, where individual cherries are scanned and can be sorted for size, colour, external quality, softness, stalk on v. stalk off, internal quality and BRIX levels.
6	Cherries are then dropped into individual packing lanes depending on the intended markets for packing in either boxes, bags, clam shells etc.
7	The fruit is then palletised and stored in a fridge ready for dispatch to market.

The size of the processing lines varies from 1 to 2 lanes generally used at individual farm level costing in the order of £200,000 to £500,000 to larger co-operative packhouses with 48 lane processing lines which can process 500 tonnes per day costing £30 to £40 million. There is also a wide choice of manufacturers with the main suppliers being Unitec (Italy), Reemoon (China) and GP Graders (Australia).

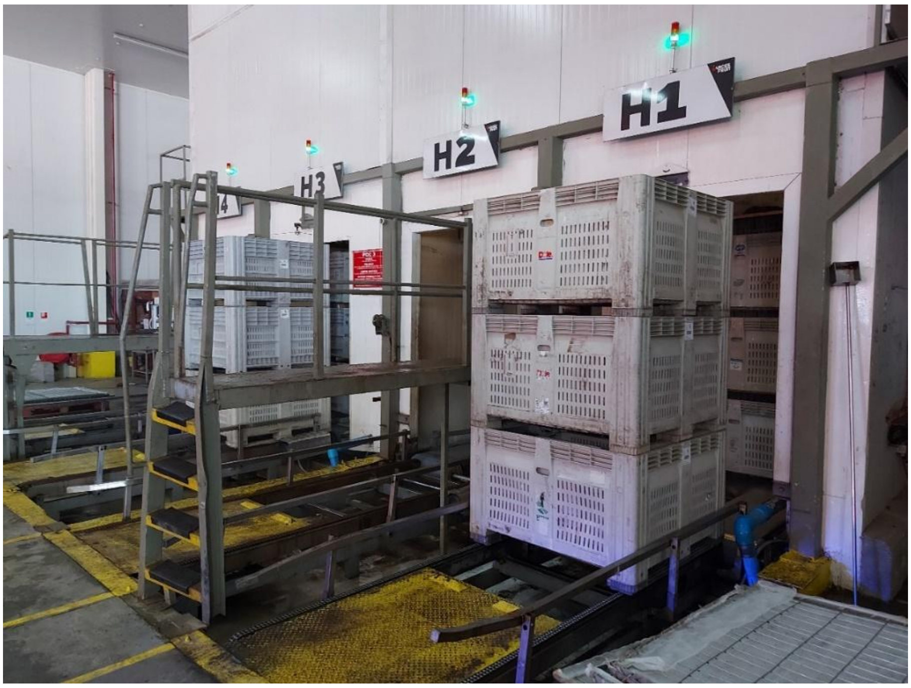


Figure 4 : Cherry bin in arrival hall about to enter a hydrocooler in Garces, Chile. Photo: Author's own.

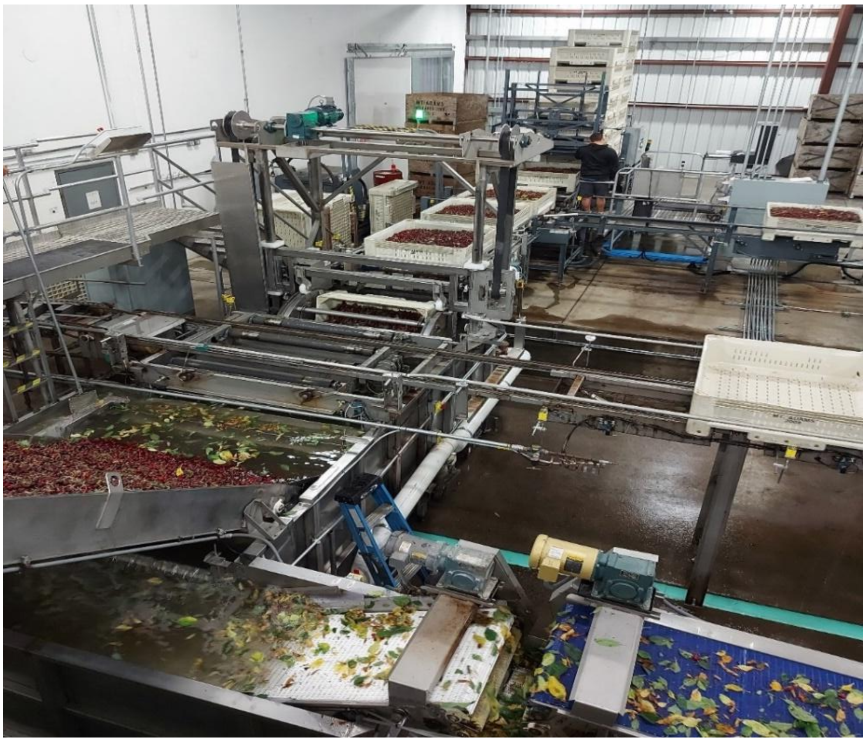


Figure 5: Cherry box tipper and trash removal at The Dalles Fruit Company, US. Photo: Author's own.

At the height of the seasons the cherry lines are run 24 hours per day with multiple shifts. In all cases the lines are run for a cherry season or campaign usually lasting around 55 days before being mothballed until the following year. Even though the capital investment is very significant, due to the high volumes that are possible, cost per kilogram of fruit are at around $0.40/kg.

Overall, the level of technology and capital investment in cherry packhouse technology is very high with ongoing research having been undertaken for future improvements.

Photo 6: Unitec cluster cutter at The Dalles Fruit Company, US. Photo: Author's own.

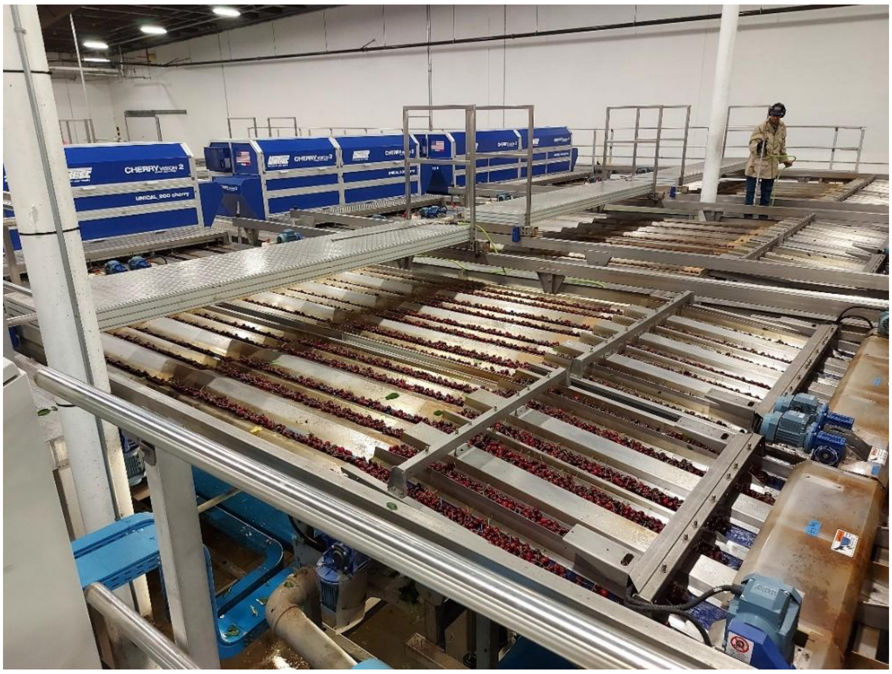


Figure 7: Unitec Cherry Vision 48 lane Sorting System at The Dalles Fruit Company, US. Photo: Author's own.

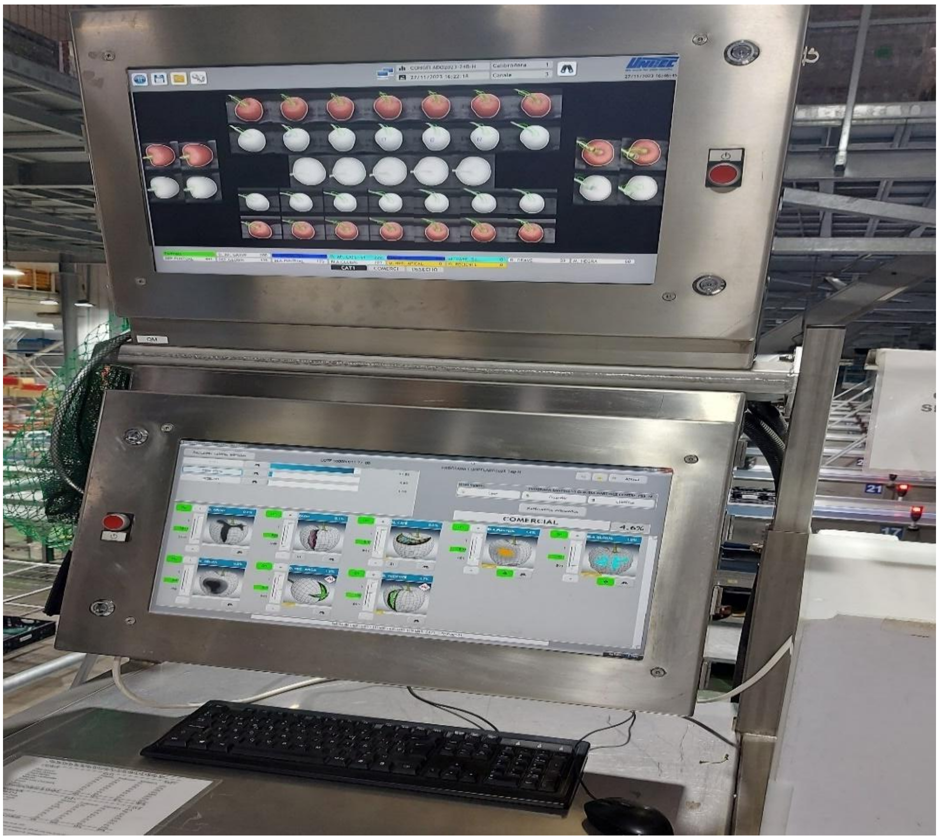


Figure 7: Unitec Cherry Vision 3, Control Computer for Defect Scanner at Garces, Chile. Photo: Author's own.

Figure8: Packing hall, Santa Barbara Ltd, Chile. Photo: Author's own.

CHAPTER 5: MECHANICAL HARVEST TECHNOLOGIES IN OTHER HORTICULTURE CROP PRODUCTION

Since the industrial revolution farmers around the world have been harnessing machine power to assist with agricultural production and harvest. In the last 80 years mechanised harvest systems have been adopted for most crops. For example: combinable crops, potatoes, sugar beet, vining peas etc.

The mechanisation of a cherry harvest is possibly one of the hardest fruiting trees to mechanise due to relatively small fruit size, clustered fruit, dense foliage, and complex tree canopies making accessing fruits at the middle of the tree with machinery difficult.

As part of my study tour I looked at a number of fruit crops that had either already been mechanised or were reviewing developmental technologies.

5.1 Sour and sweet cherries

Mechanical harvest systems are available for most tree nuts and several tree fruits including sour and sweet cherries. These systems generally use trunk shaker harvesters to dislodge the fruit and a canopy to catch the falling fruit. See photo below.

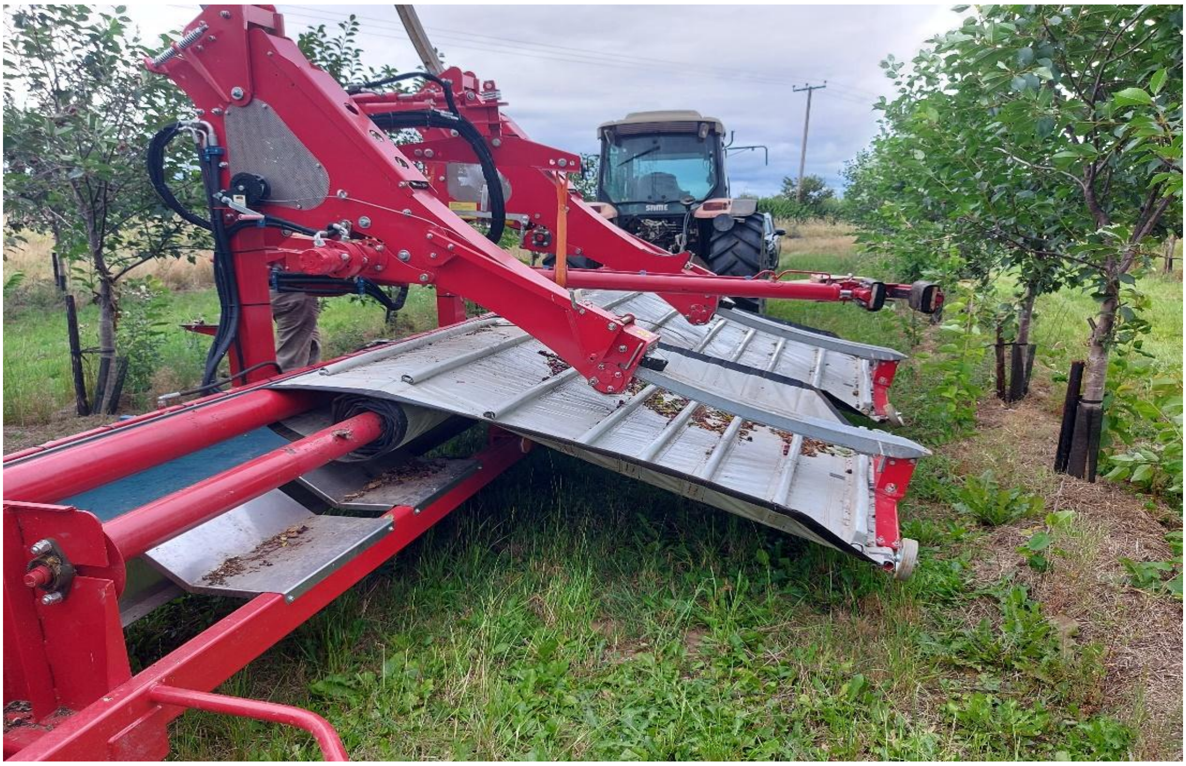


Figure9: Weremczuk Shake and Catch, sour cherry harvester, Herefordshire, UK. Photo: Author's own.

These systems are widely used for processing fruit; but they have not been adopted for fresh cherry markets. The reason for this is the high level of fruit damage caused by the height of the fall from the tree to the catch vessel and due to the falling cherries hitting the branches on the way down which causes internal bruising. In addition, the cherries are usually dislodged without the stem, see photo below. Conventional wisdom is that customers demand a cherry with a stalk. This is particularly true for the Asian market.

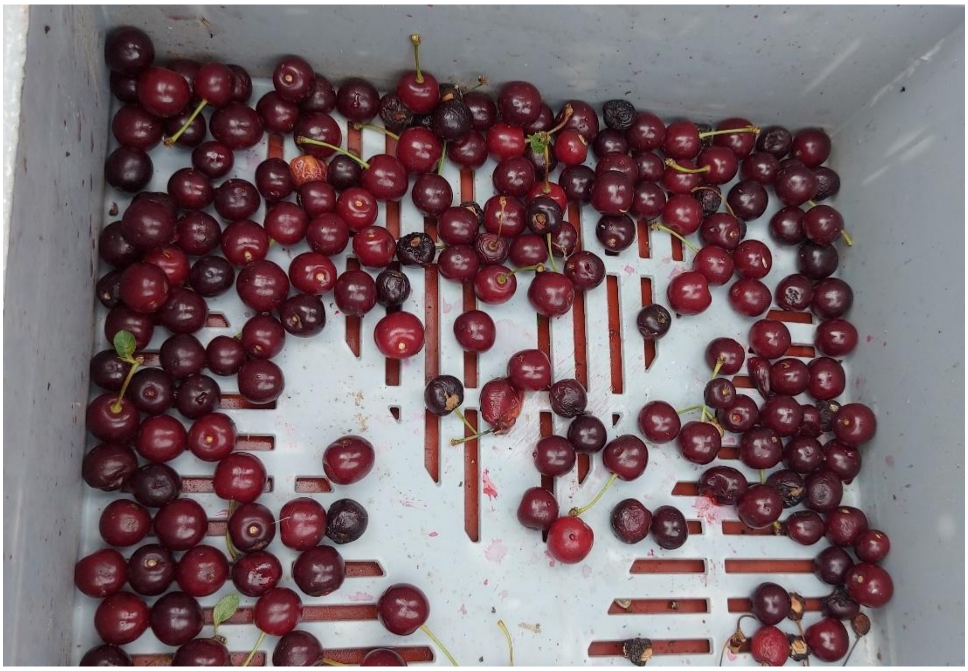


Figure10: Cherries harvested with Weremczuk Shake and Catch, Herefordshire, UK. Photo: Author's own.

5.2 Strawberries

In the last five years several technology companies have been endeavouring to develop robots to pick strawberries. These companies have started with strawberries due the to the longer growing season and high market volumes and values (30 times more by volume and 15 times more by market value then the cherry industry in the UK).

Like cherries, strawberries are a soft fleshed fruit which is generally harvested by hand with their stalk on. Historically a ground level plant, in the last decade in the UK strawberries have been grown on tabletop systems resulting in the fruit hanging below the plants. Due to this there are several similarities between the requirement to harvest strawberries and cherries.

Although still in their infancy robots are now capable of picking strawberries and several companies, for example Dogtooth and Tortuga, are looking to commercialise the technology. The challenges moving forward are increasing picking speeds, increasing the fruit clearance levels, and reducing the ratio of onsite engineers to robots. Although robots can now technically pick strawberries the jury is still out on whether they will be commercially viable compared to hand picking.

If the strawberry picking robots can be successfully commercialised, the technology should be easily transferable to the cherry industry. Already these companies are looking to transfer the technology to the table grape and tomato sectors.

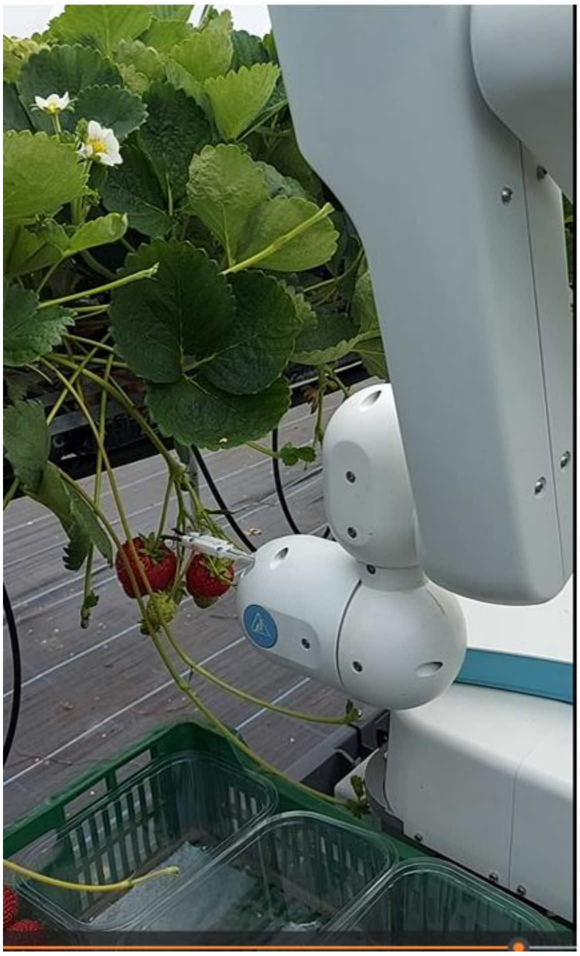



Figure 11: Dogtooth strawberry robot, Carnoustie, Scotland. Photo: Author's own.

5.3 Blackcurrants

For over 40 years blackcurrants, which grow as a 4ft high bush, have been harvested by machines. The machines work by splitting and leaning the bush to a 45-degree angle before vibrating the bushes with a system of offset weights and hard plastic fingers to dislodge fruits. The currants are then caught and conveyed to a bin, see photo 12 overleaf.

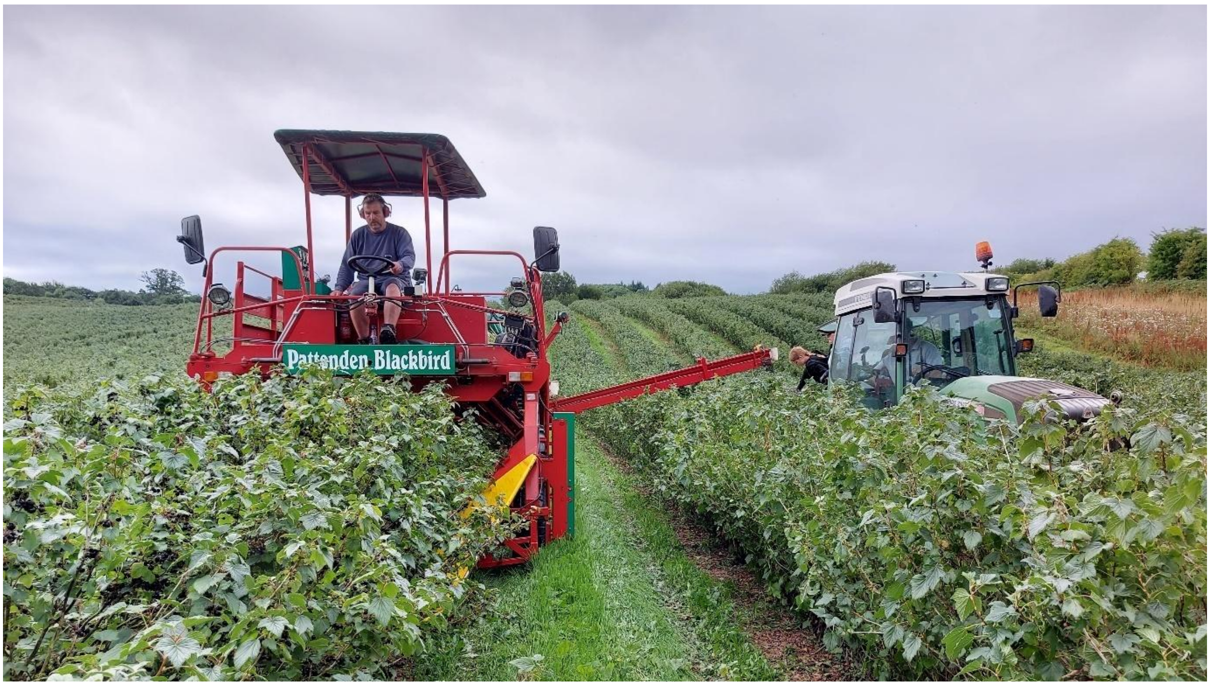


Figure 12: Pattenden Blackbird, blackcurrant harvests, Herefordshire, UK. Photo: Author's own.

The blackcurrant harvesters in the photo can pick 20-22 tonnes per day and the harvested currants are used for processing to produce Ribena. Due to this fruit quality, in terms of visual appearance and bruising, is less important. However, similar vibrate and catch technology is used for harvesting olives, coffee, and wine grapes. Could this technology be used in cherry production with dwarf root stocks?

5.4 Blueberries

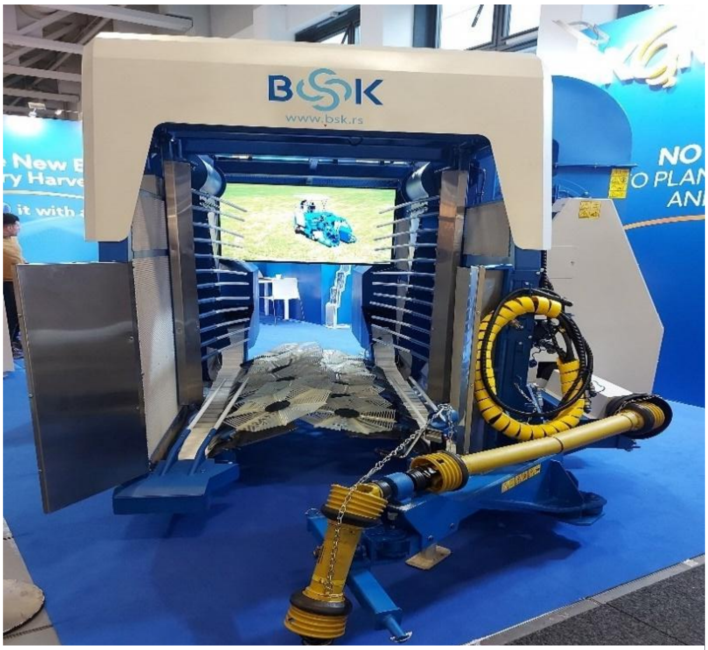


Photo 13: Kokan – Air Berry Harvester at Fruit Logistica, Germany. Photo: Author's own.

As an alternative to fruit dislodgement with vibration some soft fruit crops can be mechanically harvested by using jets of air to dislodge the fruit. See the photo of an air berry on the left. This machinery is primarily designed for blueberry harvesting and it can pick up to one tonne per hour. The key to success is to minimise the fruit damage by limiting the falling distance. Ultimately the success of the commercialisation of these machines will be the ratio of labour saving compared to the increased grade out losses due to damage during the harvest process.

Due to the shortage of labour in the UK for 2024 some UK blueberry growers are planning to exclusively use mechanical harvesters.

5.5 Summary

Cherries remains one of the few fruit crops that continue to be harvested by hand. However, technology is advancing fast and significant investments for governments and private finance in agricultural research and development is now targeting fruit crops. There seem to be two competing solutions for cherry harvest technology, individual fruit removal with robotics or mass harvest technologies with either shakers or air blowers.

CHAPTER 6: INSIGHTS FROM RESEARCH INSTITUTIONS AND MACHINERY MANUFACTURES

As part of the study tour, I visited a number of machinery manufacturers and research institutions with the aim of gaining insight into the future of agricultural technologies that could affect cherry production.

The general view was that picking fruit is the hardest task for a robot. Moravec's paradox is that it is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing chequers, however it is difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility. The difficultly to reverse engineer any human skill is roughly proportional to the amount of time that skill has been evolving in animals.

Humans and plants have evolved symbiotically for millennia. Due to this, humans are very skilled at fruit picking, they are dexterous and autonomous. This is hard to replicate in a robot. Similar to how humans and plants have evolved together, plant production techniques and robotic capability will have to evolve together. The robots will have to work within the limitation of the agronomic capabilities of plants and vice versa.

Larger machinery corporations like John Deere want multimillion pounds problems to solve as specialised harvest machinery is not scalable which has resulted in little interest in investing in research in the sector. Venture capital firms want a quick return on investments, whereas agricultural investment is more long term. However, in 2021 alone $17bn of venture capital was invested in robotic startups. Even so, robots are not taking over the world and, in some cases, developers have lost sight of the goal of reducing costs. One reason for this is that most startups want to do everything themselves from scratch. For example, create their own picking arm or write their own navigation system etc, which wastes a lot of time and money.

In the future the sector needs more collaboration and this is starting to happen. For example Lincoln Institute of Agri-Food Technologies is collaborating with Cambridge University and University College London. In America similar collaborations are starting and the Western Growers Centre of Innovation and Technology aims to set up an opensource platform policy to aid technology startup with an off the shelf image library, robotics navigation systems, picking arm etc. These collaborations should speed up robotic developments.

Robotics is more than a technological problem. It is also a people problem, as skilled people are required to design, service, maintain and operate robots. In terms of field operations most companies are looking at one field operative to between 4 and 8 picking robots. This operator will need to be skilled in robotics.

On top of this there is a regulation role for governments around health and safety implications of robots.

The route to market for the technology also needs to be considered. For example, Dogtooth is working on a business model of selling robots to the individual farms. However, farmers will need back-up and technological support which needs to be considered. By comparison, Tortuga is looking at a business model of offering a service to farmers whereby they charge per kilogram of fruit picked. This is currently based on the same price points as the costs of handpicking. Ultimately farmers need to see a benefit from adopting the technology and, until the costs savings from the adoption of robotics are clear, these machines will not become common place.

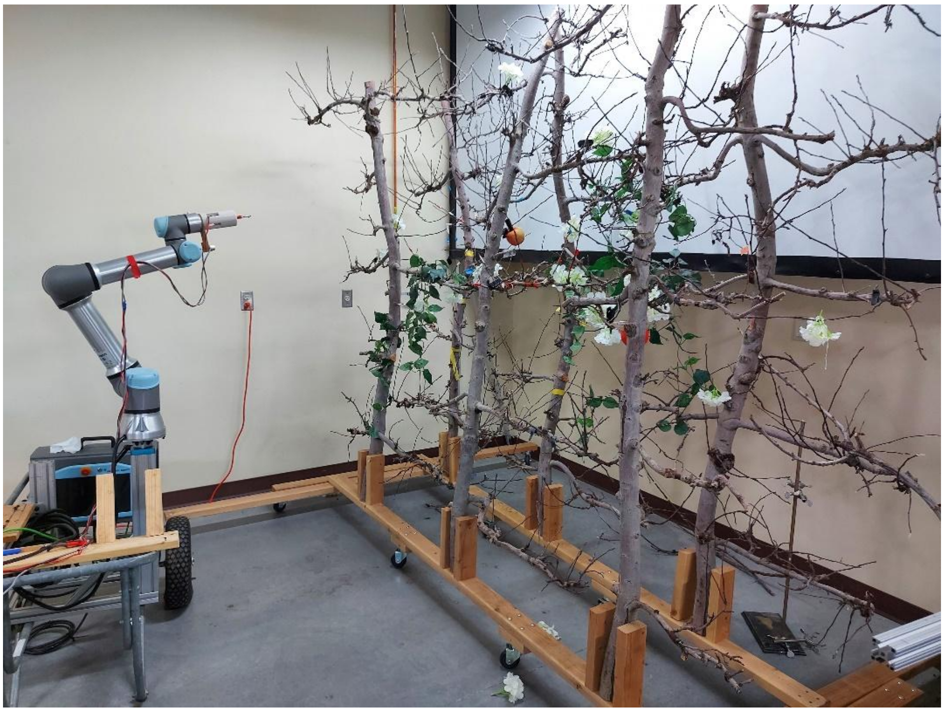


Figure 14: Robotic research at the Department of Horticulture and Landscape Architecture, Washington State University. Photo: Author's own.

In terms of mass harvesting systems for cherries, Dr Matthew Whitting of Washington State University has been working on this problem for 20+ years. The US Department of Agriculture has developed a harvester based on shaking the trunk of a 40-50° Y-trellis tree with a catching frame set at an angle parallel with the canopy to minimise dropping heights. This machine achieved a 26-times increase in picking rates, an 83-85% fruit removal rate, and only dropping heights of greater than one meter caused significant damage to the fruit. Although successful in trials it was not commercialised as the actuation system to shake the trees caused damage to the bark on the trunk allowing disease to enter the tree. In addition, this system resulted in a high proportion of stemless cherries as the pedicel-fruit removal force (the force to remove the cherry from the stem) is less than the force to remove the stem from the branch.

Unfortunately, no further work has been conducted on this system for the last five years, even though Dr Whitting's view is that the technology to mechanise a cherry harvest is available now and would be commercially viable. Research is continuing in the marketability of stemless cherries and also how cherries are damaged as they fall through the tree.

In the UK, Robert and Clive Chapman of Bravenhill have considerable experience in the manufacture of blackcurrant and blueberry harvesters using air and vibration for fruit removal. In reference to the mass harvesting of cherries, they were able to offer several useful insights:

- You need to change the growing system to suit the mechanical capabilities of the machinery.
- With shaking or blowing systems you will always get losses generally at the base of the tree.
- With shaking systems, if the fruit is grown on a trellis, you will lose fruit further along the trellis. With trellis systems concrete posts and wooden posts tend to snap during mechanical vibration, metal posts are preferable.
- You need to consider minimising the damage to the trees.
- You need to consider varieties in terms of evenness of fruit ripening and strength of the pedicel-fruit retention force.
- When designing a machine, it is best to break it down into stages. The main steps being fruit dislodgement, fruit capture and fruit transportation.

Overall, considerable research has been undertaken and is ongoing in robotics for individual fruit removal and mass harvesting techniques. This has demonstrated that the mechanisation of a cherry harvest should be technically possible in the future. However, worldwide cherry production is a specialist crop and is unlikely to attract significant capital investment in research from the large established machinery manufacturers. Therefore, if the mechanisation of a cherry harvest is going to be achieved it is likely to come through private equity investment with support from government departments.

CHAPTER 7: DISCUSSION - INDIVIDUAL FRUIT REMOVAL WITH ROBOTICS

On my study tour I did not find any grower, robotic company or research institution working directly with robotics for cherry picking. The reasons for this are that the cherry industry is a niche sector with a short harvest period and the complex tree canopies making access with robotics to fruit positioning difficult. Until robotics companies have managed to commercialise robotics for more straightforward crops like strawberries, which have more accessible fruits and long harvest seasons, investment in robotic cherry harvesting technology will not be forthcoming.

Currently it is possible to pick strawberries with robotics but the commercialisation of these systems remains elusive. The robotics industry needs to dramatically improve picking speeds and prove robots can lead to cost savings for the fruit industry. The timescale of achieving this is unclear with estimates varying widely from three to seven years or it will never be achieved.

On the positive side technology continues to develop at a rapid pace and developments in Artificial Intelligence hold promise for machine learning to improve picking speeds. In terms of technology Moore's Law, which states that computing capacity doubles every 12 to 18 months and the cost reduces by half in the same time, holds promise for future improvements and reduced timescales. I remain optimistic that cherry picking will be technically possible with robots, but the timescale is medium to long term.

For robotics to be possible in the cherry industry the prevalent growing systems need to change. Currently most cherries are grown on complex tree architecture canopy systems. For example, in the US approximately 70% of orchards are on the Four Leader system and in Chile around 80% of orchards are on Central Leader Systems. These growing systems make the adoption of robotics virtually impossible.

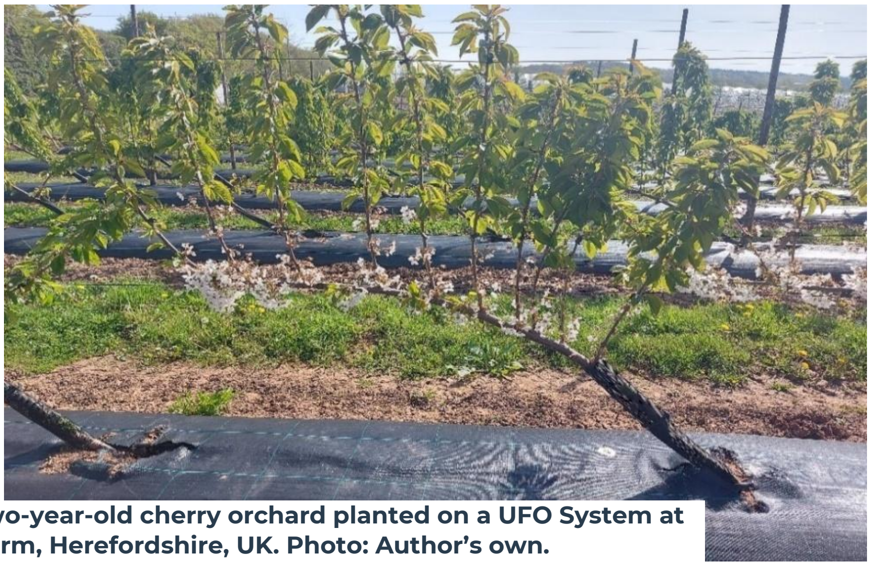


Figure 15: Two-year-old cherry orchard planted on a UFO System at Haygrove Farm, Herefordshire, UK. Photo: Author's own.

If robotics are going to be adopted in the cherry industry, growing systems must be adopted to make fruit more accessible. Fruit should be presented to the robots on a single plain canopy system, otherwise known as a wall of fruit. Growing systems like the UFO system or a Central Leader system trailed to a trellis will be most suitable. In addition, varieties like Skeena with less dense foliage will also make picking easier.

It takes three to five years from planting an orchard to it coming into production, and full production is reached in years six to seven, with the commercial life more than 20 years. Due to these long timelines new plantings of orchards should be planted with a view to being robotic friendly.

CHAPTER 8: DISCUSSION – MASS HARVEST SYSTEMS

As outlined above, the commercialisation of robotic technology for cherry harvesting is currently unclear and will not be available soon. As an alternative mass harvest techniques using vibration or air jets are technically feasible now. Below I have discussed in more detail the two main stages for the creation of a successful system, being fruit removal and fruit capture.

8.1 Fruit removal

The two options for fruit removal are air jets or vibration/shaking.

In August 2023, Clive Chapman of Bravenhill conducted a simple experiment with a handheld air jet taken from a blueberry harvester to determine whether it is possible to remove cherries with air. This experiment showed that cherries do not readily detach from the tree with air jets and Clive commented at the time of the trial the cherries were overripe which should have made it easier for them to be blown off.

In terms of vibration, tree shakers are commonly used in the sour cherry and processing cherry industries. Therefore, it is common knowledge that vibration can be successfully used to detach cherries. Most tree shaking technologies work by shaking the trunk of the tree with either a clamped arm or an actuation punch. These systems are used due to the complex tree canopy architecture making applying vibration to individual branches difficult. The disadvantage of these systems is that harvest does not begin until year six or seven when the tree is strong enough to take the vibration forces and the trunk damage shortens the productive life of the tree.

With single plain canopy systems trained to a trellis the tree architecture is simpler and will allow vibration to be applied to individual branches. This could facilitate vibration with offset weights and hard plastic fingers like the process used in blackcurrant harvesters. This will apply the vibration closer to where the fruits are positioned so less vigorous forces could be used.

8.2 Fruit capture

The reason that mass harvest techniques have not been adopted in sweet fresh cherry production is the high percentage of damaged fruits. The damage is caused by the high dropping distances and the impacts with the branches as the cherries fall through the canopy.

Research at Washington State University showed that fruit drop distances of greater than one meter caused significant damage to sweet fresh cherries. Therefore, if mass harvest techniques are going to be successful in sweet fresh cherries, the fall distances need to be minimised and the number of canopy impacts reduced.

When vibrating a vertical cherry tree the laws of gravity determine that the dislodged cherries fall vertically back to the ground impacting with the canopy below. The tree canopy also means that the only viable position to capture the falling fruit is at the base of the tree. Harvest losses are also higher around the base of the tree as any capture system must seal round the trunk. However, if the canopy was not vertical, the fruit could be captured directly below the branches. The prototype harvester developed by the US Department of Agriculture was designed for trees grown on a 40 to 50° angle. The flatter the angle the easier the fruit capture. However, the disadvantage of this was that training the trees to this angle was difficult as apical dominance is strong in cherry trees resulting in branches growing vertically away from the trellis system towards the sun. Dr Whitting suggested that to prevent this problem trellis systems need to be no less that 70° from the horizonal.

Could a successful growing system for mass harvesting of sweet fresh systems be a Y trellis grown at 70° which will allow fruit removal with a long vibrating bar using offset weights and hard plastic fingers? Fruit capture could be just below the canopy reducing fall distances, canopy impacts and harvest losses at the base of the tree. Could a system like this by commercially successful?

8.3 Advantages of a mass capture system

The advantage of the adoption of the mechanisation of a cherry harvest is the reduced reliance of human labour for fruit picking and the cost savings. In trials the US Department of Agriculture developed a mass harvest system. The labour costs for the mechanised system was $0.044/kg compared to $0.59/kg for hand picking at the time. Therefore, if labour costs are approximately 50% of all costs there is potential to reduce costs by around 43%. This represents a significant cost saving, particularly in developed countries where there is a scarcity of labour and minimum wages rates are increasing faster than inflation.

8.4 Disadvantages of a mass capture system

8.4.1 Harvest damage

It is evident that with a mass capture system harvest damage is always going to be higher than with hand harvesting by an experienced picker. The technology in a cherry packhouse is now so advanced that the automated sorting lines can detect external skin damage and internal quality. Therefore, any damaged fruits could be successfully removed on a packing line before entering the wholesale and retail sectors. The question will be the level of losses due to damage at harvest.

8.4.2 Stemless cherries

With sweet cherry varieties, generally the pedicel-fruit removal force (the force to remove the cherry from the stem) is less than the pedicel-peduncle removal force (the force to remove the stem from the branch). Due to this, mechanical harvesting by vibration is always likely to result in a high percentage of stemless cherries. This creates concerns around the shelf life and the marketability of the cherries.

In terms of shelf life, the disadvantage of the stem is that it can cause pitting in transportation and the stem usually dehydrates, turning brown prior to the main fruit decaying. The browning of the stem reduces desirability of the fruit, and this is why modern cherry storage facilities use high humidity to reduce stem dehydration. However, during stem removal, it is common for the fruit to be damaged at the fruit-pedicel junction. This has the potential to reduce shelf life.

In the summer of 2023, the author undertook a simply study to compare the shelf life of two punnets of cherries picked from the same tree, one picked stem on and one with the stems removed (stem-free). The punnets were stored in separate identical fridges for up to 42 days to compare the shelf life, see photos below. As can be seen in the photos there was a slightly higher level of deterioration in quality in the stem-free cherries but there was not a material variation.

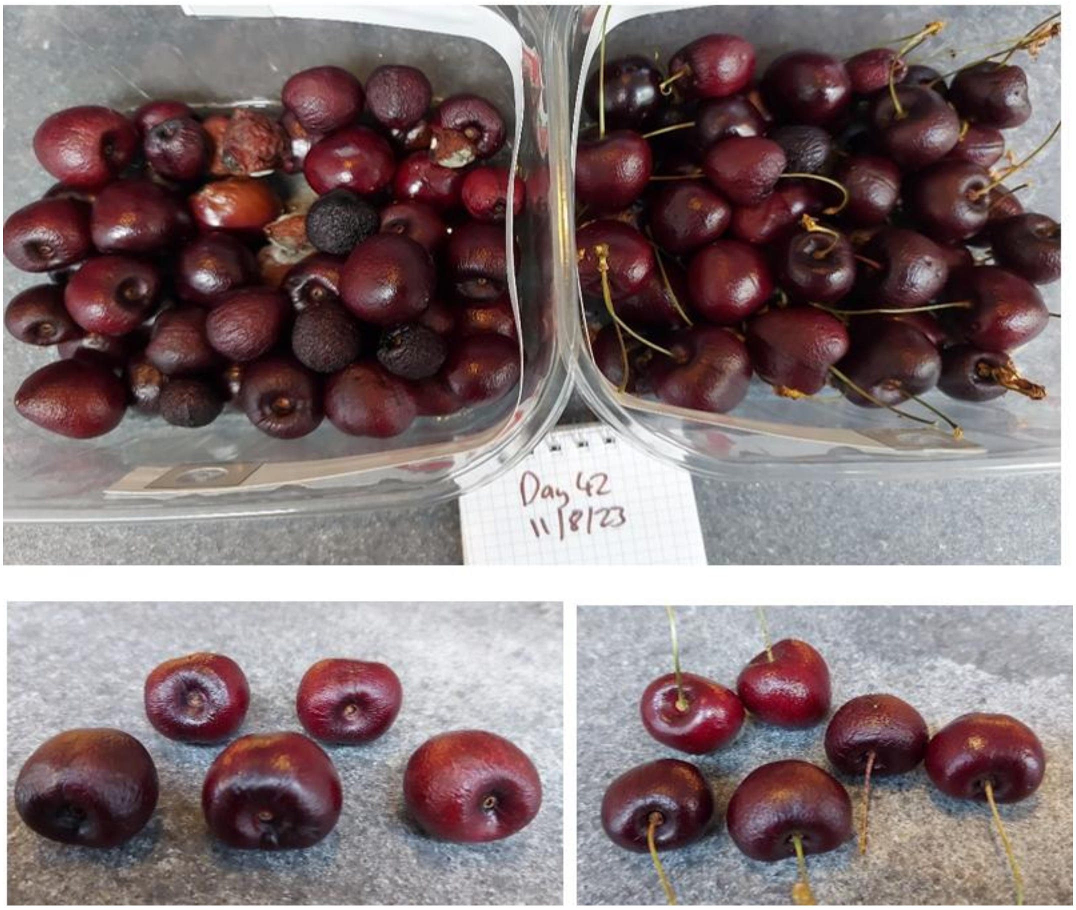


Figure 16: Comparison on day 42 of stem on and stem off cherries. Photo: Author's own.

In terms of marketability, producers and wholesalers in the US and Chile were adamant that markets in Asia demand a stem-on cherry. With comments like:

"*the fate of the cherry industry hangs on a stem*"

However, if there is no significant variation in the shelf life of cherries either with stem-on or stem-free, why is it considered vital for sweet fresh cherries to be sold with stems on? Market research in the US has shown that customer purchasing decisions are based on price and shelf life over a preference for a stem and customers were willing to pay the same price for stem-free cherries.

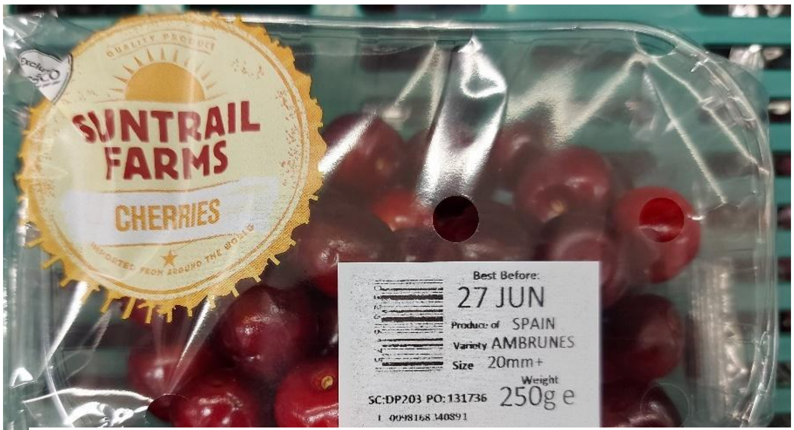


Photo 17: Picota stem-free cherries on sale in Tesco. Amersham, UK. Photo: Author's own.

The Picota brand of cherries from Valle Del Jerte in Spain is naturally harvested stem-free and produces between 4-5,000 tonnes per annum. These are marketed as a high-quality, stem-free fruit that is available throughout Europe including in UK supermarkets, see photo on page 25. This demonstrates the marketability of stem-free fruit in Europe.

In the UK, supermarkets already accept 10% of fruit to be stem-free with the Co-op working to a higher tolerance. On Copas Farms' pick-your-own farm in Berkshire, where customers can choose whether to pick with a stem-on or stem-free, the ratio is approximately 50:50 suggesting no clear preference between stem-on of stem-free fruit. Potentially there could be a difference in customer requirement and perceptions between Asia and Europe.

8.5 Mass harvest technics – Conclusion

It is technically possible to detach sweet, fresh cherries with mechanical vibration systems and, if growing systems can be adopted to allow the fruit to be caught with minimal damage, then there is potential to create significant cost savings. The disadvantages of these systems will be the additional costs created by extra harvest losses and the potential for reduced marketability in various parts of the world. The balance between these two costs will determine whether mass harvesting techniques for cherries can be commercially viable.

CHAPTER 9: CONCLUSION

The current cherry industry around the world is a paradox between the industry leading technology in the packhouses and a labourer with a bucket and ladder in the orchard. The reason for this inconsistency is that harvesting cherries is possibly one of the most difficult crops to mechanise due to the small fruit size, clustered fruit, dense foliage, and complex tree canopies.

In the developed world, with a low availability of labour and rising minimum wages, the pressure to find alternative harvesting techniques is ever-increasing to secure home-grown production against importation from lower labour cost areas of the world.

The convergence of agricultural technologies in the form of machine capabilities and improved biotechnological knowledge has the potential to change production systems to reduce the reliance on harvest labour in the production of cherries.

This report looked at two potential future harvest solutions, individual fruit removal with robotic technology and mass harvest techniques.

In terms of robotics currently this is not being developed specifically for the cherry industry, however significant investment being made in other fruit sectors where the technology has the potential to be transferable to the cherry industry. The current prevalent growing systems with complex canopy structures are not suitable for robotic harvesting. Therefore the industry should move towards single plain growing systems. Overall commercial robotic harvesting of cherries is unlikely to be possible in the short term.

For the mass harvesting of cherries, the technology is currently available and by using innovative single plain growing systems on a Y trellis it should be possible to reduce harvest losses through fruit damage at harvest. The mass harvesting of cherries will result in a stem-free product with a comparable shelf life. Initial indications suggest that a stem-free cherry will be acceptable in European and North American markets but will be less suitable to Asian markets.

CHAPTER 10: RECOMMENDATIONS FOR CHERRY GROWERS

- Growers should look to engage closely with robotic companies to learn the capabilities of robots and to explain the possibilities and limitations of differing growing systems to robotic developers.
- Future orchard planting should consider the potential for future robotics. The technology is not available now, but it could be widely used before the end of the orchard's lifespan.
- Further market research should be undertaken on the marketability of stem-free cherries to gauge market acceptability.
- A group of like-minded individuals should collaborate to develop a growing system based on a Y trellis and develop a mass harvesting machine to suit.

CHAPTER 11: AFTER MY STUDY TOUR

The Nuffield Farming Scholarship has been an amazing opportunity for me to step away from the day-to-day routine of working on a family farm and study a topic I am passionate about. I have gained enormously from the visits I have undertaken and the people I have met, and I believe I am a more rounded person as a result of undertaking this experience.

Taking an extended period away from my family business has forced me to delegate more and allows the people around me to grow in their individual roles. The time away from the coal face also allowed me to step back and review strategically my priorities in life and work.

I am already using the information and ideas from the study tour to benefit our business. In the winter of 2023, we planted three new cherry orchards on the farm totalling 2.68ha. These are all planted on a UFO single plain growing system which means they will be more suitable for future robotic technologies and could be available for developmental trials by robotic companies in 3 to 4 years' time. In addition, I have a trial plot for a Y trellis growing system (see picture below) which could be suitable for a mass harvesting machine if we can prove the growing system works.

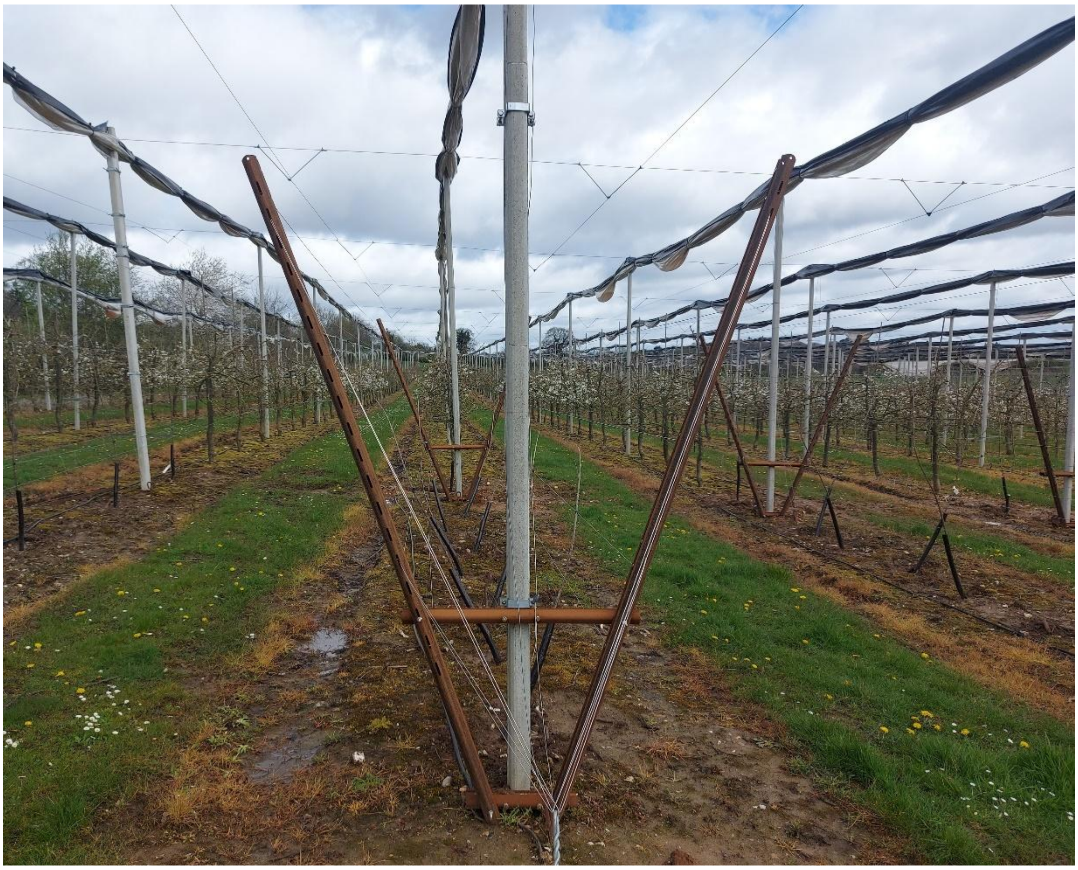


Figure 18: A trial plot for the developmental of the Y trellis growing system. Photo: Author's own.

CHAPTER 12: ACKNOWLEDGEMENTS AND THANKS

I would like to start by thanking my sponsor Malcolm Isaacs NSch for all his generous support which has enabled my Nuffield Farming Scholarship to take place and my mentor Jan Redpath who provided me with support and guidance throughout the whole process.

My sincere thanks to the many people who have taken time to speak to me and share their knowledge and experience. I will always hold dear the kindness and generosity shown to me by the people I met throughout the world.

I would also like to thank all the team at Copas Farms, particularly my brother James, who together held the fort while I was away and supported me throughout my Nuffield journey.

Lastly, I would like to thank my wife Charlotte and children Laura and George for all their support and encouragement throughout this whole journey.

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GLOSSARY

- **BRIX Levels –** Is a measure of the dissolved sugar content of an aqueous solution which is commonly used in fruit production to gauge ripeness.

- **Canopy Training System –** A key determinant of tree fruit management is the canopy training system with the aim to increase light interception, increasing fruiting wood, crop load management and ease of picking. The choice of rootstock, tree spacing and pruning techniques will determine the shape and performance of the tree. There is wide variety of different systems with different names worldwide. The different systems discussed in this report are:

- **Central Leader –** Single central vertical leader with horizonal fruiting wood to create a three-dimensional tree which is self-supporting. Horizonal branches can be trained along a trellis. Fruiting zone spread is usually around 1.5m.

- **Steep Leader –** Four steep central leaders are grown to dilute vigour and create an open vase shape with lateral scaffolding and branches developed to the outside with an opening in the middle to allow light distribution to the middle of the tree. Fruiting zone spread can be up to 3 to 4m.

- **KGB (Kym Green Bush)–** simple training system with the aim of creating 20 to 25 upright leaders which are pruned annually by removing 10 to 20% of the most vigorous branches. Fruiting zone spread can be up to 2 to 3m. System performs better in high light intensity areas where the light can better penetrate the canopy.

- **UFO (Upright Fruiting Offshoots) –** A tree structure designed to utilize the natural upright growing habits of sweet cherry branches and optimise light distribution. Created by planting a nursery tree at 45**°** and growing 8 to 10 vertical fruit bearing branches. Pruning involves annually removing the most vigorous upright branch. Fruiting zone spread should be less than 0.3m.

- **V or Y Trellis –** A split planar system usually planted at 60° to 70° to increase the interception of light. Can be used with a UFO or Central Leader planting system.

- **Chill Hours –** Cherry trees as a mechanism to survive freezing winters have developed a period of dormancy. The quality of flowering and fruit production are directly dependant on optimal conditions during dormancy. Different varieties of cherries have a different minimum requirement for the number of chill hours. For example, Kordia requires 700-750 chill hours while Lapins only required 400-450 chill hours. A chill hour is generally considered to be hour where the temperature is below 45°F (7.2°C).

- **Moore's Law** – is an observation that the number of transistors in an integrated circuit board doubles about every two years. Moore's Law implies that computing capacity doubles every twelve to eighteen months and the cost reduces by half in the same time.

- **Pedestrian Orchard –** An orchard created with dwarfing root stock and pruning systems so fruit picking and maintenance can be carried out from the ground without need for ladders or platforms.
- **Root Stocks –** This is the rooting system and stump of the tree which will determine the height and vigour of the tree. The selection of root stock will be dependent on the climatic and soil conditions. The training system and rootstock should be considered together. Dwarfing root stocks are used to create smaller trees in pedestrian orchards that can be picked from the ground.
- **Varieties or Scion –** These form the upper trunk and branches of the tree which is grafted to the chosen root stock. There are hundreds of sweet cherry varieties available to growers worldwide**.** Some varieties are very old and have been grown for generations like Bing, others are very modern and have come out of the various breeding programmes around the world. Varieties have several different traits determining their selection. For example, time of bloom, cropping date, fruit firmness, tree structure etc.
- **Wall of Fruit –** A planar continuous wall of fruit bearing surface created by a canopy architecture that is trained to a narrow continuous wall to allow increased labour efficiency and mechanisation of harvest and pruning. Usually involves a high tree planting density and training system generally using a trellis.

APPENDIX 1 – LIST OF VISITS

England and Scotland - April & June 2021 and June & August 2022

- Tim Brackhill from Tortuga Ag Tech at the Summerberry Company, Chichester. Developers and manufactures of automated strawberry harvesters.
- Stead Nicolle, Arbroath, Scotland. Cherry farmer and owner.
- Pal Johan, CEO Saga Robotics, demonstrating at the Festival of Fresh. Developers and manufactures of automated robots mainly working with strawberries.
- James Wright, General Manager, Whittern Farms Ltd, North Herefordshire. 260 ha including arable, blackcurrants, cider apples, vines and chicken production.
- Stephen Ware, Owner, Throne Farm, Hereford. 122 ha including agroforestry, arable, cherries, apples and pears. Operates a Weremczuk shake and catch.
- Ed Herbert, Founder and COO Dogtooth at James Porter's farm, Carnoustie, Scotland. Developer and Manufacturer of automated strawberry picking robots.
- Professor Simon Pearson, Lincoln. Director of Lincoln Institute of Agric-Food Technology.
- Robert and Clive Chapman, Bavenhill, Pattenden Machinery, Ledbury. Manufacturers of agricultural machinery.
- Angus Davidson, Founder, Haygrove Farm, Herefordshire. Manufacturers of tunnels and growing systems and farmers producing strawberries, cherries, raspberries, blueberries, blackberries.

USA – June 2022

- Tom Mewin, COO, Mewin Vineyard, Clarksburg, California. Grape farmer and cultivations of grain and row crops.
- Peter Ferguson, Advanced Farm, Davis, California. Manufacturers of automated strawberry and apple harvest equipment.
- Ralph Santos Jr, President/Owner El Camino Packing Inc., Gilroy, California. Grower of 60 ha of cherries and BBC Technologies Mira 360 packing line.

- Dennis Donohue, Director, Western Growers Centre of Innovation and Technology, Salinas, California. With talks from:

- Walt Duffock, Vice President of Innovation, Western Growers
- Norman Groot, Farm Bureau, Monterey
- Josh Lewis, Vice President Agric Operations, Church Brothers. Top five vegetable grower in the Monterey Valley

- Tim Dahle, Owner, Dahle Orchards, The Dalles, Oregon. 120 ha of cherry orchards
- Mike Omeg, Farm Production Manager, Orchard View Cherries, The Dalles, Oregon. 1,450 ha of cherry orchards and Unitec packing line.
- Ashley Thompson, Oregon State University and Mid-Columbia Agricultural Research and Extension Centre, Extension with speciality in cherries and pears. Visits to:

- Kelsey Galimba – Head of Centre
- Tim Pitz, Orchard Manager Mt Adams, Hood River. 323 ha fruit farm with 32 ha cherries. Other crops apples and pears
- Ed Ing, farmer and operations manager of the Dalles Fruit Company packhouse

- Dr Matthew Whitting, Associate Professor/Scientist and Extension Specialist, Department of Horticulture and Landscape Architecture, Washington State University, Prossor, Washington State.

France & Germany November 2022 and February 2023

- Fruit Logistica (Berlin)
- SIMA (Paris)
- World FIRA the Global Event for Agricultural Robots in Action (Toulouse)
- Exhibitors Visited

- PeK Automotive from Slovenia. Slopehelper a fully electric autonomous base platform to attach implements to.
- Teyme Group from Spain. Weta Robot an autonomous robotic platform for vineyard spraying.

- Meropy from France. SentiV a scouting robot for crop surveillance in arable crops.
- ANT Robotics from Germany. Valera a transport robot for agriculture to assist pickers.
- Naio Technologies from France. Robots with 100% electric with RTK GPS auto guidance coming in a variety of sizes to suit different farming operations
- SMC from France. Robotic arms mainly used in factories, but they are looking to move into the field.
- Exobotic Technologies from Netherlands. Arboto a robot offering services in tree nurseries, vineyard, and orchard.
- Exxact Robotics from France. Traxx an autonomous platform for vineyards
- Agrointelli from Denmark. Autonomous vehicles to attach implements to, for example weeding.
- Trektor from France. Autonomous platform for vineyards.

Italy – June 2023

- Nicola Rinieri, Owner Rinieri Machinery, Forli Italy. Manufacturer of orchard equipment for cultivating, pruning, mowing.
- Alberto Blosi – N. Blosi Macchine Agricole. Manufacturer of orchard platforms
- Ottavia Costa and Richardo (Head of Research) Unitec, Lugo, Italy. Manufacturer of fruit processing equipment. Currently working on 45 different fruits and vegetables. Main crops are cherries, blueberries, apples, pears, hazelnuts, employs over 650 people. Large R&D centre with 50-100 employees in the division. On cherries they are working on sensors for internal fruit quality and BRIXS levels.
- Marco Marini – Compact Orchard Platform, Sarnonico, Trento, Italy. Manufacturer of orchard platforms.
- Claudio Bortolussi (Owner) and Giorgia Brusadin at Molificio Bortolussi – Vignetinox, Fiume Veneto. Manufacturer of springs and fruit trestle systems.

Netherlands – September 2023

- Djuke Smith, Owners, Marsdijk, Utrect – Pick Your Own Farm growing apples, pears, cherries, kiwi, kiwi berries, pumpkins.
- Van Eeden - Jub Holland, Noordwizkerhout – Bulb Business specialising in tulips.
- Erik Vernooij – Owner, Cothen, Utrect. 50 ha of fruit, 16 ha of cherries, redcurrants, apples, pears.

Chile – December 2023

- Alvaro Cuevas – Head of Post Harvest Research - Garces Farm — Saint Francis of Mostazal. Forty farms owned mainly in Central Valley average size 100ha. Therefore approximately 4,000ha of cherries in production. Three packhoues, Saint Francis of Mostazal, Molina, Malloa. Also grow plums, peaches, nectarines, kiwis.
- Pelao Repe - Owner - Agricola Entre, Molina. 95 ha including 20 ha of cherries, also growing apples and hazel nuts.
- Antonio Bunster Zegars – Molina. 200 ha including 15ha of cherries. Also growing vines, beans, alfa alfa with a herd of cattle.
- Luis Ahumada – Centro De Innovacion Montefrutal (CIM) Research Station specialising in cherries.
- Paulo Munoz and Dave Cuthbert (Sourcing Director) – Angus Soft Fruit – Longavi, Chile – 92 ha blueberry farm.
- Julio Pino and Vincent from Reemoon Technology Co. Ltd, Santa Blanco, Curico. Cherry packhouse, two-year-old processing line, six lanes and 24 exits.
- Oliver Rose – Owner of Rose, at a packhouse owned by Agricola Y Ganadera, Santa Barabara LTDA. Growing 50ha of cherries and a fruit trading business. Packing done on contract.

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