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The Impact of Semi-Automated Tools and Machines on The Attraction and Retention of the New Zealand Fruit Industry Workforce

A thesis

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of the requirements for the degree

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Abstract

Semi-automation is being implemented by agricultural sectors globally in a bid to reap the many benefits of the automated world and alleviate labour crises. There is a lack of data on the impact of semi-automation on the New Zealand fruit industry workforce, particularly regarding attraction and retention. This thesis addresses the gap by exploring both the impact of semi-automation on attract and retention, and how it is perceived by the on-orchard workforce within the New Zealand fruit industry

The research questions for this study are (1) what is the impact of semi-automation on the attraction of New Zealand fruit industry on-orchard workforce? (2) what is the impact of semi-automation on the retention of the New Zealand fruit industry on-orchard workforce? (3) how does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

Purposive (non-probabilistic) sampling was used to select 20 participants from 5 stakeholder/employee groups across seven New Zealand fruit sectors. Semi-structured interviews were conducted and analysed using the General Inductive Approach. Four major themes emerged: (1) attraction and retention to the fruit industry, (2) the presence of semi-automation, (3) the impact of semi-automation, and (4) perception toward semi-automation.

The findings show that where semi-automation is applied and supported, it positively impacts attraction and retention to the industry through a widened labour

pool, improved health and safety, better working conditions and improved efficiency of tasks and information. This research provides a useful resource for Human Resource Management that captures current industry realities and recommendations for responding to the agricultural revolution.

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1. Introduction

1.1 Background

The New Zealand fruit industry is a vibrant and dynamic economic contributor to the country. The horticulture sector, which includes fruit production, generated 6.8 billion NZD in exports in the year ending June 2022 (Ministry for Primary Industries 2023b). The horticulture industry is vital on a micro and macro scale to numerous local and regional economies (Gray and Le Heron 2010).

The New Zealand fruit industry has long been facing a labour shortage crisis, placing heavy demands on the industry, particularly where Human Resources are concerned. The industry's viability is under threat, with labour shortages attributing to quantities of fruit reducing by 7.7% and losses of fruit value at $90 million in the 2022 quarter (Stats NZ–Tatauranga Aotearoa 2023a). Since 2007, various government visa schemes have been implemented in an effort to address the labour crisis. These include Regional Seasonal Employees, Working Holiday Visas, and Supplementary Season Employment visas (Immigration New Zealand, 2021). However, these supplementary schemes are not enough. During the peak of the kiwifruit and apple harvests in 2020-21, the projected shortfall of seasonal workers was 11,500 (Horticulture New Zealand, 2021). The COVID-19 pandemic significantly impacted global labour supplies, causing disruptions in various industries, including horticulture (NZKGI, 2021). In the UK, the COVID-19 costs related to the workforce for Apple production increased by 10.5% due to expenses such as recruiting and training inexperienced workers, accommodation, and operational costs (Pelham 2020). However, while it might be quick to blame Covid,

despite the reopening of borders, the New Zealand fruit industry is still facing unresolved, historical labour issues.

New Zealand currently has a very tight labour market, which stands out in intensity compared to other OECD countries (Sense Partners 2023). Low unemployment rates result in skill shortages as employers struggle to find workers with the necessary qualifications and experience (Shimer, 2012). As of the March 2023 quarter, the New Zealand unemployment rate is 3.4%, and current staffing deficits are in the tens of thousands and predicted to rise, further affecting the fruit industries labour shortage issues (NZKGI, 2021; Stats NZ–Tatauranga Aotearoa 2023b).

The labour shortage is now unprecedented due to the rapid expansion of production in the industry (NZKGI, 2021). The horticultural sector has increased in overall scale by 64% over the past decade due to investments in new crops, growing techniques and harvest and post-harvest practices (Lincoln University 2021a). New Zealand's horticulture industry has the objective to increase the farm gate value of production from $6 billion to $12 billion by 2030 while, at the same time, improving grower margins (Ministry for Primary Industries 2023a). Given its current challenges, doubling the value of production is an ambitious goal for the industry. The Growing Together 2035 – Aotearoa Horticulture Action Plan strategy clearly addresses the labour challenge *"our industry will need to adapt and become more attractive if it is to maintain competitiveness in this environment and ensure fair pay and conditions for fair work*" (Ministry for Primary Industries 2023a).

The industry has adopted various strategies to overcome these challenges and reach its goals, including implementing semi-automation (Williams et al., 2019). *Automation* is "the use of technology to perform tasks or processes without human intervention" (Brynjolfsson & McAfee, 2016, p. 37). *Semi-automation* is "the use of technology to assist or augment human performance, but with a significant amount of human involvement still required" (Brynjolfsson & McAfee, 2016, p. 37). This thesis focuses on semi-automation, although some authors cited in the broader literature use this term interchangeably with automation. Therefore, this study will use the terms automation and semi-automation interchangeably to avoid confusion. "On-orchard" activities will be the scope of this research, which is all activities that are pre-post-harvest, inclusive of land preparation, crop cultivation, maintenance, and harvesting (Bochtis & Moustakidis, 2021).

Academic research is necessary to understand the effectiveness of semi-automation in solving this labour crisis issue and to provide strong evidence of its impacts, if any. Human Resource Management (HRM) is the critical discipline to view these issues from, as attraction and retention are at the heart of its practice (Baker, 2022). Employee talent management begins with recruiting and selecting individuals and ensuring they are attracted to the organisations as a key first step (Padhi & Joshi, 2022). Human resources practices have an essential role in organisational attractiveness, such as remuneration, security and working conditions (Rynes & Barber, 1990; Williamson et al., 2009). For HRM to be effective, it needs to understand the impacts of implementation of systems, such as semi-automation, may have on these factors.

1.2 Research Gaps, Objectives and Questions

Robust data is needed to understand the impact of semi-automation on the New Zealand fruit industry's workforce concerning attraction and retention. History, HRM rhetoric and literature all expect that the scale of these semi-automation shifts will cause significant changes to the way people work and organisations employ, train, and upskill. (Allen, 2017; Carolan, 2020; Jones, 2006; Legun & Burch, 2021; Sale, 1995). Semi-automation is meant to remove some of the health and safety risks, make the work less physically demanding and create new, tech-savvy jobs (Barrett & Rose, 2022; Blasco et al., 2019; Estlund, 2021). However, there are gaps in the literature regarding how these changes will impact workforces regarding HRM practices such as attraction and retention. Will people be inspired to join? Feel displaced and find a new industry? There is a growing call for the predictions of the impacts of agricultural technology to be reassessed, and the New Zealand market is an excellent place to start (Barrett & Rose, 2022).

Nowhere in the literature are the questions below directly addressed:

(1) what is the impact of semi-automation on the attraction of New Zealand fruit industry on-orchard workforce?

(2) what is the impact of semi-automation on the retention of the New Zealand fruit industry on-orchard workforce?

(3) how does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

How the New Zealand fruit industry perceives semi-automation on-orchard will be collected and discussed in this research to address these issues. It is important to understand workers' perceptions of semi-automation as it provides insights from

those who are using and operating the technology allowing for direct findings. By understanding these perceptions, it allows inform HRM to be informed and address any concerns or capitalise on any benefits that may arise. If there are additional benefits from semi-automation, it is important that organisations capture insights and include them in their employee value propositions (EVP) to ensure they are doing the most to improve their attractiveness and offerings to potential employees. The more insight HRM practises can get on how their workforces are feeling about any changes, the better prepared they can be to proactively retain and attract employees. This work will help understand how the workforce is responding to the global automation shift by assessing attraction and retention, two of the most important aspects of HRM. The findings from this study will provide a resource for HRM to guide their implementation and workforce planning as the industry enters a new era.

This study is critical to the practice of HRM, as people's fears, aspirations and expectations must be adequately handled. In the war for talent, the industry competes to attract and retain people in a turbulent time plagued with the 'great resignation' where individuals have more power and opportunities than ever (Geisler, 2021). HRM must understand how semi-automation affects them to stay ahead of a new way of working and ensure they can make themselves the most attractive employer and industry.

To address these research gaps, this study has been designed to answer the following research questions:

1. What is the impact of semi-automation on the attraction of New Zealand fruit industry on-orchard workers?
2. What is the impact of semi-automation on the retention of New Zealand fruit industry on-orchard workers?
3. How does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

1.3 Thesis roadmap

This thesis is organised into six chapters.

Chapter 1 is the introduction and background to the research. The rationale of the study and significance of the issues being faced by the New Zealand fruit industry is highlighted to provide scope.

Chapter 2 reviews the current literature and provides a theoretical base for the research. This chapter begins with an outline of current attraction and retention challenges and the guiding frameworks to be used. An analysis of the nature of the New Zealand fruit industry workforce is explored, followed by the scope of automation within the New Zealand fruit industry, then the impact of automation on the workforce is reviewed, with a final focus on workforce attitudes towards automation and the implications this has for attraction and retention using the guiding frameworks.

Chapter 3 discusses the research questions and objectives. The theoretical framework that underpins the study is then presented and provides a rationale for

the selection of research methods. It elaborates on the research design, as well as the procedures for data collection and analysis.

Chapter 4 explores the results of the interviews. The findings are grouped by thematic review and supported directly by interview quotes. The four separate themes of attraction and retention to the fruit industry, presence of semi-automation, the effect of semi-automation and feelings toward semi-automation are then summarised to capture their key findings.

Chapter 5 discusses the results in the context of the research questions and addresses their connection to the literature review. This final section then outlines what the research has demonstrated by theoretical contributions, practical implications, limitations, and future research suggestions.

2. Literature review

2.1 Introduction

This literature review aims to provide an analysis of the context surrounding the impact of semi-automation on the attraction and retention of the New Zealand fruit industry's workforce with an on-orchard focus. Employee "attraction" for this study will utilise Herzberg's Two-Factor theory of motivation as a guiding framework, whereas "retention" will be assessed through the lens of psychological contract theory.

The literature review offers a more informed understanding of four major issues. First, the nature and key challenges of the New Zealand fruit industry's on-orchard workforce is examined. The implications the nature of the industry has for attraction and retention practises are researched and viewed primarily through Herzberg's Two-Factor theory and psychological contract theories. Secondly, the scope and prevalence of semi-automation within the New Zealand fruit industry is examined. Third, the impact of semi-automation is then examined, with a wide focus on comparable industries. Finally, worker attitudes toward semi-automation are researched with a particular focus on their relation to attraction and retention. The literature review is finally summarised with the key themes and learnings relevant to the study.

2.1.1 Attraction

Attraction challenges

The existing literature highlights the increased competition in the global market to attract highly talented employees (Ahmad et al., 2020; Arasanmi & Krishna, 2019; Hutchings et al., 2011; Tulgan, 2019). Studies have examined many different strategies that organisations are using to differentiate their offerings in order to remain competitive and attract talent (Magbool et al., 2016). Some studies focus on how organisations can leverage their sustainable business practises for attraction (Magbool et al., 2016), while others assess changing their entire employee brand to appeal to more people (Ronda et al., 2018). While the strategies differ greatly, there is a clear general consensus that organisations need to do something to stand out from the crowd (Cappelli, 2021).

Organisational attraction is challenging as not all employees value the same things in the organisation and there is no one-fits-all way to approach attraction (Chapman & Mayers, 2019). Organisations are now having to attract the diversity of prospective employees with a wide range of literature dedicated on how to accommodate attracting all different the different generational cohorts within the workforce (Aggarwal et al., 2022; Bussin, 2018; Bussin et al., 2019; Lassleben & Hofmann, 2023).

A considerable amount of literature has been published on remote and flexible work options, as these are now key factors in attracting talent (Cappelli, 2021; Thompson et al., 2015). These themes came into clear focus with the Covid pandemic (Kanwal

et al., 2022), and post-pandemic employee expectations have now changed, and organisations need to offer flexible options to attract talent (Cappelli, 2021; King et al., 2021; Morales, 2021; Murphy, 2021; Naseer, 2023). The changes and adaptations brought about by Covid have possibly set a new precedent for the flexibility organisations will need in the future to attract talent (Cappelli, 2021).

Attraction has also been greatly challenged by the organisational change from traditional, vertical, hierarchal structures to more contemporary flat formation (Atkinson, 1984; Rodrigues et al., 2015). New career types have emerged, such as protean career models, where the individuals are in charge, not the organisation (Hall, 2004). Boundaryless careers are also increasing in popularity, allowing people to have careers that move across multiple employers' adding to the casualisation of work (Arthur et al., 2005; Rodrigues et al., 2015). Literature has been explored on how these new career models impact attraction with a varied range of factors such as how these career types can encourage global attraction (Pekkala et al., 2016; Ryan & Silvanto, 2021).

Underlying Theory - Herzberg's Two-Factor Theory

Herzberg's Two-Factor Theory, commonly called the motivator-hygiene theory, looks at employee motivation regarding satisfaction and dissatisfaction (Herzberg, 1966; Herzberg, 2003; Nafe & Alizadeh, 2022). This theory will be used as a framework to understand attraction within this study.

Herzberg’s theory has both hygiene and motivational factors. Hygiene factors are maintenance factors to avoid dissatisfaction and they provide the baseline for

motivation or satisfaction even to occur (Herzberg, 1966). Hygiene factors can include pay, policies, fringe benefits, physical working conditions, status, interpersonal relations and job security (Herzberg, 1966). In comparison, motivational factors include recognition, achievement, personal growth and opportunities, responsibility and meaningfulness in the workplace (Herzberg, 1966). Multiple empirical studies have been completed that support the notion of Herzberg's theory in employee motivation (Holmberg et al., 2018; Maidani, 1991; Thant & Chang, 2021) .

While numerous attraction theories could have been selected, Herzberg's theory was chosen to guide the research for its insight into employee motivation. Herzberg's theory emphasizes intrinsic motivating factors and convincingly highlights how financial and non-financial rewards are needed in organisations to attract their employees (Armstrong & Taylor, 2014). It has been a very influential theory in the literature and still has specific relevance in motivational theories as it has been significant throughout the field of worker satisfaction (Gerhart & Rynes, 2003; Nafe & Alizadeh, 2022).

The key issues of attraction in the wider literature are vastly different (Aggarwal et al., 2022; Bussin, 2018; Bussin et al., 2019; Dineen & Williamson, 2012; King et al., 2021; Lassleben & Hofmann, 2023). Herzberg's two-factor theory is very relevant to view these challenges through, as it provides a vast but simple framework to assess many different employee motivator factors which are key in attraction. Herzberg's theory has been used in a multitude of attraction and recruitment studies (Kennedy & Mohr, 2023; Martin et al., 2006; Ricciardelli et al.,

2021; Tamosaitis & Schwenker, 2002; Vandenabeele et al., 2004). Studies have used the two factor theory to predict employer attractiveness and praised the model's ability for its explanatory power, despite its limitation of not being able to predict performance (Armstrong & Taylor, 2014; Ricciardelli et al., 2021; Vandenabeele et al., 2004). It has been used to assess both extrinsic and intrinsic motivators that may motivate individuals to work with certain organisations or role types (Ricciardelli et al., 2021; Vandenabeele et al., 2004)

2.1.2 Retention

Retention challenges

Many, if not all, of the factors that are challenging attraction in the literature, are also challenging employee retention. Common challenges include increased competition in the global market (Ahmad et al., 2020; Arasanmi & Krishna, 2019; Hutchings et al., 2011; Tulgan, 2019), accommodation of the different generational cohorts within the workforce (Aggarwal et al., 2022; Bussin, 2018; Bussin et al., 2019; Lassleben & Hofmann, 2023), and the requirement for remote work and flexible options (Cappelli, 2021; King et al., 2021; Morales, 2021; Murphy, 2021; Naseer, 2023; Thompson et al., 2015). However, many of the important factors and challenges for attraction need to be maintained for successful retention.

There are a few different distinctive points in the literature on retention, such as employee engagement. Studies show that employees who are engaged on an emotional and psychological level are less likely to leave organisations for others (Kahn, 1990). Of relevance to horticulture, the goals of farmers are often intrinsic and psychologically woven into their personal and home life due to the

meaningfulness of their work, further cementing the psychological bonds important for retention (Hansen et al., 2020).

There is also a wide body of literature that explores the positive impacts upskilling and promotion have for employee retention (Haryono et al., 2020; Ng et al., 2010). Employees who are promoted quickly are more satisfied with their job, exhibit greater organisational commitment, and feel a stronger sense of career growth and development (Haryono et al., 2020). Additional factors contributing to this include, recognition and validation, the chance to tackle new challenges and responsibilities, and increased social status associated with higher job titles (Ng et al., 2010).

Incentives/rewards are some of the big factors in retention (Kryscynski, 2021). The core groups of incentives/rewards are remuneration, benefits, affiliation, career, and work content. (Bussin, 2018; Lee & Moreo, 2007). Studies also explore that people work not only for monetary reasons but also to improve their social and personal life, eventually gaining both personal fulfilment and social inclusion (Guidetti et al., 2021).

Overall retention will be impacted as employment arrangements are expected to change, by 2050, to more short-term, transactional contracts instead of open-ended one's (Subramony et al., 2018). Temporary or “gig” employment will rise in the next decade (Chobli & Weber, 2020). “Gig” employment refers to non-permanent individuals who are hired for pieces of work that are separately paid (Page-Tickell & Yerby, 2020). This work isn't inherently low-skilled or low-paid however, with studies showing top earners are engaged in the “gig” economy (Page-Tickell &

Yerby, 2020). Some studies believe this type of work will breakdown jobs into tasks, and that each task will be able to be outsourced to different people, and that entities and organisations as they are now known may cease to exist (Healy et al., 2017). Low unemployment rates, the post-pandemic flexibility in working conditions, and the overall decline in loyalty between employers and employees will continue to be seen as more modern career structures change the way people work and employ (Chobli & Weber, 2020).

Underlying theory - Psychological Contract Theory

Psychological contracts are the unwritten rules and expectations, that exist between the employer and the employee (Tanimoto et al., 2021). This phenomenon became apparent in the changing of traditional to contemporary careers as the traditional employment certainties have been eroded (Coyle-Shapiro & Kessler, 2000). While psychological contracts are meant to be a mutual relationship, they are weighted from the employee's perspective highlighting obligations the employer may have to them (Coyle-Shapiro & Kessler, 2000). When psychological contracts are perceived to be fulfilled it increases organisational commitment and they employees will behave like a “citizen” of the company which has strong implications for retention (Coyle-Shapiro & Kessler, 2000). A psychological contract breach is when the employer fails to fulfil the perceived promises or responsibilities to their employee (Coyle-Shapiro & Kessler, 2000). When employees feel that they are not supported they will often reduce their own commitment and begin to feel negatively toward the organisation (Coyle-Shapiro & Kessler, 2000). Psychological breaches are also a key predictor of turnover which have grave implications for employee retention (Keim et al., 2014).

The psychological contract is commonly utilised to comprehend relationships between employers and employees (Mazumdar et al., 2022) Many studies have focused on the psychological contract perspectives on recruitment and retention (Festing & Schäfer, 2014; Holland & Scullion, 2021). Studies have explored the impact of the psychological contract on the re-recruitment process organisations are currently having to go through to retain employees (Holland & Scullion, 2021). Other studies have examined the effects the psychological contract is having on generational influences (Festing & Schäfer, 2014)

Given attraction and retentions' close nature in challenges, it is important to cover the psychology of retention as this is different lens to view the issues compared to the two-factor theory. Psychological contract theory has been used in many studies that focus on employee responses to change and implementations of new systems, like semi-automation, making it a suitable choice for this study (George, 2003; Lindorff et al., 2011; Senior et al., 2017). It is also a highly fluid theory, which works well in diverse studies with multiple demographics (Keim et al., 2014).

2.2 The nature and challenges of the New Zealand fruit industry workforce

Existing literature on generational cohorts, modern career theories, workforce structure and makeup will all be discussed to provide context for the current values and expectations of the New Zealand fruit industry workforce. The key challenges from this context will be identified and discussed.

Generational demographics of the workforce

The nature of the New Zealand fruit industry workforce can be best understood by firstly understanding the broader workforce in a demographic context, which can be described as generational cohorts. A generation can be defined as an "identifiable group that shares birth years, age location, and significant life events at critical developmental stages" (Kupperschmidt, 2000, p. 66). This is important as their experiences and events reflect in their core values that can create a generational identity usable for HRM, distinguishing what is essential to attract and retain each cohort (Lissitsa & Kol, 2016). The New Zealand "baby boomers" (born 1946-1964) are moving into retirement positions, as Generation X (1965-1980), millennials (1981-1996), and Generation Z (1997-2012) are taking over key positions in the workforce (Rodriguez et al., 2019). To maintain and improve attraction and retention, it is important that the generational values are recognised and that there is a cultural normalisation to ensure a more cohesive fit as they can impact organisational performance (Dutta & Mishra, 2021; Nishizaki, 2023).

Generation X see work as valuable, and they often link self-worth with promotion and the ability to work with minimal supervision, appreciating autonomy and independence (Cennamo & Gardner, 2008; Dutta & Mishra, 2021). They are also sceptical of organisations and organisational images and tend to have confidence in their personal opinions about organisations as opposed to the rhetoric from the organisation itself (Dutta & Mishra, 2021). A progression toward knowing that work is meaningful is typical of millennials, and they also prefer not to engage in repetitive or non-stimulating jobs (Dutta & Mishra, 2021). Pay and remuneration, however, remain important factors across all cohorts (Bussin, 2018; Dutta &

Mishra, 2021; Lee & Moreo, 2007). However, Organisation image is important for the most recent cohorts, with millennials and Generation Z driven by their easy access to information and quick to judge organisations based on what they can find (Anderson et al., 2017; Dutta & Mishra, 2021).

Job satisfaction and company values are vital motivational factors for millennials and Generation Z (Dutta & Mishra, 2021). Generation Z and millennials focus on personal growth and development within their careers and appear to be more individualistic (Anderson et al., 2017; Rodriguez et al., 2019). They also focus on work-life balance to pursue a life outside of the workplace and do not accept jobs that negatively impact on their physical or mental well-being (Anderson et al., 2017; Dutta & Mishra, 2021; Rodriguez et al., 2019). Generation Z has many choices in employment and can be viewed as having an impatient, "selfish", and intolerant view of jobs that do not align with them (Anderson et al., 2017; Rodriguez et al., 2019). Generation Z will act on better opportunities and quickly switch to new organisations that they align better with or can further them with their goals (Rodriguez et al., 2019). There is a common conception that organisations need to customise pre-existing roles and structures to keep Millennials and Generation Z in particular retained (Rodriguez et al., 2019).

Structure of workforce

Labour market segmentation is the theory that specific industries fall into one of two categories: (1) a periphery sector that is saturated with low-skilled, low-paid,

often itinerant or unstable employment patterns, and where disproportionate levels of part-time or temporary work are expected among mostly non-unionized workers; or (2) a core sector that consists of highly skilled and educated, well-paid employees who enjoy stable employment (Lambert, 2023). The New Zealand fruit industry is a dual labour market with both periphery and core sectors (Walker et al., 2020). The dual labour market means the different types of workers have different implications for how they should be examined (Arasli & Arici, 2019; Guidetti et al., 2021). The core group of workers keep the organisations running year-round and are often a smaller percentage of the total workforce (Walker et al., 2020). Whereas temporary workforces are required in these industries to complete the work needed at their seasonal peak.

Seasonal workforces are a type of temporary workforce, and they are commonly seen within the New Zealand fruit industry (Walker et al., 2020). Seasonal work allows employment for a peak season when personnel is high in demand; however, when the season is over, there is not enough justification for keeping the staff permanently and their work with the organisation ends (Boels, 2016; De Cuyper et al., 2008; Walker et al., 2020). Contractually this is reflected in seasonal agreements being casual or fixed-term and only lasting as long as it takes to complete a required task. This is most often for the fruit harvesting season but can be for many other tasks, such as winter pruning, summer pruning, pollination, and pest and disease control (Boels, 2016). While these roles are not all unskilled, the base levels are easily accessible to most prospective employees and often, training is provided on-the-job. More specialised tasks such as machine operators (tractors, forklifts or trucks), management positions, orchard supervisors and team leaders may require specific qualifications, certificates, and experience to complete the role

successfully. There are many pathways built into the New Zealand fruit industry to support the growth and upskilling of their staff, such as cadetships and university incentives accessible to most education levels (Lincoln University 2021b). These many pathways result from the unique nature of the New Zealand fruit industry, as they need skilled and semi-skilled labour. However, the workforce capacity required is not consistent throughout the year, making it challenging to retain and attract staff.

Workforce make-up

To combat the challenging nature of seasonal work, overseas workers heavily support the makeup of the labour pool. A temporary workforce comprises individuals with varied backgrounds and perspectives who may hold distinct values and expectations regarding their employment experience (Lips, 1998). The New Zealand horticultural seasonal workforce is made up of a combination of RSE's, overseas visa holders, MSD referrals, local individuals and students (Kilpatrick & Bound, 2005).

Recognised Seasonal Employer (RSE), Working Holiday and Supplementary Seasonal Employment work visas are just some of the schemes implemented to ease the labour shortage (New Zealand Immigration 2023b), The RSE scheme has been in place since 2007, allowing the horticulture industry to hire overseas workers to support seasonal work when there are not enough New Zealand workers to do so (New Zealand Immigration 2023a). RSE workers come from neighbouring Pacific nations, and in 2022/2023, 19,000 were allowed into New Zealand under this visa (New Zealand Immigration 2023a). The working holiday visa is available to people

aged 18-35 and is marketed to let young people travel and work in New Zealand for 12 months (New Zealand Immigration 2023c). The Supplementary Seasonal Employment (SSE) work visa allows visa holders to work for an SSE-approved employer to: plant, maintain, harvest, or pack crops (New Zealand Immigration 2023b). An example of why additional support visas are needed can be seen within the Kiwifruit sector. New Zealanders only made up 56% of the Kiwifruit sector workforce in 2020, with RSEs at 17%, Working Holiday visas at 19%, general work visas at 5% and international students at 3% (NZKGI, 2021). While a significant portion of the New Zealand fruit industry workers are employed on the basis of these visas, they are out of scope for the research parts of this thesis. The complexity and additional factors make the focus too large to consider each pool for this study's scope which is why just the New Zealand workforce is being targeted.

New Zealand workforce makeup

Focusing on the New Zealand workforce, partnerships are utilised between the fruit industry and the government's Ministry of Social Development (MSD). MSD supports New Zealand in finding work, income, and housing. MSD works with fruit industry bodies such as NZKGI to attract unemployed New Zealanders to work (NZKGI, 2022). This partnership is working, as in 2021, over 2250 people in the Bay of Plenty swapped MSD benefit assistance for seasonal work (NZKGI, 2022). Many people are thought to use these seasonal roles to land permanent jobs within the industry or as a stepping stone of experience to move into another workforce (Hall, 2022; NZKGI, 2022).

A significant portion of seasonal workers are also “contractors”. “Contractors” in this context are specific individuals that organisations use for labour; however, they are outsourced from different organisations and are not hired as direct employees (Mi et al., 2020; Nye, 2020). Outsourcing labour to third-party organisations is an excellent way to obtain skilled labour and reduce the burden of obtaining them independently (Mi et al., 2020; Ramdhani & Bakri, 2020). This is mainly used when third parties may have labour numbers, technology, machines or knowledge that the organisation lacks but only needs for inconsistent or sole purposes (Nye, 2020). More recently, seasonal contracting has been used in the New Zealand fruit industry to alleviate many organisations' labour shortages. Outsourcing has found productivity and profitability in medium to small-scale environments as it provides efficient use of the machinery and resources available in the market (Mi et al., 2020).

Permanent workforce

Despite the focus on seasonal workers, permanent roles exist throughout the New Zealand fruit industry in a part-time and full-time capacity for various functions. Positions such as Orchard Managers who oversee year-round activities are often always permanent (Careers NZ 2023). Permanent positions can also exist for orchard workers and machine operators (Hall, 2022). Some employers can use them across the different seasons and keep enough work available to justify year-round hiring (Hall, 2022). There is a common misconception that the fruit industry is just seasonal work, which is something that New Zealand horticulture is working on changing the narrative of (Horticulture New Zealand 2021).

Many New Zealand orchard owners are often owner-operator; a report by MPI states that the horticulture industry comprises a combination of large and small-scale operations, with the majority being small and medium-sized enterprises (SMEs) that are family-owned and operated (MPI, 2021). This is a shared sentiment for 'lifestyle' careers, as seen in the wider agriculture picture that often finds friends and families a common connection point to enter the industry (Moffatt, 2016). MPI commissioned a report to discuss the limitations of the next generations' entrance into orchard ownership due to declining family succession plans and high land prices, making it hard to attract or retain the current structure of ownership (Ministry for Primary Industries 2017). When looking at orchard owners, it is important to highlight that the literature states they are said to be motivated intrinsically and that this is a strong predictor of an owner's job satisfaction (Muri et al., 2020).

2.2.1 Key challenges posed by the nature of the workforce.

Generational cohorts

The key challenges posed by the workforce's unique characteristics are as diverse as its makeup. HRM needs to understand each generational cohort that exists within the workforce to best recruit, retain and motivate employees (Anderson et al., 2017; Dutta & Mishra, 2021). The generational differences mean organisations do not have a one-fits-all approach to ensure the attraction and retention of the different cohorts (Dutta & Mishra, 2021).

Seasonality of industry

The seasonality of the majority of the workforce is a big challenge for attraction and retention. Most roles available in the New Zealand fruit industry are seasonal roles. Industries that rely on seasonal labour find retaining them during the season and having trained, knowledgeable staff returning each year vital to their operations (Walker et al., 2020). If a seasonal role appeals to an employee, they likely belong to a transient employee group, e.g., students, part-time workers, and semi-retirees (Kilpatrick & Bound, 2005). Agriculture as a whole faces many issues with the weather, as poor weather conditions often mean they are unable to complete key tasks on-orchard, resulting in inconsistent working patterns (Mi et al., 2020). It is also difficult to retain seasonal workers year after year, often due to the employee's transient nature and the inability of organisations to guarantee that work will be available and what the conditions will be (Walker et al., 2020). The New Zealand fruit industry is misconceived only to offer seasonal work. It is recognised that it needs to actively promote its sector as a career choice to continue building formal and informal educational pathways and training (Horticulture New Zealand 2021).

MSD partnerships

While MSD partnerships are a great way to promote seasonal work, MSD also has its own challenges. Some challenges, such as transport, clothing, work gear and relocation for those who want to work for their own autonomy and financial reasons, can be mitigated by MSD (Work and Income 2023). Some European governments also offer incentives to entice those on unemployment benefits into fruit harvest work, such as still receiving full wages and their benefits to try and solve the labour issues (Tougeron & Hance, 2021). However, beneficiaries still

have challenges such as personal barriers of family, illness or disability, or other factors that may make them unable to complete the work (Baker & Tippin, 2004). This means that while working with MSD is a fantastic initiative to support more New Zealanders and the fruit industry, the shortfall of staff needed will not be able to be made up solely by this population for these complex social reasons.

Public perception

As current schemes cannot cover much more of the deficit, a clear directive is that more people must be attracted to work in the fruit industry. There is recognition throughout the wider horticultural industry that more people need to be brought through and encouraged to stay long-term (Horticulture New Zealand 2021). In developed countries, there is a struggle to find local and national workers who are interested in working in agriculture (Tougeron & Hance, 2021; Williams et al., 2019). Horticulture needs to raise its public profile as a job and as a career to make attraction to the industry viable for the next generations and to keep a flow of students interested in higher education to move the sector forward. Kolstrup (2012) identified that farmers needed to boost their image as a good workplace, as the status of agriculture needs to be raised to meet the current needs of society and the generation of younger people who care more about status and opinion than ever before. Meyer et al. (2016) found that public perception was one of the biggest issues with attraction within the horticultural industry. Horticultural studies are declining, and the industry and universities are partnering together to create more attractive solutions, such as Turners and Grower Global and Lincoln University offering students a full-time wage and pathway to employment while they study a diploma in horticulture (Lincoln University 2021b).

Absenteeism and injury

The New Zealand fruit industry also struggles with absenteeism within the seasonal workforce, and NZKGI (2021) found that orchard workers did not work all shifts offered to them for reasons such as “needing a day off”, “exhaustion and illness”, and “physical pain”. Combined with an understaffed season and rapid growth, orchard shifts in the 2020/21 season were often 10 hours 6 days a week, leading toward burnout (NZKGI, 2021). Agriculture can be a dangerous and hazardous area of the primary industries (Loureiro, 2009). Workers in orchards are exposed to a high risk of suffering from severe occupational injuries and illnesses (Gao et al., 2022). The literature on New Zealand-specific occupational risks is low; however, the nature of agricultural work remains relatively similar across other OCED countries. Ladders are some of the most common injuries to occur on orchards, with over 68% of participants in one study reporting an injury or near miss involving a ladder (Salazar et al., 2005). Being poked by branches, falling on the ground, lacerations from shears and being hit by objects were also common incidents reported among orchard workers (Salazar et al., 2005). Sprains and strains, broken bones, eye injuries and cuts were among the top types of injuries found on orchard workers (Salazar et al., 2005). A study in China found that physical and mental fatigue among orchard workers had an upward trend, indicating these were significant factors (Gao et al., 2022). Horticultural careers have typically been “unattractive” for new entrants due to the expectation of physical manual labour with unpredictable hours (Meyer et al., 2016). This is a challenge for attraction and retention for the New Zealand fruit industry. The seasonal nature is often weather dependent, with only a short window for key activities such as fruit harvests.

2.3 The scope of semi-automation in agriculture and the New Zealand fruit industry

There is a refreshed focus on new technologies and machines to impact the workforce by easing the labour burden and improving working conditions in the agricultural industry (Barrett & Rose, 2022; Blasco et al., 2019; Estlund, 2021). This section will focus on the types of semi-automation in agriculture, the shifting dynamic of semi-automation, and the barriers to semi-automation on-orchard.

Types of semi-automation in agriculture

Semi-automation is being introduced into the agricultural field, mainly focusing on harvesting fruit, seeding, planting, weeding, fertilising, soil analysis, environmental monitoring and irrigation (Bac et al., 2014; Botterill et al., 2017; Jha et al., 2019; McAllister et al., 2019). Semi-automation is the selected focus for this study as it is the most relevant form of automation found within the agricultural industry, particularly on-orchard, due to the fit to the conditions (Nair et al., 2021). Self-driving tractors, for example, can be programmed to be independent (fully-automated) or work with supervised autonomy where an operator controls the speed and path (semi-automated), which is currently more practical for traditionally styled orchards as often seen within New Zealand (Bochtis & Moustakidis, 2021).

These machines, tools and robots result from integrating various multidisciplinary technologies, such as machine vision, electronics, and mechanical engineering (Bochtis & Moustakidis, 2021). As agriculture is incredibly variable and has

continuously changing conditions, multi-layer systems have been developed to deal with the complexities of such an uncertain environment (Nair et al., 2021).

Some examples of semi-automation on-orchard include a robotic system for pruning grapes (Botterill et al., 2017). Electric pruners that assist individuals by taking the physicality out compared to manual pruning (Anzelloti, 2014). Mobile platforms have also been designed to minimise the use of ladders and allow orchard work to be completed at heights such as pruning and harvesting (Kutyrev et al., 2022). There are other technologies such as virtual reality headsets that can mimic the orchard conditions allowing for staff to be trained on on-orchard conditions, without the pressure of the season of that task being the first time they complete it (Kee & Zhang, 2022).

Harvesting fruit is one of the most important roles. It requires a sizable, seasonal, semi-skilled workforce, which presents a significant labour-related risk of insufficient workers for this time-sensitive task that New Zealand is already facing (Zhang et al., 2019). Labour costs for harvesting are the most substantial variable expenses in fruit production (Kutyrev et al., 2022; Zhang et al., 2019). Although significant efforts have been devoted to developing robotic solutions for fruit harvesting, the technology's progress has been limited, mainly due to inadequate harvesting speed, efficiency, and damage caused to the fruit during harvesting (Bac et al., 2014; Botterill et al., 2017; Zhang et al., 2019).

Shifting dynamic of semi-automation

It is believed that the increase in automation is also driving the amalgamation of small to medium-sized farms or organisations to scale the work to justify the

technology (Rotz et al., 2019). This poses a threat to the people and the resources rural communities may need to adopt this technology (Rotz et al., 2019; Salemink et al., 2017). There is also a significant difference in the types of semi-automation available in different sectors of the fruit industry; for example, Kiwifruit exports in 2021 were valued at 2709 million, and Avocados, by comparison, were valued at 211 million (Warrington, 2021). Therefore, the New Zealand fruit industry workforce is diverse, with no two sectors having the same opportunity or transition to semi-automation.

Despite the lack of success, the labour market and automation have also been re-evaluated in modern times due to a significant shift in how automation capabilities are perceived. Advances in machine learning and artificial intelligence are believed to have broadened the range of tasks that can be automated (Frey & Osborne, 2017). Historically the view was that tasks were in two categories: routine vs. non-routine and cognitive vs. manual (Rijnks et al., 2022). Routine and cognitive tasks were considered to be at least partially automatable, whereas non-routine tasks were believed to be less automatable under this older model of automation (Rijnks et al., 2022). It is argued that some of these non-routine tasks have already been automated or will be soon, with the aid of big data, machine learning, and enhanced sensors (Rijnks et al., 2022).

Barriers to semi-automation on-orchard

The public and private sectors continue to invest in research and development to bridge the gap and find a viable solution for harvesting tree fruit crops using robotic machines (Zhang et al., 2019). In the New Zealand context, an unsuccessful attempt was made by Turners and Growers to create a robotic harvester for harvesting apples with Abundant Robotics, who subsequently went into liquidation and the

project abandoned (Herrick, 2019). There have been many other prototype technologies for harvesting apples; however, none are quite as impactful.

Barriers to implementing automation on-orchard are significantly reported throughout the relevant literature (Rotz et al., 2019). Rural regions across the globe have faced significant obstacles in adopting the infrastructure and technology necessary for agricultural automation. For a small country like New Zealand, this is a particularly relevant issue (Rijnks et al., 2022). Some key barriers include capital, as there is a heavy resource requirement to develop and build the automation needed on the orchard (Rijnks et al., 2022). There are consistent calls on governments to support this as it is a hefty cost for one industry to develop, particularly within the New Zealand context. There are also calls that technology is creating inequality within the industry, the haves and the have-nots, as the size and location of the organisation also often dictate the implementation (Rotz et al., 2019; Salemink et al., 2017). Automation is argued to become much more affordable, as some evidence shows the cost of robotics decreased by 80% between 1990 and 2015 (Graetz & Michaels, 2018). However, at this stage, the costs are still very high (Rijnks et al., 2022).

2.4 Impact of semi-automation on the workforce

The introduction of automation has had many varying impacts on the workforce. Health and safety benefits, labour reduction and efficiencies, upskilling and reinstatement of labour, and job insecurity will all be discussed. The fourth

agricultural revolution is also discussed as an excellent model that summarises the different impacts automation has on agriculture for further context.

Health and safety benefits

For centuries automation has been destroying some jobs while creating others which often are better paid and less physically exhaustive or exploitive (Estlund, 2021). The industrial revolution proved that machines could provide the brawn behind manual labour, and this next revolutionary period with automation is an advancement on the same concept (Chobli & Weber, 2020; Coupe, 2019).

According to the literature, semi-automation's improved health and safety benefits will positively contribute to employee well-being and attraction (D'Andrea, 2021; Gao et al., 2022; Nair et al., 2021). Recent advancements in robot technology have made it possible to create machines that can automate fruit picking in fields (Bochtis & Moustakidis, 2021). This can reduce the physicality of some tasks, such as melon picking, where 80% of the worker's time was invested in putting picked melons in the bed, whereas only 20% of the time was used to find ripe melons and disconnecting them from the ground (Nair et al., 2021). A robotic system was developed to follow behind the human worker to collect the picked melons, reducing the time it took to harvest by 80% (Nair et al., 2021). Another example of this can be seen in an automated grapevine pruner, which reduces the time and the physical effort required for one of the most labour-intensive tasks on a vineyard (Botterill et al., 2017)

Semi-automation, in these instances, has reduced the physically exhaustive aspect of the work and the total amount of time taken to complete the task. Gunadi and Ryu (2021) found that more industrial robots (automation) in a local labour market had positive outcomes on the physical health of employees, particularly low-skilled. This study found that reallocating tasks from humans to robots caused them to be in better physical health and report fewer injuries. As employee safety at work is a key attraction and retention factor, as supported by Herzberg's two-factor theory, if organisations adequately convey the health and safety benefits of the technology, they will have positive attraction and retention impacts, particularly when the employees themselves see the results.

However, employee safety issues are not isolated to physically exhaustive work; robotics and automation are being introduced to mitigate the dangerous, dull and repetitive tasks humans are expected to perform (D'Andrea, 2021; Liang et al., 2020). Gao et al. (2022) found that fatigue effects could be mitigated by reducing work and task intensity and overall working hours. Another example of dangerous work within the fruit industry can be seen in pest control. Orchards spray pesticides to safeguard fruit and its quality against pests (Zhang et al., 2019). However, pesticide spraying poses inherent risks for operators in the enclosed spaces of tree fruit orchards (Zhang et al., 2019). To address this, robotic or semi-automated sprayers are likely the most viable solution to enhance operator safety and pest control efficiency (Zhang et al., 2019).

Job insecurity and semi-automation

Despite the benefits, studies and history show that automation implementation does not always have a positive impact (Nazareno & Schiff, 2021). Negative impacts include individuals feeling a loss of meaning or job insecurity (Baldry, 2012; Nazareno & Schiff, 2021). Automation changes workplace processes, tasks and structures, which can lead to higher levels of occupational stress (Nazareno & Schiff, 2021). A collection of literature covers the relationship between automation and job insecurity (Brougham & Haar, 2020; Coupe, 2019; Lingmont & Alexiou, 2020). Job insecurity is the perceived threat to the stability and longevity of an individual's employment (Shoss, 2017). Employees are likely to experience job insecurity when experiencing changes in their organisations or when they have perceived role ambiguity (Ashford et al., 1989). Schwabe and Castellacci (2020) found that introducing automation to workplaces is linked with 40% of the workforce's fear that automation will replace their jobs. The more aware that employees are of automation within their organisations or as a general concept, the lower their organisational commitment and higher their levels of job insecurity (Brougham & Haar, 2018). Fear of automation replacing jobs was also found to impact employee job satisfaction directly (Schwabe & Castellacci, 2020). Gowan (2014) states that job-loss can be viewed as a psychological failure that can have the same grieving that accompanies losing a loved one. The New Zealand fruit industry faces job insecurity as a significant concern, mainly because of the nature of the seasonal workforce, which already experience's role ambiguity (Ashford et al., 1989; Shoss, 2017). Semi-automation implementation could compound retention issues by increasing aspects of job insecurity.

Psychological contract theory is a commonly used framework for understanding employees perceived job insecurity (De Cuyper & De Witte, 2005; Keim et al., 2014). When an employee faces job insecurity, such as changing a role or a task due to automation, it can impact the psychological contract shared with the employer (Arasanmi & Krishna, 2019). Employees can feel betrayed, less satisfied, and unable to trust their employer (Arasanmi & Krishna, 2019). Studies have found that implementing new technology increases employee demands by challenging their confidence, security, and qualifications (Chen et al., 2009a). Organisational change caused by semi-automation will influence and impact the psychological contract (Conway & Briner, 2006). Psychological contract breaches through change can be mitigated through communication and involving employees in the design and planning of the change (Keim et al., 2014). If employees feel aware, involved and a part of a change decision, the shock is likely to be less, and the feelings of instability and insecurity are found not to be as intense (Bellou, 2008; Lester et al., 2007). Chen et al. (2009a) ran an experiment of two groups to implement new technology, with the experimental group receiving training and support from the IT team. As a result, they believed the new technology was superior to the old, experienced less exhaustion, and were more productive than the non-experimental group (Chen et al., 2009a).

However, displacement can still occur and not all displaced workers will naturally progress to new opportunities or adopt new skills. An example is the Luddite revolution, in which historians claim that one hundred thousand textile workers were returned to their communities with no job or income (Acemoglu & Restrepo, 2019; Jones, 2006; Sale, 1995). Automation can result in these cases of unemployment and displacement if the worker's occupation is completely replaced;

however, automation often compliments jobs, but it does not remove them (Shepon et al., 2018).

Labour reduction and efficiencies

The agricultural industry is also anticipated to undergo a reduction of workers needed for some tasks. Drone technology can facilitate the planning and execution of operations by collecting and processing real-time data (Bochtis & Moustakidis, 2021). Drones are very effective and use thermal imaging to understand how the irrigation flows and which areas of an orchard, in particular, may need attention (Jha et al., 2019). Combining this with the advances in artificial intelligence, which can target plant recognition, fruit counting and predicting future yields, there is a reduction in labour needs and increased productivity, often yielding more accurate results (Jha et al., 2019). Automation is also believed to reduce common human errors, particularly in these data entry scenarios, which can increase employee performance and notions of success (Ramachandran et al., 2022). Studies estimate that semi-automating some of these monitoring tasks, as described, could be the equivalent of using approximately 25-30 workers in some instances (Jha et al., 2019). Any reduction in workers needed is very positive for an industry in crisis due to a labour shortage.

However, implementing automation often does not cause a reduction in labour needed overall. Historically automation has had minimal impacts on overall employment numbers, but it has shifted the demand for the skillset required by workers (Bessen, 2015; Coupe, 2019; Rijnks et al., 2022; Wajcman, 2017). Key competencies throughout history have changed as the nature of work changes

(Purushothaman, 2021). For example, the industrial revolution saw people working together for long shifts needing great teamwork, interpersonal and conflict resolution skills to thrive (Purushothaman, 2021). The information era saw a drive for aspiring and growing within the workforce (Purushothaman, 2021). With Industry 4.0, or the digital era, routine and repetitive work is to be superseded by solution-focused tech thinking and working collaboratively with others (Agrawal et al., 2017; Purushothaman, 2021).

Not only will the soft skills needed with automation implementation change, but also a lot of practical skills. With the implementation of automation, a lot of “articulation work” or invisible work is required. Calibrating, maintaining, entering, and processing data and running these machines may initially increase labour numbers (Acemoglu & Restrepo, 2019; Liu & Sengers, 2021). These new tasks increase productivity and create a "reinstatement effect" that expands the scope of labour's contribution to production (Acemoglu & Restrepo, 2019). As a result, the content of tasks in production shifts in favour of labour, providing them with a broader range of opportunities. More roles will also be needed at a technical design and managerial level that the industries will need to fill (Liu & Sengers, 2021). This impact on the types of available roles is also believed to attract new entrances with technology skills to move into the agriculture (Barrett & Rose, 2022). Semi-automation, in this instance, would also allow the older population to still partake in the industry, being able to plan and supervise without partaking in the physically demanding tasks (Liang et al., 2020).

Upskilling and reinstatement of labour

The scope of semi-automation shows it is bringing in new types of technology that have not been seen before, which is an opportunity for the fruit industry to invest and upskill its people. Investing in employee development and training can positively affect retention and morale (Ng et al., 2010). Offering opportunities for upskilling and obtaining new licenses can make job prospects more appealing and employees who experience promotion quickly have greater organisational commitment (Haryono et al., 2020).

Automation's impact on reinstating labour and the types of roles needed within an agricultural context means humans will be judged much more on their "human skills" such as judgment, creativity and flexibility (Agrawal et al., 2017; Autor, 2015; Brynjolfsson & McAfee, 2016; Coupe, 2019; Purushothaman, 2021). These changes are expected to increase productivity and wages and allow individuals to be more creative and flexible, which are excellent outcomes for worker well-being and can reduce boredom and mitigate fatigue (Autor, 2015; Berg et al., 2018; Fallik, 2013; Nazareno & Schiff, 2021). This proves that if organisations can prepare and educate the workforce to collaborate effectively with automation, workers may benefit greatly in their job satisfaction (Nazareno & Schiff, 2021). These factors could contribute significantly to an employer's EVP attracting more talent to the workforce (Pandita & Ray, 2018).

Investing in employee development and training can positively affect retention and morale (Ng et al., 2010). Offering opportunities for upskilling and obtaining new licenses can make job prospects more appealing. Employees who are promoted

quickly are more satisfied with their job, exhibit greater organisational commitment, and feel a stronger sense of career growth and development (Haryono et al., 2020). Factors contributing to this include recognition and validation, the chance to tackle new challenges and responsibilities, and increased social status associated with higher job titles (Ng et al., 2010). Such programs would help reduce disparities in job skills and improve connections between industry and universities while encouraging agricultural workers to continue building their skills within the industry, allowing them to progress (Rijnks et al., 2022).

Not only does the implementation of semi-automation upskill workers, but technologically complemented jobs see an increase in demand and value (Shepon et al., 2018). Middle-skilled jobs, such as seen in the on-orchard sector, are difficult to replace as they require a combination of skills to perform the whole role (Shepon et al., 2018). The more difficult abstract and creative thinking aspects of orchard roles may not be replaced, at least not in the immediate future. However, removing the more monotonous jobs allows the more fulfilling work for humans (Shepon et al., 2018). For these reasons, there should be a focus on automation being used as a positive supplement to the working lives of individuals. Muri et al. (2020) argue that there needs to be a focus on building and designing systems to work with automated technology to alleviate some of the physical burdens that agriculturists face in their everyday jobs. Job satisfaction was found to greatly increase once these factors were addressed (Muri et al., 2020).

Semi-automation also assists in this transition phase by reducing labour time and need. For example, orchard tree pruning is a labour-intensive task estimated to

involve more than 25% of labour costs (Nair et al., 2021). Pruning fruit trees involves shaping them to maximise sunlight exposure and control fruit location and quantity to boost yield and fruit quality (Zhang et al., 2019). This technique entails selectively cutting and removing tree parts, including branch trimming and small limb removal, based on specific guidelines (Zhang et al., 2019). Researchers have developed a selective tree pruning system involving collaboration between humans and robots (Nair et al., 2021). It was found that the human-robot collaboration reduced the cycle time and decision time of pruning, allowing an overall reduced labour cost and time to complete the task (Nair et al., 2021).

Automation policy strategies must focus on upskilling, education, and re-training of their staff to keep them engaged and retained within the organisation (Agrawal et al., 2017; Nazareno & Schiff, 2021). Timing of the training is vital as if it is brought in too early or too late, it can have negative impacts on uptake (Agrawal et al., 2017). The automation must be well thought out and aligned to the task at hand to ensure it is practical and easy to use (Griep et al., 2021). Ensuring small organisations have the proper the IT training and skills to operate these machines needs to be factored in (Rose et al., 2016). There would be a strong requirement for the training to come from the manufacturer or developer, which would incur further costs and a sense of being out of control (Rose et al., 2016). General technical skills also need to be taught to employees so they have the baseline of knowledge to apply to other systems when they are implemented (Agrawal et al., 2017). There is also a connection between employee engagement and reducing turnover intent (Jung et al., 2021). If employers involve employees in the decisions and implementation, they are more likely to engage and align with the goals of the organisation (Griep et al., 2021; Jung et al., 2021).

Fourth agricultural revolution

The fourth agricultural revolution, or ‘agricultural 4.0’, examines how automation and robotics radically transform the farming and agricultural industry, and is a great summary of the impact of automation (Frankelius et al., 2019; Liu & Sengers, 2021). This model predicts that the impact of the new types of automation will improve productivity, increase yields, reduce costs, increase eco-efficiency on agricultural lands and orchards, and reduce labour needs (Barrett & Rose, 2022, 2022). Most importantly for this study’s relevance, there are also assumptions that automation will lead to social benefits such as a reduction in physically demanding labour and allowing workers and farmers more time to spend with their families through a better work-life balance with the added efficiencies (Barrett & Rose, 2022; Chobli & Weber, 2020). The fourth agricultural revolution is also predicted to have negative implications, such as the impact on farm labour due to technology replacing workers or existing workers not having the skills to operate equipment (Barrett & Rose, 2022). With the rise of digitalisation, work in the agricultural sector now requires a much more technologically savvy skill set, which is already creating a gap between labour needs and labour supply (Rotz et al., 2019). It is hypothesised that this will create increased stress on farmers/workers, negative public perception, and loss of practical farming knowledge and connection with the land (Barrett & Rose, 2022). This well-researched model accurately sums up the current and future impacts expected to change worker attitudes. This model has been selected as a guiding framework as it best captures some of the assumed social issues that affect will be affecting the New Zealand fruit industry workforce.

While many negative and sceptical views are had on automation, some studies are very neutral. Some argue that automation alongside the workforce isn't inherently good or bad for worker satisfaction; it depends on the context surrounding it (Nazareno & Schiff, 2021). For example, it is theorised that if the fourth industrial revolution comes to be, societies will see a reduced range of job opportunities, categories, and required work hours (Chobli & Weber, 2020). While this would no doubt have a large impact on society and current workers, it could equally be seen as a positive, giving leisure time back to members of society and potentially improving working conditions across the board (Chobli & Weber, 2020). There are substantial differences of opinion, the wide range of impacts need to be further assessed and understood, which this study will aim to contribute towards (Nazareno & Schiff, 2021).

2.5 Workforce perceptions towards semi-automation

As the impacts of semi-automation are varied, so are the perceptions of semi-automation by the workforces who inherit it. There are optimistic and pessimistic views from the workforce on semi-automation (Nazareno & Schiff, 2021). Workers may perceive that changes brought about by technology pose significant risks or offer unparalleled possibilities, influencing their attitude toward automation (Nam, 2019). This section will discuss semi-automation as a threat, privacy concerns, scepticism over practicality, techno-optimism and positive beliefs, age and sector/organisation size influences.

Semi-automation as a threat

Older understandings of technology and automation are generally more pessimistic, and people may feel replaced by automation, which could lead to low morale and engagement (Zuboff, 1982). Many workers experience anxiety that automation and artificial intelligence threaten their jobs, particularly those who have lived through automation taking manufacturing away from communities and devastating their of life (Kochan & Dyer, 2021). Automation is still seen as a threat that will cause widespread joblessness (Acemoglu & Restrepo, 2019). A key worker attitude, particularly in low-skilled work, is fear of technological unemployment (Frey & Osborne, 2017; Nam, 2019). Technology is still thought to create a new structure of unemployment, and concepts such as basic universal income enter the conversation (Chobli & Weber, 2020). Using fewer people would be a significant win for the fruit industry, as, for the peak of the kiwifruit and apple harvests in 2020-21, the projected shortfall of seasonal workers was 11500 (Horticulture New Zealand, 2021). While surges in labour needs are hard to avoid during harvest, particularly in sectors where the fruit only has a very small window of when it can be picked, any assistance in taking the pressure of human resources is much needed in the industry right now.

Techno-anxiety is a condition that was coined by Marcoulides (1989) specifically to describe how technology can cause people to act with nervousness and apprehension (La Torre et al., 2019). Technostress is a term defined as an inability to adapt and cope with new technologies (Brod, 1982). Some workers who experience technostress perceive they may not be provided with the up-skilling and retraining they need to function in these new roles that are evidentially created by automation. Automation can complicate things by increasing the sense of workload,

causing employees to lose their current performance path and criteria through process changes and a loss of familiar routine (Fallik, 2013; Griep et al., 2021). Any changes can make employees fear they will end up displaced due to their perceived inability to adjust to the new way of working (Roberts et al., 2022). Stress brought about by technology can decrease job satisfaction and result in lower organisational commitment (Ragu-Nathan et al., 2008).

These notions of technostress and techno-anxiety are expected to affect 50% of people and are not just limited to the older generations (Griep et al., 2021). Apprehension toward technology can have profound negative impacts on individuals within the workforce, such as anxiety-related health issues, fear of unemployment, financial insecurity and symptoms of burnout (Griep et al., 2021). The deficit model of science communication argues that people's opposition to scientific and technological changes is mainly due to a lack of understanding of these systems (Roberts et al., 2022). Technostress is a negative psychological state that can affect employees' attitudes and behaviours toward the organisation, which is important for HRM practices to avoid for both attraction and retention purposes (La Torre et al., 2019). Dual labour markets, such as seen with the New Zealand fruit industry, exhibit greater job insecurity overall, as permanent workers are found to be more affected when in the same organisation as temporary workers (De Cuyper, Notelaers, et al., 2009).

Pessimistic views on automation are also connected to worker vulnerabilities, societal position, education and geographical position (Roberts et al., 2022). Those more vulnerable to being displaced by automation by being in temporary or

precarious work will be more hostile to the change (Roberts et al., 2022). It is a widely held belief that rural areas with lower population densities have a higher proportion of jobs that are susceptible to automation when compared to densely populated urban areas (Crowley et al., 2021; Frank et al., 2018). Rural areas, where most agricultural work occurs, have limited job markets, leaving displaced workers with fewer options for employment (Rijnks et al., 2022). Secondly, the agricultural industry is highly geographically varied. When automation causes regional disruptions, displaced workers with similar skill sets may compete for a limited number of comparable jobs due to geographical clustering within the agricultural sector (Rijnks et al., 2022). Therefore it is important to understand the employment shocks automation may cause to employees and their wider communities (Rijnks et al., 2022). If employees perceive they are going to be displaced, or if they are displaced, harmful perceptions on automation will occur, despite the intention to make tasks more simple and accessible (Rijnks et al., 2022).

Privacy concerns

Trepidation over data ownership and the potential reach technology companies can have over farmers was highlighted in the literature as a concern within the workforce (Barrett & Rose, 2022; Moore et al., 2022; Wilgenbusch et al., 2022). Strategies for building trust in sharing data within the agricultural industry must be worked on, as the perception of risk with data sharing currently prevents vital information from being shared and existing automation from being implemented (Moore et al., 2022; Wilgenbusch et al., 2022). There is also a concern that there will be a loss of traditional farming knowledge with the implementation of automation and new technology (Barrett & Rose, 2022).

Scepticism about practicality

Farmers were found to be very sceptical about the use of technology and automation, often questioning how practical it is in their rural environments (Onososen & Musonda, 2022). Despite how automation is said to simplify tasks, workflows, and processes, scepticism about the practicality and usability is found to have prevented adoption (Onososen & Musonda, 2022; Rose & Chilvers, 2018). Automation and technology were described as being designed by "technologists" who want to tell practical farmers "what to do" despite the farmer's beliefs that the "technologists" do not know what it takes to run a farm (Rose & Chilvers, 2018). This highlights a conflict with automation implementation that HRM personnel should be aware of. It may take coaching and mediation work to unpack negative perceptions for the automation to be implemented successfully. There is a belief that if automation were implemented, it would not be a return on investment as there is a perception that it is very expensive and inaccessible (Nankervis & Connell, 2020). The slow introduction of automation across the agricultural industry is not helping and will take time to implement (Jha et al., 2019).

Techno-optimism and positive beliefs

Automation, however, does also have positive perceptions. Within the New Zealand context, some farmers place a high value on technology that makes the work easier or reduces the number of unsociable hours (Dela Rue et al., 2019). There are some perceptions that automation will provide positive social-economic outcomes, such as more opportunities for a wider range of people and skills, increased wages and an improved way of life (Nam, 2019). Some studies suggest that people are too

blindly accepting toward automation, citing overtly positive media stories that portray “techno-optimism” (Asayama & Ishii, 2017). Over 71% of media articles in one UK study regarding the implementation of automation and the agricultural revolution were overtly positive (Barrett & Rose, 2022). While no definitive consensus can be reached on whether the media perception is too positive or negative, it can be concluded that the media influence workers' perceptions toward automation, governmental policy, businesses and other individuals (Roberts et al., 2022).

Age and sector/organisation size influences

Perceptions of automation are also found to be linked with individuals' age. Automation and technology in agriculture are believed to be less accessible to the older generation of farmers due to the perceptions guided by their generational experiences (Barrett & Rose, 2022; Fallik, 2013; Jha et al., 2019). Younger farmers will naturally have more digital skills to thrive in the implementation due to their upbringing with technology (Barrett & Rose, 2022). Younger farmers were also found to be open to investing more money into automation (Fallik, 2013; Jha et al., 2019). On the other hand, older workers have invested time in manual processing. They are often much less interested in re-learning a new way or changing their perception of automation (Fallik, 2013). This was supported by an agricultural study that showed age was a significant deterrent in implementing technologies as older individuals were found to have more anchored habits and processes than the younger generation (Rose et al., 2016). Perceptions towards implementing automation are impacted by age and the size and scale of the operation where the individual comes from. The smaller the farm, operation, or sector, the less interest was found for some of the new technologies (Rose et al., 2016). This is important

to understand as New Zealand has an aging population and is largely made up of small to medium sized enterprises, so being aware of these potential influences of age and size will be important in understanding the results.

Despite the extremes of opinions, most of the literature focuses on the pessimistic and sceptical aspects of implementing automation. However, one study has found that 10-15% of people are engaged and excited about automation, 10-15% are very resistant, and 70-80% are ambivalent and waiting to see what happens (Fallik, 2013).

2.6 Synthesis of literature review

2.6.1 Implications for Attraction

Concluding the literature review, Herzberg's model provides a reasonable framework to summarize the findings. According to Herzberg's Two-Factor theory, workers seek a community, job security, remuneration, good working conditions and other hygiene factors as a baseline for motivation (Herzberg, 1966; Herzberg, 2003; Hom et al., 2020; Thant & Chang, 2021). Employees also want personal growth, stability, recognition, and meaningful work to keep them satisfied and engaged (Herzberg, 1966; Herzberg, 2003; Hom et al., 2020; Thant & Chang, 2021). These principles can be applied to understand attraction in a wide range of instances. If organisations can meet these requirements set by Herzberg, it would increase their attractiveness to potential employees.

The below table uses Herzberg's Two Factor theory as a framework to summarize how semi-automation may impact the New Zealand fruit industry according to the

wider literature. This table visualizes how semi-automation is reported to impact each of Herzberg's motivational factors.

Table 1 Herzberg's Two Factor Theory & literature implications

Herzberg's Factors (Herzberg, 1966)	Literature implications
Hygiene Factors	
"Remuneration"	Semi-automation is believed to reinstate labour to focus more on "human skills" and increase wages (Autor, 2015; Berg et al., 2018; Fallik, 2013; Nazareno & Schiff, 2021).
"Policies"	Semi-automation can increase on-orchard flexibility and allow for more part-time or varied hours of work, increasing the benefits the organisation can offer (Chobli & Weber, 2020).
"Fringe benefits"	Benefits do not appear to be directly impacted by semi-automation.
"Physical working conditions"	Semi-automation has positive health and safety benefits, by reducing the physicality, and replacing the human need to complete dangerous tasks (D'Andrea, 2021; Gao et al., 2022; Nair et al., 2021).
"Status"	Employees' status could be at risk by perceived or actual role ambiguity and/or structure changes caused by semi-automation implementation (Ashford et al., 1989; Bessen, 2015; Coupe, 2019; Nazareno & Schiff, 2021; Rijnks et al., 2022).
"Interpersonal relations"	Relationships between peers and managers do not appear directly altered.
"Job Security"	Semi-automation is predicted to negatively impact job security by feeling a loss of meaning and potential displacement (Nazareno & Schiff, 2021; Schwabe & Castellacci, 2020; Shoss, 2017).
Motivational factors	
"Recognition"	Semi-automation allows for better reporting and visibility of on-orchard results, making it easier for managers to praise their employees success (Ramachandran et al., 2022).
"Achievement"	The better visibility allows individuals to see where they have achieved great results. Semi-automation is believed to reduce human errors and create more successful end results
"Growth"	Semi-automation is believed to create more managerial roles for employees to progress into (Autor et al., 2013; Onesto, 2022).

"Responsibility"	Semi-automation does not appear to directly influence responsibility.
"Meaningfulness"	Semi-automation is argued to make the work more meaningful by making it more human-skill focused (Autor, 2015; Berg et al., 2018; Fallik, 2013; Nazareno & Schiff, 2021). Semi-automation is also argued by other studies to make the work more routine, boring and disengaging (Parasuraman et al., 2000).

Table 1 has included temporary and permanent workers together, however, the transactional nature of the temporary roles often means some factors such as remuneration, work availability and consistency and stimulation may be prioritised over other factors (Chen & Wu, 2017). For example, locally living seasonal workers may be family members or students as they usually do not work and take care of domestic duties or study. However, they may only engage in seasonal work for big-ticket purchases to assist the overall family income or have a small window of time to earn money amongst their other responsibilities (Kilpatrick & Bound, 2005). The motivation of some seasonal workers may not be affected by their job security in the long-term. Instead, they may be motivated by achieving their goals, having flexibility in their work, and having enough energy at the end of the day to attend to their responsibilities. These factors are likely the most important aspects of their working arrangement (Kilpatrick & Bound, 2005).

It is also important to note that despite temporary workers within the horticultural industry being transient, they have some expectation of job security. Unless they have been employed on a casual contract with no expectations from either party for when or how long they will work. Seasonal agreements are often fixed term and specify an agreed amount work. For example, if a seasonal worker is signing a contract to work a minimum of 15 hours each week for a seasonal period of 3

months, they will be expecting to be able to have the security of those hours. Some seasonal workers also return each year, building an expectation of employment that keeps the role attractive to them. It is essential not to disregard job security as an attractiveness point for seasonal workers for this reason. While it is essentially a transactional relationship, many of the seasonal workers still need to be provided with motivational factors such as achievement, recognition, responsibility, advancement, and growth. According to Herzberg's theory, all workers can be influenced by these factors despite having other priorities (Herzberg, 1966). In a time of labour shortage and crisis, organisations need to be implementing these models of motivation to their entire workforce to make the most out of attracting as many people as they can.

2.6.2 Implications for retention

The implications of semi-automation for retention are numerous considering the wider retention challenges and what semi-automation can impact. Table 2 has been derived from Herriot et al. (1997), while this table is not exhaustive, it provides a useful framework for what organisation obligations are expected from a psychological contract. As psychological contracts are so fluid and vary greatly from individual to individual, this is by no means a total list of factors that could form a part of a psychological contract (Herriot et al., 1997). However, it provides a reasonable framework that can be used for clarity for the purposes of this research.

Table 2 Employee psychological contract & literature implications

Employee obligations (Herriot et al., 1997, pp. 156-157)	Literature implications
"Training Providing adequate induction and training."	Semi-automation can assist with providing training of certain on-orchard tasks prior to having to complete them through virtual reality technology (Kee & Zhang, 2022).
"*Fairness* Ensuring fairness of selection, appraisal, promotion, and redundancy procedures."	Semi-automation allows for better reporting and visibility of on-orchard results, which would make it a fairer appraisal for managers to understand deserving employees for promotion (Jha et al., 2019; Kee & Zhang, 2022; Ramachandran et al., 2022).
"*Needs* Allowing time off to meet personal or family needs."	Semi-automation can increase on-orchard flexibility and allow for more part-time or varied hours of work, increasing the time off the organisation can offer (Barrett & Rose, 2022; Chobli & Weber, 2020).
"Consultation Consulting and communicating with employees on matters which affect them."	The implementation of semi-automation would have big impacts that would affect them. For semi-automation to be successful they would need to ensure to cover these changes and discuss them in detail (Barrett & Rose, 2022).
"Discretion Minimal interference with employees in terms of how they do their job."	Semi-automation will change the way people work in some instances (Barrett & Rose, 2022), and will allow more visibility (Jha et al., 2019; Kee & Zhang, 2022; Ramachandran et al., 2022), which could add conflict on how involved the organisation is in their management.
"Humanity To act in a personally and socially responsible and supportive way towards employees."	Semi-automation has positive health and safety benefits, by reducing the physicality, and replacing the human need to complete dangerous tasks acting in a more responsible way (D'Andrea, 2021; Gao et al., 2022; Nair et al., 2021).
"Recognition Recognition of or reward for special contribution or long service."	Semi-automation will not have a direct impact on recognition reward according to the literature, other than inferences made by better reporting tactics (Jha et al., 2019; Kee & Zhang, 2022; Ramachandran et al., 2022).
"Environment Provision of a safe and congenial work environment."	Semi-automation has positive health and safety benefits, by reducing the physicality, making tasks less physical and reducing chance of injury (D'Andrea, 2021; Gao et al., 2022; Nair et al., 2021).
"Justice Fairness and consistency in the application of rules and disciplinary procedures."	Semi-automation will not have a direct impact on fairness according to the literature, other than inferences made by better reporting tactics (Jha et al., 2019; Kee & Zhang, 2022; Ramachandran et al., 2022).
"*Pay* Equitable with respect to market values and	Semi-automation is believed to reinstate labour to focus more on "human skills" and increase wages (Autor, 2015; Berg et al., 2018; Fallik, 2013; Nazareno & Schiff, 2021). However,

consistently awarded across the organization.”	semi-automation could cause disparities between technological the haves and the have-nots (Rotz et al., 2019; Salemink et al., 2017).
“*Benefits* Fairness and consistency in the administration of the benefit systems.”	Semi-automation will not have a direct impact on benefits according to the literature, other than inferences made by better reporting tactics (Jha et al., 2019; Kee & Zhang, 2022; Ramachandran et al., 2022).
“*Security* Organizations trying hard to provide what job security they can.”	Semi-automation could threaten job-security by displacing jobs and manifesting job-insecurity in employees (Brougham & Haar, 2020; Coupe, 2019; Lingmont & Alexiou, 2020; Nazareno & Schiff, 2021).

As in Table 1, this table has included permanent and seasonal workers together. However, it is important to note that temporary workers have fewer connections and reliance on the organisation due to their transient position within the business (Lee & Moreo, 2007). Temporary workers' tasks are often highly monotonous and are argued to have fewer opportunities for skill utilization (Hall, 2006). Temporary workers experience more strain than permanent workers due to reduced autonomy and control, poor job characteristics and limited support (De Cuyper et al., 2008). Turnover intention for seasonal employees is often related to low pay, job insecurity, job stimulation and irregular, long and unpredictable hours (Chen & Wu, 2017). These factors make the psychological contract between employers and employees much more tenuous, as it is much more likely to experience a perceived breach (Chen & Wu, 2017).

Temporary workers will also have different perspectives on psychological contracts as they accept the contract knowing it will end (Schalk et al., 2010). Temporary workers are argued to have asymmetrical psychological contracts that are more determined by the organisation (Beard & Edwards, 1995). These contracts are said to be much narrower in scope compared to permanent workers as there are fewer

obligations, which can prevent the development of key connections such as trust (Coyle-Shapiro & Kessler, 2002; De Cuyper, Sora, et al., 2009). This has been hypothesised due to temporary workers' fewer interactions with human resources practices such as promotions, job security and perceived organisational support (Coyle-Shapiro & Kessler, 2002). Due to the nature of the work, temporary employees may experience a lack of consistency, predictability, and control over their roles which can make them feel that whatever thin psychological contract they have may be at risk of breaching (De Cuyper & De Witte, 2007; Schalk et al., 2010). Studies have found that temporary workers may have undesirable attitudes or behaviours due to feeling undervalued (Coyle-Shapiro & Kessler, 2002).

To help build psychological contracts and trust of seasonal workers, one of the key areas identified for retaining seasonal labour is strong leadership and management (Arasli & Arici, 2019; Lee & Moreo, 2007). Seasonal workers need to feel supported and well-connected to their direct leader to achieve high satisfaction (Lee & Moreo, 2007). This is often due to the nature of seasonal work, having limited experience and overall feeling of belonging to the organisation (Lee & Moreo, 2007).

Permanent workers are said to have much more complex psychological contracts in place (Lester et al., 2007; Rousseau, 1989). The longer an employee remains with an organisation, the deeper the employee views the relationship and the more factors come into the psychological contract becomes (Rousseau, 1989). Psychological contracts change over the course of an employee’s tenure with an organisation (Lester et al., 2007). When employees first join an organisation, their expectations align with their previous organisation and experiences (Lester et al.,

2007). This also relates to an employee's generation cohort, as workers may bring about different expectations depending on their historical experiences.

2.6.3 Key points

The nature of the New Zealand fruit industry is diverse due to its dual labour market workforce and seasonality. It has a varied labour pool of permanent and temporary workers with very different reasons and motivations to be within the industry. Staffing shortages and issues are prevalent in the industry, and key focuses are on attracting and retaining more staff. Generational diversity is needed within organisational thinking and awareness of the different career structures that have also changed how people work (Dutta & Mishra, 2021).

Herzberg's two-factor theory can be used to assess both hygiene and motivational factors that need to be present to have an attractive workforce that keeps employees retained. Attracting staff in this context is linked back to organisations having strong EVPs. EVPs need to be tailored to each group to ensure they capture their industry's diverse motivators to be effective. The nature of the industry means to that to retain employees, organisations need to have a clear culture, practical incentives and rewards to meet workforce motivators and ensure the psychological contracts are understood. Upskilling, promoting and encouraging staff to remain are key.

The scope of semi-automation within horticulture is limited; however, where it is implemented, it eases labour burdens, improving working conditions and making work more efficient and accurate. Significant barriers exist regarding the rural

communities, capital and current technology available. However, moves from government, research and development, and general advances in automation make it an ever-changing landscape.

The impact of semi-automation has been found to improve health and safety, transition jobs to be more rewarding, remove the physicality from tasks and improve the speed and quality of work. However, geographic, social and educational factors must be considered, as the positive benefits are not evenly spread. Semi-automation has also been found to cause a slight decrease in the labour numbers needed, despite this being offset by the industry's continuous need to grow.

The perception of semi-automation in the workplace can increase job insecurity and stress among employees. The fear of job loss and the perceived threat to an employee's resources can result in negative outcomes such as poor job attitudes, lowered performance, and increased turnover risk. Organisations need to be mindful of how they implement automation to best reap the benefits of attraction and retention.

2.6.4 Identified gaps

This literature review showed that there is a significant gap in assessing the impact of automation on the New Zealand fruit industry from an HRM perspective. A lot of the information referring to specifics of the industry could only be found in news articles, government statistics or mentioned as a small example within an academic source.

Academic research that highlighted the types of technology available within New Zealand is difficult to find, let alone what impact this was having on attraction and retention. There were no specific studies that assess the impact of semi-automation on an orchard context and what that may do to temporary and/or permanent workforces from a HRM point of view. While there were comparable studies done in other industries with a similar seasonal nature and workforce such as ski-resorts that did address attraction and retention, a direct comparison was not found for agriculture, let alone horticulture.

Nowhere in the literature are the questions below directly addressed:

1. What is the impact of semi-automation on the attraction of New Zealand fruit industry on-orchard workforce?
2. What is the impact of semi-automation on the retention of the New Zealand fruit industry on-orchard workforce
3. How does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

3. Research Overview and Methodology

3.1 Introduction

This chapter aims to address the research overview and methodology of this study. This includes the research purpose and objectives, framework of the study, ethics, and the data collection process, including the design, selection criteria and interview process.

3.2 Research Purpose and Objectives

The key research objective is to bring robust data to understand better the impact of semi-automation on the New Zealand fruit industry's workforce. The primary concerns that have been identified are (1) a dearth of academic research on the effects of semi-automation on the New Zealand fruit industry's ability to attract workers to orchards, (2) a lack of academic research on the impact of semi-automation on the retention of on-orchard workers in the New Zealand fruit industry's orchards, and (3) an absence of academic research on the perceptions of New Zealand fruit industry workers on-orchards to the introduction of semi-automation.

To address these research gaps, this study has been designed to answer the following research questions:

1. What is the impact of semi-automation on attraction to the New Zealand fruit industry on-orchard workforce?

2. What is the impact of semi-automation on the retention of the New Zealand fruit industry on-orchard workforce?
3. How does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

3.3 Selecting a framework

The framework selected is the General Inductive Approach. This approach allows researchers to explore new and complex questions without preconceived ideas or biases (Thomas, 2006). The General Inductive Approach also allows a theoretical framework to be developed based on the data collected, which can be refined and tested over time (Thomas, 2006). These are important features for this study as there is currently a lack of academic research on this subject to provide clear guidance. The General Inductive Approach is a rigorous method that involves a systematic and iterative process of data analysis, which increases the credibility and reliability of research findings (Patton, 2014).

The key areas of the General Inductive Approach are to condense textual data into a summary format, establish clear links between the research objectives and the summary findings and develop a framework of the underlying experiences that are evident in the data (Thomas, 2006). The General Inductive Approach was chosen above more complex frameworks because it best suited the practical nature of this research project. A framework should be selected based on what a researcher wants to achieve and what assumptions are shared (Patton & Patton, 2002), and this study wanted to practically address the three distinct research questions identified in

section 3.2. The General Inductive Approach enables these questions to be answered without boxing the data in to fit a pre-conceived narrative.

3.4 Ethics

Ethical Approval was obtained from the University of Waikato Management School Ethics Committee prior to data collection (refer to Appendix A). Each participant was given the Participation Information Sheet before the interview commenced (refer to Appendix C) and completed the Consent Form (refer to Appendix D).

Ethics was a forefront focus for this study as it involves the participation of orchard workers who have fragile working arrangements and are engaged in precarious work. There is a significant power imbalance between orchard workers, managers, and owners. Workers may fear for their employment if their opinions are expressed. This same risk applies for any supervisors, managers or orchard owners interviewed within this study albeit on a different scale, as they may fear repercussions or have commercial interests when discussing these issues. These participants were protected from harm by making them completely anonymous and removing identifiable content from the discussion. No link has been made to any contractors, companies or industry bodies and all information has been grouped and generalized within the thesis itself to avoid detection. All interviews are confidential, and once this thesis has been accepted all notes will be destroyed and recordings erased after 3 months. The data itself will be retained for a minimum of 2 years.

3.5 Data collection

3.5.1 Design

A qualitative design was used to achieve these aims as this study is inductive and descriptive in its approach (Bekhet & Zauszniewski, 2012). The strength of this methodology is that it enables key themes to emerge from the data collection and analysis that may have been obscured, reframed or left invisible by more structured methodologies (Bekhet & Zauszniewski, 2012). The qualitative research methodology is aimed at obtaining perspectives on automated technologies to uncover a deeper understanding about the struggle of labour attraction and retention (Kornuta, 2019).

Semi-structured interviews were selected as they show on a micro level how individuals within the New Zealand fruit industry feel about the impacts of semi-automation on their careers and work challenges. Semi-structured interviews have been found to be most effective in eliciting rich and detailed data on participants' experiences and perceptions when compared to structured interviews and focus groups (Braun & Clarke, 2006). The flexibility and responsiveness of the interview format allows participants to expand on their answers and clarify their responses as needed (Braun & Clarke, 2006). Semi-structured interviews also provide the ability to accommodate diverse participant perspectives and backgrounds (Opdenakker, 2006). This method allows natural reciprocity between the interviewer and the interviewee and enables rapport to be built more easily (Kallio et al., 2016). The interview questions used to guide the conversation are located at Appendix B. Open ended questions were used to establish more about the individual’s background.

3.5.2 Selection of Participants

All participants in this study are associated with or employed by fruit orchards within New Zealand. Specifically, this study engaged with orchard workers, supervisors, managers of orchards, senior business managers, orchard owners, research and development managers and executives. Participants across the hierarchy of the New Zealand Fruit Industry were included to capture the unique experiences and different perspectives impacting directly on the industry. A New Zealand Ministry of Business, Innovation and Employment's (MBIE) project focused on agricultural labour security, yet agricultural workers themselves were not involved in the initial framing or set-up – despite their significance to the topic (Burch & Legun, 2021). This work intends on collecting usable data from those involved within the industry to provide robust and grounded discussion. All participants are New Zealand citizens or residents.

The aim was to obtain interview responses from at least 20 people, as this was a pragmatic number considering the resources and timeframe of this study. Purposive (non-probabilistic) sampling was used with the selection process aimed at obtaining a broad range of perspectives across different positions and relationships to orchards. This sampling method is best used for exploratory and descriptive research, as was the case for this study (Berndt, 2020). Purposive sampling also allows for the researcher's judgment to select participants and ensure that the appropriate people are interviewed (Berndt, 2020). Although purposive sampling bias has a much higher risk than probabilistic sampling methods due to its non-random selection process, this risk was mitigated and by using rules and criteria for judgement throughout the research process (Berndt, 2020).

Three different approaches were used to reach out to potential participants including (1) direct contacts with companies and organisations within the industry, (2) personal professional network, and (3) snowball method.

(1) Potential participants were identified by sending out emails to companies, organisations and industry representation bodies along with an information letter to gain their permission to contact themselves or their staff, or have their staff contact me. In the instance of the larger, more formal companies the general enquires email address was used through the company website and was then re-directed or my information passed on to potential participants. For smaller organisations contact was made with the owner/operator as they typically deal with all enquires.

(2) Having worked in the Kiwifruit and Avocado industries, my own personal network and fruit industry experience was used to contact potential participants, for example using platforms like LinkedIn.

(3) The snowball method, or chain referral sampling, was also a method used. While the snowball method has been criticized for its potential biases and limitations in terms of generalizability, it remains a valuable technique for recruiting diverse samples (Bauer & Gaskell, 2000). The snowball method yielded good results for this study, as 5 participants were sourced through this method.

3.5.3 Interviewing

Prior to the interview beginning, each respondent was provided with the information sheet to enable their understanding of the study. The consent form was

also provided and discussed prior to the interview commencing so it was clear the participant understood what was happening to their information. Each participant was informed that they had the ability to decline any particular questions, withdraw from the study until a certain point in time, and ask any questions or clarify information. They were also made aware that they could receive a summary of the research findings when concluded if they wished.

The physical location was more often online and/or via Zoom as the location of the interviewees was not often practical for an in-person interview. A total of 13 of the 20 interviews were conducted virtually. For these online interviews, the researcher was in a private home office or room, with the interviewees in a location of their choosing. It is important to note for two of these interviews, phone calls were requested over Zoom or Google Meet due to concerns from the participants about online access or troubleshooting issues. The seven interviews conducted in person were all in a private space chosen by the respondents. These settings included on-site meeting rooms or areas within a private dwelling. It is important to note that all participants were offered the option of a virtual meeting in consideration of the post-Covid era, with heightened changes regarding safety and convenience.

3.6 Data Analysis

The data was analysed using thematic analysis, which is described by Braun and Clarke (2016) as a method of identifying, analysing, and interpreting patterns of meaning in qualitative data. This involves using codes to establish themes that create a framework for interpreting and reporting the data, whilst ensuring that the

analysis is anchored by the research question (Braun & Clarke, 2006). This is a flexible approach for extracting meaning from the data, which worked well for this study as there were specific questions to answer (Braun & Clarke, 2006).

The data analysis was determined deductively, by the research objectives, and inductively, by multiple readings and interpretations of the raw text (Thomas, 2006). The main task of the interview analysis was the development of categories into a summary framework that conveyed key themes and processes. The transcripts were reviewed and entered into NVivo for organizing and analyzing qualitative data. Themes and categories were organized into a code/tag tree, to be hierarchically organized, using parent and child code/tags. The categories were independently revised and refined to search for sub-topics, inconsistencies, and new insights.

3.7 Participants

Seven different sectors within the New Zealand fruit industry were accessed. Kiwifruit was the top exporting horticultural produce in 2021, with a value of 2709m (Warrington, 2021). While Kiwifruit is a dominating sector in this study, this is reflective of the wider industry as Grape Wine follows at 1858m and Apples 847m (Warrington, 2021). The breakdown of participants from each sector is described below in Table 3. The number of participants by role is described in Table 4, giving an indication of the spread of different positions participants originated from. Grouping participants into the five different categories of roles were as follows; Orchard manager was assigned to a participant if they were hired as the role of orchard manager within a fruit industry sector. This could be a small, independent orchard or a larger organisation. Orchard owners were categorized by owning an orchard within the New Zealand fruit industry. It is important to note

that some participants owned orchards, but also professionally manage some orchards they did not own, these people were classed as orchard owners for the purpose of this study. Orchard workers were defined as being employed with the purpose of complete on orchard work. This included roles such as supervisors or team leaders, or machine operators and included seasonal and permanent employees. Research and developers were classed by their involvement in developing and piloting semi-automation within the New Zealand fruit industry. These participants ranged from being employed by agricultural organisations, to wider technology businesses. Senior managers referred to managers who were at often an executive level of employment within a fruit industry organisation. Due to the small sample size and industry, this study has refrained from providing any further information about the participants to maintain anonymity. Even assigning pseudonym could be risking anonymity as the information gathered is often very specific and is within a very small context. The participants also came from a wide range of geographical locations, including Central Otago, Martinborough, Hawkes Bay, Bay of Plenty, Gisborne, and Northland. Participants also came from a wide range of backgrounds, including corporations, growers' groups, and others who were completely independent.

Table 3 Breakdown of participants by sector

Sector	Number of participants
Apples	4
Kiwifruit	8
Citrus	2
Avocados	2
Olives	1
Berries	1
Grapes	2
Total	20

Table 4 Breakdown of participants by role

Role	Number of participants
Orchard Manager*	5
Orchard Owner	5
Orchard Worker	3
RND Developer/Manager	3
Senior Manager	4
Total	20

*If a respondent identified as a both an orchard owner and a professional orchard manager they were marked as an orchard manager.

4. Results and Findings

4.1 Introduction

This chapter will discuss the results and findings of the study. The semi-structured interviews were conducted between November 2022 and January 2023. The first section outlines the participants and different sectors, the second section summarises the results of the thematic analysis of the identified categories and sub-themes. The third section addresses each category and sub-theme and supports it with evidence from the data. This chapter concludes with a summary of each category finding and how these relate to the research questions.

4.2 Categories and sub-themes

The thematic analysis stemmed four categories, each of which contains sub-themes. The upper-level categories were derived deductively from the specific research objectives and their associated sub-themes derived from inductive analysis of the data. The categories may have the following 5 features (Thomas, 2006):

1. A category label – a word or short phrase used to refer to the category.
2. A category description – which captures the meaning of the category, including key characteristics.
3. Text associated with the category that illustrates the meanings, associations and perspectives.
4. Links – a hierarchical link within each category (themes and sub-themes) and links to other categories.
5. A framework that the category is imbedded in, although not always the case.

The categories and associated sub-themes are summarized in Table 3 and explored in depth in the paragraphs below:

Table 5 Results categories and sub-themes

Categories	Sub-themes	Case occurrence	Case occurrence %	Coding count
Attraction and retention to Fruit Industry	Family & Friends	14	70%	19
	Job availability & progression	9	45%	11
	Success	5	25%	7
	Lifestyle	18	90%	22
Presence of semi-automation	Limited semi-automation	13	65%	22
	Current semi-automation	8	40%	17
Effect of semi-automation	Widened labour pool	8	40%	13
	Health and safety improvement	7	35%	13
	Decreased labour	7	35%	10
	Upskilling	8	40%	11
	Better results, faster	14	70%	17
Feelings toward semi-automation	Positive future plans	13	65%	18
	"Old school" mentality and scepticism	10	50%	12
Other findings	RSE	6	30%	8

4.3 Attraction and Retention to Fruit Industry

The category labelled “Attraction and Retention to Fruit Industry” refers to how participants became involved in, attracted to, and remained within the industry. The key characteristics of this category are the responses on how participants entered the fruit industry and what they enjoyed most about their work. This is important as it directly relates to understanding attraction and retention for those within the

industry. The associated sub-themes derived from this category are outlined below with text examples and supporting comments.

4.3.1 Family & Friends

A prominent theme to emerge was that being connected through family or friends were vital entry points and the reason why many people remained in the industry. Seventy percent of participants are coded to this sub-theme. It was common for orchard owners to remark on the reliance on friends and family for some of the seasonal work challenges. Permanent staff also commented on how important it was to have these connections, particularly in smaller run orchards, *labour hasn't really worried us. They are all local people, friends of a friend or family, that sort of thing."* There were also remarks that family and friends have been critical during times of limited accessibility to labour.

Being born into a family orchard and growing up working on orchards from a young age was referenced often. It was clearly a path that many orchard owners were proud of, with one commenting, *"I was born into kiwifruit. I am a workaholic for anything relating to caring for the fruit."* People within the industry frequently encourage their friends to 'try out' the industry across entry levels through to senior management positions, or often to give a hand during harvest. Many of these introductions have been enough to have people enter the industry for many years. A senior manager said he started out as a favour to a friend, *"he asked for a hand one day and I gave him hand for harvest and then ended up just sticking around, never left."*

The attraction to the industry within the family and friend sub-theme was often presented around important sociological aspects of physically working on orchards. Orchard workers being able to go out and pick fruit, talk, spend time together, and listen to music became apparent as a key draw card to the industry. One orchard owner discussed how he had a failed implementation of a new pruning technology based on an air compressor, whereas the much quieter electric version was well received by the workers. The explanation given for this was *"if people are working outside in the fields, that's part of the appeal for them that they can be family and talk nonsense and listen to heavy metal if they want to."* The key difference in success and failure of technology was being the ability to talk to each other while working. Social connection was a universal positive for permanent and seasonal workers alike. One senior manager commented, *"the management are some of the best people I have ever worked with. They are now like family to me. They motivate me every day."*

4.3.2 Job Availability and Progression

In terms of attraction and retention in the New Zealand Fruit Industry, this research revealed job availability and progression as a sub-theme. Participants highlighted that the industry was initially appealing due to its accessibility, minimal entry barriers, and diverse range of job opportunities. Cadetships and clear and accessible pathways to progress into leadership roles were cited as key attraction and retention reasons for some participants.

A senior manager commented that they first started in the fruit industry due to unemployment and orchard work was the original role they were offered through

MSD. *"Went into MSD and ... pretty much the main job that you could get was anywhere in an orchard. And so, I started in the orchards… I thought this is the lowest risk job because of how much work there is in the region for it."* The senior manager spoke about the public perception of orchard work and how they originally thought it was not a standalone career and it was just picking fruit seasonally. However, when they realised the year-round opportunities and career pathways available, they were surprised and impressed commenting *"not a lot of people pay any attention to the orchard work as a career or even as a serious job as they think it's all just picking fruit. But once I realised there was so much more to it than that I realised it was a very good place to be."*

Almost half of the survey participants experienced natural career progression within the industry, either through structured development programs like cadetships or via the hierarchical structure of the business/sector they were employed in. Cadetship programs, which offer a combination of formal education and on-the-job training, were commonly mentioned within this sub-category of results. One orchard manager had quite a formal introduction to a cadetship programme within the fruit industry, engaging in formal learning and collecting the required qualifications through the local Polytechnic, *"started in the cadetship program, so I've done all the qualifications and unit standards through the Polytech."* Another orchard manager had a less formal cadetship experience but was given practical work, which laid down the foundation within their sector and what they referred to as 'grassroots stuff'. This included pruning and thinning techniques, supervising picking gangs and general exposure to on orchard activities.

Orchard & Senior Managers commented about how they followed natural progression and made it to management at a young age and very quickly, with one remarking *"followed the path, grabbed any opportunity I could, and it surprised me how quickly it came about."* The participants believed that opportunities exist for those who build the skills and work from the foundation level *"my role was a natural succession, but it happened a lot faster than normal than I would've thought. Through working in the roles, I just had the skills, and the opportunities were there."* Other orchard workers commented how they had some good mentors that had *"stuck with them from the beginning"* and if it wasn't for the strong leadership and guidance they may not have progressed as far through the managerial ranks themselves. They commented there was a cohort of individuals who were supported by these mentors which provided them with the ability to become future leaders.

This sub-theme also highlighted a belief that the bigger organisations had more opportunities and were the main places to achieve progression and leadership. A senior manager commented they progressed from a small, family owned and operated orchard into their leadership role at a big organisation to make use of all the new technology and maximise their potential, *"I moved over because of the automation, all of the variety and technology that they were focusing on, so many options and all the opportunities that the big corporates can offer."*

4.3.3 Success & Lifestyle

Achieving success, lifestyle and work life balance came across all different sectors and roles within this study. While the notion of success meant slightly different

things to each participant, it generally referred to achieving positive outcomes related to the quality of the fruit. For instance, some participants expressed pride in delivering excellent results for the orchard owners they worked for, commenting *"I love that I can help them smash out really good results and achieve, achieve big things in their orchards."* Whilst others enjoyed seeing the tangible results of their hard work in achieving targets or goals, *"if you do a good job, you see the fruits of your labour and think, yeah, that's good."* Similarly, many participants took pleasure in selling high-quality products that looked visually appealing.

The industries afforded lifestyle was a key theme to emerge in relation to attraction and retention, as whilst participants discussed the trials and intensity of harvest, gratefulness for the freedom, variety, and flexibility the work offers were apparent. Orchard owners and managers spoke about how creating something physical in an outdoor environment that encourages families to work together is one of the favourite aspects of their role, with one commenting *"I love, love creating things. Obviously passionate about fruit as you can create the lifestyle with the family in and love working on and in the land."* There was a shared sentiment amongst participants about how on an orchard if there is nothing pressing to do, it is very easy to finish early and enjoy a long weekend. Participants felt the flexibility of their roles allowed them to be much more present with their families, enabling them to plan work around their day, not the other way around. Examples given by orchard owners included being able to pick children up from school, or *"it's great if you can go to your kid's cross country, and actually get to be present and watch. That's something this career allows."*

Orchard owners, managers and workers all commented about how the variety and consistency of jobs kept the work stimulating. Many reported never feeling bored, as there was always something to do, a new season to prepare for or work towards. *"No two days the same"* was a specific sentiment shared by three separate participants.

4.4 Presence of semi-automation

This category refers to how much semi-automation participants are currently seeing within the New Zealand Fruit Industry. Key themes include the types of technology available and how widespread it is within their sector and personal experience. Each sub-theme links to the overarching category of the presence of semi-automation and provides insights into how this contributes to attraction and retention within the industry. The associated sub-themes are outlined below, with text examples and supporting comments.

4.4.1 Current semi-automation

According to a senior manager from a large organisation, automation is currently a significant focus in the working world, *"automation is currently the forefront of our working lives, it's a huge space at the moment."* However, they also noted that the development of semi-automated machines is limited, and there are no machines that operate completely without hands-on intervention, *"while it is a core focus that is being pushed, it is also stagnant. There are no fully automated machines, as in no hands on, everything we have is a tool or semi-automated."*

The participants discussed various semi-automated machines and tools, with platforms, hydro ladders, and electric pruners being the most common. One orchard owner owned three platforms and planned to invest in more, while another owner mentioned purchasing electric pruners for all staff due to their effectiveness. Additionally, a research and developer described a machine designed to shake or strip bushes and trees to increase efficiency during winter pruning. Skilled pruners make the initial cuts, and the machine then removes the cuts from the vine.

Orchard owners also discussed piloted fruit picking bins they had seen in action that use Bluetooth and GPS to manoeuvre unaided around an orchard, *"the bin can follow you on Bluetooth or on Wi-Fi it's really cool."* The results showed that the bins would follow the picker around on the orchard and would then send automatic notifications when it was full or almost full so tractor drivers would know when it was ready to be collected. Two orchard owners had tried to re-create a similar machine on their own orchards as they could not access a commercially complete one yet.

Some semi-automated tasks on orchards are outsourced by orchard owners. Modified tractors are commonly used to lay special orchard foundations and materials that owners may not have access to. A contractor provides this service across New Zealand due to high demand, as reported by one orchard owner who stated that the contractor operates several machines and travels throughout the country to perform the service *"he's not even based locally... he has a few different machines and goes all over New Zealand applying the service it's that niche nobody else really does it, but it is in demand."*

A research and developer mentioned using virtual reality headsets for employee training through realistic simulations. They explained that these tools can imitate the state of an orchard at any given time and assist in teaching employees how to prune, *"they are virtual reality assisting tools that mimic the state of an orchard at any given time that will largely assist in training people how to prune."* A senior manager also expressed interest in this technology, specifically for training RSE workers who may struggle with the various stages of orchard work due to weather and seasonal conditions. They noted that virtual reality training could help ensure workers are adequately trained and avoid costly mistakes, *"there are so many different stages on orchard they need training for, however it is all determine on the time of year and weather, and it can be difficult to get them up to speed and ensure they don't make any costly mistakes, so the virtual reality training is definitely something that we are looking into."*

Semi-automation reported also included data collection machines like robots and drones that could count fruit and estimate crop yields. Those interviewed, including research and developers, senior managers, and orchard managers, all discussed the use of semi-automated robots that can move around orchards and provide accurate fruit and flower counts using cameras and AI. One senior manager referred to the technology as *"simple, time saving stuff."* An orchard owner was particularly interested in unmanned aerial systems and how they can detect disease, monitor yield, and provide orchard monitoring by setting waypoints for the drone to fly over each day and provide information block by block and row by row. The owner emphasized how much time is saved by identifying which areas need attention and saving unneeded man-hours, *"they can detect disease, yield monitoring, orchard*

monitoring, you just set your way points and it will fly out each day and give you all this information, block by block, row by row. It is fantastic."

The results found that current semi-automation was often only being considered out of necessity. A research and development manager explained that some tasks are relatively easy and not physically demanding, so there isn't much motivation to use tools to assist growers or managers. The decision to adopt automation is driven by the need for labour. When asked whether the need for automation would still exist if the labour crisis were resolved, the participant responded that there wouldn't be as much pressure, but if labour became less accessible or more expensive, many businesses would not survive, *"some of these tasks are relatively easy to do and are not super hard on the body, so they isn't much drive or need to bring in tools to assist when it can be done by a grower or a manager themselves. It's all needs driven and right now its labour that's needed so that's what's driving a lot of it."* While a temporary reprieve may be possible, relying on labour going forward would not be sustainable, "…*however, the reality is if labour got any less accessible or more expensive than it is right now, many businesses would not survive. So, they might have a temporary reprieve, but it just wouldn't be sustainable to rely on labour going forward regardless."*

One research and developer discussed how they were commissioned for designing automation in the New Zealand context, with a focus on efficiencies, better data collection and obtaining a clearer picture for organisations and growers to understand how their crops are performing. These technologies often incidentally reduced the labour needs of these orchards or removed some of the tedious aspects

of the roles such as physical counting and monitoring, *“I don’t even think a human could do this type of work with the accuracy and speed we get from this technology, but it would be a fulltime job within itself.”*

4.4.2 Limited semi-automation

While participants could generally list a few instances of semi-automation they had heard of in their sector, the majority commented that technology was just not quite there yet outside tools such as platforms, hydro ladders, and electric pruners.

There was a strong response to the presence of semi-automation being limited with 65% of participants coded to this section. One orchard owner commented, “semi-*automation on orchard? Look, I think it's very limited.”*

A research and development manager noted that they are facing challenges in developing ‘harvest assist’ technology, as it is difficult to replicate complex tasks with machines. According to the manager, machines are often too strong and lack the necessary dexterity. There was a common perception among orchard owners, managers, workers, and researchers that semi-automation was not suitable for many complex on-orchard tasks. For example, one researcher said, *"getting a robot dexterous enough to manipulate and tie a wire is something that we have not seen, and I will be surprised if it becomes a reality anytime soon."* While some orchard owners and managers were sceptical about the usefulness of automation in their fields, others remained open-minded. One owner stated that they found it challenging to envision how automation could help harvest fruit, but they *"never say never."* Another owner shared a similar sentiment, stating that they could not see how a machine could accurately pick out ripe fruit while leaving green fruit and

flowers untouched commenting, "*even when we pick by hand you've still got to be so careful because the fruit bruises so easily and then its damaged. We have to train our staff on a particular way to hold and pick the fruit as otherwise you can see finger-marks and blemishes on the fruit. We had a newbie just the other day do this wrong, and you could see the bruising. How will a machine do it better?"*

The results showed there was a concern about the technology not being designed for the New Zealand market. Some participants wondered if the results would be accurate in a New Zealand setting, or if something went wrong with the machine if they would have a trained technician available to assist with repairs, *"what happens when the machine goes wrong in the middle of harvest? I might have 1 or 2 days leniency but who's going to help? Do I make a call to USA or wherever the bloody thing is made?"* One participant noted that much of the automation tech used in their sector came from Florida, which posed issues with the different shades of green between their trees and those in New Zealand, making it difficult to accurately assess chlorophyll levels and nutrient content.

There was recognition that orchard structures would need to change in order to implement new technology such as harvest assist tools. One orchard owner discussed this in detail, stating that they needed to change the full layout of their orchard, *"the days of the freestanding trees are over, now we are planting high-density number of trees per hectare and a two-dimensional sort of framework. I had to replace them…with a view to being able to use more machinery, more technology for the future."* An orchard manager also commented on how they are changing the style of their trees by moving away from 3D style trees and using lots of platforms

and hydro ladders that need 2D. A senior manager summed it up by saying *"for automation to work you need a purpose-built orchard… under our care we do not have any orchards that are suited for automatic spraying or anything like that."* Another orchard manager discussed how, for his type of fruit, even with 2D trees, it is difficult to get the consistency and order needed for current automated technologies to be successful *"they would be a hard one to automate because…generally every tree is different. So, there's no one straight path."*

The cost of redesigning an orchard to be fit for purpose is only one small part of the capital discussion that emerged in the data. One orchard owner discussed how supportive and innovative the technology is, however, expressed doubts surrounding how affordable it is, "*what they've developed…is just fantastic. It's just whether or not we're going to be able to afford it. Cause we're getting the same price for our fruit we were 30 years ago."* An orchard manager discussed how they have yet to see any margin be lucrative enough cost-wise to justify the implementation when compared to other options, *"I've yet to see many automation solutions that cost less than the labour or they're at least as expensive and there's just not a lot of margin to be implementing it."* One orchard owner commented that each pair of electric pruners were $3000 NZD, and that they would need at least 20 pairs to fully transition their workforce over to them. A senior manager commented that capital investment is a foreseen issue, and thinks it will be difficult to convince growers, *"I think the bigger investment from the grower is going to be the hard sell."* Another orchard manager also agreed with this thinking, stating that the impact of semi-automation on the industry would be determined by its cost. A specific example was given of the electric picking bin that was piloted and followed people around on the orchard. However, the orchard owner commented *"it is a*

capital matter. Money rules the world, and that's what it's come down to. I can't afford it."

Capital was also seen as a barrier to the industry in general, not just regarding automation as one research and developer commented, *"all the options are becoming much more expensive and it's just removing the profit left in it. It Is getting so expensive to manage, so whether it continues to be viable is to be considered."* A senior manager discussed the industry changes they foresaw, including smaller orchards banding together and becoming more corporation based. They noted that the environment was still quite competitive, with everyone working in silos and competing against one another, and that smaller organisations were likely to miss out, predicting eventually they will band together, "*I suspect in 10 years' time they will all morph into wider groups or be absorbed by the big players because it just isn't sustainable anymore."* The senior manager mentioned that this type of behaviour was commonplace in the USA. Another senior manager discussed how their organisation trialled an automated picker and how difficult it had been to fund a start-up like that. They also commented that they had seen a few smaller companies fall off the radar due to *"the big ones just sinking a lot of money, a lot of the automation companies have not done so well."*

Semi-automation was not only seen as limited in smaller organisations, it was observed to be a lot more limited in the smaller sectors of the fruit industry, *"our sector within the industry is boutique, to put it politely. It's an old sector, but has not got the scale or the dominance, particularly economically to provide a research space the same way kiwifruit does for example."* Senior managers commented that

some semi-automation may end up being owned and operated by contractors who rent it out, using the machines and working for them as the financial burden of owning the technology themselves was too great. A senior manager reported that some serious conversations were had regarding the future and if it was a contracting one.

A research and developer explained that their automation work is mainly focused on the USA market, despite being based in New Zealand. This is because the USA has stricter regulations on orchard structures, which results in greater consistency, and more funding to employ and test high-end technology. They described the vast scale of some orchards in the USA, with a single owner potentially owning 10,000 acres of flat land and having strict rows and precise infrastructure. The developer emphasized the significant difference in capital outlay between the USA and New Zealand markets. While funding for a few pilot robots may be available in New Zealand, larger companies in the USA can afford to purchase an entire fleet of machines right away.

Automating orchards and organisations can be very costly due to the increased reliance on machinery. Once a machine breaks down, the downtime becomes very expensive, *"if, for instance, eight people are working and something goes wrong, it can result in significant lost time."*

4.5 Impact of semi-automation

This category examines how semi-automation is currently affecting the New Zealand fruit industry. The sub-themes are interrelated, reflecting the various consequences of semi-automation.

4.5.1 Widened labour pool

The results indicate that there is a widened labour pool in seasonal fruit work, with older individuals entering the field to supplement their income, particularly those interested in caravanning and motor homing, *"we are getting an aging population and there's a lot of people interested in caravanning and motor homing and at the moment with the cost of living they want a bit of extra money….that's another lot of labour that's not previously looked at."* However, physical limitations of the older generation may affect their ability to perform certain tasks. To overcome this, participants believed that semi-automated tools such as electronic pruners can be used, allowing older workers to continue working in the industry longer, "*while harvesting might be achievable for some, if they had electronic pruners or something, they might find it quite enjoyable and something they can do more year-round."* An older orchard owner also noted the importance of electric pruners in enabling them personally to prune, as they were physically unable to do so before. These advancements have been revolutionary for them, allowing them to rely less on contractors to complete the work.

In addition to widening the labour pool to an older generation, the potential for semi-automation to make orchard work more accessible to a broader range of people was discussed. According to a senior manager, platforms can make it

possible for those who are not physically fit enough for traditional orchard work to participate, expanding the workforce, "*it's just going to, expand that workforce and just bring people in that would not normally be physically capable of doing 15000 steps a day. Platforms and such put them in a position where they can work from a seat or undercover or not physically demanding. So, it does actually expand our labour force."*

An orchard owner discussed how they are moving away from harmful mentalities in the industry that have been prevalent in the past. They cited the example of the attitude towards workers who were unable to carry heavy bags long distances, stating that the response was often, *"if you can't hack it, bugger off and we will get someone else."* However, they emphasized that those days are gone, and they are depending more and more on backpackers and women who they need to treat better and differently. The results showed that participants believe that semi-automation makes orchard work more accessible to women, who may not be able to carry heavy loads for extended periods of time, "*they're often just not built to carry 20 kilos around their neck all day, but with these electric bins it becomes a much more manageable task."* Another orchard manager highlighted the advantages of having women as his preferred labour source, noting that they are much more selective on the orchard and do not damage crops, *"women are great, they don't rip shit and bust. They are much more selective on the orchard. Where we can make up for the physical strength with electric pruners and whatnot."* To accommodate their physical differences, the manager ensures that his staff, especially women, have adequate break routines, managing them better so that they can continue to work for several days, *"we have quite a few break routines. We just manage them better;*

they wouldn't do any more than 1 hour 45 minutes on a physical task without a proper break and stretching."

An orchard manager pointed out that semi-automation not only makes orchard work accessible to those who may not be physically capable, but also more lucrative for those who are, *"we have lots of hydro ladders, lots of platforms, which makes the work more bearable and actually widens our ability to be able to hire people."* This reduces the need for "undesirable" tasks on the orchard, which may initially deter some individuals from the industry. Another orchard owner acknowledged that the younger generation may not have the same level of physical strength or experience with manual labour stating, *"they don't even know how to dig a hole."* They are not at fault for this lack of experience, as they have not had the same opportunities to engage in physical work. As a result, the orchard owner believes *"expecting them to do well in this outdated environment, well you are dreaming."*

4.5.2 Health and safety improvement

Participants highlighted the use of electric pruners has enabled orchard managers and workers alike to continue pruning without the risk of developing Repetitive Strain Injury (RSI). According to one manager, *"[Electric pruners] that's just been a revolution for me pruning. I wouldn't be still pruning in the orchard if I didn't have that because otherwise, I'd just get RSI."* Another senior manager noted that RSE workers are particularly susceptible to RSI and that electric pruners are necessary to prevent injury and allow them to continue working "*a lot of the RSE guys need simple solution like this to keep them in the game*." However, another orchard owner claimed that electric pruners could still cause RSI due to the

repetitive motion involved in using any tool for extended periods of time, *"using any tool for 8 hours is tough, your shoulder and triceps are still getting a workout and it's still that repetitive motion that causes RSI."*

Orchard workers are not only at risk of developing RSI, but also of rolling their ankles during the harvest season according to some sectors. According to a senior manager, they typically experience more than 80 cases of rolled ankles in a season. However, the use of platforms has significantly reduced this risk, *more we go towards using platforms, the less likely it is that you would roll your ankle because you are staying still on the platform."* The manager notes that the more they use platforms, the less likely it is that workers will roll their ankles since they are stationary on the platform. Additionally, an orchard owner stated that working from heights and ladders is difficult and stressful, often resulting in delayed onset muscle soreness. Platforms, on the other hand, are safer, more stable, and a less physically challenging option for workers, "*working from heights and from ladders is horrendous. Platforms are much better, safer and stable. Going up and down these tall ladders is really stressful, and they develop a lot of delayed onset muscle soreness, and it just is a much tricker physical activity than a platform."*

The results showed each sector seemed to have particular tools for their type of plants or orchards that assisted workers. A research and developer discussed how the machine created to come and strip the vines after they had been pruned saves a lot of the physicality and common injuries that are sustained by their orchard workers. They reported seeing a reduction in the injuries reported, particularly on rotator cuffs, *"the tendrils that hang on to the wires make it a very physical job,*

and you can imagine these guys just pulling all day and damaging rotator cuffs and all that sort of stuff."

Some participants also discussed how while most automation on orchard was safe and went well, like anything a small percentage goes wrong and can have detrimental consequences. Discourse came up around safety issues involving autonomous or semi-autonomous robots on orchards, and whether you can trust having people working at the same time as these machines.

4.5.3 Upskilling

40% of participants mentioned upskilling. Orchard owners expressed scepticism about the maintenance of machinery and indicated a preference for good equipment operators rather than good fruit pickers in the next 10 years, *"growers want to see someone who could take care of equipment. So, they would like good operators, not good fruit pickers."* However, most respondents were confident that their current workers could easily learn the technology used in the industry. Some participants, including a senior manager, believed that almost anyone could be trained to use semi-automation, such as platforms, as the SOPs (Standard Operation Procedures) were well-structured and the equipment was easy to us, *"it actually isn't that difficult to get people on platforms. We can have people almost pretty much straight off the street and give them a few basic rundowns. We've got some really, really well-structured SOPs."* A senior manager mentioned that finding machine operators was an easy task these days, as tractors are equipped with air conditioning, radios, and are priced around 60k. However, they also pointed out that mundane tasks, such as fixing a broken post, are difficult to find someone to do. Another

orchard manager agreed and suggested automating the *"brain drain jobs, like mowing lawns at night using robots, as people often get bored sitting on a tractor all day."*

The results showed that upskilling and using semi-automation were mainly discussed in relation to existing machine operators, rather than general orchard workers. A research and development participant noted that operating new semi-automated tools was not significantly different from operating a tractor, stating that a capable operator with some skill could do it, *"you don't have to be particularly have to be a capable, attractive operator to do it, it's not complex work. But you need some skill as an operator, so you don't destroy everything in the vineyard while you're doing it."* Similarly, a senior manager stated that if someone had the necessary tickets to operate within an orchard, they would be able to operate the semi-automated tools they had seen on the orchard, *"you were a machine operator and you had all your tickets to operate within an orchard you'd be all right to operate it."*

As per a senior manager, transitioning orchard workers into machine operators is a common practice in the industry as good operators are hard to find, *"we struggle with finding good operators and as we grow, like, we constantly have to train people from the ground up because we are a growing industry."* However, training and upskilling machine operators can be challenging as the machinery they operate can vary greatly. For short or seasonal tasks, it can be especially difficult to upskill someone to operate a spray machine compared to other machine operators, as the investment in training may not be justified by the limited amount of work available,

"it's a lot of work to upskill someone to be able to operate a spray machine compared to maybe other machine operators and then it's not necessarily needing them so consistently, so that makes it even harder because you put all the knowledge into them and then you can't really give them heap of consistency."

During the interviews, participants discussed Health and Safety concerns regarding semi-automated tools and raised questions about policies related to licensing. One research and development manager also considered the potential implications of advancing technology on training requirements and the costs associated with obtaining the necessary credentials to operate such machines, "*are they meeting the legal requirement to operate this machinery with this short period of training, or do they need the re-certification? You'd have to be re-certified every couple of years I guess depending on the machine."*

A senior manager mentioned a prevalent mindset among horticulturists and New Zealanders in general to fix and solve issues, including machinery problems, on their own. However, they stated that not everyone has the required mechanical expertise and it is a mistake to assume that a mechanical mindset is necessary. They believed that semi-automation allows for the use of lower skilled workers, commenting, *"we aren't mechanics. If the glass breaks, call a glass technician If the motor won't start? Ring the garage or the engineer. Just because you own a range rover you aren't expected to service it yourself. I think that's a mistake to think a mechanical mindset is needed, this type of automation is actually allowing us to use lower skilled workers."* Additionally, this manager acknowledged the need for diversity in the workforce's skillset, as not every employee needs to possess the

same set of skills. Another research and developer supported this idea, stating that although basic maintenance, such as replacing a part, may be possible for growers, it is not reasonable to expect them to know how to repair the machines if something goes seriously wrong. In such cases, technicians would need to be called upon to make the repairs, *"basic maintenance may be able to be done by the grower, such as replacing a part. But the reality is if something goes seriously wrong you will need to use technicians and they will need to be available to make the repairs. It's not reasonable to expect a standard orchard owner or manager to know how to repair these machines."*

A senior manager mentioned that the introduction of automation and the changing nature of the HRM space has created new roles and changed the competencies of some members of their HRM team. They emphasized the need to plan for the future by looking ahead for five years to determine what kind of labour force will be required with the introduction of automation. They also stressed the importance of accommodating these changes and upskilling the current workforce.

4.5.4 Decreased labour need

According to the data, participants in the study believe that semi-automation reduces the demand for labour. An orchard owner shared that the introduction of a semi-automated tool allowed him to manage the orchard by himself, and he no longer needed seasonal employees, *"as soon as I had this tool for harvesting, wow! My five seasonal employees went, and I can now manage the home orchard by myself."* However, orchard managers in larger operations still require seasonal labour, but the use of semi-automation can reduce the hours and days required for

extra labour. One senior manager suggested that the implementation of semi-automation allows workers to have more time as machines can work overnight, enabling workers to come and go more fluidly and spend time with their families.

A senior manager talked about how automation, such as a fruit counting robot that removed the physical people having to come and count the fruit was a game changer, as the people who were being hired to do the task often lacked the motivation to get the counts 100% correct, whereas a machine would be a lot more accurate and motivated. *"If it's three o'clock in the afternoon, it's hot and you're a uni student the last thing you really care about is getting your apple count 100% correct. It's just a paycheck, which is understandable... the machine is much more consistent and accurate and doesn't take so much convincing to do the work."*

Despite the implementation of semi-automation, the fruit production industry is still facing a growing need for more labour due to significant annual growth rates. A senior manager commented that regardless of semi-automation available, "*interestingly, because of the way we have chosen to continue to grow, we do need more people regardless of the extra gadgets we have on hand."*

4.5.5 Better information, faster

A common thread throughout the data was the idea that semi-automated tools could provide more accurate and precise results compared to a human performing the task alone. This not only improved the quality of the work but also significantly reduced the time taken, as exemplified by an orchard owner's experience with electric pruners, *"I can now use one tool instead of three...I can get through 10 times as*

much work." While this may be an exaggeration, other orchard owners echoed similar sentiments, with one estimating that electric pruners could reduce the time required to prune an orchard by 20-25%.

A senior manager highlighted the benefits of crop imaging, stating that the technology provides accurate and fast information on various aspects of their orchards, such as winter buds, flower buds, freshly pollinated fruit, and fully grown fruit. They emphasized the value of this information, stating that it would be a full-time job for a human to do this work with the same accuracy and speed. Another developer agreed, stating that cameras working with AI saves time and reduces biases. They explained that relying on human methods means sampling only a portion of the vines, leading to a larger margin of error, *"a human method means they may only sample 20 out of 200 vines to get an estimate for crop yield, however if a machine can count all of it, or even for arguments sake half of it, you have a much smaller margin of error and you've removed the physical labour effort."* Another developer stated that a machine they use to remove vines estimates a 25-30% time savings compared to pruning manually.

According to an orchard owner, unmanned aerial drones could incorporate additional data to provide recommendations. The owner suggested that the drones could use historical and predicted weather forecasts to match yield results and help determine the best days for spraying, among other things. The drones could become so advanced that they could assist in identifying what works in different circumstances over time, which is much more advanced than what he is currently

able to do, "*overtime it becomes so clever it helps you unpack what works in what circumstances and can estimate best days to spray and all sorts of neat things.*"

A research and developer mentioned how they switched from a method that was harmful to the end result, to a new method that was equally efficient in terms of time and resources. *"We used to use chemical thinners and then manually pick up what was left, but now we have mechanized thinners that do the same job in a similar amount of time without damaging the fruit quality."*

A senior manager mentioned that the implementation of automation has been beneficial for their industry as it enabled their business to scale up significantly, making management much easier. They highlighted that the use of platforms and automated equipment has allowed for more extensive scaling. They compared the current situation with the past, where managing at the current level would have been challenging without the use of technology, making it harder to operate cost-effectively, *"when going back 10 years prior to the tech, managing at this level would be a bit of a headache to run it let alone being able to make it a cost-effective operation, it would be so much harder."*

The use of semi-automation in orchard operations was found to offer faster results that are not dependent on weather conditions. A senior manager noted that the weather has traditionally been a limiting factor in horticulture, but automation can help overcome this challenge. Automated platforms, for instance, can operate in the rain because they are equipped with covers, which makes orchard operations less dependent on favourable weather conditions.

Some participants reported instances of automation that did not yield better results and attempts to speed up the process with machinery actually resulted in an unsatisfactory outcome that took twice as long to correct manually, *"they thought they could trial this big hedge trimmer type machine to prune the trees to make it quicker and more uniformed. But it made a huge mess, and it now has to be undone by manual pruning."*

4.6 Perceptions toward semi-automation

This category labelled "perceptions toward semi-automation" refers to how participants are feeling about semi-automation. The key characteristics of this category are in their direct response to being posed the question "how do you feel about semi-automation within your industry?". Each sub-theme links to three different grouped responses by participants. This is an important area to cover as it directly answers research question (3) how does the New Zealand fruit industry on-orchard workforce perceive the impacts of semi-automation? The associated sub-themes derived from this category are outlined below with text examples and supporting comments.

4.6.1 Positive future plans

The majority of participants in the study were positive about the idea of semi-automation in the industry. One orchard owner believed that having a machine pick the fruit would be a vast advancement, *"it would certainly be an advantage, wouldn't it? If we could send a machine down the road to pick our fruit, it would be a huge advantage."* A senior manager shared the same sentiment, adding that the

long-term effect of semi-automation would reduce costs and improve the working conditions for individuals, *"we've got automated sprayers and mowers working overnight… then there is an ability for people to come in and out more fluidly and that means you go home to see your kids, then I'm all for that."* There were also positive reactions to the idea of automation being involved in participants' particular tasks. An orchard worker discussed going from having to mow, to monitoring a semi-automated mower is something they would be all for.

Respondents were also dubious about the impact on capital and cost, however, overall would readily agree to its benefits such as noted by one orchard owner, *"there's no way around it, so as long as people are willing to invest in automation, then yes you're going to see benefits from it especially as we move forward."*

An orchard manager expressed enthusiasm for new technology by attempting to create their own version of an electric bin. They explained that the bin on wheels that was more efficient than the stationary bin that required five people to lift. However, they were unable to perfect the electric component and is eagerly waiting for a commercial version to become available.

4.6.2 Old school mentality and scepticism

There was a theme of an "old school" mentality existing among orchard owners. Not all participants reported the industry as a whole favouring automation. According to an orchard owner, there will always be growers who prefer the traditional approach, *"you're always probably going to find growers that are old school and will steer away from automation and want to be hands-on."* An orchard

manager also noted that convincing those who are resistant to change, particularly from the older generation, can be challenging as they tend to be set in their ways, *"the people who are resistant to change, and there's a lot of those, just getting them to look at something from the other side of the coin or the other side of the fence is hard, older generation are pretty stuck in their ways."* A senior manager noted that changing the industry's mindset has been a slow process, and it took a few influential players to adopt new technology before others started considering it seriously. This slow pace of change is a concern for the industry, as they risk falling behind in a fast-changing world of semi-automation, *"the landscape has changed so much in the last 10 years that the industry doesn't actually know enough, they don't know enough about what roles and what jobs they're going to need in the future, let alone they've hardly got a handle on it now."* Another senior manager acknowledged that although orchard owners are generally open to new things, they tend to be slow to change. This short-sightedness in investing in new technologies was reported as posing a challenge for the industry, as they are uncertain about future job roles and investments.

A research and developer mentioned that the industry does not know enough about what roles and jobs they need, let alone what the future holds, *"the landscape has changed so much in the last 10 years that the industry doesn't actually know enough. They don't know enough about what roles and what jobs they're going to need in the future, let alone they've hardly got a handle on it now."* Another senior manager agreed, stating that the industry's mindset and financial situation contribute to the reluctance to invest in new concepts.

Two orchard workers initially commented that they thought semi-automation would be bad for the workforce and that it would take peoples jobs away, however they changed their mind throughout the duration of the interview. They concluded that they did actually have too many jobs available and that reducing some of them would be good, but not to get *"too carried away."*

An orchard owner shared an example of the challenges faced by the industry when helmets became mandatory on farms, stating that finding a comfortable helmet that fits is difficult due to the many different sizes and shapes. Additionally, the helmets are heavy and not designed to be worn with sun hats, and they make it difficult for workers to communicate with their dogs. Overall, the owner felt that the helmet requirement was impractical, "*it just felt so ridiculous and impractical to the way of life."* This was likened to the implementation of semi-automation, and the orchard owner used it as an example of how implementation should not go and how the practicality of the automation needs to be there.

An orchard worker expressed concern about fitting into the industry due to cultural differences. According to him, automation could attract more locals to the job, as it would not be as physically demanding. He also noted that the majority of his colleagues on the orchard were foreigners, and as the only one who did not speak their language, he did not find it enjoyable, *"automation will attract more kiwis… means it's not as hard of work and they will be more interested…90-95% of people are foreign that I work with on the orchard, which is fine, I just don't know if I will stick around for long because it's not really fun being the only guy who doesn't speak the lingo."* When asked to elaborate on what he meant by 'foreign' he

clarified that he was referring to individuals who did not communicate in English with him or their peers, and he was unsure if they were New Zealand citizens who simply chose to speak another language.

Some growers have been slow to adopt new technologies, even when they are available and being used by others. One research and developer explained that while stripping machines were great, not everyone was using them, and the curve of implementation for some of these technologies was too slow compared to the benefits they give. When asked why, they explained that smaller businesses were *"very heavily reliant on contractors to do the pruning work and were fine with the way that was going… and it probably didn't help that some cowboys used it incorrectly and damaged their orchard."* It was also mentioned that some people used the machines incorrectly and damaged their orchards, which likely discouraged others from trying. Despite this, participants commented the adoption of new technologies may increase soon due to a shortage of labour. Contractors are struggling, and even those who previously relied on them may now be forced to try new technologies. As one person put it, *"labour availability is just becoming not there, even the contractors were struggling, so now it's proven and been used by a few other guys I think we will see an increase in adoption."*

4.6.3 Regional Seasonal Employees (RSE)

Regional Seasonal Employees (RSE) and their contribution to the New Zealand Fruit Industry was a theme that presented itself multiple times throughout the data analysis. Whilst outside of the scope of this thesis, it is important to mention as RSE workers were often used as a comparison tool to semi-automation, or what the other

current response to the labour challenge is. Interestingly it was an area highlighted as a preference for parts of the industry when compared to semi-automated tools, or as a supplementary pairing with the tools as mentioned by a senior manager *"a team of skilled and trained RSE's on step ladders will outperform a team of locals on a platform day… You put these RSEs on the platforms and the machine itself can't work fast enough to keep up with their pace."* Another orchard manager also supported this preference for RSE's over current semi-automation as *"the technology's not quite there as far as we want it to be. I still don't see a significant reduction in the use of RSE's over the next five years."*

5. Discussion

5.1 Discussion introduction

In this chapter, the results are discussed concerning the literature and the original research questions.

1. What is the impact of semi-automation on the attraction of the on-orchard workforce to the New Zealand fruit industry?
2. What is the impact of semi-automation on the retention of the on-orchard workforce to the New Zealand fruit industry?
3. How does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

This research aimed to understand how semi-automation, in the on-orchard workspace impacts attraction and retention within the New Zealand fruit industry. Twenty people involved in the on-orchard workspace were interviewed to expand current knowledge of how semi-automation is influencing attraction and retention from their perspective. Attraction and retention have been examined, through Herzberg's two-factor theory of motivation, and through psychological contract theory, to provide well-researched discussions and consistent lenses.

Utilising the General Inductive Approach, four major themes were identified with a total of fourteen sub-categories. The themes presented naturally grouped responses and concepts received from the interview questions, which were structured around the research objectives.

5.2 Summary of discussion

Actual and perceived impacts of semi-automation on both attraction and retention of the on-orchard workforce to the New Zealand Fruit Industry were the focus of this study. The responses of the 20 participants interviewed in the study are considered against the frameworks of, Herzberg's Two Factor Theory (Table 1, Herzberg, 1966), and Psychological Contract Theory (Table 2, Herriot et al., 1997).

The impact of semi-automation on attraction to the New Zealand Fruit Industry was ubiquitously seen as positive amongst participants. Semi-automation in the fruit industry is able to directly reduce factors including the physicality of on-orchard tasks, as well as extending work windows into a wider range of weather conditions, and improved comfort for the workforce. The net results for the workforce can include; improved physical working conditions, more consistency in working days and hours, a wider demographic participating as part of the workforce, the workforce being less fatigued, and improved Health and Safety. Accessible entry to the industry was also found to be a key attraction point, with the availability and quantity of jobs having a favourable impact on attracting individuals to the fruit industry, with semi-automation set to further allow accessibility. These results aligned well with several factors in Herzbergs Two Factor Theory including: organisational polices being able to accomodate more flexibility in respect to part-time or varied hours; more consistent working hours providing both more consistent, and possibly improved remuneration; improved job security, improved physical working conditions and overall improvement of the work itself.

Retention was also reported by the participants as being positively impacted by semi-automation. The framework for retention was based on Pyschological Contract Theory as this encompasses the unwriten rules and expectations that exist between the employer and employee. The rules are very important for the retention of employee's as when breached employee's will start looking for alternative employment. Many of the important factors identified for attraction need to be delivered and maintained for successful retention, as that delivery is a key rule that must not be breached by the employer. Health and safety in the workplace is positively impacted by semi-automation due to reduced injury risk. In the context of on-orchard activites within the New Zealand Fruit Industry there was no evidence of job insecurity or job displacement experienced by participants due to semi-automation, despite the literature emphasising the risks. Furthermore, all of the semi-automation present complemented existing jobs, and the core training and skills were largely within the capability of the existing workforce. Participants viewed any upskilling as providing a clear progression pathway, which proved to be an excellent incentive for workers to remain in the industry. The study also found that success and achieving excellent results were critical motivators for workers in the industry, and semi-automation was found to improve motivation and overall retention rates by reducing human error and streamlining processes. These factors are consistent with Psychological Contract Theory (Table 2) by providing: training, needs, humanity, environment, pay and security.

The perception of semi-automation was also largely positive and reflected the beneficial impacts on attraction and retention. That said, there were concerns regarding barriers to implementation, such as limited access to semi-automation and significant capital expenditure. Despite their enthusiasm for the benefits of

semi-automation, these barriers resulted in ambivalence and a slow adoption rate among some participants. Perceptions were influenced by the sector and organisational sizes and scales, as this affected the capital expenditure and range of semi-automation available to them.

The perception of semi-automation was also largely positive and reflected the beneficial impacts on attraction and retention. Additional factors that were related to perception included: owners and managers were open-minded to introducing semi-automation; the currently accepted and proven technology was thought of positively to reduce physicality, workload, and number of employees required; adoption of semi-automation is typically slow; the size of the New Zealand market and access to technology from off-shore was seen as a barrier; sector size within New Zealand was seen as a potential barrier; large capital costs were another frequently cited barrier.

5.3 Discussion

5.3.1 What is the impact of semi-automation on attraction to the New Zealand fruit industry on-orchard workforce?

Semi-automation reduces physicality attracting more entrants

The use of semi-automation was supported by the literature and results to make some on-orchard tasks less physically demanding (D'Andrea, 2021; Gao et al., 2022; Nair et al., 2021). While the literature evidenced that electric pruners and platforms reduced the injury rates and the need for strenuous physical labour (Kee & Zhang, 2022; Kutyrev et al., 2022), the results have further contributed to this knowledge by revealing it also attracts a wider range of individuals. The people

found to be attracted by the impacts of semi-automation on physicality include the older generation and the less physically able or minded. Younger demographics were also found to be more attracted to on-orchard work with semi-automation, as their generational values of well-being were met (Dutta & Mishra, 2021; Onesto, 2022; Rodriguez et al., 2019). By semi-automation removing some of the physical strain, orchard owners commented they are seeing a lot more students and young mothers interested and able to work on-orchard.

No sources in the literature were found to connect semi-automations physicality reduction to outcomes for workforce attraction, particularly in the New Zealand horticultural context. This study can make this connection and provide a strong finding for the industry and HRM practices. Tables one and two established through the use of the guiding frameworks, imply that physical well-being is important for both attraction and retention. Thus, it is important to highlight that this finding is very relevant to fulling both these factors, making a stronger contribution to the current gap in the literature.

The participants believed to have observed the resistance of the older generation implementing semi-automation. The literature also supports the difficulty in transitioning older demographics to new technology as they are often anchored in their own ways of completing work (Barrett & Rose, 2022; Fallik, 1988; Jha et al., 2019). But it is important to note none of the participants reported themselves feeling this way. This same type of resistance was not mentioned by the participants for new entrants, and likely this is related to these individuals not having the same

ingrained behavioural patterns and experience on-orchard compared to those existing in the industry (Rose et al., 2016).

Semi-automation increases flexibility

Semi-automation makes the New Zealand fruit industry more attractive due to an increase of organisational flexibility which confers to the work-life balance of people, and this appears to apply to all demographic groups. The results showed organisations could be more flexible with some of their shifts and tasks as semi-automation was positively impacting the accuracy and efficiency of tasks through its intervention. Flexibility is a key challenge for attraction in today's workplace as highlighted by the literature review (Cappelli, 2021; King et al., 2021; Morales, 2021; Murphy, 2021; Naseer, 2023). Flexibility aligns with the current generational and environmental norms, therefore it has been translated into a necessary organisational policy for organisations to attract talent (Cappelli, 2021; Dutta & Mishra, 2021). Organisational policies are important for attraction as they are highlighted as a hygiene factor in Herzberg's two-factor theory (Herzberg, 1966). This theory states that desirable policies, such as flexibility, allow employee satisfaction to occur, which is supported by the findings of this study (Herzberg, 1966).

Semi- automation improves the consistency of work

Some semi-automation was found to give employees more consistency in days and hours that they can work on-orchard. Agriculture as a whole faces many issues with the weather, as poor weather conditions often mean they are unable to complete key tasks on-orchard (Mi et al., 2020). The results showed that employees could work

on orchards in the rain using some types of semi-automation, such as covered platforms, giving employees more consistency in their work schedules. Offering all of the workforce more consistency and certainty for work, making the role much more appealing. This is particularly important for seasonal employees, as according to the literature, consistency of work is one of the most significant areas of risk (De Cuyper & De Witte, 2007; King et al., 2021; Schalk et al., 2010).

Job security and remuneration are both hygiene factors in Herzberg's framework (Herzberg, 1966). These elements are needed for employee satisfaction to occur, and the absence of these elements can cause employee dissatisfaction (Herzberg, 1966). As semi-automation could secure more working days and hours for staff on a more consistent basis, it could increase their job security. By increasing the consistency remuneration is also better supported, as seasonal and permanent workforces alike can both be dependent on workable conditions on-orchard to improve their remuneration opportunities.

Semi-automation positively impacts accessibility to new entrants

The easy access to the industry was found to be a key attraction point by the current workforce. Within this study, there was specific mention of MSD referrals. This research supports that current attempts at partnerships with MSD are working at attracting individuals to the fruit industry, adding to the body of literature that these partnerships are a success.

Semi-automation was found to make the transition into on-orchard work even more accessible. Participants believed that some semi-automation made tasks even easier,

allowing lower barriers to entry. The literature infers this could be problematic for retention, as it was also argued that employees get bored and complacent when tasks are too simple and not mentally challenging (Parasuraman et al., 2000). Herzberg's theory has the work itself and responsibility as motivator factors, which also would support that roles that are not interesting and do not allow autonomy would not have attractive qualities (Herzberg, 1966). However, the context in which these tools were described was as an add-on to a task, not the entire task, so on-orchard workers still had to operate and focus. This could equally be seen as an improvement to working conditions, which is seen as a hygiene factor that the absence of could cause dissatisfaction anyway (Herzberg, 1966). Despite the risks of potentially oversimplifying the work, semi-automation is positively impacting the attraction of accessibility, which had favourable impacts within this study.

5.3.2 What is the impact of semi-automation on the retention of the New Zealand fruit industry on-orchard workforce?

Semi-automation improves health and safety

Semi-automation was also found to enhance the health and safety of the workforce, by reducing the risk of injuries such as RSI or rolled ankles (Gunadi & Ryu, 2021; Liang et al., 2020; Nair et al., 2021). This finding can be assessed for retention purposes, as meeting employees' implicit expectations regarding their physical safety and well-being is a critical aspect of the psychological contract (Herrick, 2019; Walker, 2013; Walker & Hutton, 2006). When employers are perceived as not protecting their employees, a psychological contract breach occurs, lowering trust and increasing the risk of turnover intentions (Walker, 2013). Taking every

opportunity to improve the health and safety of employees is also a requirement of the modern-day workplace expectations influenced by contemporary career theories and new generational values (Anderson et al., 2017; Dutta & Mishra, 2021; Rodriguez et al., 2019). Orchard owners in this study have acknowledged that the old practice of physically exhausting their workers is no longer acceptable. It is crucial for organizations to provide satisfactory working conditions to retain their workforce. (Newaz et al., 2019). It's fundamental for HRM to understand that semi-automation can assist the fruit industry could address physically dangerous and strenuous work and any other potentially harmful working conditions.

Semi-automation was also found to assist in retaining staff by enabling individuals to have longer working lives on-orchard. Participants mentioned that some RSEs were able to work injury-free throughout the season by utilizing electric pruners or platforms. Similarly, older individuals who may have struggled with traditional pruning methods were able to prune with ease using these semi-automated tools. Although studies have shown that semi-automation improves health and safety (D'Andrea, 2021; Gunadi & Ryu, 2021; Liang et al., 2020; Nair et al., 2021), there is currently no research until now linking this to the longevity of the workforce in the New Zealand horticultural industry. This finding contributes to filling the gap of literature on semi-automation's impact on key HRM practises.

Semi-automation does not cause employee insecurity

The literature found that implementing semi-automation may cause employees to feel job insecurity, which could result in turnover (Autor et al., 2013; Brougham & Haar, 2020; Coupe, 2019; Lingmont & Alexiou, 2020). However, the results of this

study indicated that the participants were not affected by job insecurity resulting from semi-automation. Although two participants initially expressed concerns about automation displacing workers, they later retracted their views when considering the shortage of labour. Research has shown that although there may be negative perceptions or media influence on automation, the actual outcomes for participants were positive when they took their circumstances into consideration (Onososen & Musonda, 2022; Roberts et al., 2022). This is supported by the deficit model of science communication discussed in the literature review, which asserts that people's fear of automation can be attributed to their lack of understanding (Roberts et al., 2022). It is crucial to note that once individuals better understand automation, their fear can significantly decrease (Roberts et al., 2022). The fear of job displacement caused by semi-automation is not currently evidenced in the current study, which is, in contrast to some of the existing literature (Fallik, 2013; Griep et al., 2021; Roberts et al., 2022). This could be explained as the literature used examples where semi-automation is more advanced in other industries which were not always specific to the horticulture context (Fallik, 2013; Griep et al., 2021; Roberts et al., 2022).

Semi-automation does not displace workers in the New Zealand fruit industry

The lack of job loss insecurity among participants could be associated with the absence of significant changes or job cuts reported by the participants in this study. This contradicts previous research indicating that semi-automation would complicate existing roles and create more managerial roles (Autor et al., 2013; Onesto, 2022). Contrary to expectations, the study found that semi-automation made the tasks easier, allowing even lower-skilled workers to perform them. This is however consistent with what is stated in some literature, which suggests that

automation typically complements jobs rather than replaces them (Shepon et al., 2018). The limited presence of semi-automation on New Zealand orchards again could be the reason for the discrepancy between these results and previous studies. New Zealand is a small country that lacks the necessary infrastructure and capital for large-scale automation to transform the industry. However, it's important to consider the risk of displacement caused by semi-automation as the technology continues to develop in the country.

Semi-automation will upskill the current workforce

Researchers and developers, in the current study, predicted that orchard workers will need more machine operating skills rather than general orchard skills. However, this view was not supported by orchard owners and orchard managers in the context of the semi-automation currently available in the New Zealand fruit industry. This finding was surprising as the general literature shows that there is a definite need for investing in formal technical and vocational training and retraining programs to ease the implementation of semi-automation (Rijnks et al., 2022). The perceived ease of transferring employees into more technical roles could be answered by looking at the specific New Zealand fruit industry context. The results showing many cadetships and natural progression pathways are evident, so the formal training could be perceived to be implied by the managers. The results showed that the technology used within the New Zealand fruit industry is still very supplementary and not technically challenging. Therefore, the automation might not yet require formal training, and as the current end users, orchard owners and managers may be more aware of this fact than those designing the technology. Conversely, research developers may be more aware of what is on the horizon and how it is going to differ from current technology. This disparity in the results

between researchers and developers and orchard managers and senior managers was consistent with the literature (Rose et al., 2016). It is important for HRM to be aware of, as when selecting or progressing employees, it is important to consider wider organisational facts and opinions and not assume they are on the same page.

The results also highlighted virtual reality technology being able to mimic orchard conditions, allowing for year-round training and development options. The ability to upskill and assist training with virtual reality tools fulfils requirements from the psychological contract theory obligations framework outlined in Table two. The results further supported the positives for these tools, as upskilling employees to promote them is a key aspect of retaining them. These implementations are important for HRM practices as it allows competency to be demonstrated year-round, allowing more opportunities for promotion and skill demonstration. Employee growth and status were highlighted by the guiding frameworks of key competencies for both attraction and retention.

Semi-automation increases employee success

The study discovered that incorporating semi-automation led to higher rates of task success, hence was more rewarding for the workforce. Owners of orchards expressed their enjoyment in producing visually appealing fruit, while managers and workers shared similar sentiments and took pride in delivering excellent results for growers. Achievement is a factor in Herzberg's theory as a motivating factor, therefore success in a role and executing it accurately can be seen through this framework as increasing work satisfaction which can ultimately lead to increased retention (Herzberg, 2003; Lee et al., 2000). The psychological contract theory can

also help explain this drive for personal and organisational success, as employees feel the need to reciprocate the positive treatment they receive from organisations (Trevor & Nyberg, 2008). The results showed participants had very strong connections with their managers and colleagues, and often referred to them as family, with some attributing their personal success to their support. This infers the industry likely has elements of strong psychological contracts, and that this is another reason why employees are motivated to get such good results to return the sentiments from their employers. The results showed that semi-automation could provide more accurate fruit counts, detect nutrient deficiencies, and help pinpoint problematic areas of the orchard assisting in their overall success and allowing them to achieve better, more accurate results which they pride themselves on doing.

Semi-automation and employee connection

Many participants reported strong social connections to their managers, and colleagues, or staff, emphasising that the relational aspect of the psychological contract was important. The results reported that participants felt like family, and more than one attributed their success within the industry to their continued attraction and retention. This was supported by a finding from a similar study on Australian farmhands who found the positive relationship with their managers was fulfilling the psychological contract needs (Moffatt, 2016). There needs to be careful consideration that automated processes do not disrupt the close nature of relationships within the industry. One participant described how the loud noise of a semi-automated pruner prevented the social connection of the seasonal workers, so they did not use it as they valued the connection to others around them more than the assisted pruning. Semi-automation, therefore, needs to retain or enhance the specific worker experience for the benefits to be felt. This is important for HRM as

if the semi-automation implemented is incorrect, they may see a misuse or a decline in attitudes towards it.

5.3.3 How does the New Zealand fruit industry on-orchard workforce perceive semi-automation?

Semi-automation is well received

Participants overall were open to the introduction of semi-automation. No results highlighted any negative assumptions about the actual impact of semi-automation, outside of the implementation barriers. Implementation barriers were the key reasons for negative consequences within other studies, largely highlighting capital and investment needed (Barrett & Rose, 2022). Semi-automation was perceived to reduce the workload, reduce physicality, reduce the number of people required, and make things easier and quicker, as captured in the sub-themes and above discussions. Overall, participants felt very enthusiastic about automation and saw it as an area they were excited to embrace to reap the benefits.

Semi-automation has a slow adoption rate

Although semi-automation was generally well-received, it was observed that the New Zealand fruit industry was slow to adopt and invest in these new technologies. A similar finding was evident in the Barrett and Rose (2022) study, where UK farmers perceived the agricultural sector as hesitant to adapt and embrace technology. There is ongoing discussion regarding traditional orchard owners and managers who resist change, especially regarding automation to be more hands-on, which may contribute to the slow adoption (Fallik, 2013; Mowbray, 2017). The

participants did not personally hold these ideas and only spoke of them as they heard them from others. This resistance is not unfounded, as experts express concern that relying too heavily on automation could lead to losing practical farming knowledge and skills, as understood in the fourth agricultural revolution model (Barrett & Rose, 2022). The results supported this finding, with even semi-automation-supportive orchard owners and managers worrying about what they would do if the automated systems failed, or how machinery would be repaired if it was designed in an overseas market. Many people felt sceptical during the study, expressing doubts about whether automation could accurately complete the work. Considering the risks of implementing new systems or changes is common, so these concerns are understandable. It is very important for HRM managers to understand that these feelings exist within the workforce, so they can ensure adequate conversations, training and transitions occur.

According to experts in research and development for new technologies, many individuals in the fruit industry are not aware of the extent of automation currently available or in development, and how it can benefit their orchards. Two separate orchard owners discussed how they could not imagine automation being able to work for their sector due to fruit colour recognition seeming “impossible”. However, it is well documented that automated robots that can pick fruit based on colour exist and are used in overseas markets (Onishi et al., 2019). One of the results presented was about an orchard owner who expressed keen interest in electric fruit-picking bins that could follow staff around the orchard without any manual control. The orchard owner faced a challenge in connecting with the university students who had displayed the bin at a local field day. As a result, they sought the researcher's advice on how to reach out to engineers from the same university. This example

illustrated the absence of coordination between these technologies and their dissemination to the broader industry, even though this specific technology was not yet available for commercial use. These examples highlight that some of the fruit industry may be unaware of what the technology can achieve for them, or their orchards and that this is why ambivalence or uncertainty toward it is being experienced. It is well documented in the literature that semi-automation on-orchard is still in its burgeoning stages, often associated with limited knowledge of their presence and how to access it (Fallik, 2013). However, there is even disparity between different orchard owners, as while some did not know about fruit colour testing, others were well aware of the technology and were trying to calibrate it for the New Zealand context. It is an important finding for the industry to understand feelings about automation may change when the workforce understands how exactly it may help them, and that there is a wide range of experience and automation usage out there.

The New Zealand fruit industry greatly varies their opinion on semi-automation between sectors

The fruit industry had varying levels of knowledge and assumptions about automation across different sectors. More prominent sectors like kiwifruit and apples had greater organisational investment and frequently tested new technology. These respondents were often more aware of other automation or had a broader perspective on what may be able to be automated. Conversely, the smaller sectors such as berries and citrus, tended to be more family-owned and operated and generally had a lot less exposure, unless they took it upon themselves to visit and import technology from overseas markets. However, exceptions did exist, and this was not a ubiquitous result of the study. During the discussion, it was observed that

some participants from larger sectors lacked knowledge about the impact of automation on their industry. On the other hand, participants from smaller sectors showed a greater interest in incorporating automation into their long-term goals. This indicates that feelings toward semi-automation shape to be more positive as the other options dwindle, making it the only option to move forward, which is a feature in the New Zealand market. This is important for HRM to consider as they may need to educate their sectors on the worsening labour situation to get them to consider more semi-automation so they are ahead of the curve and invest money where it will pay off in the future.

RSEs vs semi-automation

When discussing the costs, RSE workers came up multiple times within the results. RSE's were consistently reported as a very familiar and often preferred labour option to alternatives, including automation. One participant outlined in detail how when they brought in platforms to their orchards, they assumed this would be the easiest and most cost-effective form of labour, so they transitioned all their thinking and strategies around this. However, when they found that RSE's were working so fast that the platform slowed them down, it changed how they saw things. They have since gone back to a plan that focuses on RSE's as a key group of labour and has reduced the adoption of platform technology. This was an interesting find within this study as RSE's were initially out of scope as a labour group to be affected by automation. However, the findings of this study cannot be underestimated in that RSE's are currently viewed by some as an alternative to automation, and they are an appealing solution (partial) to reducing labour crisis issues. Another interesting finding is that RSE's do not come trained, however, their attitude and motivations for working mean they are quick and dedicated to the task

at hand (Rees, 2009). One senior manager commented to fully automate all the packhouses and use the remaining RSE's out on orchards, and you'd have far fewer issues. Despite the positive feedback on semi-automation, this example shows it needs to be applied in the specific context of each workforce which HRM and managers need to be aware of.

5.3.4 Other findings - barriers to semi-automation

It was surprising to discover that the New Zealand fruit industry prefers semi-automation, which raises the question of why this technology isn't more prevalent. The study highlighted significant barriers preventing the adoption of semi-automation in orchard settings. These results were unexpected, but they arose naturally from discussions about the benefits of semi-automation and why it isn't used more frequently.

Understanding the barriers to implementing semi-automation is a complex topic that warrants its own dedicated project. Nevertheless, it is essential to share the findings of these studies to contribute to further research. In the realm of HRM practices, it is critical to have a clear understanding of any potential barriers that may impede successful implementation. By understanding potential issues, HR managers can plan more effectively and take a realistic approach to their strategies. This knowledge is also useful for workforce planning by providing insights into the necessary skills and competencies for the future, as well as the types of jobs that may be required. Additionally, this understanding can impact talent acquisition by enabling HR managers to identify the skills needed to thrive in a challenging

environment and retain the right people. Moreover, it can affect training and development by identifying obsolete skills and focusing on the ones required for the future. By considering these factors, HRM practices can become more efficient and effective, leading to a more successful business.

Capital is main barrier to semi-automation

Interestingly the results showed very similar adoption barriers to that of a study completed by Rose et al. (2016) on the uptake and use of semi-automated tools in a UK farming context. During discussions about implementing semi-automation on the orchard, the capital was identified as the main obstacle and concern. It was mentioned 14 times by different participants. This was also highlighted in Rose et al. (2016) as a core factor in the implementation of decision support tools in agriculture, a comparable model that assesses automation barriers. Based on the results, an orchard owner stated they are still getting the same price for their fruit as they did 30 years ago. While technology was reported to be getting cheaper, as outlined in the literature review, it is frequently an additional capital cost that cannot be financially justified (Graetz & Michaels, 2018). One orchard owner said the cost of electric pruners was around $3000 NZD per pair, and they would need 20 pairs to replace the current manual pruners, making it an outlay of $60,000 NZD.

The issue of orchard structure impacting what technology can be used also poses a challenge. Existing orchard structures would rarely be destroyed and rebuilt in a way that could work well with new emerging technology, such as automated pickers or robots that needed a particular style of growth or spacing between trees (Zhang et al., 2019). The return on investment to take down a fully functioning orchard

would not be at all realistic. However, several participants mentioned that they were constructing new orchards using a 2D style or were contemplating the arrangement of rows to optimize placement for various automated tools such as electric pruners and mowers. This indicates that people generally respond positively to automation if they can afford and manage it. However, the issue of inequality arises for smaller, family-owned orchards that are not expanding or building new ones.

Capital was found not to be as much of an issue for participants from larger corporations, which was also supported by the wider literature (Rose et al., 2016). However, it is a significant concern for most of the New Zealand fruit industry, particularly orchards which are typically small to medium-sized entities. MPI also recognise that significant capital is needed to futureproof horticulture and that the government needs to assist in this endeavour (Ministry for Primary Industries 2023a). These issues show New Zealand faces similar issues to the USA and other global markets, where fruit production has become more condensed and corporate-driven. One participant commented on how they envisaged the next ten years, with fewer smaller players existing on their own and large players instead becoming the core of the industry, particularly in the more dominant sectors such as kiwifruit. The rationale was that they would no longer be able to survive on their own as the rapid technological changes would increase capital outlay and not be worth pursuing. The low viability of existing as a small entity was echoed by participants in other sectors and was a common theme. This has been well supported in the literature that there is inequitable access to semi-automation (Barrett & Rose, 2022). Wider literature supports that governments need to provide support and subsidies for the infrastructure and adoption of these new technologies (Mi et al., 2020).

The ultimate performance factors, which are related to determining if a technology is viable, come back to improvements related to processes, productivity, financial outcomes, and sustainability (Rose et al., 2016). Peer recommendation was highlighted as a key predictor of uptake, as the credibility of another farmer is seen as very reliable and a key indicator for their own success (Rose et al., 2016). Trust relates to this area; knowing the tool was evidence-based from a reputable source down to the manufacturer was important (Rose et al., 2016). This was a common theme in the results, as participants discussed it often takes a reputable person within the industry to take on and trial a technology before anyone else will consider it.

5.4 Theoretical contributions

There was no existing literature on the impact of semi-automation on the attraction and retention of the New Zealand fruit industry, or wider horticultural workforce. What semi-automation can contribute on-orchard and what functional benefits it may have has been documented (Anzelloti, 2014; Barrett & Rose, 2022; Kutyrev et al., 2022; Rose & Chilvers, 2018; Rose et al., 2016). Other industries have studies of semi-automation with inferences that could be made about attraction and retention (Chen & Wu, 2017; Nazareno & Schiff, 2021; Shepon et al., 2018). However, this is the first piece of research to combine these factors together and find evidence supporting their relationship in the unique, New Zealand context.

This thesis begins to fill the gap in the literature on the impact of semi-automation on the attraction and retention of the New Zealand fruit industry workforce. This

work has done so by completing a qualitative study gathering the perceptions of 20 New Zealand fruit industry workers and evidencing the findings against the existing literature. This study addresses the gap by finding both attraction and retention can be positively impacted by the implementation of semi-automation through reduced physicality, improved health and safety and increased flexibility. It is important this gap is addressed for HRM practises as the industry is experiencing a labour crisis and academic recommendations and support are required to better understand solutions. Organisations need to align themselves with the latest generational values and landscape changes to attract and retain talent (Dutta & Mishra, 2021; Lissitsa & Kol, 2016; Nishizaki, 2023; Rodriguez et al., 2019).

Significant contributions are made to the gap of perceived and actual job displacement by semi-automation, particularly in the horticultural industry. Some literature widely supported that semi-automation replaces jobs, making them more skilled and difficult to get into (Baldry, 2012; Bessen, 2015; Chen et al., 2009b; Nazareno & Schiff, 2021) However, through asking participants of their personal experiences with semi-automation this study did not find the same results. This is likely due to semi-automation within New Zealand being a burgeoning area, that is only in its infancy with limited literature on its existence. The sector's labour needs continue to grow year on year, so it is understandable that no displacement patterns have been reported yet. While this is a strong theoretical contribution for now, this is unlikely to remain the same in future years based on existing studies and data. This helps inform current HRM issues of retention that in the horticultural context semi-automation currently has positive impacts, without any wider displacement concerns.

This research also contributes that Herzberg's Two-Factor theory and the psychological contract theory, specifically the perceived organisational obligations by Herriot et al. (1997), still have relevance in the modern context. Herzberg's two-factor theory gave specific insight and support to the findings that company policies that are flexible allow for the attraction of employees, and that it can better bolster the other hygiene factors such as remuneration and job security which prevent dissatisfaction and again allow attraction to occur. While some semi-automation was found to potentially put at risk motivator factors such as employee responsibility through reduced autonomy, these same actions improved the overall working conditions which if did not exist would cause dissatisfaction and the opposite effect of attraction could be present. Herzberg's framework not even alluded to these factors within its framework, but it gave a context in which to measure each. This helped the researcher make inferences and analysis the impact of each factor within its own category.

Psychological contract theory gave specific insight into the unwritten obligation's participants expressed. The strong desire for achievement by participants was able to be connected to their positive views and admiration for their colleagues and managers. This connection helped reinforce how important it is to honour the workers for retention and overall organisational success purposes. The psychological contract theory also provided a framework to place the results that organisations are expected to look out for their employee's health and safety, and that semi-automation allows them to do that.

While these were not perfect theories, as described the frameworks they provided held true against many of the results predicting employee motivations and perceptions how these relate to attraction and retention. This is important for HRM issues as it gives other researchers and practitioners practical ways to assess attraction and retention.

5.6 Practical implications

The results from this study show the sub-theme of job availability and progression is a key attraction and retention point to the industry. Organisations need to ensure continued access to these entry-level positions and pathways. The New Zealand fruit industry should continue strongly with cadetships and vocational training, particularly now with the shift to semi-automation. Creating a career within the fruit industry from the ground up is just as accessible as ever with the assistance of semi-automation.

Despite the ease of transferring current orchard staff over to semi-automation, it is vital that organisations fully train their staff in the new technology. Full training will also minimise the risk of job insecurity and fear of displacement. Despite how trivial the training may appear to be, fully documented standard operating procedures and training sessions will set good habits and expectations for the future, starting to build the new soft skills required for the changes to come.

Consultation of the workforce is key as it will help assess the practicality of the semi-automation by those who will be using it, ensuring it is a wise use of investment at a time when capital is tight. The results of the study showed that all

employees who were made aware of the use and need for the technology were highly supportive of its implementation compared to those who were not. If the tool is implemented, does not work and the employees were not consulted, it will degrade the psychological contract It is also important to ensure the employees maintain their connection to their position and what they are doing. Meaningful work was a strong result of the study as a key attractor and retainer and is found by the wider literature as a key predictor for the affective commitment (Jiang & Johnson, 2018). Organisations should not lose sight of their main employee motivators such as working outside, physically achieving things, and having flexibility with the seasons. Organisations can engage their employees by having regular meetings to propose and receive new ideas.

Organisations can also work with engineering firms or universities to understand what technologies are being piloted and what to expect to see in the future. It is also important for orchard managers, owners, and senior managers to ensure they stay up to date with the semi-automation tools being implemented in foreign markets to stay current on offerings.

From an employee perspective, recommendations are to embrace semi-automation without fear of displacement. Semi-automation will have many positive improvements on the day-to-day operations. Continuing to advocate for what areas need improvement to employers is vital to ensuring the right technology is designed and implemented that will best work on-orchard. Employees should also seek out their own career development initiatives, such as taking courses to improve their

technological skills. By improving their ability to work with new technology, they are bolstering themselves to have employable skills in this new market.

5.7 Limitations

Although this study has made important contributions, it also has some limitations. The sample size of 20 people means some caution should be used in generalising the results to represent the industry. The sample also came from those who could be contacted via the internet, either having a presence online or a general email. The exception was those who were contacted through advertisement by a wider industry body. Due to the rural nature of the New Zealand fruit industry, it is important to consider that there would be suitable participants who were not as connected that may have differing opinions.

This study also only spoke with people currently engaged within the New Zealand fruit industry. It would be beneficial to understand how attraction is observed in the wider public domain with people not already attracted to the industry. How transferable these findings would be to the wider population would be an interesting study that would provide further insights and potential strength to this research.

When obtaining participants, it was difficult to engage seasonal workers. As they often are transient by nature, and not often involved in industry body communications they can be hard to contact. The managers interviewed were not asked to provide details for their seasonal workers due to the power imbalance that

may affect ethical considerations. Limited resources and time constraints made it challenging to reach out to them while also maintaining these ethical boundaries. This meant the study was slightly skewed in the perspectives of permanent workers. To avoid this in the future, the methodology could be clearer as to how many participants to interview from each different category.

5.8 Further research

The results of this study should be incorporated into a quantitative study to evaluate its applicability in a larger context. Quantitative data would provide more objective data in this area that could be communicated by numbers. This quantitative study could include a survey of the wider population should be completed to understand attraction and retention from the population outside of the current workforce should be completed. It would also allow for greater generalisation of the results to the wider population as it would encompass a larger pool of participants.

While this research was a preliminary first step, a specific study should also be done to assess the attraction and retention of on-orchard seasonal and permanent workforces separately and in more depth. The combined workforces are a complicated and unique structure of great interest that warrants their own study. It would be useful to complete a triangulation method approach to increase validity, as the triangulation method has both benefits of quantitative and qualitative studies enhancing the rigour and reliability of the study (Bekhet & Zauszniewski, 2012).

This study also only assessed on-orchard operations, a full study could be completed to assess the wider industry, such as the post-harvest workforce. This aspect of the workforce makes up a large portion of the skills shortage and would be vital to collected academic data on. Again, a triangulation approach would be best to collect the most information for the aforementioned reasons.

A full study should also be undertaken to understand the specific barriers facing the implementation of semi-automation on-orchard. Capital seems to be a key issue as it was the key reason for the slow adoption of semi-automation reported in the results, and this was also supported in the wider literature (Barrett & Rose, 2022). A study understanding the costs of a potential return on investment, particularly within the New Zealand context, would be an excellent resource for the industry, and wider academic literature to have.

Another research area of note would be to understand what the wider public perception of horticulture is in New Zealand and to find ways to specifically debunk these concerns. As this study has shown the working conditions of horticulture are improving due to semi-automation, so it would be advantageous to understand what other barriers may be impacting attraction to the industry.

5.9 Concluding statement

This research fills a critical gap that was identified in the literature by addressing the specific area of how semi-automation impacts on attraction and retention for the on-orchard workforce in the New Zealand Fruit industry. As a general technology semi-automation fulfills many of the key factors identified within the frameworks

for Herzberg's two factor theory and the psychological contract theory. Overall, the impact of semi-automation is very positive, and it is clear that semi-automated technology is a critical component for improving attraction and retention in the New Zealand fruit industry. This work provides key information to HRM managers, general managers and others in the fruit industry on the impact semi-automation is currently having on attraction and retention in the on-orchard workspace.

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Appendices

Appendix A – Waikato Management School Human Research Ethics Committee Approval

WAIKATO MANAGEMENT SCHOOL
TE RAUPAPA

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

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Rowan Lowe
By email: rowan.lowe2@gmail.com

17 May 2023

Dear Rowan

Ethics Application WMS 22/83
The effect of semi-automation on employee attraction and retention in the New Zealand fruit industry.

The above research project, as outlined in your submitted application, has been granted Ethical Approval for Research by the Waikato Management School Human Research Ethics Committee.

Please note: should you make changes to the project outlined in the approved ethics application, you may need to reapply for ethics approval.

Best wishes for your research.

Kind regards,

Amanda Sircombe

Amanda Sircombe
WMS Research and Postgraduate Manager

Appendix B – Interview Questions for Participants

Research project: The effect of semi-automation on employee attraction and retention in the New Zealand fruit industry.

Note to explain to participants: Semi-automation in these questions refers to any type of technology on the orchard, such as a picking assistant, robot pruners, drones or self-driving buggies or tractors – just anything technological that has come on to the orchard to make things easier for you and the managers in getting all the tasks done.

Interview questions:

1. What got you interested in this industry?
2. How did you get involved with your particular role?
3. What does a day at work usually look like for you?
4. What do you enjoy most about your job?
5. Have you seen automation within your industry? What effects has it had?
6. Has automation affected your role? How?
7. How do you feel about the idea of automation in your industry? How do you feel about the idea of automation in your job?
8. Do you think that automation has changed the people you work with? If so, what changes?

Thank you for all that valuable information, it is much appreciated. Is there anything else you'd like to add before we end?

Appendix C – Participant Information Sheet

Waikato Management School
Te Raupapa

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

The effect of semi-automation on employee attraction and retention in the New Zealand fruit industry.

Overview

Kia ora, my name is Rowan Lowe and as part of the Master of Management Studies, I am required to conduct a research project in form of a thesis. This thesis I am undertaking forms an important part of my Master's degree. For this thesis, I wish to research the effect of semi-automation on employee attraction and retention in the New Zealand fruit industry, focused on orchard work only. I am really interested in the fruit industry as I also work as a Human Resources Advisor for EastPack, a Kiwifruit company in the sunny Bay of Plenty.

The fruit industry in New Zealand is facing a labour shortage crisis and is struggling to attract and retain employees. Something needs to be done to keep the current workers, and also to expand the pool of interested candidates to orchard work. To try and achieve these goals, there is a refreshed focus in new technologies and machines to ease the labour burden and improve working conditions in the agricultural industry.

Currently there is not much information in the literature when it comes to gaining agricultural workers insights and opinions about the future and proposed technological changes. This research project intends on collecting useful and meaningful data from those involved within the industry, to provide discussion surrounding the future ahead.

What will you have to do and how long will it take?

This is a completely voluntary interview request. Should you agree to partake, as a participant you will be interviewed regarding your involvement within the fruit industry, and any impacts or thoughts you may have on automation. This will take approximately 30-45 minutes in most cases (and could be considerably less in some).

I would like to record these interviews for my own use to ensure I am able to have an engaged korero (conversation) and not concerned with writing notes at the time of the interview.

What will happen to the information collected?

Once the interview has been completed, only my supervisor and I will have raw access to the information you provide in the interview recording and any notes. In the final thesis document, all of the information you have provided will be made anonymous as I will only use collective terms that might be used to describe a type of group and no individual names will be used, this includes any companies and contractors. At the end of the research project all notes will be destroyed, and recordings erased.

The final product that has been anonymised will be posted online in a thesis database accessible by other academics/students. There will also be a presentation given to the New Zealand Fruit Growers Charitable trust regarding the general findings from the research project. This work also may be submitted for industry journal publication.

Declaration to participants

If you take part in the study, you have the right to:

- Refuse to answer any particular question, and to withdraw from the study at any time.
- Ask any further questions about the study that occurs to you during your participation.
- Be given access to a summary of the findings from the study when it is concluded.

If you have any questions about this research project, you can contact me on 0279416013 or e-mail me at rowan.lowe2@gmail.com. My project is being supervised by Senior Lecturer Hataya Sibunruang and she can be contacted at hataya.sibunruang@waikato.ac.nz or contact her at the below:

Hataya Sibunruang

Department of Human Resources

Waikato Management School

PO Box 3105

HAMILTON 3240

NEW ZEALAND

Thank you sincerely for your consideration of being a part of this study.

Appendix D – Consent form for Participants

Waikato Management School
Te Raupapa

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

The effect of semi-automation on employee attraction and retention in the New Zealand fruit industry.

Consent Form for Participants

I have read the Information Sheet for Participants for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study at any time, or to decline to answer any particular questions in the study. I agree to provide information to the researchers under the conditions of confidentiality set out on the Information Sheet.

☐ I agree for this interview to be audio recorded

☐ I agree to participate in this study under the conditions set out in the Information Sheet form.

Signed: _____

Name: _____

Date: _____

Researcher's Name and contact information:

Rowan Lowe, rowan.lowe2@gmail.com, 0279416013

Supervisor's Name and contact information:

Hataya Sibunruang, hataya.sibunruang@waikato.ac.nz