Understanding Decision Making for Automation in Packhouse and Human Capital Requirement

Promoting career pathways in agriculture

A report for

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Executive Summary

The adoption of automation in packhouses is eminent. Businesses will need to make decisions on how much is enough. While some businesses have been adopters for well over 20 years, the late adopters and businesses at different stages of expansion now have learning opportunities. Serious thought should be put into decision making around automation as it is a big investment. All direct and indirect costs should be assessed and considered. The stand-alone equipment makes it possible to sectionise adoption, and input capacity (fruit bins) and physical size of facility structure will determine the level of automation. An important element is the philosophy of the organisation. Two places visited as part of this research chose to not run their equipment to full capacity to not 'automate people' out. Community survival is built around their business with many two-generation family employees.

Automated packhouse equipment is designed with the turnkey concept, requiring technicians to plan production and run the line, as well as maintain the equipment. Business has the option to re-skill/upskill the current workforce or recruit for needed skill. While much consideration is given to retaining the current workforce, it is important to note that the development of soft skill will be essential for new roles.

Developing soft skill can be achieved through in-house mentoring and gradually introducing suitable employees to the new roles. Business must understand this will take time and be ready to invest time.

As an aging workforce might choose to opt out of new roles, businesses will need to weigh the non-monetary cost of releasing a workforce that understands the culture of the organisation and ensure a transition plan is in place.

The future of the industry will rely on transforming the potential of younger people through new technology and new thinking. Building the future workforce means a target audience of secondary school students. The industry stakeholders will have to take a role in creating awareness of career opportunities in the sector. The industry bodies should collaborate with schools on career day events, field trips, speaking engagements and coordinate with individual businesses on internship program or job shadow. There should be stronger engagement and involvement of the industry stakeholders with youth organisations.

This study aims to be a living document as the author will be looking more into the work currently done by different industry sectors within Australia in creating awareness and promoting career pathways to the target cohort.

Since the start of this study, the author has been involved in a career day event, and guest speakers at both university and secondary school events.

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Foreword

Growing up, my profession of choice was to be a pharmacist. Thanks to my dad (blessed memory), an Agric Engineer, on his insight that there will be a future for a degree in Storage Technology, I completed my BTech in Storage Technology in Nigeria and later moved to Australia for my postgraduate studies. My PhD research at the University of New South Wales was around extending storage life of fresh produce. I spent some time working in the food industry before taking up a technical position at Geoffrey Thompson Holdings in Shepparton, Victoria.

Jeftomson is a vertically integrated horticultural business - growing, storing, packing, transporting and marketing apples and pears in both domestic and export markets. As our organisation continues to grow, I began thinking about how prepared we were for the next level of expansion. Already automated in certain processes, how much more would be needed for better efficiency, the human capital required, and if collaboration would be needed with other packhouses in the vicinity to run an efficient fully automated process? Thinking ahead, the strategic plan for the management of the business, which thrives from local industry interaction, I realise is not just unique to us but relative to the size of operation.

As an industry representative in a committee looking at 'Skilled Workforce Solutions' for horticulture in the region, I realised that as an industry, we have not done much in securing enough of the future workforce pool, especially in enlightening students on career options in agriculture and the agri-food sector. In line with that, I thought it would be worthwhile incorporating this into my Nuffield study, to gain an understanding of what is being achieved around the world to create awareness and promote career pathways in agriculture. An industry that is so diverse and becoming increasingly automated might capture the interest of the next generation, but they need to be aware of it.

I researched equipment manufacturers and businesses that are already in the realm of automation and for their understanding of the human capital/skill requirement.

For my six-week Global Focus Program, I travelled in the company of nine other scholars to Ireland, USA, Mexico, Brazil and New Zealand at the back of the Contemporary Scholars Conference at the Netherlands.

My individual travels took me to Europe where I visited 17 packing facilities in Italy, France, Netherlands and the UK; with processing spread across apple, cherry, tomato, stone fruit, melon and cut flowers; two machine manufacturers and two other non-agricultural operations that have deployed automation. In North America (Canada & USA), I visited ten packing facilities covering, apples, pears and nursery/cut flower, one food processing plant, a winery and a hydroponic operation. While in North America, I also met with industry stakeholders to understand their work in promoting careers in agriculture.

Figure 1: Olabisi (Bisi) Oladele, the author of this report

Acknowledgements

An apple is only good for the person holding it, while an apple tree with the right condition will thrive and feed many more mouths. Choosing to be an apple tree, I was opportune to be linked by Nuffield Australia to my investor William Buckland Foundation (WBF). May I then extend my sincere gratitude to those who believed I was a suitable candidate for a Nuffield Scholarship and my investor WBF who through their continuing support to the cause of Nuffield made this learning adventure possible for me.

A huge thanks to the board and management of Geoffrey Thompson Holdings for being a fantastic employer, supporting and releasing me for my travels and especially the MD Garry Parker who continues to believe in me.

A special appreciation I extend to those businesses and organisations that hosted me, sharing their time, knowledge and experiences with me.

To Muyiwa, Tomi and Tobi, who gave me the assurance that they would be ok while I pursued my learning adventure and continued to touch base to ensure I was going well during my solo traveling, thank you guys. We all made it! You are the best. I acknowledge my extended family and friends who supported and encouraged me during my time away.

A big thank you to my colleague, Jennifer Shields for her editorial guidance.

And to the Almighty God, the giver of life that enables me to do all things, I give my endless thanks for the great things he has done for me.

Abbreviations

Ag	Agriculture
AITC	Agriculture In The Classroom
ABS	Australian Bureau of Statistics
CAD	Canada
CASE	Curriculum for Agricultural Science Education
FANR	Food, Agriculture and Natural Resources
FFA	Future Farmers of America
GB	Great Britain
GDP	Gross Domestic Product
HBW	High Bay Warehouse
IT	Information Technology
OMAFRA	Ontario Ministry of Agriculture, Food Resources Agent
PFB	Pennsylvania Farm Bureau
STEM	Science Technology Engineering Mathematics
SKU	Stock Keeping Unit
TFWP	Temporary Foreign Worker Program
UK	United Kingdom
US	United States
WBF	William Buckland Foundation

Businesses and Organisations Visited

Italy
Salvi Group, Ferrara
Laimburg Research Centre, Terlan
GEOS, Lanze AT
Lagnasco Group, Lagnasco CN
Rivoira, Verzuolo CN

France
Mesfruit, Salaise sur Sanne
Earl Lazare Didier, Villes sur Auzon
Earl Provence Alpilles, Eyguieres
Cofruidoc, Saint Just
Earl Des Clairettes, Vauvert
Mas Saint Paul
Sas Gerin Charles & Fils, Carpentras
Mafagrobotic, Montauban
Philibon, Montauban
Mountounade, Bressols
Stanor, Moissac
Novacoop
Technic Moules

Netherlands
Fruit Master
Greefa

United Kingdom
Cottage Farms, Kent
Collision associates, Norfolk
Collison cut flowers, Norfolk

Canada, Ontario
CAHRC, Ottawa
4-H Ottawa
Norfolk Fruit Growers' Association, Simcoe
AgScape, Milton

USA, Washington
First Fruit Orchard, Prescott
Allan Bros, Naches
Gilbert Fruit, Yakima
Van Doren, Wenatchee
McDougall Fruit, Wenatchee
Starr Ranch fruit, Quincy

USA, New Jersey
New Jersey Department of Agriculture, Trenton
Robbinsville Hydroponic farm, Robbinsville
Kube Pak Greenhouse Operation, Allentown
Cream Ridge Winery, Cream Ridge

USA, Pennsylvania
PA Farm Beureau, Camp Hill PA
Mobile Ag Science lab
Krouse Food
Rice Fruit, Gardener

Objectives

The aim of this study is to investigate human capital requirements for increasingly automated industries with focus on packing establishments.

The study looked at:

- The different levels of automation and business decision making required around automation uptake.
- The skill requirement to efficiently perform in such operations.
- How to raise awareness and promote career opportunities in agriculture and agri-food sectors to students with a focus on secondary schools.

Chapter 1: Introduction

The agri-food sector continues to be a significant contributor to the economic success of developed countries:

- The Australian Bureau of Statistics (2018) reported that the Australian agriculture sector, at farm-gate, contributed 3% of Australian total gross domestic production (GDP), with a gross value of farm product of $60 billion in 2016-17. The sector, including food and fibre industries, provide over 1.6 million jobs to the economy.
- The Canadian agriculture and agri-food sector employ over two million people, equating to one in eight jobs in the Canadian economy and 12% of total Canadian employment (Canadian Agricultural Human Resource Council, 2016).
- In the UK, the entire agri-food supply chain, from agriculture to final retailing and catering is estimated to contribute £96 billion or 7% of gross value added, with employment of 3.8 million people for the whole food supply chain (UK Strategy for Agricultural Technologies, 2013).
- Americans spend 13% of their household budget on food, with agriculture, agri-food and related industries contributing $992 billion to the US GDP in 2015. The sector provides 11% of all US employment, with 21.6 million jobs. This is broken up into direct on-farm employment of 2.6 million and the rest in the auxiliary and agri-food related industries (United States Department of Agriculture Economic Research Services, 2018).

1.1 Current labour outlook

Even with these figures, labour shortages are continuously being echoed for the present and the future:

- UK post-Brexit will be experiencing a further pressure on labour needs, with 27-35% of workers in food processing, 50-60% full timers and 90% seasonal workers in the agriculture sector all employed from outside of the UK (Collison, 2018)[1].
- The primary production sector alone in Canada is estimated to be short 113,800 people by 2025 (Canadian Agricultural Human Resource Council, 2016). A more recent report

[1] Martin Collison is the Director of Collison & Associate. A consultant to both industry and government, and involved with writing government agricultural policy.

shows over 10,000 vacancies in the top three occupations associated with farms and over 7,000 with those associated with food manufacturing, which are the highest recorded for food manufacturing since Canada's Job Vacancy and Wage Survey statistics started (Canadian Agricultural Human Resource Council, 2018).

- Pratley (2012) reported a sizeable job market in Australian agriculture with more than 4,000 jobs consistently being advertised yearly seeking agricultural professionals. This is for positions requiring tertiary qualifications with Australian universities only able to meet 20% of the job market demand.
- In the US, it is expected that only 61% of job openings in the sector by 2020 will be filled (Goecker, *et al*., 2015).

While statistics may differ from one country to another, it is obvious that the availability of skilled people to work in agriculture and agri-food positions will not be meeting the demand. Labour shortage has always been mentioned as a major and growing concern in many countries. New Zealand relies on a Regional Worker Scheme, USA on a H2-A visa program, UK on Seasonal Agriculture Workers Scheme, Canada the Temporary Foreign Worker Program (TFWP) and Australia on the Seasonal Workers Program.

One common theme in most developed countries is the lack of willingness of domestic workers to do farm or packhouse jobs, yet willing to take up the same job for extra cash and visa requirements when backpacking in other countries. The industry then continues to rely on backpackers and foreign workers. While the TFWP program is a relief to the Canadian agriculture sector, it is not seen as a long-term economic option. A primary agriculture company estimated it was $12,000 more expensive to hire a low skilled, temporary foreign worker than a Canadian (Canadian Agricultural Human Resource Council, 2015).

The Canadian Agricultural Human Resource Council, by developing a National Workforce Action Plan, identified ways to on-board individuals that were ready to join the workforce (e.g. temporary foreign labour, second career, recent graduates and immigrants). Whilst these short and mid-term solutions to addressing the labour shortage are a step in the right direction, it is important to consider a long-term plan, targeting those that are yet to enter the workforce by creating an awareness that could influence their future career decision making. This will be in positive messaging and impactful learning experiences about agri-food careers. The elimination of process jobs in favour of automation might also be a good selling point.

1.2 Quest for automation

Along with the labour shortage is the labour cost itself. The states of Washington and California in the USA, which are both major fruit and vegetable producers, have minimum wage around US$13/hr. Ontario province, Canada is at CAD$11.60/hr with an expected wage rise to CAD$15/hr by January 2019. Martin Collision (pers. comm., 2018), noted that a minimum wage of GBP£6.50/hr introduced in the UK in 2016, will be increasing to GBP£9/hr by 2020, although farming has always had a national living wage which is higher than the minimum wage. Superannuation, which used to be optional for employers, is now mandatory, so this in addition will raise expected wages by 37% by 2020. With 80% of the marketing through retailers, retailers' own costs in line with the wage rise will again very likely flow back to the food chain with farmers sitting at the bottom of it.

Martin also noted that with the restricted labour supply and rapid increase in wage cost, alongside technology costs that are reducing, UK businesses are adopting more automation.

Automation or digital quest are now at the forefront for every sector. We all know we need more of it, but to what level of infiltration and what existing infrastructure and process changes will be required.

1.3 Future workforce

Jobs in agriculture, like any other sector, are changing from what it was always known to be. While putting temporary measures in place for labour shortage, it is important as an industry to have strategic planning for the future. But is the industry equipped with the skills that will get it to the next level?

Whilst working on temporary solutions to skill and fill labour shortages, strategic planning is required to build a strong collective of future workers for the entire agriculture sector. The future of the sector are the current agriculture students and the ones yet to make the commitment to study. The interest of the former must be maintained and the later gained.

While looking at the human capital requirement for this new wave of automated operations, it is important to know the different types of equipment that are currently in use and understand the justification and deciding factors of a business around complexity and the choice of automation needed. This study will focus on automation in packhouses.

Chapter 2: Automation in the Packhouse

Labour challenges have been the mainstay for the shift towards automation. Automating the packhouse can be considered as not just making the task easier for those wanting to work in the industry but also to tackle the labour shortage challenges in the industry. Replacing physical tasks should be welcoming to the industry, as manual handling and long hours have been the main factor for people not considering a job in agriculture.

> *Automation is the use of technology to improve processes and outcomes with substantially reduced reliance on human involvement.*
> Skill Impact – Case for Change

The journey of horticultural produce remains similar from the farm through to the consumer. Reviewing fruit for example, produce is harvested, and either packed immediately or stored and packed later. The packing process includes washing, sorting and grading (Figure 2), waxing (in some instances), sticker labelling (if required), packing in boxes/crates/trays as loose (jumbo as known in Italy) or prepack packaged in bags, punnets or trays.

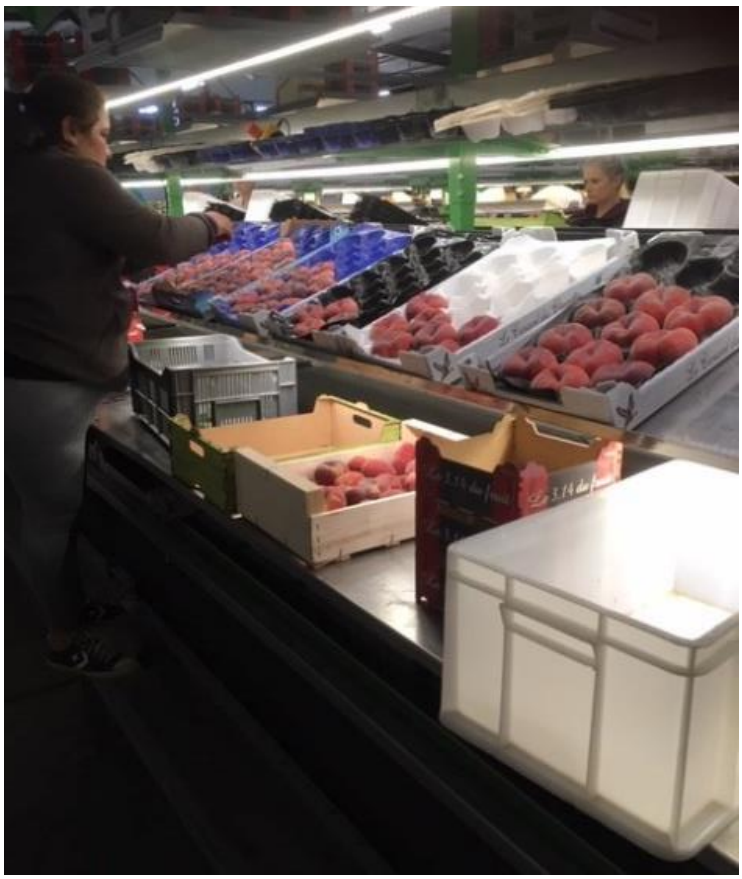


Figure 2: Packer grading to five different customer requirements (Author)

Straight picked fruit bins from the orchard come with different quality and sizes of fruit that must be graded to meet different customer specifications. Relying on operators to grade for colour and size whilst inspecting for quality at the same time will deter their decision making/judgement, which then gets more challenging with different customer requirements ranging from class one fruit to juice/peeler grades.

This part of the study looks at different types and levels of automation adoption and outcomes for different businesses, with horticultural produce as the main focus. Automation involves using technology to perform routine processes. Most tasks within the packhouse are routine and businesses continue to be reliant on people making decisions. Sorting of produce according to size, quality and colour is a complex procedure making automation now a necessity in packing facilities. The industry has for a while evolved from relying on line operators doing the sorting and grading to more reliance on different levels of machine involvement.

There are various steps within the packhouse (warehouse as used by the Americans) in the processing of horticultural produce, with different machines now developed. The range of automation now defines the level of automation within a business. After consideration of the cost of the machinery, the decision on levels of automation will very much be dependent on volume handled by a packhouse and on needs basis.

There is an obvious productivity gain in businesses with more automation as shown in Table 1.

While some businesses will aggressively invest in automation to innovate, grow and capture market shares, some others will be for improved efficiencies in slower growing businesses.

Table 1: Summary of productivity in some businesses visited during this study (Author)

	Business Capacity (tons/annum)	Equipment	Presizer		Packing line			Rapid packing line		
			Productivity (tons/hr)	Number of staff	Productivity (tons/hr)	Number of staff	Productivity (kg/man hr)	Productivity (tons/hr)	Number of staff	Productivity (kg/man hr)
Apples										
Salvi	133,000		22	7	**7.5**	18	**417**	3.75	7	**536**
GEO	70,000		28		**31.2**	80	**416**			
Lagnasco	32,400		20		**50**	32	**1,562**			
Rivoira	65,000		31		**42.2**	35	**1,205**			
JMC Fruit			18.5	6	**3**	8	**375**	3	4	**750**
		robotic packing						4	4	**1000**
Moutounade[2]*	8,000			2	**3.5**	7	**500**	5	5	**1000**
		robotic packing						3	3	**1000**
Fruit Master			25	5	**3.5**	7	**500**			
Cottage Farm			13.8		**5**	12	**416**			
First Fruit	207,000	BLUE packing line			**23**	93	**247**			
		SILVER packing line			**34.5**	84	**410**			
		RED packing line			**46**	82	**560**			
Allan bro	83,500				**48**	50	**960**			
Gilbert	82,000				**42.2**	90	**468**			
Starr ranch	86,100	commit to pack line	none		**26**	110	**236**			
Rice fruit	44,160		23	12*	**19**	60	**316**			
Norfolk	18,145				**14.26**	50	**285**			
Other produce										
Salvi		packing line - kiwi			**3.28**	16	**205**			
Lagnasco		presizer peach			**37.5**					
Rivoira		nectarine packing line			**18.75**	50	**375**			
		kiwi packing line			**18.75**	70	**267**			
Earl Lazare Didier - Cherry					**1.6**	20	**78**			
Meffre melon		old packing line			**5**					
		new packing line			**10**					
Philibon melon					**40**	250	**160**			

[2] Moutounade is a Maf packhouse where all their equipment is trialled

2.1 Automated equipment

2.1.1 Presizer

The sheds with technology known as a presizer (Figure 3) usually process more than 80,000 bins per annum. This is an equipment that grades mixed orchard bin fruit into different combinations based on weight, colour and defects (external and/or internal). High value delicate varieties such as Honey Crisp are not presized as double handling increases the potential of bruising and stem punctures The presizers generally have two or three staff operating them, with one in the control room and the other on the floor attending to alarms as they arise. The presizer which could be water lanes or dry bin filler, operates through the process of orchard bin fruit running on cups through an optical camera. Every single piece of fruit is photographed 28-35 times at the minimum, within a few seconds of rotation. Computer software identifies measured values from these images and accordingly assigns every fruit to precisely defined quality classifications. On the cup conveyor belt, the fruit are allocated to different water flume lanes (Figure 4) or bin filler. Fruit with the same size, quality and colour are filled into the same bin.

Figure 3: Presizer with options for both wet and dry fruit filler (Author)

Figure 4: Presized Golden Delicious at Mesfruit (Author)

There is an option to have Near Infra-Red incorporated into the sorting system. This is a non-destructive technology for internal defect detection.

Although the defect sorters have 80-90% accuracy built in, most businesses visited preferred to reduce this and allow the packers further down the packing line to make informed decisions on the final quality, depending on who the customer is. The presizer does a reliable task in sorting fruit into the required grades with minimal staff. Pre-sized fruit bins could either be sent straight to the line for packing to fill customer orders or be put into cold storage to await orders. There is the option for all empty bins from the presizing process to go through a bin wash unit to be cleaned before the next use.

The orchard bins may be brought in directly from the field during harvest for presizing or could be in refrigerated holding rooms for when presizing is required. Most presizers have a stacker/ de-stacker unit. Forklift drivers feed and take pre-sized bins from the presizer. Most businesses visited tend to not presize the high value delicate varieties such as Honey Crisp, as double handling increases the potential of bruising and stem punctures.

Another level of automation to this process is the High-Bay Warehouse.

2.1.2 High-Bay Warehouse

The High-Bay Warehouse (HBW) is a fully automated storage chamber with complete elimination of forklift use from when a truck is unloaded until it is dispatched. The HBW could be used to store either straight picked orchard bins, presized bins, or finished pallets from commit to pack processes.

A logistic interface coordinates between storage, sorting and packing. Bins are held in stacks of three, on racks that could be up to ten high (Figure 5). The higher the holding rooms are built, the lower the per bin cost. There is however a height limit, based on temperature control, when bins are stacked too high. All movements are fully automated and operate on a Warehouse Management System which is interfaced to a Production Planning System through which bins are called for when needed.

As bins are required for the presizer, the automated shuttle collects the bins and directly feeds them into the presizer bin tipper. Once the bins are filled, the shuttle takes them back inside the racked holding room until they are required on the rapid packing lines, or for direct dispatch in bins. The HBW allows direct access to the grade ordered by a customer within a minimal time.

Figure 5: High Bay Warehouse at Rivoira (right), with shuttles to and from the HBW (left) (Author)

2.1.3 Packaging hall

With so many different customers and each wanting their own unique packaging, packhouses in Europe and USA tend to handle a lot of different packaging types. Packhouses visited will have packaging delivered to the packing hall from the mezzanine on conveyors or a rotating system (Figure 6). Based on the packing program for the day, the cartons could be coded for later use by automated labeller and/or palletiser.

Figure 6: Packaging delivering to packing hall at Philibon (Author)

2.1.4 Pack lines

Fruit that has been presized for quality and colour are delivered to dedicated packing lines where fruit are placed in trays/cartons. Commit to pack lines have optical cameras on the lines similar to the ones on the presizer, sorting and grading for quality colour and size before packing (Figure 7). There are options for manual packing lines or semi auto tray packing lines. With the semi auto tray packing, fruits are placed on trays automatically, with their position adjusted manually before placing in cartons. This packing line requires fewer people, but fruit must be of a high quality. The expectation is to process five tons/hour with three people. While one person de-stacks trays for auto filling, one arranges fruit in tray and the other put trays in the box, which is then manually stacked on pallet or conveyed to the palletiser. There is an option for automatic carton filling to required weights, after which the carton is released

automatically to a conveyor to be palletised. Noted is a large transference towards prepack lines in countries visited both in Europe and North America.

Figure 7: Melon going through an optical camera (Author)

There is an advanced technology referred to as a rapid or speed packer and palletiser. This has just one person to arrange fruit in the machine filler for robotic arms to pick and drop into packing trays that are already in the carton or punnet. Once the required number of tray layers in a carton is achieved, the carton is automatically conveyed to the palletiser. This technology has a glitch in that configuration of trays will have to be same for the entire production run.

An improvement to this is robotic arms that are individually operated. These arms have an added advantage of being able to position fruit by colour with stems pointing in the same direction.

2.1.4.1 Rapid packing line

When required for the rapid packing lines the robot delivers bins to the tipper. The rapid pack bin tipper has the ability to partially tip a bin, metering out the exact weight required to fill the production order. The unused part bin is then returned to the holding room. This is a pack to order process where only pallets needed for orders are packed. Once the fruit is packed it

is taken by robot to the holding docks for dispatch, or if not required that day, back into the refrigerated holding room.

Figure 8: Robotic packing of apples at Terre De Crau (Author)

2.1.5 Accustack

This is an interesting concept of layered conveyors as dynamic storage prior to palletising. One palletiser can handle different Stock Keeping Units (SKUs) at different times. A SKU is accumulated on the Accustack until the required number of cartons or trays to make a pallet is met. The accumulated trays are palletised, labelled and moved to the conveyor while the palletiser awaits the next SKU (Figure 9).

Figure 9: Accustack in use for tomato trays (Author)

2.1.6 Palletiser

Crates and cartons are automatically stacked based on a customer's configuration requirements. Labelling with full traceability is done just before or at this stage. Finished pallets are automatically moved by a robot or a forklift (Figure 10).

Figure 10: Automatic palletiser (Author)

2.2 Automated packhouse case studies

This section highlights some key areas of the various packhouses visited during this study. Table 1 provides a productivity comparison between these businesses.

Case Study 1: Salvi Group, Italy

Owner(s): Salvi family business. Operations run by the third generation but visited daily by second generation (Figure 11).

Number of years in business: History dates to 1891 but company, *Salvi*, started 1968.

What they pack: Apples, kiwi, pears, table grapes, citrus fruits, strawberries, peaches, nectarines, apricots and plums. Also involved in research and nursery.

Business capacity: Annual turnover of €180 million. 133,000 tons of fruit handled per annum and 1,000 tonnes processed per day. One third ownership of the research company CIV Italian Vivaisti Consortium. 5,000ha with about a quarter owned by the Salvi family.

Business model: The Salvi Group is vertically integrated from research, nursery, fruit production, storage, processing through to sales and marketing.

Comment: The business would have only been able to do a third of the throughput with the same amount of staff (before automation).

Packhouse automation: Presizer (two types - one for dry fruit (kiwi and stone fruit) and the other one for wet fruit (apples). Rapid packing line.

Figure 11: Author with 2nd and 3rd generation Salvi

Case Study 2: GEOS, Italy

GEOS is one of seven cooperatives that make up VI.P totalling 1,720 farmers. VI.P – the Val Venosta Co-operatives Association (Figure 12).

Owner(s): GEOS membership of 300 farmers

Number of years in business: Founded 1946

What they pack: Apples

Business capacity: 70,000 tons for 200 working days.

Figure 12: Image from GEOS booklet showing the seven cooperatives that make up VI.P

Packhouse Automation: Automated for 24 years with ongoing modifications. Presizer. Automatic labelling and palletiser with integrated weighing system. High-Bay Warehouse.

Comment: With the level of automation, the business still chose to have forklift drivers on the line placing bins brought out by robots from HBW on the packing line. This is to ensure the 30 forklift drivers needed during the three weeks harvesting still have work available.

Case Study 3: Lagnasco, Italy

Owner(s): Cooperative of 240 growers (Figure 13)

Number of years in business: Started 1989

What they pack: Apple, peach, nectarine, kiwi and cherry

Business capacity: 83,000 bins (apples), 100,000 bins of other produce

Automation: Since 2007. Presizer (3000 bin capacity. Two bin fillers with 36 lanes). HBW with shuttles. Palletiser (four), packing lines (three). Same line for dry and wet grading. Line diverts to whichever is applicable, brush for apples and belt for peaches.

Return on Investment: Cool store building (15 years), presizer (ten years).

Comment: 30% reduction in employees, better quality and efficiency

Figure 13: Author with the team at Lagnasco

Case Study 4: Rivoira, Italy (Apple) & Kiwi Uno (Kiwi, nectarine, peaches, plum)

Owner(s): Giovanni Rivoira family

Number of years in business: Started 1960. Second generation, with third generation starting to take up some positions.

What they pack: Apple, kiwi, nectarine, peach, plum.

Business capacity: 500 hectares family owned and 180 growers with 15 hectares average/grower. Annual process capacity of 65,000 tons apple. Dispatching 25 containers/8 hr day.

Automation: New three level warehouse built 2016. Housing the Presizer (basement) with capacity of 35 tons of apple/hr, packing hall with six packing lines: two prepack lines – punnet (manual), one prepack – bag (manual), one loose and two loose export lines, palletisers (five) and packaging hall (mezzanine). There is also an HBW with storage capacity of 18,000 bins or graded apples.

Fully automated packhouse, with Laser Guided Vehicles LGV used for transportation throughout the packhouse operation. Forklift is only used for truck loading.

Return on Investment: Five-to-ten years.

Case Study 5: Cottage Farm, Kent, UK

Owner(s): Chris Browning, second generation.

What they pack: Apples for 68 English growers and handles imported apples.

Business capacity: 3.3 million cases annually.

Automation: Presizer, semi-automated packing lines and palletiser.

Case Study 6: Allan Bros, WA, USA

Owner(s): Fifth generation family owned.

Number of years in business: Started 1955.

What they pack: Apples and cherries.

Business capacity: 80,000 bins (36,800 tons) four years ago, now 200,000 bins (92,000 tons). 30-40% Allan bros own fruit.

Total Workforce: 400 employees (local – packing, shipping, warehouse operations) + 150 H2-A Visa program participant from Central America, Mexico.

Automation: Presizer, Semi auto packing line.

Case Study 7: Starr Ranch, WA, USA

Owner(s): Jim Dalton, third generation.

Number of years in business: Started 1934.

What they pack: Apples and cherries.

Business capacity: 210,000 bins (96,600 tons). 60% from own orchard.

Automation: Commit to pack line and robotic palletiser.

Case Study 8: Norfolk Fruit Growers' Association, ON Canada

Owner(s): Collectively owned by eight members with no share capital.

Number of years in business: Started 1906 with 13 members, now eight members – two associates, and six full board members. Associate members do not incur gain or loss, with little exposure to risk, therefore no voting right.

What they Pack: Apples.

Business capacity: Store and handle 18,145 tons of apples annually from 1,400 acres (15% of the total Ontario apple production).

Automation: Hybrid and Commit to pack lines.

Case Study 9: Rice Fruit, PA USA

Owner(s): Family owned, fourth generation transitioning to fifth generation.

Number of years in business: Started 1913.

What they pack: Apples, stone fruit.

Business capacity: 96,000 bins (44,160 tons) annually. 15-20% of own fruit + 40 other growers.

Total Workforce: 140 all year round. All from local area. 40% English only, 40% Spanish only and 20% bilingual.

Automation: Presizer, commit to pack lines (two).

Comment: Business operates inefficiently by design as they would not want to automate people out. Value people over full automation.

Case Study 10: First Fruit, WA USA

Owner(s): Ralph and Cheryl Broetje (Figure 14).

Number of years in business: Started 1968.

What they pack: Apples and cherries.

Business capacity: 6,000 acres. 400,000 – 500,000 bins (184,000 - 230,000 tons) all from the orchard. 5% of Washington state apple industry.

Total Workforce: 600 people + 1,400-1,500 in the Orchard.

Fruit First has three different packing halls with different levels of automation. While the silver and red lines are highly automated, the very first line – the blue line reflects on how the business started, demonstrating the owners' strong attachment to the community. The only automation on this line is the bagging line.

Something interesting about the last two businesses (Case studies 9 and 10), is the choice to not run as efficiently as possible as they do not want to automate people out. All workers at both businesses are local and they believe their commitment is first to the community before business profitability.

With many businesses yet to adopt full automation in their packhouses, it is important to understand the human capital involved.

Figure 14: Author with Cheryl Broetje, First Fruit, WA, USA

Chapter 3: Understanding Human Capital Requirements for Automation

Automation involves using technology to perform routine process. With most tasks within the packhouse routine, automation removes human involvement in that precise task and instead shift roles to the use and maintenance of the machine or to ancillary activities.

Skill shifts have always accompanied the introduction of new technology, so there is no surprise that the recent adoption of automation has accelerated the shift in required workforce skills. One study by Bughin, *et al.* (2018) on automation and the future of the workforce reported there was a strong growth in demand for technological skills as well as social and emotional skills (such as leadership and managing others) and to a lesser extent physical (manual) skill. They noted there has always been a concern for the proportion of jobs that will be lost to automation, but the reality is that automation will reshape jobs by either replacing, augmenting or creating new ones. They also noted that competition for high skilled workers will increase while displacement will be concentrated mainly on low skilled workers.

Martin Collison having worked as a consultant to Felixstowe, the largest port in UK, gave an insight into that business. Felixstowe employs up to 22,000 people with most of those driving trucks. They expect two thirds of these positions to disappear in ten years with the advent of automated forklifts, auto warehousing and self-driving trucks. However, they believe they will still need the same number of people with the expectation that trade continues to grow. Staffing changes are in areas such as managerial and marketing/salespeople, information technology (IT) and engineers to put machines together and manage them.

"So, the jobs will be there but whether we can train people quickly enough to do the job as the nature of work as we know it now will change quickly" (Collison, pers. comm., 2018).

Skill and cultural changes will be the fundamental motivations that go with this change. According to Martin:

"Mid-management are like sergeant majors in the army. They look after their staff and shout a lot, telling their staff exactly what to do. So rather than possibly a team of 20-25 relatively low skilled staff that they boss around in order to do a good job, the focus might have to be ten skilled staff with a technical background, who not only run the lines but are able to value-add through business plans and innovation".

Along with addressing the skill shift, companies will need to be prepared to make significant organisational changes. Jobs and positions will need to be redefined as tasks change with a shift to more cross-functional and team-based work. Adopting technology comes with additional cost to the technology cost itself. There is a cost to sourcing human capital, re-skilling existing workforces or managing those who will not be retained due to automation of specific job roles or activities.

The executive team must have or seek enough knowledge of how automation adoption will impact the current way of doing business and future financial performance, which is a skill requirement for that level of operation and decision-making roles. The key to this will be automation potential for the business and the current workforce skills and dynamics. It is important to note that timing is important as early adopters tend to attract the talent they need, leaving the slower adopters limited options and further upskilling costs.

The current workforce will need to make better use of their existing skill sets or work on acquiring new ones. The real challenge will be how to retrain current low skilled workforce members to be able to do the new job and benefit from the investment.

> *CFO asks CEO: "What happens if we invest in developing our people and they leave us?"*
> *CEO: "What happens if we don't and they stay?"*
>
> *Unknown*

The organisation will have to identify competencies required to use automated equipment, to work in automated processes or new jobs created by automation. This will help to target investment in skills that will be beneficial to the organisation and the individuals.

According to the equipment manufacturers visited[3], the current packhouse technology is designed around a turnkey system with very little human involvement. Once input parameters are set very few key operator adjustments will be required. A high level of technically skilled maintenance crew with electronics, mechanical, Programmable Logical Controllers (PLC) programming and IT credentials will be needed.

Along with obtaining technical skill, will be an awareness and development of soft skills. It is important that training organisations understand this and make provision for these types of

[3] Maf Roda in France, Greefa in Netherlands and Van Doren in the USA.

abilities in their training programs. The current and potential workforce will need to understand the social implications of the move to automated work processes and how to manage the impact on the organisation (Skill Impact, 2017), for example, boredom, specialisation, or the inability to find other specialised employment.

Bughin, *et al.* (2018) reported that soft skills will play an important role in the readiness of the workforce towards automation with that including the ability to communicate and work well with others, solve problems, and creativity. Their study also shows that skill requirement for automated systems involve high levels of cognition and complexity than that needed in a low-skilled workforce.

> *Robots may acquire analytical and mathematical skills, but they can't replace humans in leadership and managerial roles that require people skills*
>
> Guthrie-Jensen Consultants (2018)

A business will have multiple contributors to an efficient production run. It is important that key employees can work backwards to figure out solutions to problems that could come from any of the multiple sections within the business. Simply put, complex problem-solving skills.

People management, coordinating with others, decision-making, negotiation and serving others are other skills that make for a mastered role (Guthrie-Jensen Consultants, 2018).

The skill gap will have to be undertaken by recruiting for skills needed or teaching current employee skills that are new or qualitatively different.

3.1.1 Recruiting for skill

When recruiting skilled individuals, the reward to the business is immediate, but only if the right individuals have been recruited. There were some instances where businesses were unable to have current employees with enough skillset to build up on and have had to fill such positions externally. Some businesses consider bringing in new skillsets as an added advantage for fresh ideas especially where quick outcomes are needed. Conversely, a cost is involved for the time it will take for new recruits to understand and adapt to the new environment and culture.

3.1.2 Re-skilling

Most places visited indicated a preference for internal recruitment and/or re-skilling and were happy to invest in a workforce that has been loyal to their businesses. This is easier as they already understand what the employee can bring to the position and the training that will be needed to function in the new role. They have the opportunity to gradually give the employee increased responsibility, and to ascertain their performance and suitability for a higher role. In a highly variable and subjective business, it is important to be able to match the entire fruit production process to a market requirement, an ability that comes with knowing the business.

> *The conventional definition of management is getting work done through people, but real management is developing people through work*
>
> David Wynne Finch, 2013

In-house functional knowledge, experience and understanding of the company's culture is preserved as employees acquire the needed skills.

This is in line with the philosophy of First Fruit Orchard with a servant leadership approach in their business. The organisation promotes from within and helps people with ambitions to grow to their full potential.

- *"We believe in building a team rather than hiring a team"* (Paul Esvelt, pers. comm., 2018).
- *Investing in human capital pays off with motivation and loyalty of workers"* (Matt Miles, pers. comm., 2018).
- *"We watch for potentials and then develop them*" (Andre Broe Jensen, pers. comm., 2018).

Businesses that have re-skilled supported their employees in formal training through training organisations, machine manufactures and in-house training by local consultants that were involved at the initial implementation. The capability of training systems has been able to accommodate a range of ages, abilities and stages of professional life.

3.1.3 Releasing

There are instances of older employees that are close to retirement and see no value in their reskilling. The tendency for businesses is to want to release this group of employees for potentially significant savings. There is however the risk of potential loss of knowledge of the

company, culture and operations. Rice Fruit PA, USA managed this by holding back on full automation capacity of their presizer. The automatic labeller was disengaged such that labels are manually applied by this group of employees. This was considered as part of the implementation cost.

3.2 Skill shift redefining operation

Warburn Estate, Victoria, Australia

The winery workforce was previously at different levels of operators. Just like in most processing companies, the operators are good at what they do, especially the long serving employees. Attaining transfers of their knowledge to paper to train newer employees was virtually impossible. With automation understanding clearance and how far to move machine was no longer required. A push of a button now does the job with no variation in changeover. Instead of having operators that 'just know what to do', the machine now does the job. Automation however brings a difference to how staff are managed. With machines working on sensors, it is important to have people with understanding of what is happening in the background to be able to fix problems. It then requires a different level of operators called technicians who understand how the machine works. The previous operators now have the option to upskill as technicians or down to material handlers.

It is certain across all sectors of work that jobs as we know it have and will continue to change. The future success and growth of the agricultural sector will be in having a healthy pool of potential workforce which can only be built through awareness of the diverse career opportunities in agriculture and ag sector with target audience of secondary school students.

Chapter 4: What Makes a Career of Choice?

Student Survey

The author conducted a survey asking students to name three jobs they knew in agriculture. This was done at three schools in Shepparton, in Victoria. A total of 399 year 10 and 11 students were surveyed across one private and two public schools. 997 responses were received (~2.5 responses per student).

More than half of the responses were a 'type of farmer' (crop, livestock, dairy, etc).

For a better perspective, 'farmer' responses were not considered in further analysis.

From a total of 57 jobs mentioned, a further grouping into 29 was done based on similarity e.g. Agronomist and Horticulturist (see Appendix for job group).

- 15 of the 29 jobs require tertiary study but only four were in the top ten jobs. This was 38% of the responses.
- Of the top 20, 11 of the 29 jobs (43% of responses) require tertiary study.
- With 'farmer' responses included, only 21% of overall responses are jobs requiring tertiary study.

A response like this, reflecting a narrow view of agriculture careers by students in farming community shows that there is lack of awareness in the diversity of Ag careers available to them.

**Author's disclaimer: This might not necessarily represent youth's job awareness of the whole industry, considering that there will be differences between urban and regional students.*

- Author's unpublished survey

Figure 15 below summarises the survey results in a word cloud, where the relative size of the font equates to the number of times that profession was used as a response.

Figure 15: Careers in Agriculture word cloud from a survey of 399 secondary school students across three schools in Shepparton, Victoria (Author)

Ag sectors like other industry continue to evolve, not just in production and marketing space but also in policy making. Agriculture as we know it has emerged with a greater emphasis on product quality, vertical integration from production to consumer, and environmental, welfare and ethical issues. It is important that the next generation of practical researchers, farmers and service providers to the ag sectors are adequately prepared and trained.

As the industry progresses into increased technology and innovation, so too is the need for highly skilled individuals to fill them, further widening the spectrum of ag careers that will be needed (Collison, 2018).

> *Rapidly evolving talent, innovation and technical aptitude will be required to meet the challenge of sustainable food production*
>
> Martin Collison

The United Nations Food and Agriculture Organisation estimates a 60% increase in food production to feed the expected world population of 9.1 billion by 2050, on less land and with fewer resources. It will require STEAM (science, technology, engineering, agriculture and math) as stated in New Jersey Food Agriculture and Natural Resources Education (FANR) fact sheet, to be efficient and productive, which will directly translate to requiring more people in all agricultural career areas including professional/scientific agriculture careers.

Farmers depend on a wide range of professionals who support the work they do. These include veterinarian, scientists, food processors, equipment mechanics, conservation planners, business managers and more. As observed in all countries visited, a shortage of these professionals is predicted for the future if not enough young people consider agriculture-related careers. With more and more families moving away from farm life, fewer students are thinking about working in an ag-related field. With so many unique and dynamic career options in the sector, it is important to keep turning up the volume to reach the ears and pick the interest of youth. Agriculture touches every basic need of our lives with plenty of opportunities outside of the farmgate.

From the work done by Goecker, *et al.* (2015), an average annual opening of 57,000 jobs is expected in the US between 2015-2020 in ag and ag-related sectors. Half of this will be in management and business, 27% in science, technology, engineering and math (STEM), 15% in sustainable food and biomaterials production and the rest in education, communication and government services. It is expected that only 61% of these will be filled based on the present new graduate turnover. With the expected job opportunities for food, agriculture, renewable natural resources, and environment, the strongest job market will be for plant scientists, food scientist, sustainable biomaterials specialists, water resources scientists and engineers, precision agriculture specialist and farm-animal veterinarian. E-commerce managers and marketing agents, ecosystem managers, agri-science educators, crop advisors, and pest control specialist.

> *Careers in Agriculture are incredibly diverse, and they are not all on the farm*
> Goecker et al., (2015)

In a world of so many options, how does the industry get the attention of the target audience? Marketing is an important concept mentioned in the work of two Canadian Nuffield Scholars. Daynard (2009) in her Nuffield report mentions that in agriculture, the language is such that few people outside of the sector understands, or even wants to understand. Tapping into the world of youth "buzz words" might be a suggestion. Industry needs to start thinking like the target audience.

This was demonstrated in the collaborative work of a Canadian agri-business, the Farm Credit Canada, with a local school in Saskatchewan to raise awareness of the sector. The Business and Social Tech students were presented with a challenge to market a career in ag to a young

person without a farm background. The students were opportune to industry speakers and field trips and their final projects judged by a panel of agri-food industry representatives. This concept has since been used by ag-education organisations in Canada with different project topics for competitions with the outcome of creating awareness of the ag industry.

The perception of people about the industry is that it is low paying, physically demanding and long hours. As much as this is true of some sectors of the industry, this is far from an average job within the industry. With advent of technology, alternative ways of completing the very manual jobs are now advancing. A lot more work needs to be done to improve the perception of agri-food careers with youth. Effective marketing of agri-food careers to youth will have to be connecting them to STEM. According to Parker (2016) in her Nuffield report, these careers need to be '*mainstreamed' through the lens of STEM and connecting youth with interesting examples of agri-business, Ag science and Ag engineering jobs'*.

4.1 The stakeholders

This section looks at the collaborative effort of industry stakeholders in creating awareness of career opportunities in the industry.

The three main stakeholders in ag career education and awareness were identified by Parker (2016) as the ag industry bodies, the ag-education organisations and youth development organisation and their collaborative roles analysed. With the target group as youth, how best to get them than through the education system. In the US, the education system plays a major role, with schools often serving as a mechanism to reach the target audience in one of several ways:

1) Classrooms as the place where the ag career messages are delivered.
2) Internships or work experience in ag-food.
3) Class field trips organised by the educators.
4) A class project as an opportunity to research about the ag-food sector.

Youth organisations within and/or outside of the school system has also been effective in not just the learning but also equipping youth for leadership positions within the industry. The ag-education organisations are a strong link between the industry and the student. Putting together practical and informative ready-to-use packages for schools. They would be a hybrid of school and field-based learning. With the growing disconnect between agriculture and the general population, so is the fewer classroom teachers with the knowledge, confidence or

interest to incorporate agriculture related topics into their teaching plans. The industry bodies and the ag-education organisations in Canada and the US have played major roles in bridging this gap for learning outcomes. They provide:

- Curriculum-linked resources that educators can use in the classroom to teach about agri-food topics, including careers.
- Workshops to educate the educators (equipping them with knowledge and confidence to teach agri-food topics).
- Guest speakers who bring agri-food information into the classroom.
- Connections to agricultural businesses for field trips and work placements.

4.1.1 Ag industry sectors

The first interaction in the industry with potential employees is usually at interviews or during work placement after enrolment in an ag program. It is important that the industry sector is involved earlier by providing hands-on learning experiences and employment opportunities to those students still in secondary schools and most importantly partnering with educational organisations with the mission to increase food and agricultural literacy. Industry investment into the future employees could be through speaking engagement and/or opening their doors for farm/field visits. The industry should have a valuable role in providing technical expertise and experiential learning for students, which could range from a half day job shadow to few weeks/month internships. This becomes a win-win for the schools and the industry with students using these experiences to make informed decisions on career options and the industry with a pool of potential employees.

An interesting effort is the collaboration of an agri-business with a local school in Saskatchewan, Canada (Bellinger, 2018). Faced with the challenge of filling positions, the Western Equipment Dealers Association are working directly with high schools to find a new generation of employee. The work with Sun West DLC is an online elective program targeting grades 11 and 12 students across the province. The three course components are 50 hours of online instructions, 40 hours practical work study at a local dealership and a two-day boot camp at the province Polytechnic. According to the Vice President Larry Hertz, where dealers used to get people walking in the door looking for jobs, now they are having to go and search for them.

Industry bodies in the US have been able to fill in, on behalf of farmers in the area of ag literacy. Educating the public on how food is created, not cooked.

The author was opportune to the work done by the national and state farm bureau in coordinating these.

4.1.1.1 American Farm Bureau Foundation for Agriculture

With a mission statement of '*building awareness, understanding and a positive public perception of agriculture through education'*, the foundation as evolved over 50 years from its original focus on just research about ag mechanisation and technology to now a strong education focus in response to industry advances and assessment of continuing needs. The foundation's definition of "agriculturally literate" is that the person understands the relationship between agriculture and the environment, food, fibre and energy, animals, lifestyle, the economy and technology. The foundation offers a variety of standard-based programs for educators, volunteers and families. Among the resources and program are the Purple Plow challenge[4] and My American Farm[5], both of which have reached 1.1 million people and played 122,651 times online respectively. The Purple Plow STEM challenge uses science, technology, engineering and mathematics resources to encourage students to research scenarios related to food, hunger and sustainability; while My American Farm is an online educational game for Ag education.

The goals of the foundation are:

- Educating about the importance of agriculture.
- Making farming real.
- Working to overcome common misconceptions about agriculture.
- Reconnecting the American public with the people that grow their food.
- Equipping ag leaders with skills they need to educate Americans of all ages.

4.1.1.2 Pennsylvania Farm Bureau

The Pennsylvania Farm Bureau (PFB) have as part of their services, the education component under the PFB Ag Promotion Committee. The group recruit volunteers to help with their drive to connect students with careers in agriculture (Lassi, per. Comm., 2018). The volunteers visit

[4] www.purpleplow.org

[5] www.myamericanfarm.org

middle schools, talking to students about the wide range of careers available in ag and ag-related sectors. The committee puts together a kit with instructions on how to set up a school visit as well as materials to use during the presentation. Volunteers read books that are linked to activities that capture agriculture (Figure 16). This does not have to be linked to the curriculum.

The organisation has a website with extensive information for students, educators and volunteers[6].

PFB regularly organises Educator's Ag Institute events where educators have a chance to see farming in action and learn how to teach their students. Ag Educators are shown how to incorporate lessons about ag into their existing teaching notes. The aim is to help students better understand where their food and fibre comes from and learn how ag affects their everyday lives.

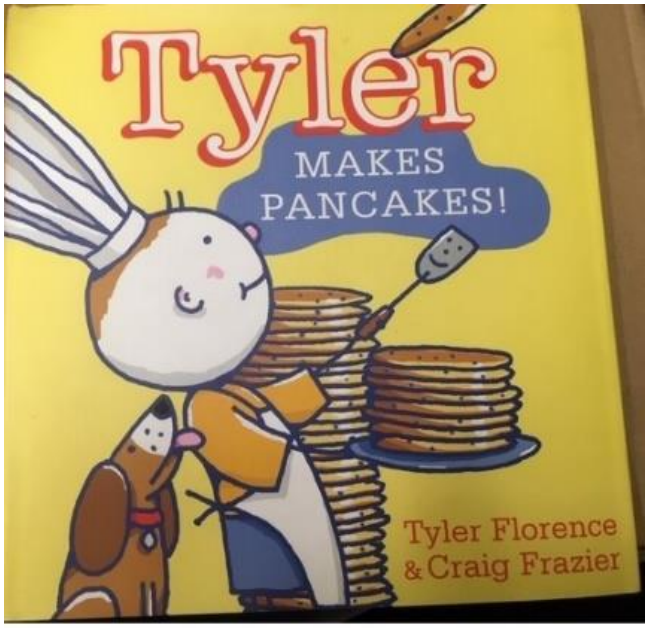


Figure 16: A book used for the volunteer reading program (Author)

This organisation is again linked to youth service organisation 4-H and Future Farmers of America (FFA), and 4-H leaders in Pennsylvania are mainly PFB members. 4-H and FFA members go to the school as the volunteer farmers, being part of the community.

Another success story of PFB is the *Mobile Ag classroom program*. This is a mobile ag education science lab complete with all supplies and a certified teacher, all in a 40-foot trailer (Figures

[6] www.pfb.com/agcareers

17, 18, 19). The trailer travels to schools on request. Certified teachers employed by PFB take students through hands-on experiments with outcomes linking to agriculture. The content of the lab class is designed to target grades K through 8. The curriculum which is a formal lesson plan for the ag class meets the state standard and are endorsed by the Department of Agriculture meaning their facts are accurate. Mobile Ag class is supported by ag companies.

Figure 17: Displays in the inside of the mobile Ag lab (Author)

Figure 18: The Mobile Ag Ed Science lab at a school (Author)

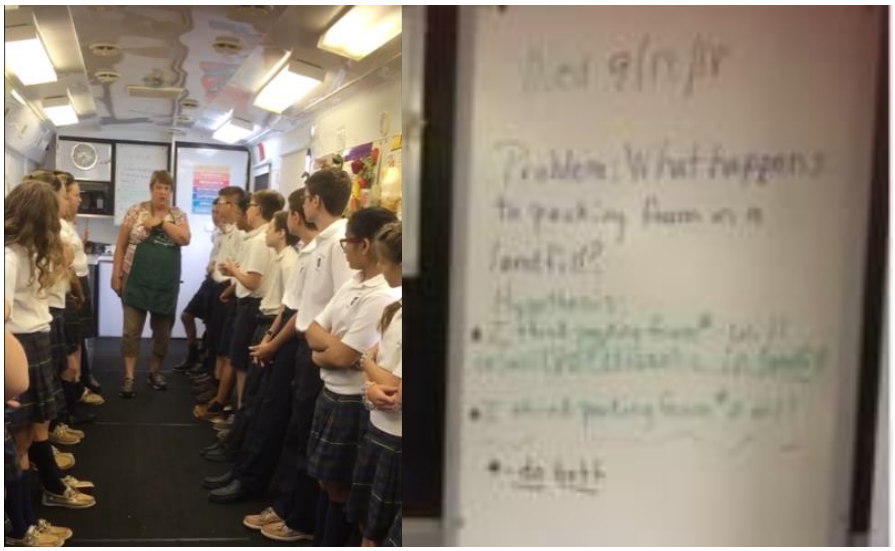


Figure 19: Jean Roger with a class of 24 7th graders in the Mobile Ag lab. Outcome are biodegradable product are made from agricultural product (Author)

4.1.2 Ag-education organisation

The ag-education organisation as a strong link between the industry and the students, put together practical and informative ready-to-use packages in school. The author was able to gain an audience with Nancy Trivette[7], who gave an insight into the ag education platform.

4.1.2.1 New Jersey Food, Agriculture & Natural Resources Education

Food, Agriculture & Natural Resources Education (FANR) is a division of the New Jersey Department of Agriculture with ag-education as part of their portfolio. There are similar programs across the US but structured differently in each state where it could also be within the universities or the Department of Education. In NJ, the program works closely with the Department of Education to deliver secondary ag education.

New Jersey FANR programs prepare young adults for leadership and careers in the science, business, education and technology of agriculture. This is done through the transformation of traditional agriculture or horticulture programs to academically- or STEM-infuse agricultural science programs with agricultural science laboratories. STEM has become a hot topic in education. It is important that these subjects are taught with a real-life approach to give students the ability to problem solve and develop critical thinking skills. Food, fibre and shelter are necessities for human survival and are provided by agriculture. This therefore makes possible to connect ag students with the concepts of STEM in a way that directly and indirectly

[7] Nancy wears different hats in different organisations. A board member of the National Council for Agricultural Education, Ag Education Leader and state FFA Advisor of the NJ Dept of Agriculture, NJ state CASE leader and member of National CASE Advisory committee, Nancy has also held various positions within the National FFA.

impact their lives. For example, a discussion on genetics can explore how purposeful selection on genes can be used to breed cows that will produce more milk rather than farming more cows to produce the same quantity or to breed apples that will not turn brown when sliced.

FANR has the uniqueness of having all concepts of ag education incorporated into their program – instructional programs, professional development of teachers and school programs. This allows for multi-faceted connections with the industry. A key program of FANR is Curriculum for Agricultural Science Education (CASE). Although incorporated into NJ Department of Agriculture, CASE was a project of the National Council of Agricultural Education (known as The Council). Established to develop ag STEM programs, CASE delivers a structured sequence of courses across five pathways through intense professional development for teachers; lesson, course and program assessments; as well as certification. CASE equips teachers to elevate student experiences in the ag classroom, preparing them for success in college and future careers in STEM. Teachers go through 80-hours of training to use the resources. The 150 days curriculum (foundation) of 45 mins class periods, introduce all freshmen (first year) in the ag program to what food is all about. The lessons are delivered on Principles of Agriculture – Animals and Plants, Agricultural Power and Technology, Natural Resources and Ecology and Agriculture Business Foundations. Students who complete CASE courses are certified with ensured articulation within post-secondary education institutions.

4.1.2.2 The National Council for Agricultural Education (The Council)

Serving school-based agricultural education, The Council represents a national team of ag education (comprising of organisations and entities representing students, teachers, teacher educators, state leaders, alumni, industry, state and national foundations and government). The Council provides leadership for stakeholders in Ag, food, fibre and natural resources system education. Envisioning a world where all people value and understand the vital role of ag, food, fibre and natural resources in advancing personal and global well-being. The Council mission is to prepare students for successful careers and a lifetime of informed choices. This ag education is delivered through classroom/laboratory (contextual learning), supervised agricultural experience programs (work-based learning) and student leadership organisations (e.g. FFA).

4.1.2.3 Agriculture in the Classroom

Agriculture in the Classroom Canada (AITC-Canada) is an educational organisation with a mission to increase food and agriculture literacy. This is by engaging students and educators to enhance their knowledge, understanding and appreciation of agriculture and food. With the growing disconnect between agriculture and the general population, fewer classroom teachers have the knowledge, confidence or interest to incorporate agriculture related topics into their teaching plans. Although programs are provincial based, the overarching national agenda is to provide:

- Accurate, balanced and current curriculum-linked resources that educators can use in the classroom to teach about agri-food topics, including careers.
- Workshops to educate the educators (equipping them with knowledge and confidence to teach agri-food topics).
- Guest speakers who bring agri-food information into the classroom.
- Connections to agriculture businesses for field trips and work placements.

The AITC-Canada has a career website profiling real people working in Ag and food at various capacities such as business, technology and innovation, math and finance, engineering and mechanics, and science[8]. The Saskatchewan government has a similar program[9].

4.1.2.4 AgScape

Funded by Ontario Ministry of Agriculture and Food Resource Agent (OMAFRA), grants, sponsorships and donations, AgScape is the voice of AITC, Ontario. AgScape is part of AITC-Canada but specifically for Ontario province. While other AITC programs focus more on elementary schools, AgScape does more with secondary schools hence the interest of the author in their work. AgScape on a broad base provides factual, balanced, curriculum-linked food literacy programs and resources to Ontario educators and students (Reining, 2018). The organisation includes not just traditional roles detailed in the resources put together for teachers, but also have linked the program to Ontario's standard curriculum. Although optional, it works with teachers first, establishing awareness, see the value and possibly get their interest, as there are various ways of teaching to meet the curriculum outcome. The resources are promoted through outreach, website and social media. AgScape runs booths at

[8] https://aitc-canada.ca/en-ca/for-educators/agriculture-careers/category/science
[9] http://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/thinkag/career-profiles

teachers' conferences, talks to teacher candidates in university agriculture departments and at the college of teachers.

The flagship program of the organisation is the teacher ambassador program, designed for grades 7-12. At the onset the ambassadors wrote their own resources. Apart from not being consistent, it was difficult to grow the program. This has since changed with centralised resource planning. At the request of a classroom teacher, 12 topics are delivered to the classroom by hired teacher graduates on behalf of AgScape. The idea is that students get a broad introduction and understanding of the topics and start to build their critical thinking skills. Taking a fact based, balanced and unbiased approach, students are presented with different sides of an argument and then let make their own decisions. Each of the 12 topics has a career component to them, but one in particular is dedicated solely to careers. Working with grades 7-12 is an opportunity to reach more students that are about to make career decisions. There has been a good uptake by teachers that are aware of the program, and the challenge now is to get more teachers interested. As a measure of the teacher ambassador program, tracking of students' perspective before and after has been positive.

Growingcareers[10] is another initiative of AgScape. This is a website created with the idea of a go to place for students and teachers for careers in agriculture. Currently with 75 career profiles, the organisation has gone out into the industry to ask real people about their jobs.

> *The future in agriculture is promising and this is a great place to learn about the opportunities*
>
> *Growingcareers*

Another of AgScape programs is Student Event, which is mainly a career competition. This event was incorporated into AgScape by Becky Parker (2016) as part of her Nuffield program outcomes. Students go through different stations representing different sectors of Ag. They learn about the sector, followed by creative activities undertaken to win or loss 'fake money'. This is done as part of school learning through the Specialist High Skills major program or as after school activities through partnership with the 4-H program. 4-H does their leadership program (soft skill) and AgScape the competition.

[10] https://agscape.ca/growing-careers

Another career website of interest is Tasty Careers. An initiative of the National Skills Academy for food and drink, Scotland, the website is dedicated to connecting youth with careers in the Food and Drink industry[11]. Careers are interactively mapped with detailed information about a job. Ambassador information is also integrated into the job/career, with answers to questions the youth would have asked at a face-to-face opportunity.

4.1.3 Youth organisations

Youth organisations within and/or outside of the school system have also been effective in not just the learning but also equipping youth for leadership positions within the industry.

4.1.3.1 Future Farmers of America

FFA is a career and technical student organisation for agriculture clusters. Intended to promote and support middle and high school classes, all Ag students are FFA members. The organisation provides premier leadership, personal growth and career success through its students governed. Though embedded in the formal school system, the organisation collaborates with the Agri-food sector. FFA connects its members and alumni to colleges and career opportunities through My Journey and Ag Explorer[12]. With a national membership of 669,989 and 8,630 chapters. New Jersey has 2,508 members in 36 chapters.

FFA models the three components of the council with emphasis on soft skills. The combined youth development approach embedded in formal education and opportunities for career readiness produces youth that will be able to adapt into the workforce or proceed to further studies.

The author's visit to NJ Department of Agriculture co-ordinated by an FFA alumnus included visits to two businesses, both with FFA alumni. FFA members and alumni continue to utilise their leadership skills through such visits. The three alumni, none from farming backgrounds and all in different sectors – government, entrepreneurship and a viticulture apprenticeship, agreed that FFA has shaped them into their current careers and has proved rewarding (Fillebrown; Schmidt; and Clement, pers. comm. 2018). All three alumni regularly give leadership talks to high school students. The advantage of this is that students find it easier to

[11] http://tastycareers.org.uk
[12] https://www.agexplorer.com/

visualise themselves in a career when receiving information from someone who looks and thinks like them (or at least not too far from them).

4.1.3.2 4-H, Canada

4-H Canada is a youth serving organisation with an agriculture focus and commitment to building future leaders. 4-H stands for:

Head: managing, thinking;

Heart: relating, caring;

Hands: giving, working; and

Health: being, living.

Starting in the US in 1912 and Canada in 1913, 4-H spread to Europe in the 1920s with the likes of Finland, Sweden and Norway taking it on. It started to pick up interest and grow in countries where Ag was still a very significant portion of their GDP and attached to USA university researches into those countries. 4-H now exist in over 50 countries and as of 2016, has a membership of 6 million active participants and 25 million alumni.

4-H Canada has 25,000 members between 6-25 years old depending on the province and 7,700 volunteers across the country. With programs traditionally based on agriculture, 4-H has since expanded its focus to include citizenship, healthy living, science, engineering and technology programs under the following pillars:

- Sustainable ag and food.
- Environmental and healthy living.
- Science and technology.
- Community engagement and communication with various topics.

The 4-H program is modelled around positive youth programming focusing on asset building in youth. Experiential education and youth-adult partnership are also components of the 4-H program. Projects are organised and done at the club level while programs like public speaking, leadership, camps, scholarships and competitions are done at the provincial level. The national body organises the larger scale conferences, scholarships, campaigns, science fairs and Career on the Grow. The Career on the Grow program has two streams of internship and job boards online.

The national body for 4-H is funded by the government through Ag and Agri Food Canada, as well as large companies supporting projects of interest. For example, Trans Canada (an oil company) will fund projects around environmental issues, or banks supporting projects around community development. With fewer people choosing the ag career pathway, 4-H works with organisations that are in the space of looking at skills gap. Understanding what those organisations are looking for, 4-H creates awareness to their members, with the aim of broadening their horizons. For example, a member who is not interested in livestock could suddenly pick up an interest in lavender farming considering lavender oils could be quite expensive.

Although membership was initially Ag family kids, 4-H is now able to attract urban kids who are showing an interest. In British Columbia, 4-H programs account towards high school credits and teachers are leaders in 4-H schools.

Conclusion

Advantages and decision making around level of automation in the packhouse:

- Autonomy of different processes – sorting and grading, packing, palletising and storage – makes it possible for businesses to go at one hit on full automation, or gradually based on priority and funding.
- Government funding and cooperative models make decision for automation easier with little or shared risk, both of which work to favour packhouses in Europe.
- Some businesses with strong community commitment choose to intentionally run equipment below capacity to allow for more staff on the line. Two of these are First Fruit, WA and Rice Fruit, PA, both in the USA, who virtually have their businesses built around their local community.
- Presizing (sort and grade) close to time of packing, saves on investing another optical sorting camera on the packing line.
- Automation enhances operational efficiency and productivity per man hour, as the line only runs the exact size and grade to fill specific orders. Businesses that have set customer requirements can presize exactly to that, and just fill up trays into cartons at packing time.
- For flexibility of markets, accuracy of the presizer optical sorter can be pushed back and have packers make informed final decisions.
- High value delicate varieties such as Honey Crisp are not presized as double handling increases the potential of bruising and stem punctures.
- Consistency is needed in packed product, as 30+ packers are not required to make subjective quality decisions. This also translates to a better return for growers.
- Sorting cameras with Near-Infra-Red are essential in regions prone to internal issues.
- 30% reduction on staffing levels – Most businesses have retained the same level of staff but increased their throughput subsequently expanding their orchard base.
- Presizers that run with two or three staff have a separate outlet for fruit with leaves. This saves on having three or four people de-leafing before the camera.
- Health and safety issues of staff relating to reported injuries and claims from sprains dramatically reduced.

Skill requirements:

- Equipment are designed with turnkey technology concepts with base parameters set, therefore there is a requirement for technicians with electronics and mechanical backgrounds as well as a workforce generally to be tech savvy.
- In addition to technical skills, there is the need to develop soft skills. An in-house mentoring program is established to develop this.
- There is a shift from different levels of line operators to a distinct divide into technical operators and material handlers (packers).
- More line operators are trained as technicians that are able to run, maintain and troubleshoot equipment.
- Involvement of more staff with innovative ideas and regular training to improve soft skills.

Promoting career opportunities in agriculture and agri-food sector to secondary school students:

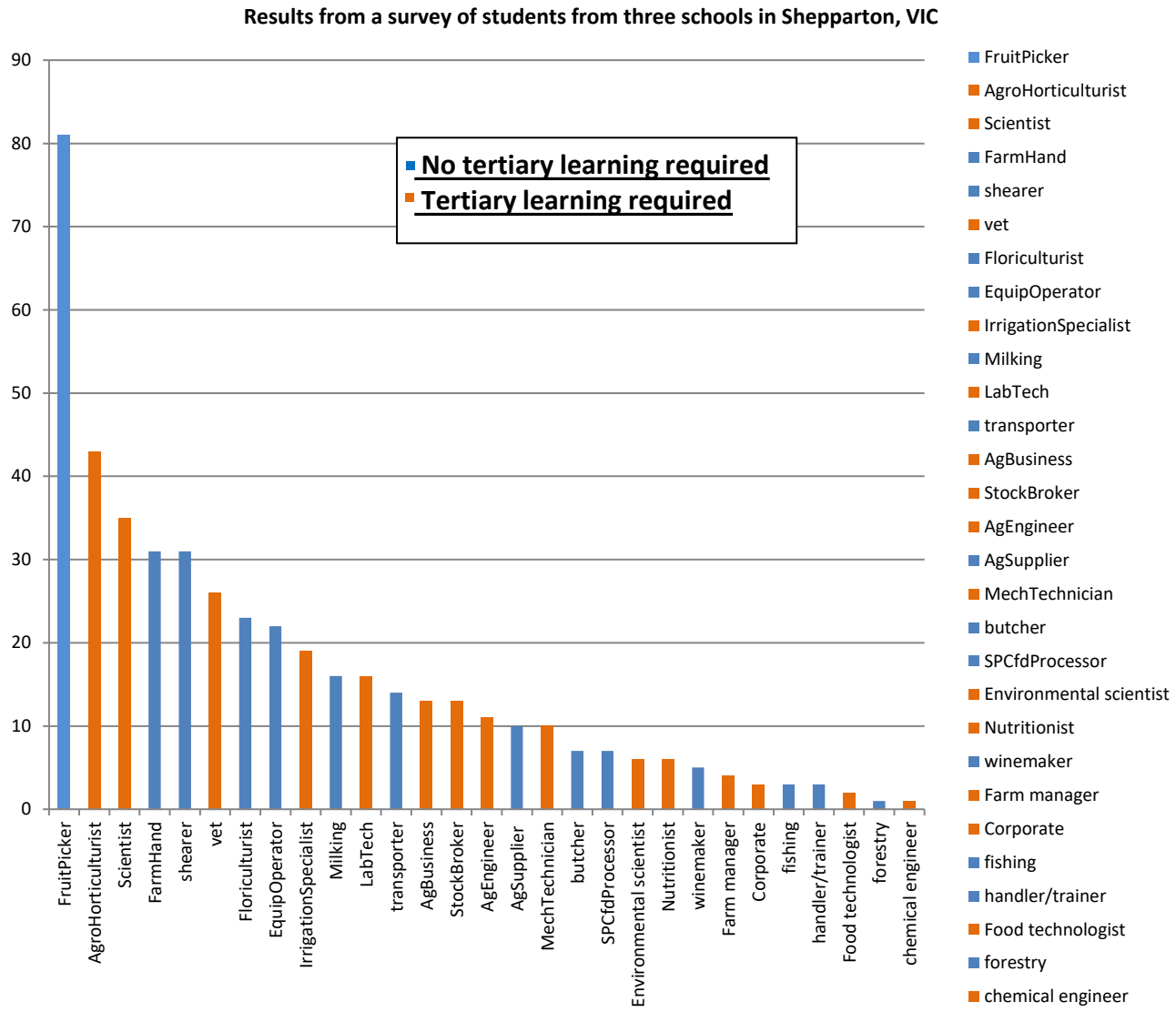
- Individuals in industry see the importance of a continued healthy industry, therefore investing time and funding and giving experiential opportunities to students is vital.
- Industry representatives as guest speakers in schools.
- Ag-education programs, sometimes as stand-alone or incorporated into the industry body organisations, create strong links between industry and students.
- Accurate, balanced and current curriculum-linked resources made available to help educators incorporate agriculture into their teaching plans.
- Field visits of educators and students to further appreciate and understand agriculture.
- Industry body support and involvement in youth organisations' programs – FFA and 4-H.
- Various informative websites detailing career options and what it is involved.

Recommendations

It is eminent that the future of the industry is in automation. As more businesses consider uptake of automation:

- Not all levels of automation will be suitable for all businesses.
- It is important that the management understand and have a clear expected outcome. A business that is community focused will have to consider increasing throughput to run efficiently without reducing its workforce.
- Current skill levels are to be assessed against needed skills and training plans put together for re-skilling and up-skilling. It is worth considering a local technical consultant to be part of a project for future training of staff.
- Some indirect costs should be considered and factored into the implementation cost.
- Business should consult with labour unions associated with their staff to address fears relating to the impact of automation on jobs and bring unions on board with flexibility for cross-section as mobility. Automating tasks does not equate to eradicating jobs.
- Industry stakeholders should take an active role in increasing the interest of the youth which are the future of the industry. This could be by direct involvement with the schools or youth organisations through speaking engagements to showcase career opportunities or experiential opportunities for real life experience. Increasing youth interest is the key to future operational success, expansion, innovation and a sustainable industry.

Appendix


Results from a survey of students from three schools in Shepparton, VIC
No tertiary learning required
Tertiary learning required
90
80
70
60
50
40
30
20
10
0
FruitPicker
AgroHorticulturist
Scientist
FarmHand
shearer
vet
Floriculturist
EquipOperator
IrrigationSpecialist
Milking
LabTech
transporter
AgBusiness
StockBroker
AgEngineer
AgSupplier
MechTechnician
butcher
SPCfdProcessor
Environmental scientist
Nutritionist
winemaker
Farm manager
Corporate
fishing
handler/trainer
Food technologist
forestry
chemical engineer

References

Australian Bureau of Statistics (2018). https://www.abs.gov.au/ [Accessed 15 Oct 2018].

Blanc, T. (2018). Personal communication. Operation manager, Maf Roda, France.

Bellinger, N (2018). Ag equipment program open doors for next generation. https://www.farms.com/news/ag-equipment-program-opens-doors-for-next-generation-135675.aspx [Accessed 15 Sep 2018].

Bughin, J., *et al*. (2018). Skill Shift: Automation and the future of the workforce. McKinsey Global Institute. Discussion paper. May 2018. https://www.mckinsey.com/~/media/mckinsey/featured%20insights/future%20of%20organizations/skill%20shift%20automation%20and%20the%20future%20of%20the%20workforce/mgi-skill-shift-automation-and-future-of-the-workforce-may-2018.ashx [Accessed 10 Sep 2018].

Canadian Agricultural Human Resource Council (2018). Agriculture and Agri-Food Labour Market Information Update. February 2018.

Canadian Agricultural Human Resource Council (2016). Agriculture 2025: How the Sector's Labour Challenges Will Shape Its Future.

Canadian Agricultural Human Resource Council (2015). Addressing Labour Shortages in the Agriculture and Agri-food Industry Through a National Workforce Action Plan. Prepared by the Labour Task Force. Revised February 2015.

Clement, K. (2018). Personal communication. FFA alumnus Farm Coordinator, Robbinsville Hydroponic Farm NJ USA.

Collison, M. (2018). Personal communication July 2018. Consultant to both the industry and UK government. Norfolk, UK.

Daynard, K (2009). Recruitment into Agriculture Careers – Strategies to increase Enrolment in Agricultural Colleges and Universities. Nuffield report.

Esvelt, P. (2018). Personal communication. Technical Manager First Fruit Orchard, WA USA.

Fabian, T. (2018). Personal communication. Sales Manager Van Doren, Wenatchee, WA USA

Fillebrown, L. (2018). Personal communication. FFA alumnus. Project specialist FANR, New Jersey USA.

Finch, D.W (2013). Collaboration and people. Nuffield report

Geltch, M. (2018). Personal communication. General Manager Warburn Estate Winery, NSW, Australia.

Goecker, A.D., *et al*. (2015). USDA Employment Opportunities for College Graduates in Food Agriculture, renewable Natural Resources and the Environment United States, 2015-2020. https://www.purdue.edu/usda/employment/ [Accessed 15 Sep 2018].

Guthrie-Jensen Consultants (2018). 10 skills you'll need to thrive in 2020. https://guthriejensen.com/blog/skills-future-2020-infographic/. [Accessed 15 Oct 2018].

Jensen, A. (2018). Personal communication. Operation manager, Salvi Fruit, Ferrara, Italy.

Lassi, S. (2018). Personal communication. Assistant Director, Pennsylvania Farm Bureau, PA USA.

Miles, M. (2018). Personal communication. General Manager, Allan Bros WA, USA.

New Jersey Food, Agriculture & Natural Resources Education (2018). Fact sheet. 2018 & BEYOND.

Parker, B. (2016). Inspiring Gen Z to Consider Careers in Agriculture and Food. Nuffield report.

Pratley, J. (2012). Professional Agriculture – A Case of Supply and Demand. Occasional Paper 12.01, Australian Farm Institute.

Reining, C. (2018). Personal communication. Program leader AgScape, Ontario Canada.

Skills Impact (2017). Automation Skills Cross-industry project: Case for Change. https://www.skillsimpact.com.au/site/skilliampactmedia/uploads/2018/07/CFC.AutomationSkills171130.pdf [Accessed Sep15 2018].

Schmidt, S. (2018). Personal communication. FFA member. Viticulturist Apprentice, Cream Ridge Winery NJ USA.

The UK Strategy for Agricultural Technologies (2013). https://www.gov.uk/government/publications/uk-agricultural-technologies-strategy [Accessed 25 July 2018].

Trivette, N. (2018). Personal communication. Program leader FANR, New Jersey USA.

United States Department of Agriculture Economic Research Services (2018). Ag and Food Sectors and the Economy. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/ [Accessed 15 Sep 2018]

van de Kop, D. (2018). Personal communication. Operations manager, Greefa, Netherlands.

Plain English Compendium Summary

Project Title:	Understanding decision making for automation in packhouse and human capital requirement

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Objectives	To investigate human capital requirement and decision making around automation in packing establishments. To promote carrier pathways in agriculture.
Background	As an industry representative in a committee looking at Skilled Workforce Solutions for Horticulture, the author recognised that there is very little involvement of the industry in preparing the future workforce for the continuing highly automated industry.
Research	Packing facilities and equipment manufacturers were visited in Italy, France, Netherlands, UK, USA and Canada to gain understanding on human capital and business decision requirements around automation uptake. Industry stakeholders were interviewed in USA and Canada to understand their involvement in creating awareness and promoting careers in Agriculture in secondary schools.
Outcomes	Automation enables competitiveness through productivity gain. Technical skills required can be achieved through retraining or upskilling promising employees from current workforce through the service of external training providers. Soft skills such as problem-solving, communication, and people management can be acquired through in-house mentoring. Industry stakeholders' to be involved in secondary schools through speaking engagements and experiential opportunities.
Implications	Establish career pathways to be promoted in secondary schools. Organise Q&A events with more of younger industry representatives as panellists. Industry presence in career day events. Participation in experiential and internship programs.
Publications	Nuffield Australia National Conference, September 2019, Brisbane, Qld