Horticulture Innovation Australia

# Final Report

## Transformational Innovation Performance Analysis

Dr Damian Hine
The University of Queensland

Project Number: AI13011

**AI13011**

This project has been funded by Horticulture Innovation Australia Limited using industry levy and funds from the Australian Government.



ISBN 0 7341 3587 4

Published and distributed by:
Horticulture Innovation Australia Limited
Level 8, 1 Chifley Square
Sydney NSW 2000
Tel: (02) 8295 2300
Fax: (02) 8295 2399

# Table of Contents



# List of Figures

# List of Tables



# List of Boxes

# 1 DEFINITIONS AND INITIALISMS

| | |
|---|---|
| Capabilities | A set of differentiated skills, complementary assets, and routines that provide the basis for a firm's competitiveness in an industry (Teece, Pisano and Shuen, 1994). Examples include: quality control processes, talented human resources and positive reputation amongst consumers. |
| Capital Productivity | Measures the importance placed on, and satisfaction with, performance and improvements in performance related to the efficiency of capital in the generation of output. It is defined as value added per dollar of capital. Capital productivity results from improvements in, for example machinery and equipment used. |
| Competitive Advantage | The strategic advantage a business entity has over its rivals within its competitive industry. Achieving competitive advantage strengthens and positions a business better within the business environment. |
| Dynamic Capabilities | Change-focussed, repeated activities that either directly or indirectly affect existing capabilities to alter firm/farm outputs and performance. |
| Farms and Growers | In this report, firms describe all horticultural operations, also referred to as orchards, groves, vineyards, greenhouses, nurseries, and sometimes plantations. Growers are the person, persons, or business entities who own and or manage these operations. |
| Full-Time Employees (FTEs) | The number of full-time employees is equal to the number of full-time equivalents; a unit that indicates the workload of a full-time employed person. |
| Innovation | The development and implementation of new practices or technologies that a farm business has introduced over the last three years prior to survey. Innovations are measured by 13 horticulture related variables and are classified as product, operational process, managerial practices, or organisational practices. |
| Innovation novelty | Innovations can either be new to the firm when introduced for the first time within the firm or new to the industry when such an innovation is introduced for the first time in the industry segment that the firm operate in. |
| Labour Productivity | The value added per worker. This measure reflects the importance placed on, and satisfaction with, performance and improvements in performance related to the efficiency of labour in the production and sale of output. |
| Micro-horticulture enterprises | Growers or farms employing five or fewer full-time employees. |
| Multifactor Productivity | Reflects improvements in efficiency when growers combine a set of inputs to produce outputs. Multifactor productivity in this study refers to the growth in output that is attributed to labour and capital input. |
| Non-innovators | Those reporting no innovation in any of the innovation types. |
| Non-novel innovators | Those innovators reporting at least one type of product, service, process, management or marketing innovation that was only new to the firm (NTF) but not to the industry. |
| Novel innovators | Those innovators reporting at least one type of product, service, process, management or marketing innovation that was new to the industry (NTI). |
| Profitability | The degree to which a firm achieves financial gain. |
| Research and development (R&D) | The systematic investigation or experimentation involving innovation or technical risk, the outcome of which is new knowledge or improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products and processes. |
| Significant difference | A result is deemed statistically significant if it is likely to have occurred by chance. As used in statistics, significant does not mean important or meaningful. |
| SME (small and medium sized) horticulture enterprises | Growers or farms employing more than five and fewer than 200 full-time employees. |
| Sources of innovation | The origin of ideas or information for a firm's innovation activities. |
| Value Chain | In this report, the horticultural industry value chain. It depicts the stages of progression (relating to product development and logistical movement) and value-adding activities in the sequence including pre- to post-harvest, from farm to plate. Value is added at each step throughout both product transformation (or processing) and the incorporation of quality, sustainability, and other attributes of products resulting from, inter alia, how a product is produced, stored, processed, packaged, transported, quality controlled, and traded (Dixit, 2014). |



# 2 EXECUTIVE SUMMARY

Innovation is essential for Australian horticulture to remain competitive and achieve the productivity improvements necessary to survive and grow. Horticulture Industry Australia selected the University of Queensland to conduct this national Transformational Innovation Performance Analysis to gauge both the level of innovation and the productivity that is currently occurring across the industry groups within the HIA purview. This was undertaken using a survey design which attracted 501 responses from growers and that took on average 35 minutes to complete. The response rate for the survey was 68 per cent. This survey design also afforded direct comparisons on two fronts: first, within Horticulture itself; and further, with similar surveys conducted across a wide range of industry sectors in Australia over the last three years by the researchers involved. The survey thus provided a cross-sector performance yardstick to clarify the results and feedback to growers about their industry.

We went further than the typical input-output analysis, or multifactor productivity analysis to drill down into the farm/grower level. Our questions, designed and validated in surveys over many years, were reconfigured where necessary to tailor them specifically to the sector. This provided a rich suite of responses that told the story not only of horticulture as a sector, but also of how growers innovate and seek to improve their farms' productivity. This ground-up approach is also designed to provide a much more detailed analysis of those factors that support and lead to innovation and productivity improvement.

The results of the survey were extensive and diverse. On the whole, we applaud the horticulture sector for the level and range of innovations it has produced. This is an industry that faces extensive global competition and pressure to perform under often adverse environmental conditions. It could be expected that, in such a situation, in what are generally regarded to be traditional industries, the pressures on surviving on a day-to-day basis may overwhelm any focus on innovation. However, the evidence appears to dispel such concerns. One of the major findings was that nearly 80 per cent of growers reported some form of innovation, whether it was new to the farm or new to the industry. This number is much higher than what we have grown to expect through our studies of other Australian industries.

Importantly, we saw that horticultural businesses were much more likely than any other industry we have encountered to engage with peak bodies and industry publications as sources of these innovations. Our analysis of how innovation and capabilities relate to productivity and other performance indicators rendered mixed results. The strongest relationships were found between solving customers' unmet needs and productivity, whether it be labour or capital. Growers chasing pricing and cost advantages were also likely to be satisfied with productivity outcomes. We also found that those firms with innovation leadership capabilities were more successful in fostering labour productivity. High levels of innovation are confirmed to have a positive relationship with productivity performance.

We analysed the impact, assets and capabilities possessed by each farm have on their performance. We actually found that the level of dynamic capabilities, that is those assets, routines, skills and activities, equate to many other Australian industry sectors. To a great extent, this also explains why many of the managerial behaviours we examined correspond. The findings of this study point to the importance of capability development to foster innovation and productivity in this sector. While we support earlier calls for greater training and skill development, we also show that greater engagement with, for example peak bodies and research institutes, can lift innovation performance.

## Summary of main findings

**Demographics:**

- Most horticulture operations (80.5%) are micro-enterprises, employing fewer than six full-time employees; this is also represented in the responses to this study.
- Small and medium sized enterprises (SMEs) and micro-growers represent 91% of exporters, but contribute fewer than 10% of export value.
- The majority of growers sell within the Australian market. International sales activity seems limited, with only 10.2% of growers deriving the majority of their sales from exports.
- The majority of growers have some form of tertiary education.
- Farming in horticulture is dominated by family businesses.
- 31% of respondents are 'hobby' or part-time farmers with the remainder indicating that farming is their main source of income.
- Few farmers engage in outsourcing, with nuts and other fruits at the higher end (40%) and vegetables and nurseries (25%) at the lower end of the spectrum.
- Approximate 36.4% of respondents applied for finance, and most of them were successful (85.5%).

**Innovation:**

- Most of the growers surveyed (76%) reported one or more type of innovation.
- Vegetable farmers are the most active novel innovators.
- Micro growers do not actively engage in research and development (R&D).
- The horticulture industry tends to outperform the average business in Australia regarding innovation and R&D.
- The most important sources of information for innovation originated from within the business, and peak industry bodies and industry publications.
- Confidentiality agreements and trademarks are the most popular intellectual property protection strategies, followed by plant breeder's rights and trademarks.
- Innovative growers are more likely to plan than non-innovators. This finding was even more profound for novel innovators.
- Novel innovators indicated that they seek to grow moderately (50.4%) or substantially (17.6%).
- Growers perceive that increasing profit is both the most important motive for innovation and the most important benefit they gain from it.
- New crop types or cultivars, new equipment, soil and pest management practices, as well as fertiliser applications are the most used types of innovation.
- The most important sources of information for innovation originated from within the business and from peak industry bodies and industry publications.
- Confidentiality agreements and trademarks are the most popular intellectual property protection strategies, followed by plant breeder's rights and trademarks.
- Innovative growers are more likely to plan than non-innovators. This finding was even more profound for novel innovators.
- Novel innovators indicated that they want to grow moderately (50.4%) or substantially (17.6%).
- Growers' most important motive for innovating and also the most important perceived benefit from innovation is to increase profit.
- New crop types or cultivars, new equipment, soil and pest management practices as well as fertilizer applications are the most common types of innovation.

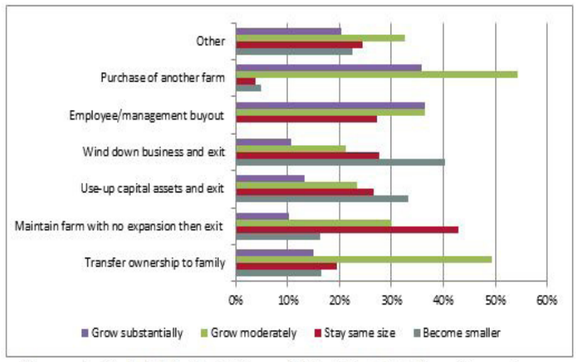
**Innovation and horticulture grower performance:**

- Innovation matters for horticulture performance. This result was consistent for different types of innovation and performance.
- While process innovation is most widely used, its relationship with performance is weaker than other types of innovation. Indeed, organisational and managerial innovation and new additions to the value chain, while used less frequently, matters most for performance.
- New farm management practices are important to all types of performance bar labour productivity.
- Pest management innovations are most important for labour productivity, followed by equipment and management innovations.
- Capital productivity stems from novel management practices.
- High levels of innovation are positively associated with multifactor productivity.

**Challenges (international and local):**

- The Australian horticulture market is characterised by a highly concentrated group of buyers; this underline the imbalance in bargaining power within the industry, with 64.6% of growers selling more than 75% of their produce to five customers or less. Indeed 46.9% of growers are deriving the bulk of their sales from one buyer.

FIGURE 28 GROWTH OBJECTIVES BY INNOVATION NOVELTY




**Chi-square tests indicated significant differences (at the 5% level of significance) for employee or management buyout.**

- The majority of horticulture growers are micro and small operations who lack scale economies. This stifles competitiveness, drives up production and processing costs, and limits innovation capacity.
- An aging grower population struggles to find suitable employees and develop exit strategies (such as succession planning). Growers ranked factors that significantly limited their ability to achieve their business objectives to include, buyer demand, growth in main product market demand and prices as most important, followed by marketing, sales and management skills .

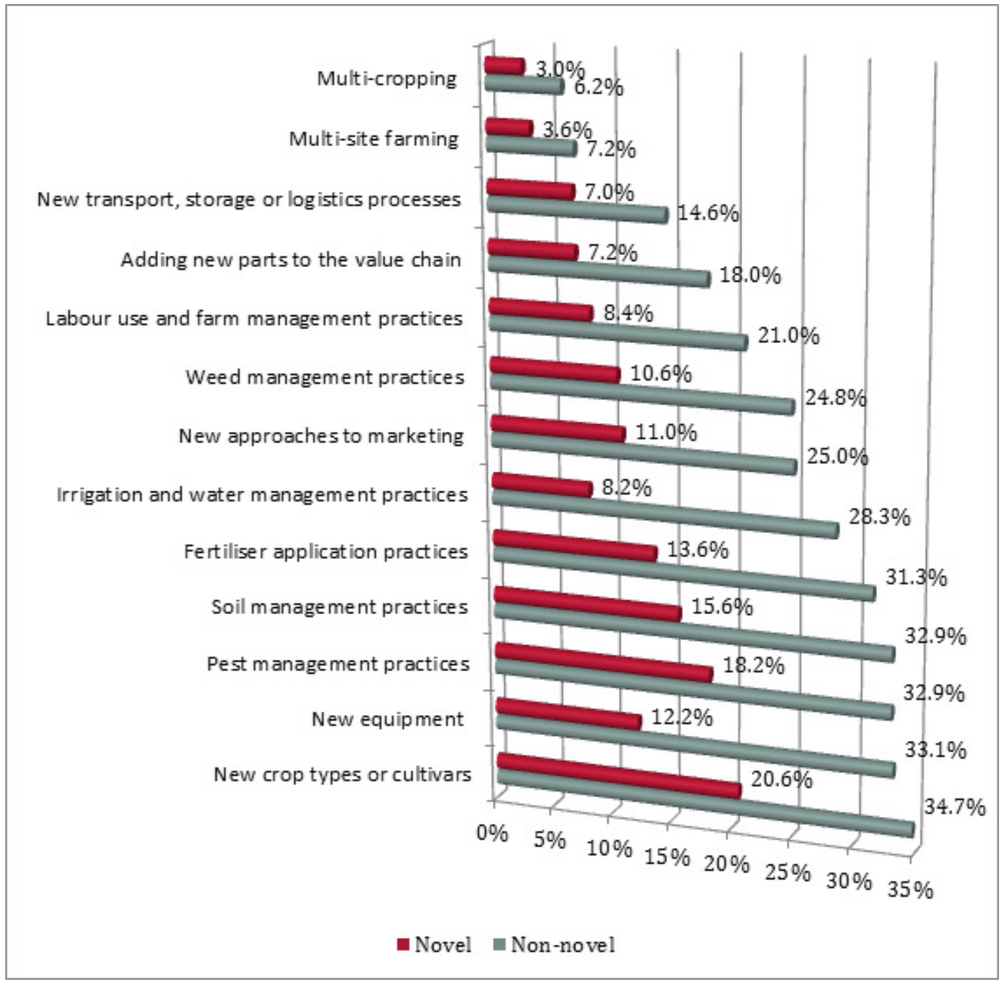
**Competitive advantage:**

- While product/service quality and pricing, as sources of competitive advantage, did not correlate with any innovation type, addressing unmet customer needs seemed to drive the introduction of a wide range of innovation types by growers.
- Surprisingly, only the adoption of new to the industry crop types provides a differential advantage. New crops already known to competitors do not support any form of advantage.
- Product range differentiation is not only supported by introducing new products, but also by adding new parts to the farm's existing value chain, as well as novel approaches to marketing such as offering a different product range.
- Novel marketing innovation matters to all forms of competitive advantage.

**Dynamic capabilities:**

- Dynamic capabilities are important to novel innovations of all types.
- Dynamic capabilities enhance the grower's ability to adapt to changing market conditions by introducing innovations to address current and emerging market needs, but also to enter new markets or new parts of existing value chains to build competitive advantages that ultimately enhance their performance.

FIGURE 35 INNOVATION NOVELTY AND INNOVATION TYPES



# 3 INTRODUCTION

Farmers face increasing pressure from buyers to produce better products at lower prices. This is because products, practices and processes (innovation) change, as farmers seek to improve the return on the resources employed in the production process (productivity). Innovation not only translates to higher margin products, it also advances environmental sustainability goals to satisfy regulatory needs and those of increasingly informed consumers (Hall & Dorai, 2011; Spielman & Birner, 2008) (see Box 1). While it is well recognised that achieving productivity through innovation improvements has proven difficult in horticulture, diffusing innovative and productive grower practices can improve the financial performance of the entire industry (OECD, 2011).

### BOX 1. GROWING POSITIVE AT SUNDROP FARMS

*With increasing pressure on the environment resulting from diminishing water availability and over-reliance on fossil fuels, many farms are struggling with supply. In response to this, Sundrop Farms have traded traditional farming practices for new technologies that leverage renewable resources such as seawater and sunlight.*

*The company's main farm is located in South Australia where energy from the sun is harnessed to desalinate seawater and produce freshwater for irrigation, greenhouse electricity, and energy to heat/cool the greenhouse. Through this highly innovative approach, Sundrop Farms have abolished the need for pesticides because seawater sterilises the air. This strategy also makes better use of land resources as Sundrop can locate farms on degraded land and thereby free up valuable farmlands for others. As a result of having freedom of location, Sundrop Farms also enjoy lower operating costs as they can function closer to the end customer.*

*Source:* www.sundropfarms.com

Assessing innovation and the productivity performance of growers in horticulture has been carried out previously at the broader industry level (e.g., ABS, 2012). However, these analyses do not explain where innovation is occurring and how it helps individual growers or groups of growers to improve performance and productivity. Without evidence-based decision making at the industry level, initiatives will continue to be ad hoc and address symptoms rather than causes, thus threatening to perpetuate underperformance in a group of industries vital to the Australian economy.

To rebuild competitiveness and exploit increased international discretionary consumption (which creates opportunities for higher value and higher margin markets), more Australian growers require well-informed strategic support to capitalise on the higher-margin opportunities that are increasingly presenting themselves through improved efficiencies and products. Discovering, translating and diffusing transformational innovation provides the platform for the recovery and growth of horticulture in Australia. This project supports the sustainable growth of the horticultural sector by improving our understanding of how much, what and where innovation is occurring across most horticulture industries in Australia. This information will be disseminated as best-practice in an attempt to positively impact upon industry competitiveness through the innovation growers implement.

This is important because, while innovation can enhance productivity and provide new market opportunities, the type and extent of that innovation must be understood and benchmarked to inform future industry strategy. Traditional factor productivity studies with aggregated data do not offer the ability to produce actionable ideas across the industry. The results gathered from grower input and translated to an integrative analysis of innovation in horticulture will extend existing knowledge on innovation for Australian horticulture.

Innovation is defined in this study as the development and implementation of new practices, products or technologies that a farm business has not previously used and is likely to use on an on-going basis. Farmers in the horticulture sector were asked to indicate whether or not they had introduced any product or process innovations over the last three years as well as the source of such innovative activities and the reasons for implementation and outcomes associated with them. Innovations were categorised according to the specific types of innovation including, new managerial processes, better ways of managing natural resources, the introduction of new products, extending the value chain, improving or changing production and/or irrigation practices (see Box 2) and the purchase of new equipment for various purposes.

### BOX 2. WORLD-CLASS IRRIGATION AT CUTRIFRUIT

*CutriFruit is one of the leading growers of stone fruit in the country. Based in Victoria, the business focuses on large scale production and has recently broken into the international market. To support premium prices charged to both domestic and international buyers, product quality is paramount and the business is fast becoming a leader in quality processes.*

*For this purpose, CutriFruit utilises only the most modern technology. They use a world-class automated irrigation system based on wave technology to capture data from field sensors. The data are then routed to a central software system that assesses and regulates the needs of trees. High powered frost turbines are also used in winter to ensure damage to trees is minimised.*

*CutriFruit is clearly an innovator in its product sector, with the owners winning several awards for leadership and entrepreneurial insight as well taking out the top position at the regional business excellence awards in 2007.*

*Source:* www.cutrifruit.com.au

This HIA project aims to provide a baseline measurement of innovation, innovation capabilities, innovation performance, and productivity in the Australian Horticultural sector. It does this by tailoring a proven methodology in collaboration with industry players to address the distinct nature of this sector. This approach involves using an industry-wide survey of 501 growers across a diverse range of grower groups and regions, supplemented by illustrative best practice cases. To gain greater insight into the innovation and productivity improvement process, we would like to see this analysis extended to include a larger sample of growers. With a 68 per cent response rate to our questionnaire, we believe this is very possible with further support in the near future.

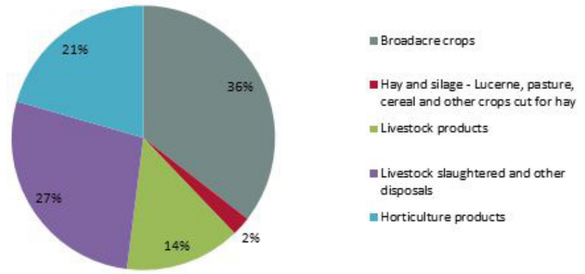


# 4 BACKGROUND

## 4.1 Horticulture in context

The ANZIC (2006) industry classification broadly classifies horticulture as comprising nursery production, turf growing, floriculture production, mushroom growing, vegetable growing, as well as fruit and tree nut growing. In this study we used the ANZIC classification, which is also supported by Horticulture Innovation Australia (HIA, 2015), and the Australian Bureau of Statistics (ABS, 2014a, 2014b). We thus include all horticulture products, both raw and processed, into the following sub-sectors: nurseries, cut flowers or cultivated turf (including trees, shrubs, plants, seeds, bulbs, corms, tubers, propagating material, plant tissue cultures and herbs); perennial bush and tree nuts (almonds, macadamia and other tree nuts); orchard fruit (apples, pears, citrus and custard apples); stone fruit (mangos, avocados, cherries, olives, lychees, nectarines, peaches, etc.); other fruit (strawberries, bananas, grapes, pineapples, dried fruit, blueberries, etc.); as well as vegetables (including mushrooms and potatoes).

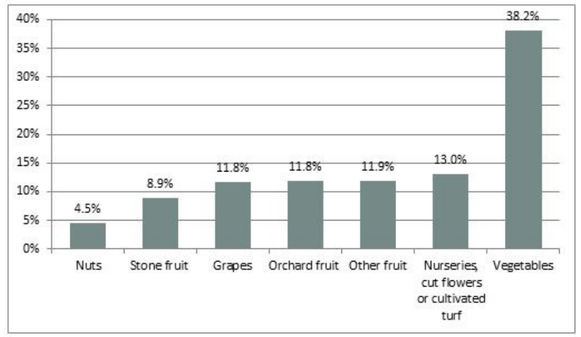
FIGURE 1 VALUE OF AGRICULTURAL COMMODITIES PRODUCED, AUSTRALIA, 2012-13




Of the estimated 128,917 farming operations in Australia, around 27,904 were horticulture growers trading during 2013 (ABS, 2014a). Horticulture represents the **third largest agricultural sector** in Australia behind broad acre and livestock when comparing the value of agricultural commodities produced for the year ending June 2013 (ABS, 2014c). Horticulture is responsible for 21 per cent ($9.188b) of the $48.048b total gross value of agricultural production as depicted in Figure 1.

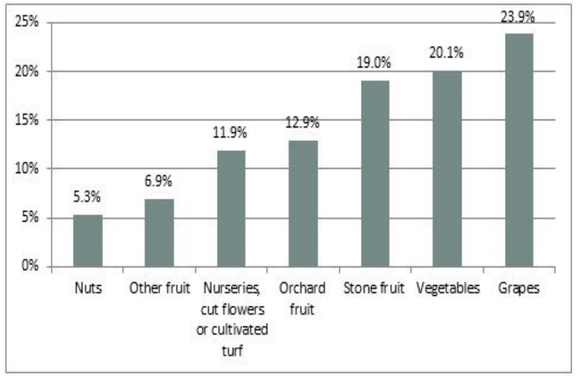
In terms of gross dollar value within the horticulture industry, the lion share is taken by **vegetable growers with 38 per cent** ($3.77b) of total horticulture commodity value, followed by the rest of the sub-sectors in various stages of industry development and all contributing less than 14 per cent each (ABS, 2014c) (Figure 2).

FIGURE 2 RELATIVE GROSS VALUE OF HORTICULTURAL COMMODITIES PRODUCED IN AUSTRALIA, 2012-13




In terms of firm numbers the picture looks different in that **most horticulture businesses are grape growers** (including wine and table grape growers 23.9%), followed by vegetable (20.1%) and stone fruit (19%) (ABS, 2014a) (Figure 3).

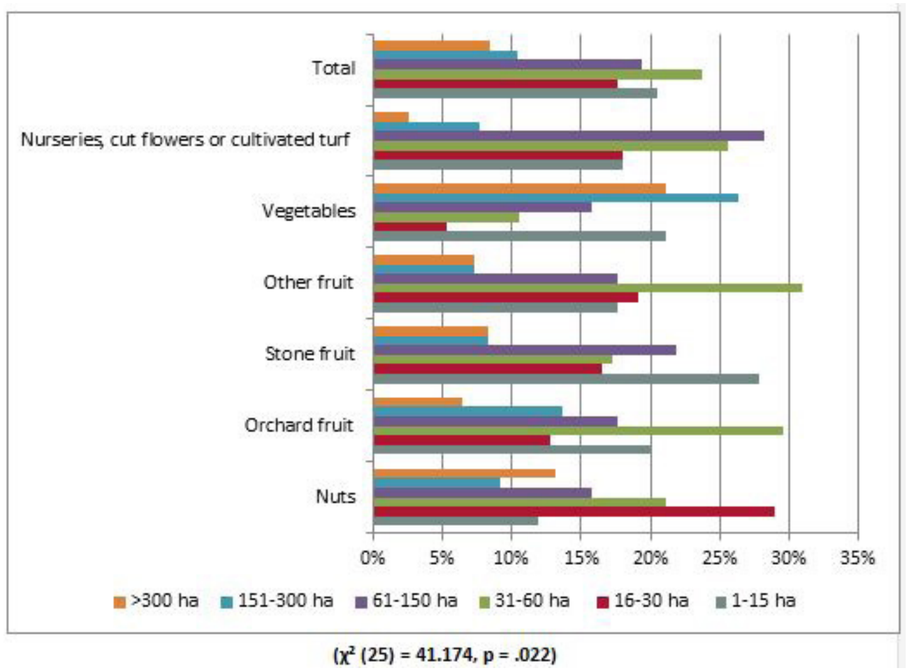
FIGURE 3 RELATIVE NUMBER OF HORTICULTURAL BUSINESSES IN AUSTRALIA, 2013




When compared to other agricultural cropping systems, horticulture operations are **more intensive i**n investment, labour requirements, and other inputs. These operations also tend to operate on **smaller parcels** of higher quality land (mean land size of 52 hectares in our sample) commonly with irrigation systems. We asked growers about the size of their farms. Figure 4 outlines the total land area, including that used and unused for farming purposes, to show that vegetable farms tend to be the largest (151 and 300 hectares), followed by nurseries, cut flowers or cultivated turf (61 and 150 hectares), fruit farms (31 to 60 hectares), nut growers (16 and 30 hectares) and stone fruit (fewer than 15 hectares).

Horticultural production therefore tends to be more intensive, with higher per unit values of produce. This shows that the industry places more importance on innovation in that it strives to increase efficiency and competitiveness, as discussed next

FIGURE 4 RELATIVE SIZE OF HORTICULTURE OPERATIONS IN HECTARES BY PRODUCE CATEGORY




$(\chi^2 (25) = 41.174, p = .022)$

## 4.2 Dynamics impacting horticulture: The need for transformational innovation

Given the higher projected global and national population levels, the increasing affluence in many countries, and consequent demand growth, the gross value of horticultural production in Australia is expected to increase gradually within the medium term (Moir & Eather, 2015). Such production growth could be much higher in the longer term if Australian horticulture can strategically focus on improving international competitiveness. This focus would capitalise on higher forecasted international demand as world population increases. At the same time however, other countries are increasing their focus on horticulture for both food security and economic reasons. For Australian growers, production growth in horticulture has to be achieved within an increasingly constrained environment. This constraint results from, among others, competing land use pressures, climate change, and increased threats to biosecurity. The Australian horticulture industry therefore requires both mitigation and adaption strategies to cope with the realities of our changing world. Innovation is central to solving these issues.

Australian growers therefore face two main challenges: firstly, to competitively provide produce under increased environmental constraints, and secondly, to effectively manage the distribution and marketing of Australian produce to local and international consumers (Penniceard, Vitartas & Charters, 2012).

Australia's competitive position within the global market, characterised by intense price competition, is changing for two reasons: first, international trade is more liberalised and globalised thus opening doors to new markets, and second, competitors with lower cost bases are entering markets already served by Australia. Australian growers are disadvantaged in that they incur higher relative labour costs and have to deal with chronic labour shortages compared to increasingly competitive countries like South Africa and Chile (Moir, Thompson & Hogan, 2012).

With a relatively high Australian dollar, these factors impede Australian horticulture's international price's competitiveness thus making it difficult to expand locally and internationally. This especially applies to forward value chain activities in that higher value processed product exports are increased, unless improvements are made that can create better margins and returns sufficient enough to finance new assets, crops, ideas, approaches and markets.

The currently weakening Australian dollar will, however, help local growers to exploit international opportunities emanating from past trade agreements with New Zealand (ANZCERTA 1983), Singapore (SAFTA 2003), United States (AUSFTA 2005), Thailand (TAFTA 2005), Chile (ACFTA 2009) and the ASEAN-Australia-New Zealand Free Trade Area. More recent trade agreements focus on opening opportunities in Asia (Moir & Eather, 2015). Current horticulture exports to China may be relatively low but are expected to increase with the China–Australia Free Trade Agreement (CAFTA 2014). This agreement removes all tariffs on horticulture, including those up to 25 per cent on nuts over four years and those up to 30 per cent on citrus over eight years. Similarly, the Japan-Australia Economic Partnership Agreement (JAEPA 2014) has increased export prospects by eliminating tariffs on asparagus, many other vegetables, and macadamia nuts as well as removed tariffs on most fresh and canned fruit and vegetables over periods of up to 15 years. In addition, other more recent free trade agreements were entered into with Malaysia (MAFTA 2013) and Korea (KAFTA 2014). Our proximity to Asia, combined with higher expendable consumer income levels and changing consumer behaviour (e.g., increased popularity of fresh fruit as gifts), provides an excellent opportunity for the horticulture industry to capitalise on the expanding international counter-seasonal trade.

In addition to the above, the horticulture industry faces substantial issues at a national level. Horticulture Innovation Australia provides an extensive list of these issues in a recent published consultation paper (HIA, 2015). This paper contends that the structure of the value chain, access to consumers, and high costs and technical problems resulting from the existing retailer duopoly is the first area of concern for the industry. As well, the local market is dominated by two supermarket giants threatening the bargaining power of small horticulture operations who are price-takers. The second main concern involves the absence of scale economies in the great majority of micro and small horticulture operations that stifles their competitiveness, drives up production and processing costs, and limits their innovation capacity. The third major concern relates to Australia having the oldest and least fertile soils in the world (OECD, 2013) combined with limited water resources. Therefore, extensive farming practices are required to ensure sustainable management of the natural resource base by tackling the problems of soil nutrition and water scarcity that increase the on-going pressure of high costs.

To address the above challenges and take available opportunities would require Australian horticulture to improve its innovation capability and to focus on strategies that would enhance the longer term sustainability of the industry. Australian agriculture has a tradition of innovation and adaptation in overcoming challenges. One of the key drivers of productivity is farmers' ability to develop and adopt new innovations (Mallawaarachhi et al. 2009). It is therefore imperative to establish the current state of innovation capacity, practices and outcomes within Australian horticulture.

# 5 RESEARCH METHOD

The purpose of the survey was to provide Horticulture Innovation Australia (HIA), its members and their industries with data to inform better decision making for improving industry innovation and productivity performance. Analysis of these data can guide the translation of the activities and processes that lead to successful innovation outcomes once the results are disseminated across each industry.

To operate this survey, we used a multi-method approach. First, we conducted a quantitative study based on previous successful surveys in the field and extensive input from HIA nominated horticultural experts. This provided a profile of growers in their industries, regions, innovativeness, technological sophistication, size, age (both individual and tenure), performance, capabilities, labour force, farm management, innovation characteristics, and access to resources. Second, we undertook a series of semi-structured interviews, either by phone or email. These interviews sought to probe more deeply into the decisions, actions and behaviours of the businesses.

## 5.1 Sample

The survey initially targeted a stratified sample of 2,400 (to attain a response of 1,200) growers across grower groups and regions to ensure representativeness and comparability between industries and grower profiles. The broad population was defined as all horticultural firms (farms or growers) in Australia. The database from which the sample was drawn was developed from contact details provided by grower groups and supplemented from publically available data. However, because the grower groups provided only 1,961 contacts, of which 1,311 were not active anymore, only 660 growers were available.

To build a detailed understanding of the innovation process to share across industries, the initial survey was supplemented by 13 illustrative case studies, based on interviews and secondary data. For this purpose, farms/businesses were drawn from those who completed the questionnaire or were identified as innovators from secondary data.

## 5.2 Survey and response rates

The survey combined elements of other previously designed, developed and validated surveys. It also included firstly, a national survey on capabilities and innovation; secondly, the collaboratively developed Cambridge-UQ Innovation Survey that was developed and validated over a period of 20 years; and thirdly, other validated technology and business capability scales. We tailored the survey using feedback from industry experts **to ensure that the results can easily be adopted** by growers and grower groups. The benefits of this approach far outweigh those of a generic cross-sectional survey that only provides insight into the industry level. We used this survey method as the basis for all of our previous innovation surveys, and therefore it provides a benchmark against which to interpret the findings from this study.

The final questionnaire contained questions to address the general characteristics of the grower, technology, innovation, competition and collaboration, finance and managerial practices. It took approximately 35 minutes to complete. All respondents were guaranteed anonymity and confidentiality, and were protected by the ethics procedures set out by the University of Queensland.

The survey, administered via telephone by Colmar Brunton, allowed us to achieve a higher response rate than would be expected from mail-outs and online surveys, which typically deliver response rates below 10 per cent. With 441 valid responses and 209 refusals to participate, our final response rate was **68 per cent**. An online survey was also administered to complement the telephone survey in that it reached grower groups not included in the telephone survey thus resulting in a further 60 responses. This dual-response strategy ensured a large and highly representative data set to analyse. The integrity of the data was extremely high because of the higher response rate, but also the completeness of the surveys. Therefore, while more expensive than other data gathering methods, this approach will be much more valuable in supporting better decisions at the grower and industry levels.

Figure 5 provides a breakdown of the **sample's representation** of different grower groups by produce, as compared to the Australian population of growers (ABS, 2014a). Although a number of growers engage in mixed farming, they were classed for our purposes in accordance with the crop type they derive most revenue from as a proportion of their farm income. While the sample represents all major grower groups classified in this study, it over-represents 'nuts', 'orchard fruit', 'stone fruit' but underrepresents 'other fruit' (including grapes), 'vegetables' and 'nurseries, cut flowers or cultivated turf'. Nut growers are the most overrepresented in the sample, with vegetable farms the least represented relative to grower population. Apple growers represent the largest crop category followed by olive, macadamia, avocado and the rest.

## 5.3 Case studies

The quantitative analysis is supplemented by 13 case studies to offer rich explanatory information and to guide potential future studies. These case studies were purposively chosen from a range of grower groups, sizes and states selected from among the highly innovative respondents. Case studies were constructed from three main data sources: secondary textual data, interviews with senior executives, and survey based data and observation.

## 5.4 Analysis

The analytical techniques employed in this study reflect those used in previous reports by UQ, offering the added advantage of direct comparability of findings. Data analysis techniques were chosen based on appropriateness to the data and violations of parametric data assumptions. Descriptive statistics such as mean, standard deviation and standard errors were presented where data were continuous. Where data were not continuous, frequency and count data are presented. The implications for interpretation of data based on the construction of the variables are discussed where appropriate throughout the results section in this document. The data were analysed using the SPSS statistical package (Field, 2009). The main analytical techniques used were: descriptive statistics and frequency analysis; tests of differences between groups (mainly chi-square and t-tests); (Spearman's) correlations), and ordinary least squares regression analysis.

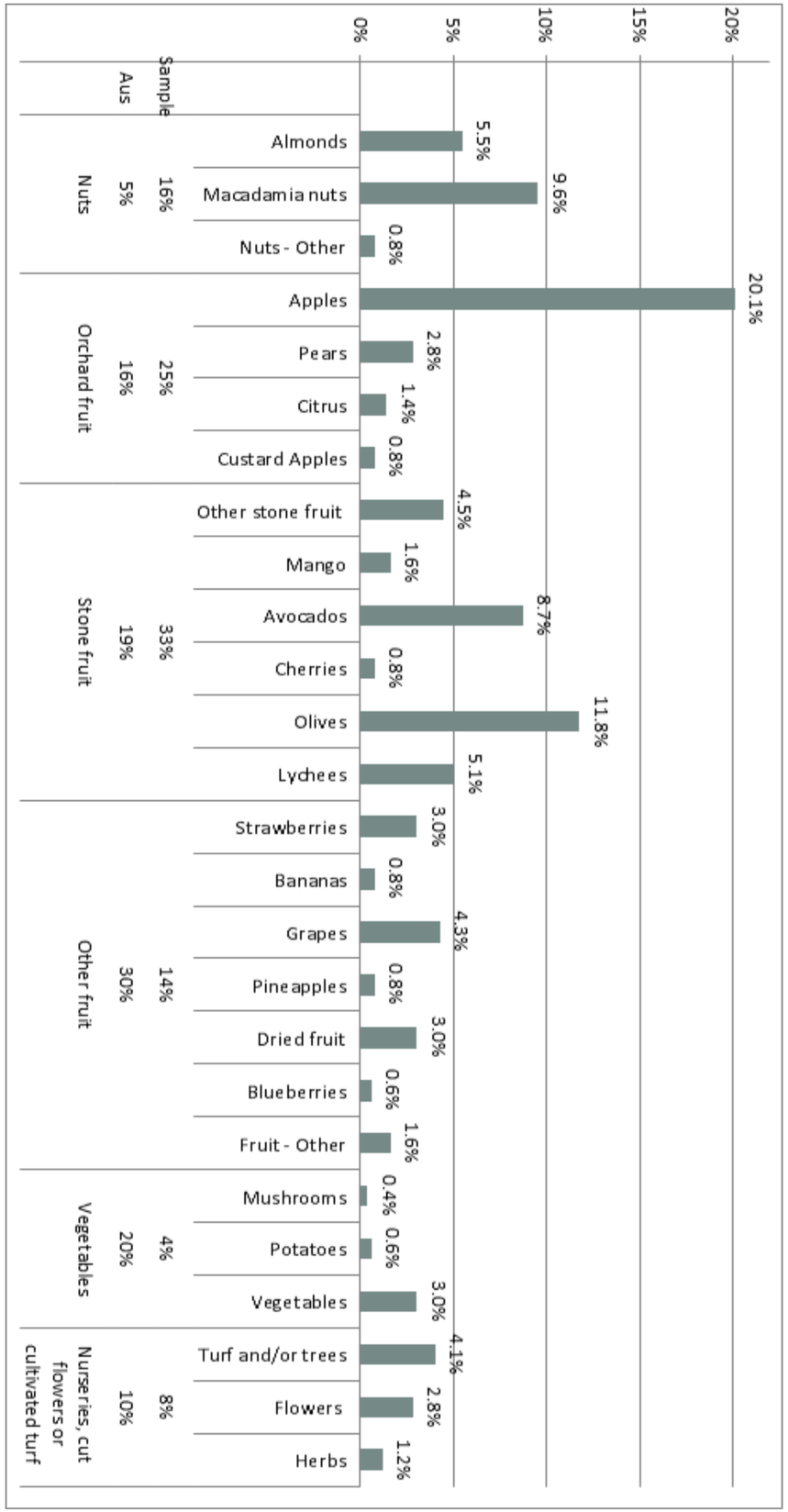


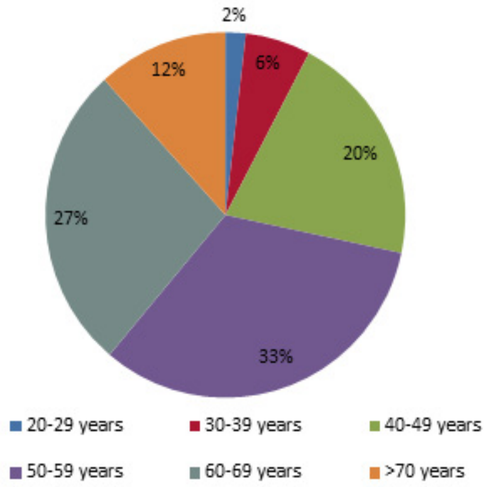

FIGURE 5 SAMPLE REPRESENTATION OF HORTICULUTRE OPERATIONS

# 6 HORTICULTURAL INNOVATION

## 6.1 Demographics

The average age of horticulture growers is 56 years. This is the same as the average age for all farmers across Australia (ABS, 2012; ABS, 2014b), showing that the sample used in this study is representative. Most growers are older than 50 years (Figure 6). **Almost 12 per cent of growers are older than 70 years providing further evidence of an aging grower population**.

FIGURE 6 AGE DISTRIBUTION OF GROWERS




Seventy-nine per cent of all farm owners or managers in Australia are male (ABS, 2014b). Australian farmers' gender representation is correctly reflected in the sample of horticulture businesses, further supporting this study's sampling approach (see Figure 7). **Owner-managers represent the majority of the sample** in that 98 per cent of respondents manage the farms with 88.4 per cent also being owners (see Figure A.1 in Appendix).

Education is important to the adoption of new technology in Agriculture (Lin, 1991) in that it plays a role in building the adaptive capacity of farmers (Fielke & Bardsley, 2014). The majority of growers have some form of tertiary education (see Figure 8).

FIGURE 8 LEVEL OF EDUCATION

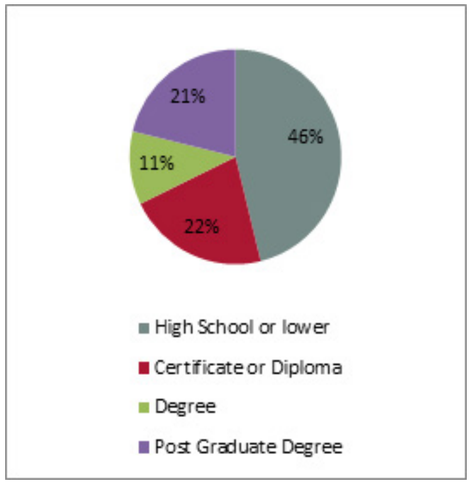



FIGURE 7 GENDER REPRESENTATION IN AUSTRALIAN FARMING AND HORTICULTURE

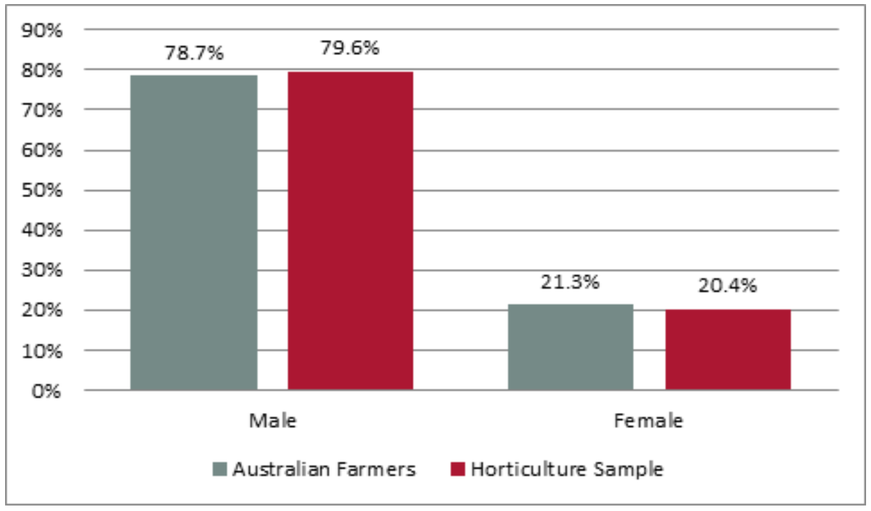
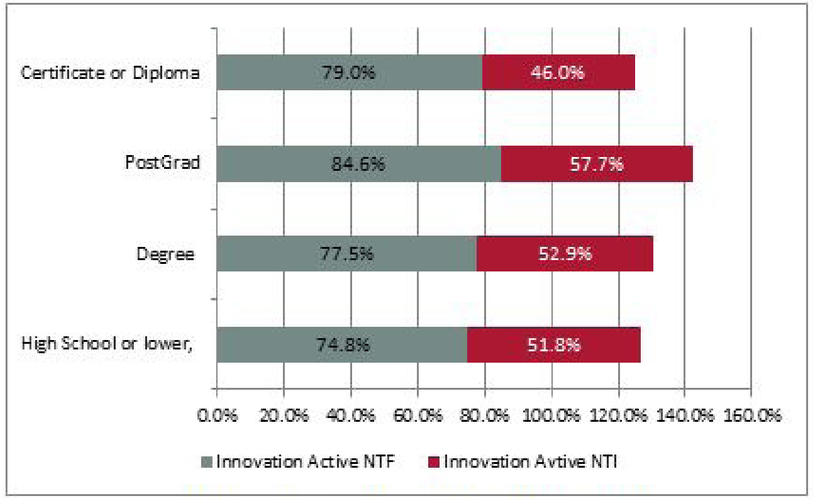



Figure 9 depicts the relationship between innovation activity and level of education. It shows insufficient support for the conjecture that higher levels of education facilitate the adoption of innovation because many growers without any tertiary qualifications also innovate. Supplementary regression analysis (not reported here) confirmed this finding, with the exception being a significant positive relationship between post graduate qualifications and being novel or new to the industry innovations.

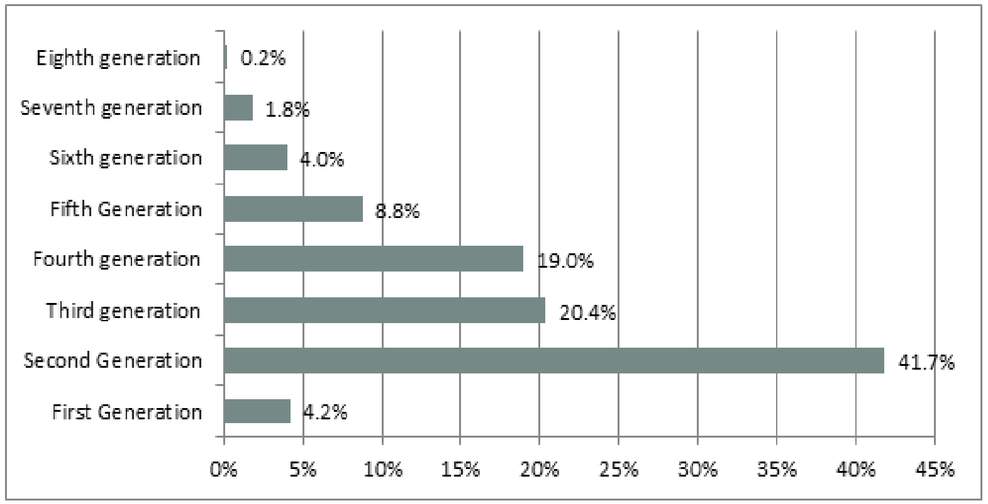
FIGURE 9 INNOVATION ACTIVE GROWERS BY LEVEL OF EDUCATION




**($\chi^2$ (3) = 2.549, p = .467) and ($\chi^2$ (3) = 2.104, p = .551)**

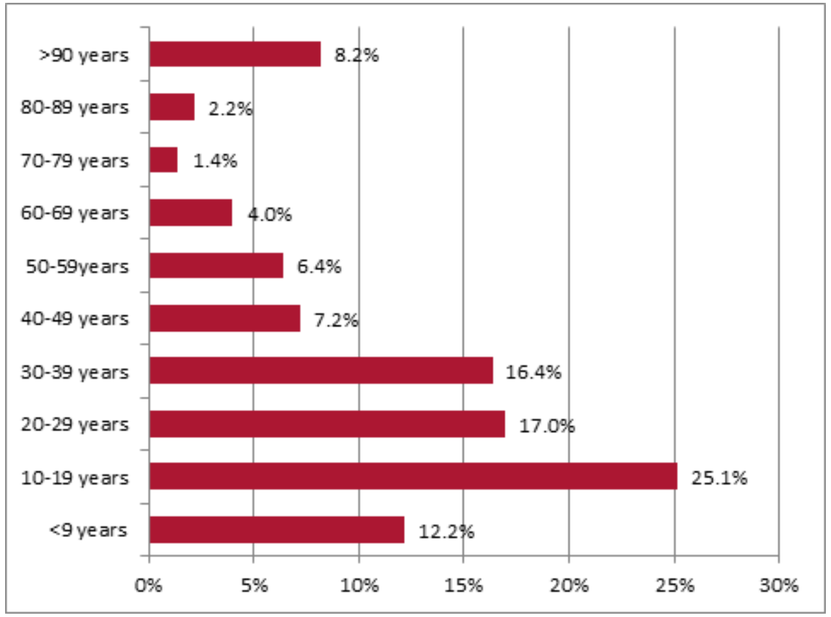
The majority of growers are second generation farmers, with 48.2 per cent of horticulture operations having been passed down over three to five generations (Figure 10). Because the industry is dominated by family businesses (Kimura & Antón, 2011), new entry to horticulture is lower compared to other business enterprises in Australia.

FIGURE 10 GENERATIONS OF FAMILY WORKING THE FARM



In line with Figure 10, just over half (54.3%) of horticulture operations are younger than 30 years with the majority being between 10 to 19 years old (Figure 11).

FIGURE 11 AGE OF HORTICULTURE OPERATIONS




The horticulture growers in our sample include both part-time, hobby and full-time commercial farmers: 31 per cent of respondents deriving the majority of their income from activities not related to their farming; and 69 per cent of respondents indicate that farming is their main source of income (Figure 12). Figure 13 adds to this understanding by showing that 45.5 per cent of the latter group did not derive any income from non-farming activities; they rely solely on farming activities for their income.

FIGURE 12 DERIVING MAIN INCOME FROM FARMING

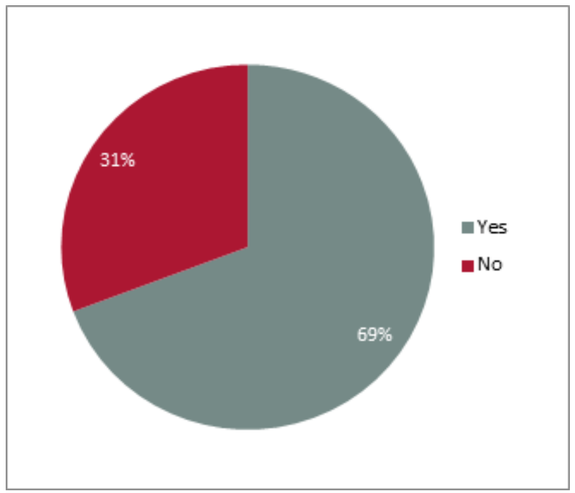
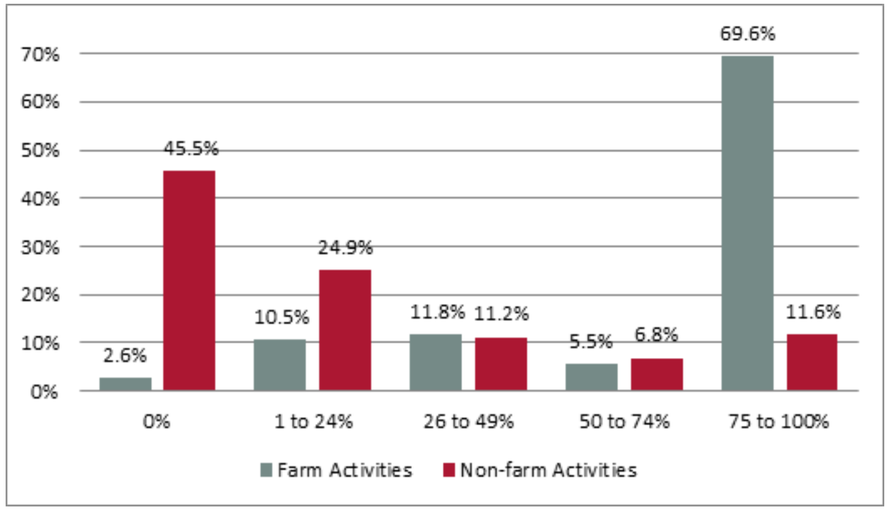





FIGURE 13 PERCENTAGES OF INCOME DERIVED FROM FARM AND NON-FARM ACTIVITIES

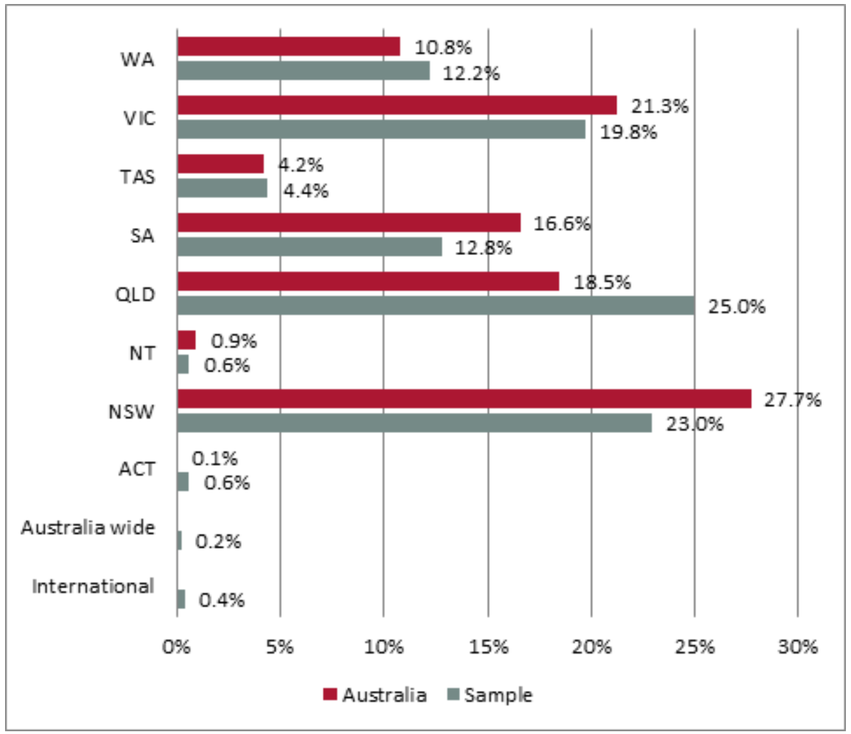



Supplementary statistical analyses also revealed that grower age and farm age correlate positively (0.221** and 0.194**) with farm income being the main source of income. However, grower age and farm age were negatively correlated (-0.225** and -0.206**) with the main source of income earned off farm. This means that younger growers who farm on newer concerns tend to gain their main source of income from work performed outside their farm operations. This reflects the cost required to set up new farm operations, necessitating income being derived off-farm.

We found both a statistically significant positive correlation between income from farming activities and new-to-the-industry innovation activity (0.125**) and a negative correlation for income from non-farming activities and new-to-the-industry innovation activity (-0.124**). This indicates that growers who primarily depend on income derived from their farms tend to implement new-to-the-industry innovations, whereas growers who derive their income from other sources do not actively implement novel innovations. There can be myriad reasons for this, including time and financial pressures, which stymie the opportunity to innovate.

We also investigated the physical location of the respondent's main activities. Less than one per cent of respondents indicated that their operations span Australia or internationally with the greatest majority (99%) of respondents having main operations being state-bound. Figure 14 demonstrates where the main activities of horticulture operations occurred and compares this with the relative number of all horticulture operations within Australia as per the Australian Bureau of Statistic's data (ABS, 2014a). The sample used in this study correctly reflects the main locations of farms, with slight deviations for Queensland and New South Wales.

FIGURE 14 LOCATION OF MAIN ACTIVITIES



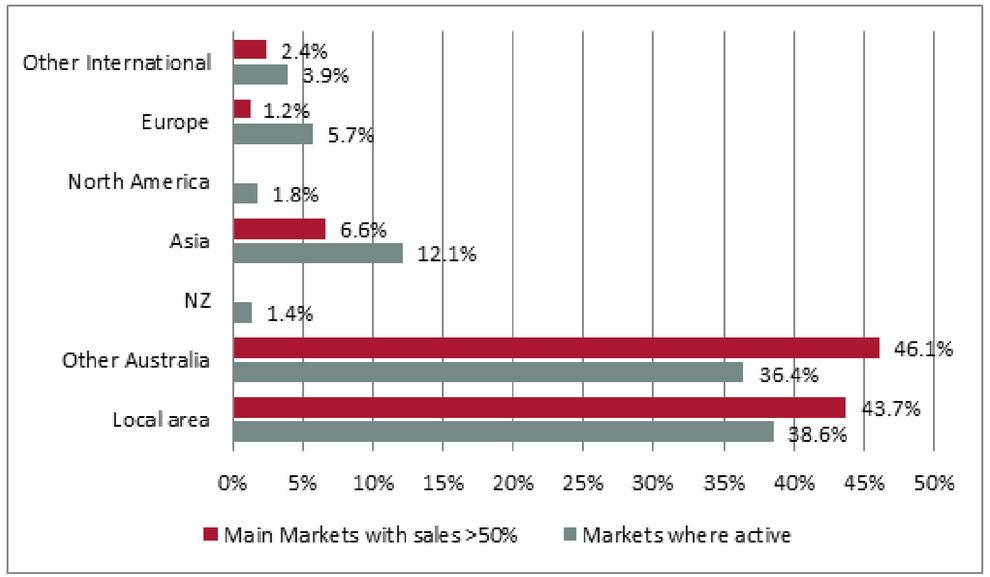

As evident from Figure 14, very few of the growers in the sample concentrate on international markets, as explained next.

## 6.2 Market location and exports

As stated previously, the horticulture industry is dominated by a large number of micro farming operations with very few large operations. As a consequence, 75 per cent of the growers in our sample are active within the Australian market with **38.6 per cent targeting local markets** (town or city in close geographic proximity to their main operations) and 36.4 per cent targeting national markets (Figure 15). International sales activity seems very limited. Even though 25 per cent of respondents indicated some activity in overseas markets, **only 10.2 per cent derived the majority of their sales from exports**. Most exports are directed at the Asian market in line with recent free trade agreements as discussed above.



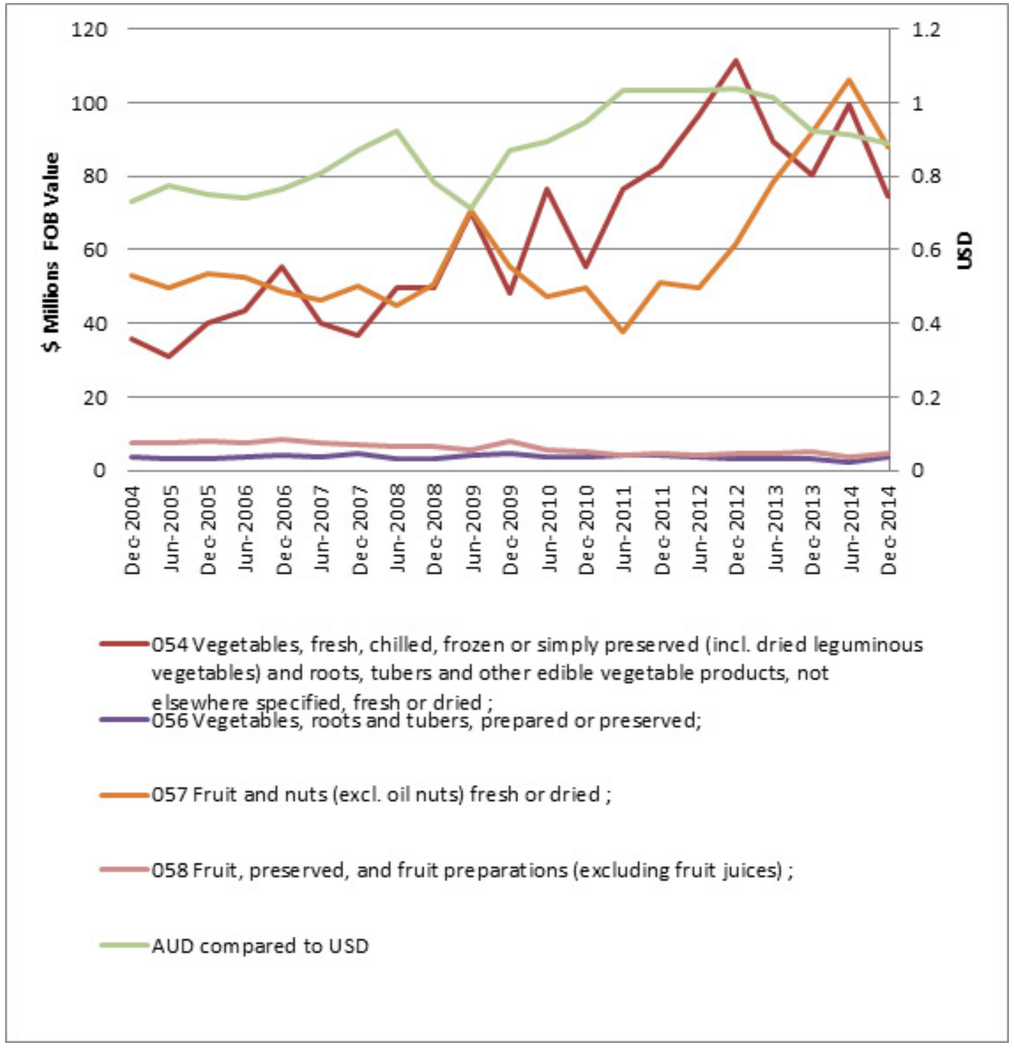
FIGURE 15 MARKETS WHERE GROWERS ARE ACTIVE AND WHERE MAJORITY OF SALES ORIGINATE FROM




None of the respondents identified North America or New Zealand as their main markets. This is further evidence of the changing international competitive landscape, especially when considering orange exports as an example. In the 1990s, Australia dominated the market for imported out-of-season oranges in the United States but today has less than 10 per cent of this market that is now dominated by South Africa, Chile and Peru (Moir et al., 2012). This shift in competitiveness was largely due to prolonged droughts as well as the appreciation of the Australian dollar. At the same time however, exports of oranges have increased to Asia especially China (via Hong Kong), Japan, Malaysia and Singapore.

Figure 16 depicts the monthly dollar export value (measured in $millions, Free on Board [FOB] value on the left axis) averaged over six months of Australian horticulture exports. Figure 16 specifically depicts fresh and processed vegetables, fruits and nuts (according to the three-digit Standard International Trade Classification) from December 2004 to December 2014 (ABS, 2015). The six month averages of the US-AUS dollar exchange rate are also provided for the same period, expressed on the right axis in US dollars. It is clear from the data that, although **the exchange rate directly impacts upon export levels of fresh produce, especially around the GFC** (September 2008 to about December 2009), such an inverse relationship is less pronounced in other periods. This indicates that, while numerous factors impact upon export levels, the exchange rate has a more pronounced long-term effect on processed produce exports especially preserved fruits. This highlights difficulties in maintaining markets when price competitiveness declines.

FIGURE 16 AUSTRALIAN HORTICULTURE GOODS EXPORTS AND EXCHANGE RATE EXPRESSED AS SIX MONTH MOVING AVERAGES




Another important consideration is that, during the 2012-13 period, large firms (i.e., those with 200 or more employees) comprised only nine per cent of all the agriculture, forestry and fishing exporters, but were responsible for 91.8 per cent of the dollar value of exports. While SMEs and micro growers therefore represent 91 per cent of the exporters, they contributed less than 10 per cent of export value (ABS, 2014d). It seems therefore that firm size is an important determinant of export value.

The size of growers was determined by three variables; employee numbers, land size, and the value of capital invested in equipment.

Most horticulture operations (80.5%) are micro-enterprises, employing fewer than six full-time employees, with the majority of growers (25.1%) being non-employers (Figure 17). Only 19.5 per cent of the growers in the sample employed more than five employees with less than one per cent employing more than 101 employees. The majority of the sample therefore comprises micro and SME horticulture operations. Some crop types are more labour intensive than others with the majority of orchard fruit, stone fruit, other fruit, vegetables as well as nurseries, cut flowers, and cultivated turf growers employing more than five employees (Figure 18). The majority of nut and stone fruit producers tend to be micro-enterprises.



FIGURE 17 FIRM SIZE: FULL-TIME EMPLOYEES (FTE)

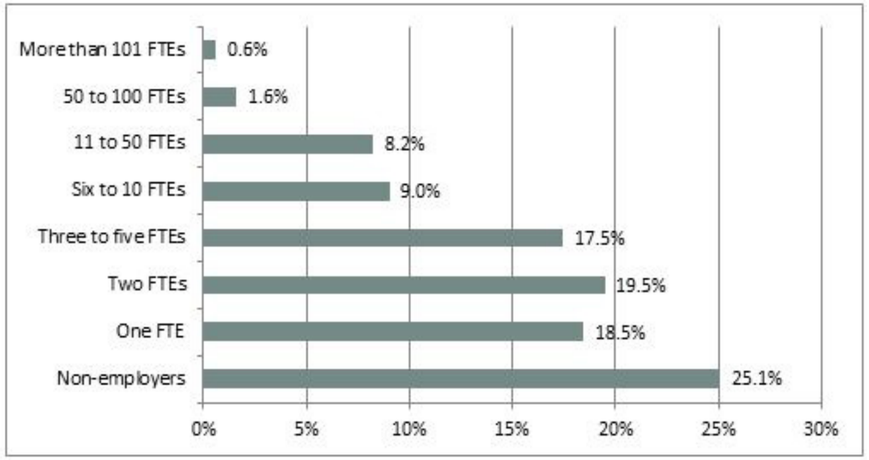
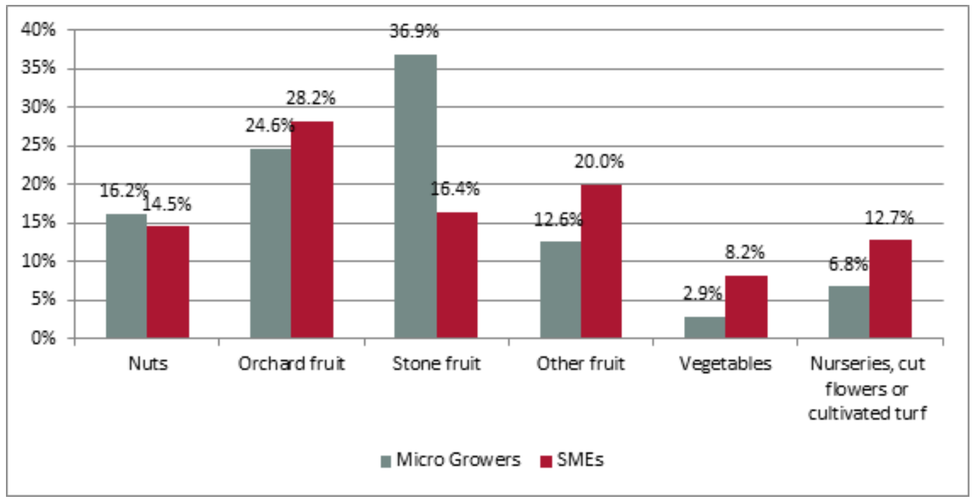



FIGURE 18 MAIN CROP TYPES BY EMPLOYEE SIZE

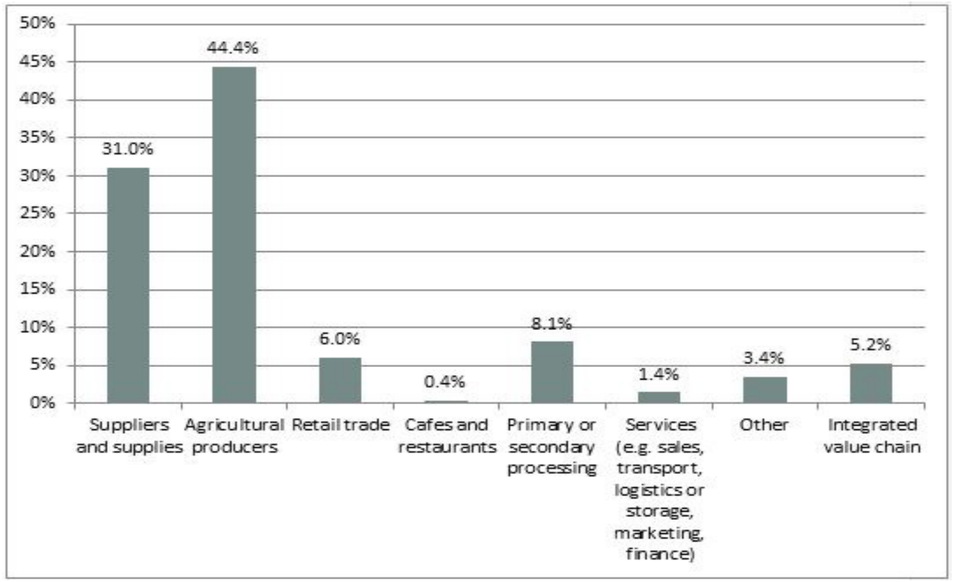



**($\chi^2$ (5) = 24.648, p = .000)**

## 6.3 Business behaviour and performance

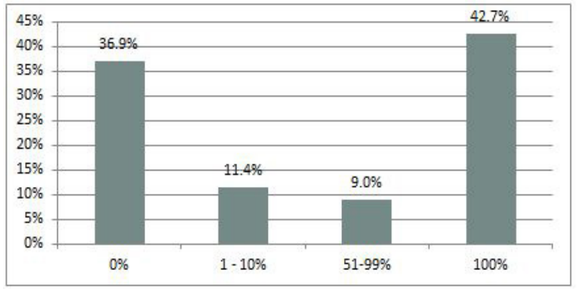
Respondents were asked to indicate what percentage of their business activities took place in different parts of the horticulture value chain. It comprises all activities involved in delivering produce from the farm to the consumer and includes the inputs, production, processing, packaging, storage, distribution, marketing and selling. Dummy variables were created for each value chain category if respondents indicated that 50 per cent or more of their activities were in one specific category. If activities were spread among different elements of the value chain (for respondents that reported operations across different value chain categories, it was coded as an integrated value chain. The results in Figure 19 indicate that most respondents were primary producers (implying that the majority of their activities comprise growing and cultivating horticultural produce) with the second largest group being involved with supplies to the industry. Very few respondents (5.2%) have integrated value chains that provide numerous opportunities and enhance long-term performance (See Box 3).

FIGURE 19 FARM SIZE IN HECTARES (PER CENT




branding than those that do not sell their produce under their own brand name (Figure 20).

FIGURE 20 PROPORTION OF PRODUCTS SOLD UNDER OWN BRAND




Most of the respondents reported that they engage in planning activities related to monthly management accounts and business plans, regardless of their innovation status (Figure 21). Innovative growers engage more in planning that encompasses a wide spectrum of planning activities. **Growers that implement innovations new to the industry planned more** than those who were firm innovators, with the exception of business plans. The results are similar than those found in the Queensland Business Innovation Survey (Verreynne & Steen, 2014), which used a large sample (n = 1 277) of Australian firms from various industries (Figure 22). In addition to the planning activities illustrated in Figure 21, respondents also responded to an open-ended question that they were actively engaging in planning related to irrigation, strategic and growth, succession, occupational health and safety, and operational, environmental and quality assurance.

### BOX 3 MANSFIELD'S PROPAGATION NURSERY BRINGS EXTERNAL OPERATIONS IN-HOUSE

*At Mansfield's Propagation Nursery innovative business development is a key factor in the business's success to date. The primary focus of the business more recently has been on acquiring other businesses in their supply chain.*

*In 2010, Mansfield's acquired Austraflora, a native plant developer and marketing company. By bringing these operations 'in-house' overall costs to the business were reduced, which has led to a 20 per cent cost saving for customers. Last year, they acquired a tissue culture business that helped to reduce production costs and make the business more competitive with other nurseries. It is also anticipated that this acquisition will reap $1.5 million in additional sales.*

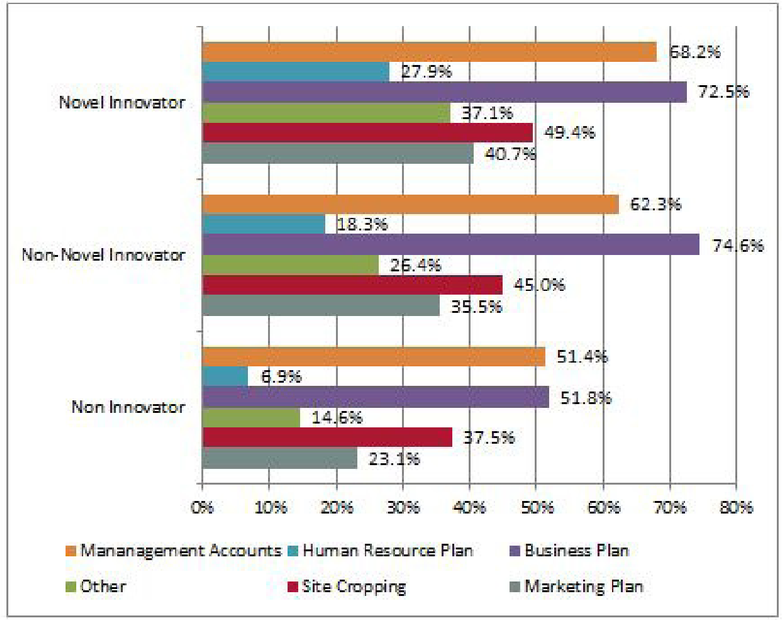
*Both of these acquisitions have given the company greater control over plant quality and have facilitated easier communication that has allowed new plant varieties to be developed much faster. Furthermore, the firm's commitment to business excellence and to furthering the industry at large has led to the receipt of several important awards such as the second best production nursery in the world in 2012 and various young leader awards.*

*Sources: www.mansfields.net.au; Hortlink Summer (2013-2014)*

**Building a differentiated advantage when producing and selling a highly homogenous produce is difficult and thus relies on other strategies to improve competitiveness**. One strategy is to brand products and create brand equity. In our sample, a similar proportion of farms indicated that they were more extensively using

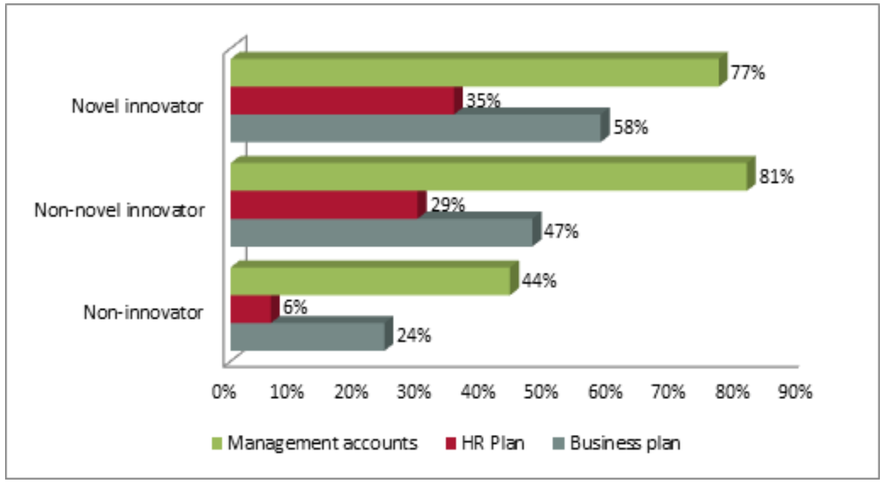


FIGURE 21 PLANNING ACTIVITIES WITH INNOVATION NOVELTY



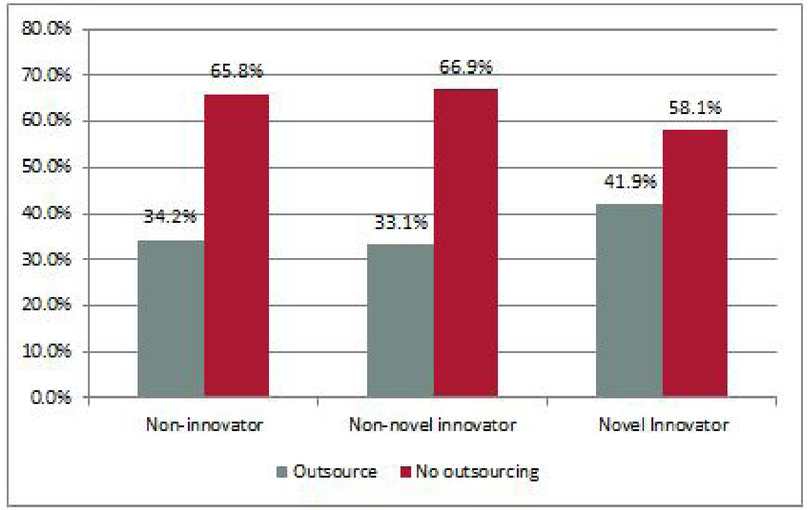

**($\chi^2$ (2) = 9.121, p = .010); ($\chi^2$ (2) = 19.773, p = .000); ($\chi^2$ (2) = 18.386, p = .000); ($\chi^2$ (2) = 18.205, p = .000); ($\chi^2$ (2) = 4.155, p = .125); ($\chi^2$ (2) = 9.828, p = .007)**

FIGURE 22 PLANNING (QLD INNOVATION SURVEY)




The majority (62.3%) of horticulture firms do not engage in outsourcing any of their farming activities. However, novel innovators are more likely to outsource than non-novel and non-innovators (See Figure 23), although this difference is not significant.

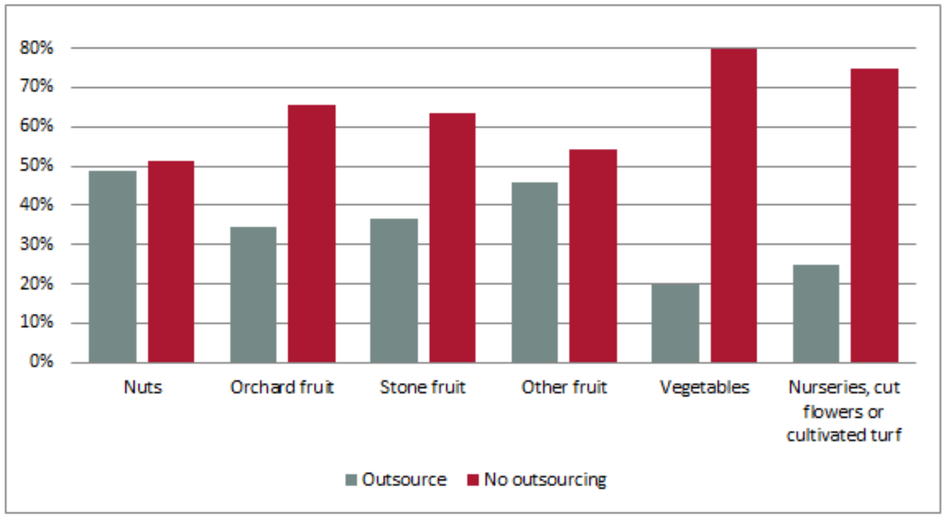
FIGURE 23 OUTSOURCING WITH INNOVATION NOVELTY




$(\chi^2\ (2) = 3.738,\ p = .154)$

Significant differences however, are found after comparing outsources across grower groups (Figure 24). While nuts and other fruits farms are outsourcing more than 40 per cent of their activities, vegetables and nurseries outsource fewer than 25 per cent of their activities.

FIGURE 24 OUTSOURCING WITH GROWER GROUP

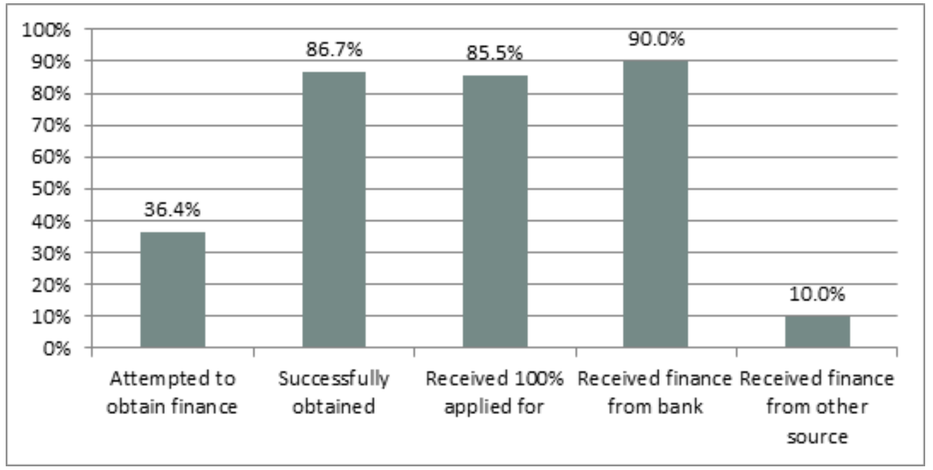



$(X^2\ (5) = 12.051,\ P = .034)$

We also investigated the attempts by farmers to obtain additional finance for their activities. Approximate 36.4 per cent of farmers applied for finance, most of whom were successful at receiving the majority of credit applied for (85.5%) (see Figure 25). Banks are the most likely source of this finance. Lack of access to funding sources is often said to be one of the major obstacles to innovation at the business level (McCarthy, Oliver & Verreynne, forthcoming). Within the sample of growers, this seems to be less of an impediment, given the high rate of success in obtaining new finance from banks. This assumption is confirmed in Figure 33, with farmers indicating that finance was not a business limitation.

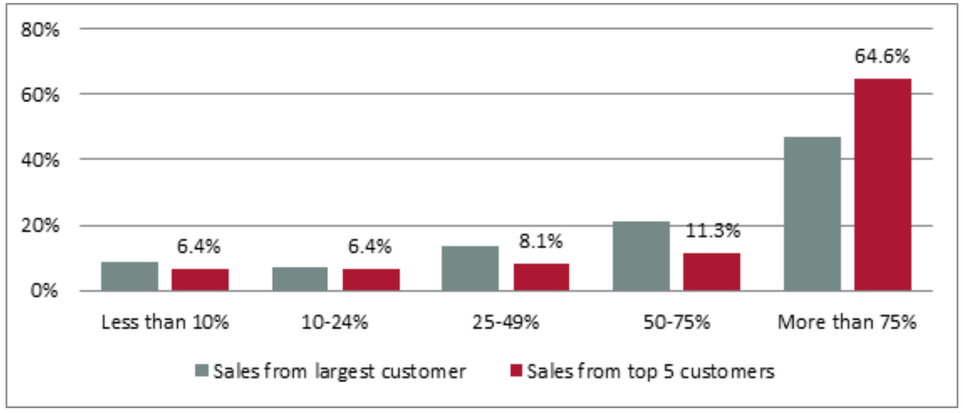


FIGURE 25 ATTEMPTS TO OBTAIN FINANCE



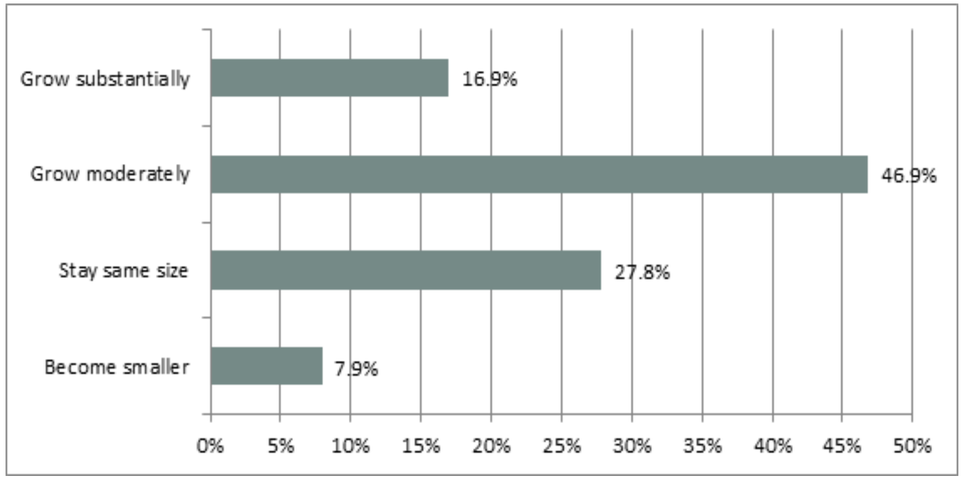

Results from the survey confirm that **the Australian horticulture market is characterised by a highly concentrated small group of buyers; these results points to an imbalance in bargaining power within the industry** (Figure 26); for example, 64.6 per cent of growers sell more than 75 per cent of their produce to five or fewer customers. This trend is confirmed when looking at sales revenue from farmers' largest customer: 46.9 per cent of growers are deriving the bulk of their sales from one buyer. This suggests that growers generally heavily rely on one or fewer than five buyers.

FIGURE 26 BUYER CONCENTRATIONS




Growers were asked about their business growth objectives. Most (46.9%, see Figure 27) reported moderate growth intentions, with only 7.9 per cent indicating that they plan to shrink their farming activities. The Queensland Business Innovation Survey (Verreynne & Steen, 2014) reports that 8.3 per cent of Australian firms had substantial growth objectives, 52.9 per cent of moderate growth objectives, 31.6 percent wanted to stay the same, and 7.2 per cent planned to shrink. While more farmers therefore indicated that they wanted to grow substantially, it is when these results are compared against innovation activities that interesting findings emerge.

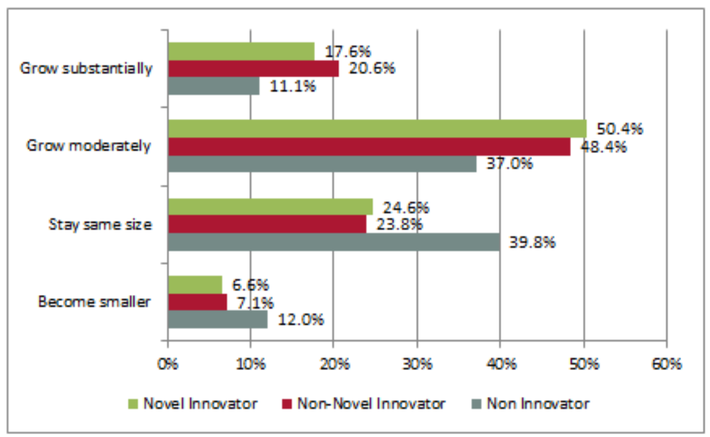
FIGURE 27 GROWTH OBJECTIVES




Significant results were found when comparing growth objectives with innovation novelty as reported in Figure 28. Growers who want to maintain the size of their farms or want to become smaller tend not to engage in any innovation. The majority of non-innovating growers (51.8%) therefore do not aspire to achieve any growth or would rather make their operations smaller.

That said, **growers who want to grow did engage more in innovation**. Most novel innovators (50.4%) indicated that they want to grow moderately with 17.6 per cent wanting to achieve substantial growth; 68 per cent of novel innovators therefore want to grow their operations. Similarly, the majority of non-novel innovators (69%) also want to achieve growth with 48.4 per cent moderate and 20.6 per cent substantial. 'Ancillary' (as used in Table A.2 in The Appendix) means the analysis of the comparison between growth objectives and performance categories (discussed below) that was also performed. This comparison shows that the substantial growth motive is associated with higher means on all performance categories including profit, growth, labour productivity, capital productivity, market share, and customer satisfaction. Therefore, the intention to grow is generally associated with higher levels of innovation among horticulture growers (see Box 4).

FIGURE 28 GROWTH OBJECTIVES BY INNOVATION NOVELTY




$(\chi^2\ (8) = 18.306,\ p = .019)$

However, the observation that innovation is implemented even in the absence of a growth aspiration implies that maintaining current production levels also require some minimum level of innovation. Around seven per cent of growers innovate even when they are contracting their operations. Innovations are diverse and although growers that want to grow their operations primarily adopt innovations, such innovations may also have benefits in helping achieve retrenchment targets.



**BOX 4. STAHMANN FARMS PRACTICE INSECTICIDE-FREE PECAN FARMING**

*As the largest pecan grower in the Southern hemisphere, Stahmann Farms have led the way in terms of innovative practices and this has supported their rapid expansion.*

*At their primary Pecan site in New South Wales, Stahmann practices insecticide free farming methods and utilises highly developed biological pest control techniques such as natural insect predators and moulds. These production practices provide the company with a competitive advantage as they can publish that they are insecticide free, which is becoming an important factor in horticulture. Furthermore, the introduction of more natural pest control methods leads to positive environmental benefits for the land and also for consumers.*

*Source:* www.stahmannfarms.com.au

Concerning exit strategies, growers were asked to indicate how they are planning to exit their businesses if they were to exit within the next five years. **Most growers intend to maintain their farms with no expansion and then to exit** (Figure 29). The second most popular exit strategy is to purchase another farm on exiting the existing one, followed by transferring ownership to family members. Employee or management buy-outs seem to be the least popular exit option. This is self-evident given that most growers are non-employers or micro enterprises for which this exit strategy is not an option.

The finding that maintaining operations and then exiting is the preferred exit option among growers is interesting given that most growers want to grow their operations. To further investigate this and as a robustness test, we cross-tabulated exit strategies with growth intentions and report the results in Figure 30. Results indicate that firms aspiring to grow would exit their business by purchasing another farm, after an employee or management buyout or by transferring ownership to family. Growers who want to maintain the size of their current operations opt for the following exit strategies: winding down operations and exit, using up capital assets, and exit and maintaining operations without expansion until exit.

FIGURE 29 EXIT STRATEGIES

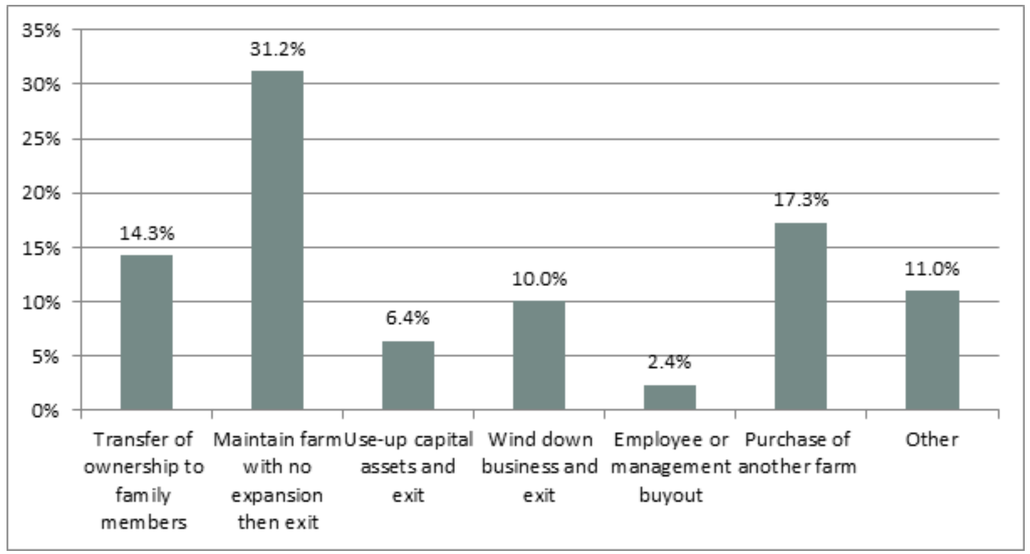
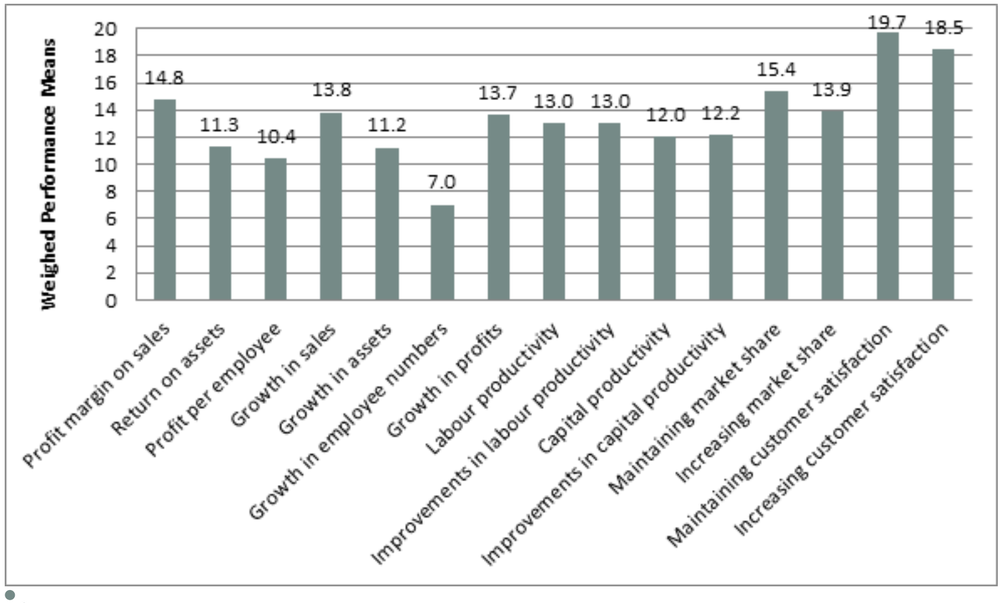



FIGURE 30 GROWTH OBJECTIVES WITH EXIT STRATEGIES


**Chi-square tests indicated significant differences (at the 5% level of significance) for employee or management buyout**

Grower performance was measured by asking respondents to rate 15 performance variables on a five-point Likert scale according to their relative importance to growers and growers' satisfaction with their current performance on these variables. These are all self-reported measures in that respondents rated their own performance for these different dimensions. Self-reported measures have been shown to highly correlate with objective measures of performance (Dess & Robinson, 1984; Hogan & Coote, 2014) and are therefore deemed appropriate for the purposes of this report. Satisfaction and performance scores were multiplied to provide a combined performance score for each variable out of a possible maximum score of 25. The weighted performance means of all 15 performance variables are presented in Figure 31.

FIGURE 31 WEIGHED PERFORMANCE MEANS



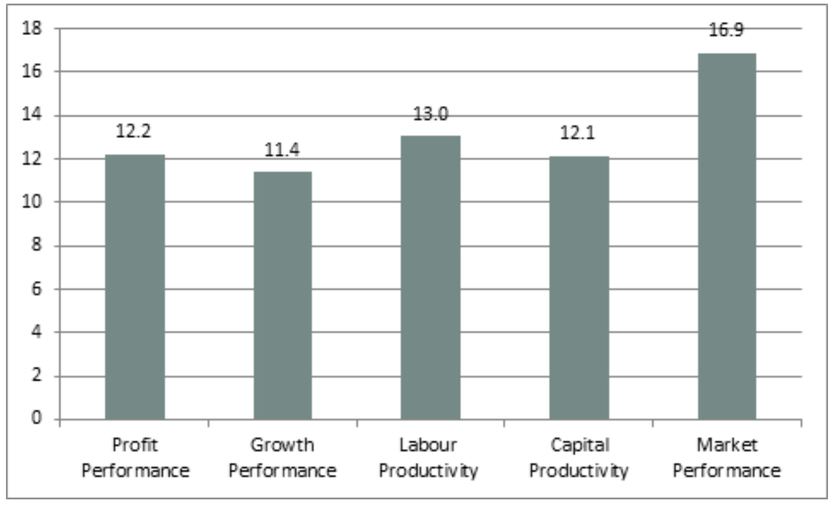



The highest average performance scores for growers related to maintaining and increasing customer satisfaction. It is clear that on average horticulture operations place a high premium on customer satisfaction and are in general satisfied with their current performance, not only in maintaining, but also in improving satisfaction levels. The second highest performance aspect was for maintaining market share. After considering the relatively high score for increasing market share, it becomes clear that **customer satisfaction and market share are important performance themes.** Growth in sales and profits, as well as increasing profit margins were, as expected, important performance indicators, followed by labour productivity. In general, growers did not focus on growing employee numbers.

To better understand these indicators, we divided the performance scores into five broader categories, namely: profit performance (profit margin, return on assets and profit per employee); growth performance (growth in sales, assets, employee numbers and profits); labour productivity (labour productivity and improvements in labour productivity); capital productivity (capital productivity and improvements in capital productivity); and market performance (maintaining and increasing market share together with maintaining and increasing customer satisfaction). The means of each of the combined averaged performance categories are presented in Figure 32. This shows that market performance and labour productivity were most important to growers. These results are used in subsequent analyses to explain how and why growers innovate and create competitive advantage.

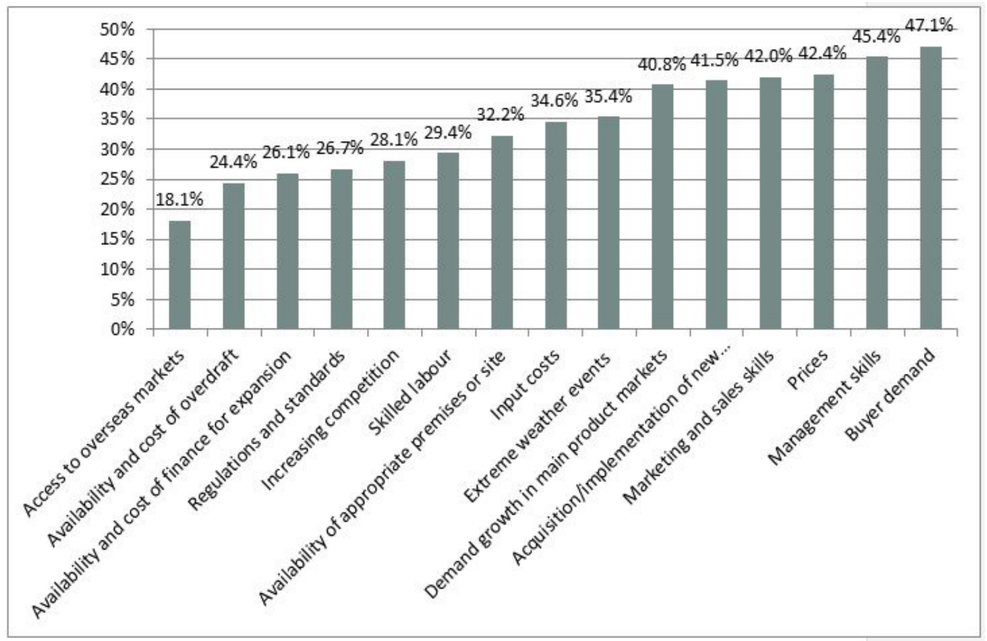
as was confirmed earlier (Figure 25). Access to international markets was only recorded in fewer than 20 per cent of the valid responses, making it the least important impediment to business performance. This does, however, not imply that international market access is unimportant. With only 10 per cent of the sampled growers deriving 50 per cent or more revenue from international sales, and with the rest focussing on the Australian market, it is likely that the importance of entering international markets is not well understood.

FIGURE 32 PERFORMANCE CATEGORY MEANS




To determine what factors impact upon business performance, growers were asked to rank factors that significantly limited their ability to achieve their business objectives over the past three years (Figure 33). Buyer demand (47%), growth in their main product's market demand (41%), and prices (42%) were clearly seen as obstacles. Marketing, sales (42%) and management (45%) skills also concerned growers. The finding that acquisition and or implementation of new technology also hampered objectives is surprising, given the high propensity of horticulture growers to innovate. Access to finance is a lesser obstacle

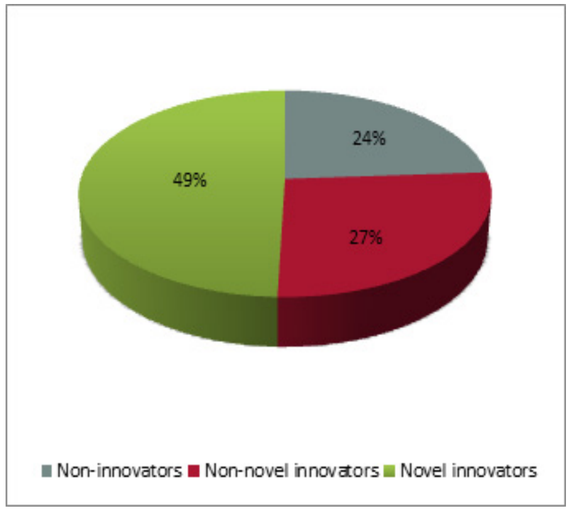
FIGURE 33 SIGNFICIANT LIMITATIONS TO ACHIEVING BUSINESS OBJECTIVES




## 6.4 Innovation in horticulture

Respondents were asked if they have implemented any new innovations (for types of innovation, see Figure 35) during the last three years and to indicate if these innovations were new to their operations (non-novel) or to the industry (novel). It therefore implies that if the grower implements an organic pest management strategy that has been in practice within the grower group for some time, such an innovation would be regarded non-novel. The remaining firms were classified as non-innovators. Most of the growers surveyed are active innovators (76%) reporting one or more innovations (Figure 34). **Horticulture growers are more innovative than the average Australian firm** with 65 per cent of all Australian firms reporting some form of innovation in our previous research (Verreynne & Steen, 2014). Approximately 26.5 per cent of the innovative growers have introduced innovations that were new to the firm with half (49.5%) introducing both new-to-the-firm (NTF) as well as new-to-the-industry (NTI) innovations over the past three years. **Novel innovations in the horticulture industry are more readily reported than in the rest of Australian firms** where a third (33%) of firms are regarded as novel innovators (Verreynne & Steen, 2014).

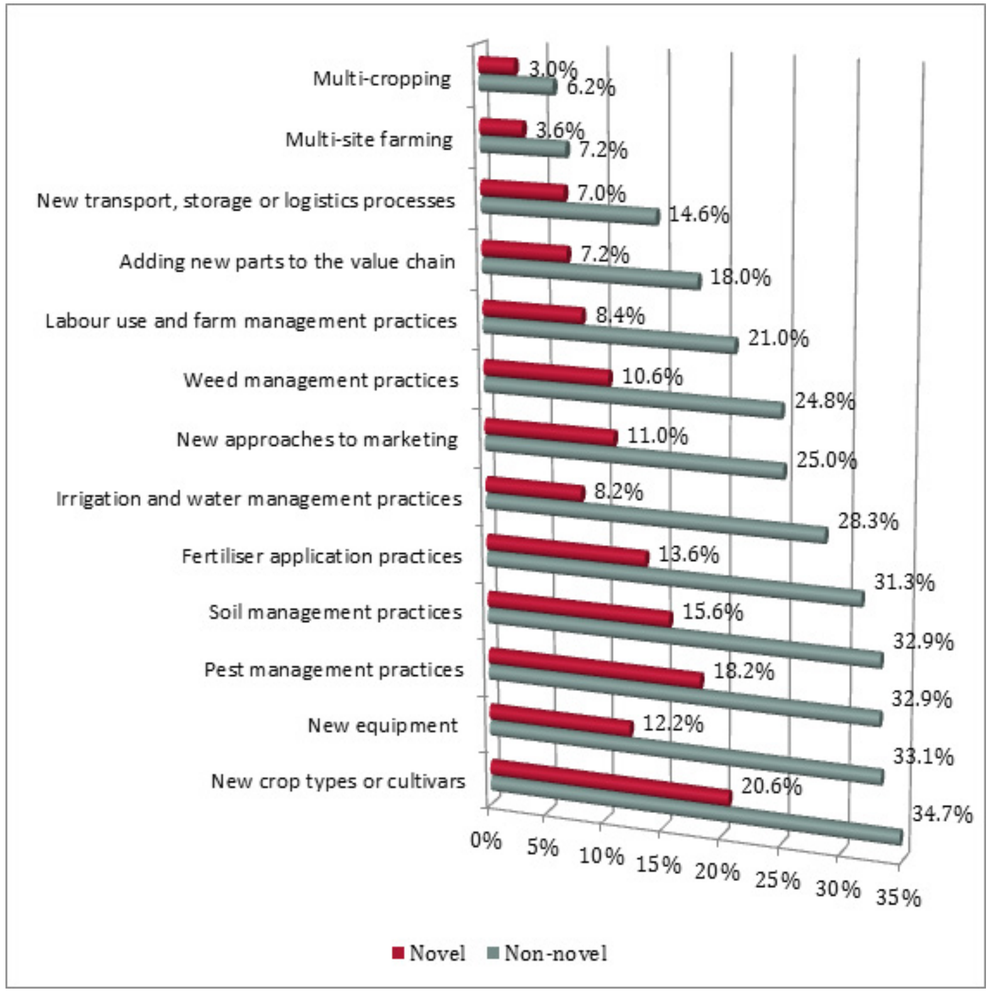
FIGURE 34 INNOVATION NOVELTY TYPES




Considering only those farms that reported the introduction of novel or non-novel innovation, Figure 35 summarises the different types of innovation that were introduced. It shows that new crop types or cultivars, new equipment, soil and pest management practices, and fertiliser applications are the most likely types of innovation in that they are being implemented by more than 30 per cent of growers. New crop types or cultivars are also the most likely novel innovation type,



FIGURE 35 INNOVATION NOVELTY AND INNOVATION TYPES




followed by pest and soil management practices. Each of these is the most prevalent type of innovation likely to be required on farms apart from weed management. Intensive multi-crop and multi-site farming are still in their infancy; involvement in logistics and transport is also limited, notwithstanding its potential benefits. Tropicana Banana is an excellent example of how logistics innovation, specifically aimed at improving packaging, can provide multiple benefits (see Box 5).

### BOX 5. TROPICANA BANANA INCREASE THE SHELF LIFE OF THEIR BANANAS

*Tropicana Banana is the leader in banana production across Australia with more than three million 13kg cases of bananas sold to Australians every year. Central to their success is their focus on creating the perfect ripening environment in order to produce longer lasting fruit. By creating the optimal humidity, not only are appearance and flavour improved, but shelf life is also increased by 3-4 days.*

*In addition to their thermfresh ripening rooms, Tropicana Banana also controls humidity through specially designed packaging bags that keep bananas fresh for longer. And the innovation doesn't stop there; the company has also developed a unique carton for banana storage during distribution that protects bananas while they are in transit and provides better ventilation to extend shelf life.*

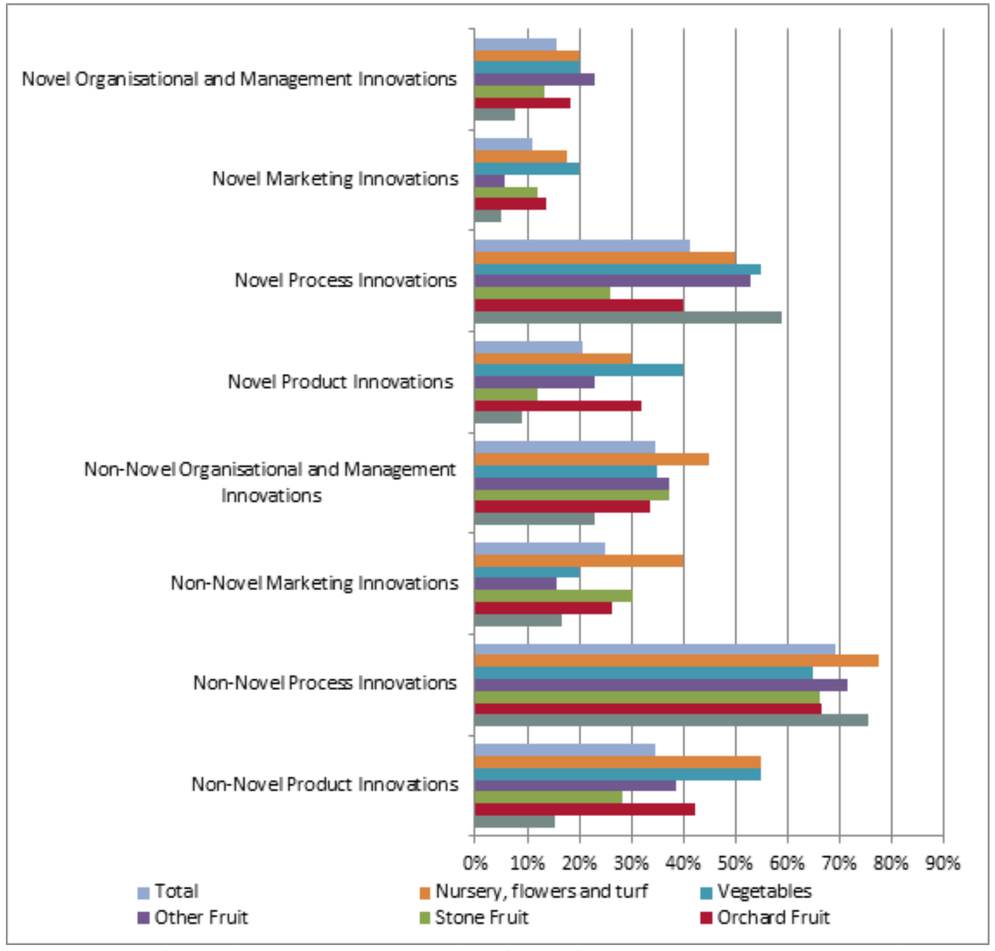
*Through engaging in production and packaging innovations, Tropicana Banana fulfils their objective of remaining the 'pick of the bunch' for all customers.*

*Source:* www.tropicanabanana.com.au

In Figure 36, we categorise the four different broad innovation types (See Figure A.3 in the Appendix for individual innovation types with grower categories). The evidence points to process innovation, the 'how' rather than the 'what' of production, dominating both novel and non-novel categories. Process innovations include weed, pest, soil, irrigation, and water management practices, multi-cropping, fertiliser application practices, new equipment as well as new transport, storage and logistics processes. Because these innovations constitute the major group of activities that farms are involved in, higher attempts to innovate in those areas are not surprising. As such, the majority of respondents reported that they introduced non-novel process innovations (new to the firm: 69.1%) and novel process innovations (new to the industry: 41.1%).



FIGURE 36 INNOVATION TYPES BY CROP TYPES




**Chi-square tests indicated significant differences (at the 5% level of significance) for product and marketing new to the firm innovations, as well as product and process new to the farm innovations.**

*Product innovation* relates to the introduction of new crop types or cultivars and was the second highest innovation category with growers reporting 34.7 per cent non-novel and 20.6 per cent novel product innovations. *Organisational and management innovations* involve multi-site farming, adding new parts of the value chain (including retail and logistics), and any new approaches to labour use or other farm management practices; 34.5 per cent of growers introduced non-novel organisational and management innovations and 15.8 per cent novel. *Marketing innovation* describes any new approaches to marketing the farm's production but was the least implemented innovation category with 25 per cent non-novel and 11 per cent novel types reported.

Marketing and organisational or management innovations, especially adding new parts to the value chain, are all areas that would create new opportunities for growers as illustrated in Box 3 with the case study of Mansfield's Propagation Nursery. A lack of attention to these areas of innovation leads to missed opportunities to adopt innovations from other industry sectors that may have a major positive impact for individual growers.

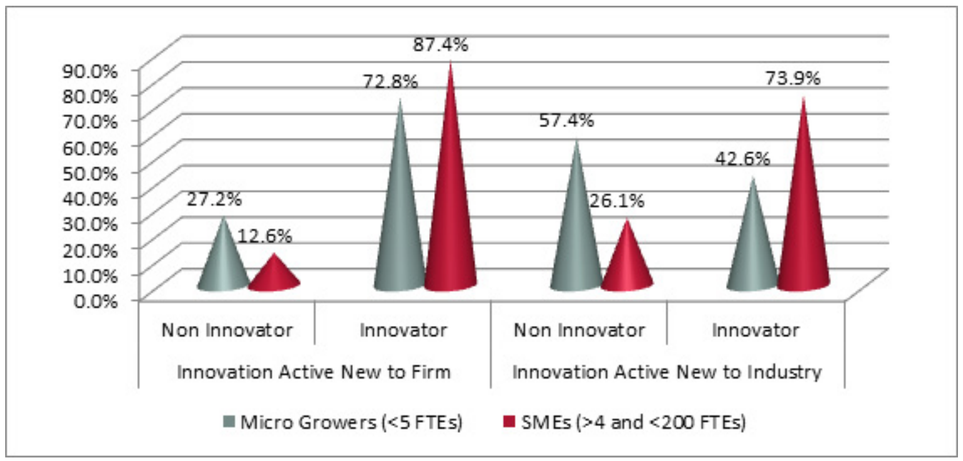
Figure 36 also compares innovation categories across the major crop types. Very few differences emerge but, interestingly, process innovations that are non-novel were more important to nursery, flowers and turf as well as nut growers. However, novel process innovations were very important to nut, but much less important to stone fruit, growers. New product innovations were most important to vegetable as well as nursery, flowers and turf growers than for the other grower categories because the nature of their operations makes the introduction of new cultivars or crops more likely than with orchards or other perennials. After comparing the different grower groups across the different innovation categories, it seems that nursery, flowers and turf growers are the most active non-novel innovators whereas **vegetable farmers tend to be most active novel innovators**. Although nut growers rate relatively highly on process innovations they are on

average the least active as non-novel innovators, whereas **stone fruit growers tend to be the least novel innovation active** when measured across all four innovation categories.

There were significant differences (p=.002) in innovation novelty between micro growers and SMEs, with SMEs more likely to innovate (see Figure 39). We distinguish here between micro growers that employ fewer than five employees and SMEs employing between 5 and 199 employees. The difference is even more pronounced when looking at the highly significant finding (p=.000) that 73.9 per cent of SMEs compared to only 42.6 per cent micro growers implement one or more novel innovations. **Larger growers therefore tend to innovate more and implement more novel innovations than smaller growers**.

Firm size as a determinant of innovation is one of the most studied variables in the innovation literature (Becheikh, Landry & Amara, 2006; Raymond & St-Pierre, 2010). In general, findings confirm the greater innovation propensity of larger firms (Bhattachaya & Bloch 2004) in that they benefit from economies of scale, smaller risks associated with R&D expenditure, greater market power, and better appropriation possibilities (Galende & de la Fuente, 2003). Small firms need to commit a much larger proportion of their resources when undertaking R&D than larger firms, making innovation very risky for small firms (Audretsch 1995; Klomp & van Leeuwen 2001). Collaboration between smaller firms to share the costs and risks of innovation is one strategy to improve the innovation performance of these growers.

FIGURE 37 INNOVATION NOVELTY AND FIRM SIZE



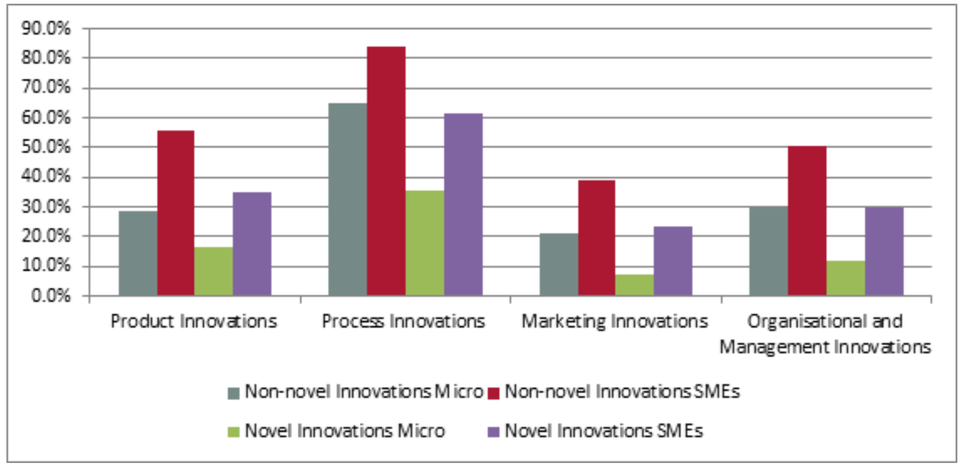

**($\chi^2$ (1) = 10.066, p = .002); ($\chi^2$ (1) = 33.885, p = .000).**

From considering different categories of innovation novelty against business size, the higher innovation propensity of larger growers is again confirmed (Figure 38). Also, as shown in Figure 37, the difference between SMEs and micro growers is more pronounced for novel than for non-novel innovations.

This highlights the finding in a study on productivity and farm size in Australian agriculture by Sheng et al. (2015:16) "suggesting that productivity improvement among smaller farms can be made through increasing their ability to access advanced technologies, rather than simply expanding their scale". Micro growers are not well enough resourced to conduct extensive research and development (R&D) and would hence rely more heavily on adopting technologies already available within their industry rather than develop novel innovations themselves. By doing this, they can increase their productivity without having to achieve scale benefits. This does not however imply that all micro growers are not innovative as illustrated by Paxton Passionfruit (see Box 6).

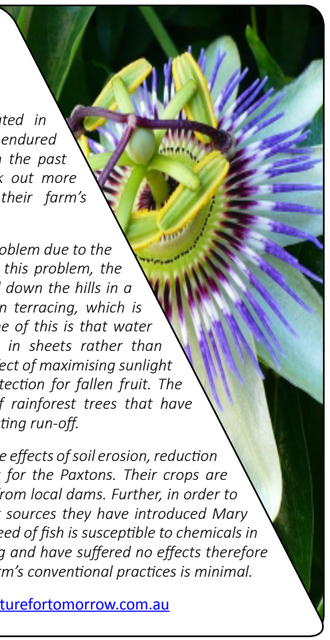


FIGURE 38 INNOVATION CATEGORIES, NOVELTY AND FIRM SIZE




**Chi-square tests indicated significant differences (at the 1% level of significance) for all relationships.**

### BOX 6. PAXTON PASSIONFRUIT FARM KEEPS SUSTAINABILITY SIMPLE



*Paxton's Passionfruit Farm, situated in the Sunshine Coast hinterland, has endured many environmental challenges in the past that have led the owners to seek out more innovative solutions to ensure their farm's sustainability.*

*Soil erosion has been the biggest problem due to the location of the farm. To overcome this problem, the growers planted their trees up and down the hills in a north-south alignment, rather than terracing, which is typical of passionfruit. The outcome of this is that water slowly runs off the turfed slopes in sheets rather than channels. It also has the residual effect of maximising sunlight in winter and providing shade protection for fallen fruit. The Paxtons also have a plantation of rainforest trees that have helped reduce soil erosion by impacting run-off.*

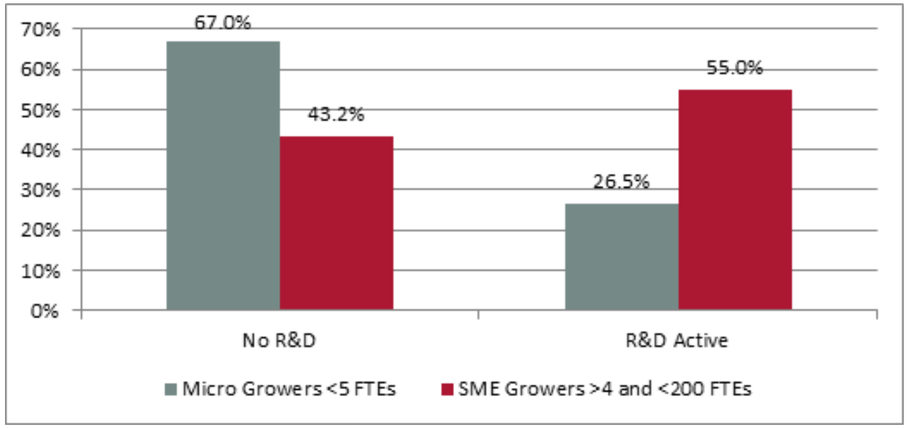
*In addition to mitigating the negative effects of soil erosion, reduction in water pollution is a top priority for the Paxtons. Their crops are watered by sprinklers that are fed from local dams. Further, in order to monitor the quality of these water sources they have introduced Mary River perch into the dams as this breed of fish is susceptible to chemicals in the water. The fish are still breeding and have suffered no effects therefore the environmental impact of the farm's conventional practices is minimal.*

*Source: Keith Paxton;* www.horticulturefortomorrow.com.au

For non-novel types of innovation the greatest difference between SMEs and micro growers involves the new approaches to marketing, new transport, storage or logistics processes, new crop types or cultivars and soil management practices (see Figure A.4 in the Appendix). For novel innovations, the largest difference between SMEs and micro growers entail new approaches to marketing, new equipment, new crop types or cultivars and soil management practices (Figure A.5 in the Appendix). Regardless of the level of innovation novelty, **larger growers therefore tend to introduce all types of innovation more than micro growers, but more specifically as it applies to marketing, crop or cultivar types, and soil management practices.**

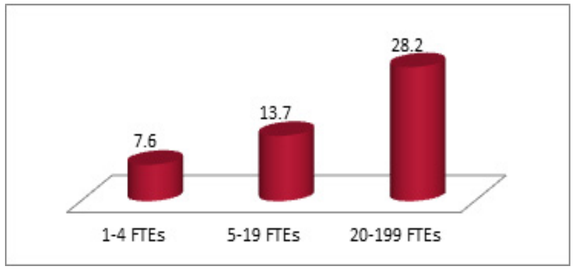
It is clear that, when it comes to R&D, the horticulture industry tends to outperform the average business in Australia (See Box 7). The majority of growers (64%) in our sample indicated that they engaged in R&D activities. 55 per cent of the R&D active growers were SMEs and 26.5 per cent were micro growers (Figure 39). The majority of micro growers (67%) therefore did not engage in any R&D. The R&D activity of Australian firms from all industry sectors are presented in Figure 40 (Verreynne & Steen, 2014). Only 7.6 per cent of micro enterprises (i.e., fewer than five full-time employees) were R&D active, compared to 13.7 per cent for small enterprises (i.e., between five and 19 full-time employees, and 28.2 per cent for medium enterprises (i.e., between 20 and 199 full-time employees). **Micro growers in horticulture are therefore more than three times more likely to engage in R&D than other micro businesses in Australia while, for SME growers, the rate is almost double.** The higher frequency of R&D is surprising, but given higher innovation levels within horticulture as compared to the rest of Australian firms, as discussed above, it would follow that R&D, as an important antecedent to innovation performance, would also be higher.

FIGURE 39 R&D ACTIVE WITH GROWER SIZE (EMPLOYEES)

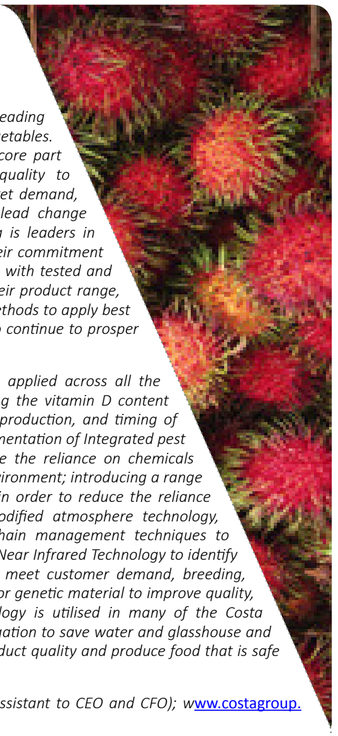



**($\chi^2$ (2) = 32.249, p = .000)**

FIGURE 40 R&D ACTIVE BUSINESSES IN AUSTRALIA (FROM UQ SURVEY)




### BOX 7. COSTA GROUP IS AT THE FOREFRONT OF HORTICULTURAL INNOVATION METHODS



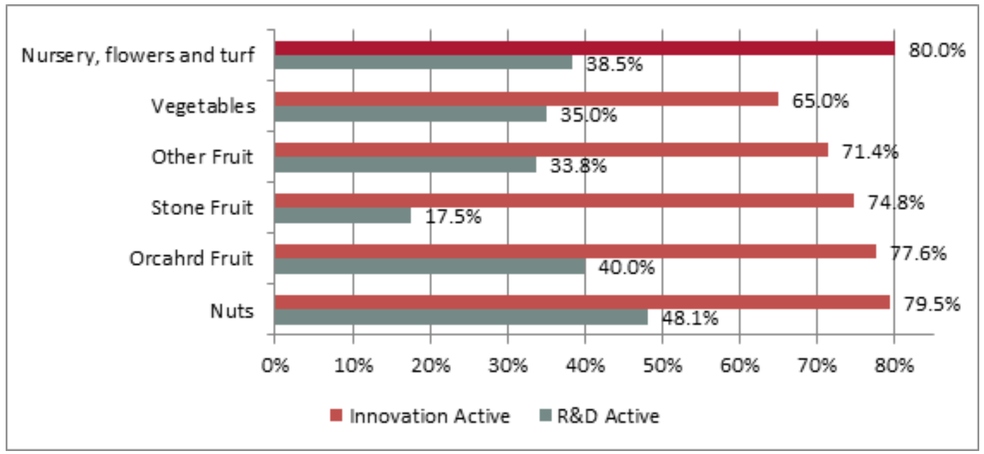
*Costa Group is Australia's leading supplier of fresh fruit and vegetables. Research and Development is a core part of the Costa commitment to quality to respond to external factors (market demand, environmental changes) and to lead change via vision and forethought. Costa is leaders in agronomy and farming due to their commitment to continuous improvement along with tested and proven food R&D. Across all of their product range, Costa farms employ innovative methods to apply best management practices in order to continue to prosper in a highly competitive market.*

*Some of the innovative methods applied across all the product ranges include: Enhancing the vitamin D content in mushroom; improved growth, production, and timing of berry varieties in substrate; implementation of Integrated pest management strategies to reduce the reliance on chemicals and minimise the effect on the environment; introducing a range of biological farming techniques in order to reduce the reliance on chemical fertilisers; using modified atmosphere technology, improved packaging and cold chain management techniques to improve shelf life; introduction of Near Infrared Technology to identify fruit with a high brix content to meet customer demand, breeding, selection and evaluation of superior genetic material to improve quality, size and timing. Modern technology is utilised in many of the Costa facilities, such as utilising drip irrigation to save water and glasshouse and tunnel technology to enhance product quality and produce food that is safe to consume.*

*Sources: Ivanka Gale (Executive Assistant to CEO and CFO); w*[www.costagroup.com.au](http://www.costagroup.com.au)

R&D activity between grower groups differed substantially in that nut growers outperformed the rest of the growers, with stone fruit farmers lagging behind the rest (Figure 41). When comparing the innovation activity with R&D activity, the correlation seems less obvious. This difference has to be interpreted by considering that an innovation-active measure does not account for innovation intensity or the number of innovations that were implemented. It rather indicates if a grower has implemented one or more innovation. Considering this, Figure 41 seems to suggest that, although stone fruit growers have the smallest number of R&D-active farms, their activity is associated with proportionally the largest impact on innovation when measured by the number of innovation active firms.

FIGURE 41 INNOVATION AND R&D ACTIVITY WITH GROWER GROUPS

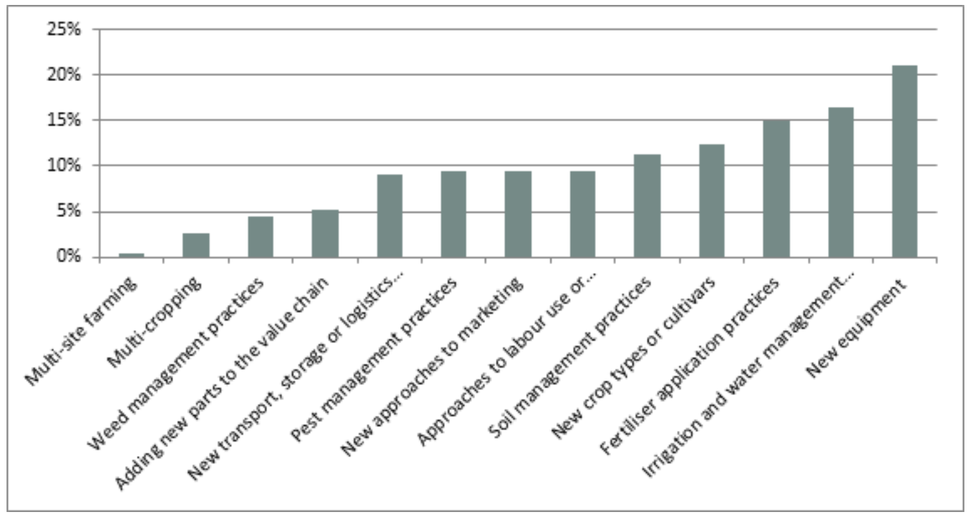



**($\chi^2$ (5) = 3.265, p = 0.659); ($\chi^2$ (10) = 73.060, p = .000)**

The innovation that had the greatest impact was the introduction of new equipment, followed by irrigation and other water management practices, and fertiliser application practices (Figure 42). New crop types and soil management practices also rated proportionally high. The least important innovation types were multi-cropping and multi-site farming. Actual implementation of innovations (Figure 35) compares well with grower perception of the impact of different types of innovation, providing further robustness to the results.

Self-reported measures of the impact of innovation provide insight into what growers perceive to be the main drivers for engaging in innovation activities, as tested in our survey by asking respondents three questions. First, what innovation type had the greatest impact on the farm over the last three years? Second, what were the top three reasons why they innovated? Third, what were the outcomes?

FIGURE 42 IMPACT OF INNOVATION TYPES



## BOX 8. SUSTAINABILITY LEADS TO LOWER COSTS AT ANDERSON HORTICULTURE

*The Andersons own an avocado farm on the north coast of NSW where they sell several varieties of avocados to nurseries across Australia. Anderson Horticulture has a strong national reputation as a leader in quality production processes. In an effort to reduce production costs the Andersons have recently sought out more environmentally-sustainable farming methods. One of which is the use of Integrated Pest Management (IPM) which has seen the owners reduce costs substantially.*

*Within this approach, natural predators are used to control pests and a habitat is created so that they can thrive. New predators are only introduced if required. By using this method, financial and environmental costs are avoided as there is no need for expensive insecticides and fungicides.*

*In addition to management of pests, water conservation is important for the Andersons. By using under-tree sprinklers at night and plastic mulch and trickle on young orchards, Anderson Horticulture is able to manage their water efficiently.*

*The motivation for Anderson Horticulture, like most businesses, is profit. With the use of more sustainable methods the quality of their product is much better and costs are minimised. Furthermore, they are also taking care of the land for future farmers.*

*Sources:* www.andersonhorticulture.com.au*;*

www.horticulturefortomorrow.com.au

Results of the second and third survey questions, relating to the three or fewer main reasons for innovating, are presented in Figure 43. Respondents were given 26 options to choose from as well as the opportunity to specify if the reasons were not included in any of the options. For the purpose of this report, only the options with a valid response rate of higher than two per cent for either 'reason' or 'outcome' are reported in Figure 43. The results are arranged in order of increased frequency for 'reason for innovating'. **Growers' most important motive for innovating is to increase profit** (see Box 8).

Other less important reasons relate to increasing crop yields, efficiency of supply, income, and soil quality. These results correspond well with the importance ratings of performance variables of which profit margin and growth in profits was rated very high. Although increasing market share and responsiveness to customer needs as well as establishing new markets were all regarded as highly important, they were reported in less than one per cent of the responses as reasons for innovating. It therefore seems that growers do not perceive innovation to have the potential to contribute substantially to these performance variables. Innovation motives can be complex as some innovations may require yield to be sacrificed but may provide other benefits including product quality as is the case at Pacific Coast Eco-Bananas (See Box 9). The benefits of innovation that are reported by growers are clearly related to their business strategy. While this would vary from grower to grower, the ultimate aim is to increase financial returns from the business.

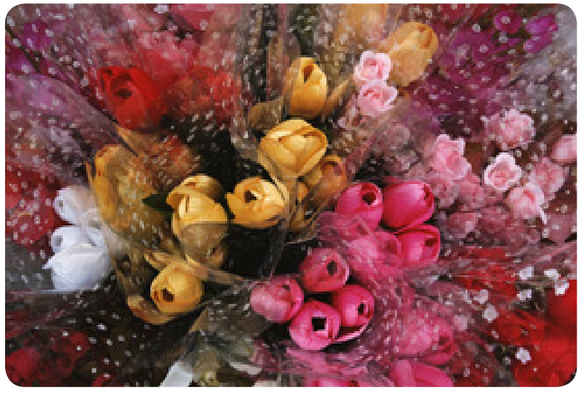
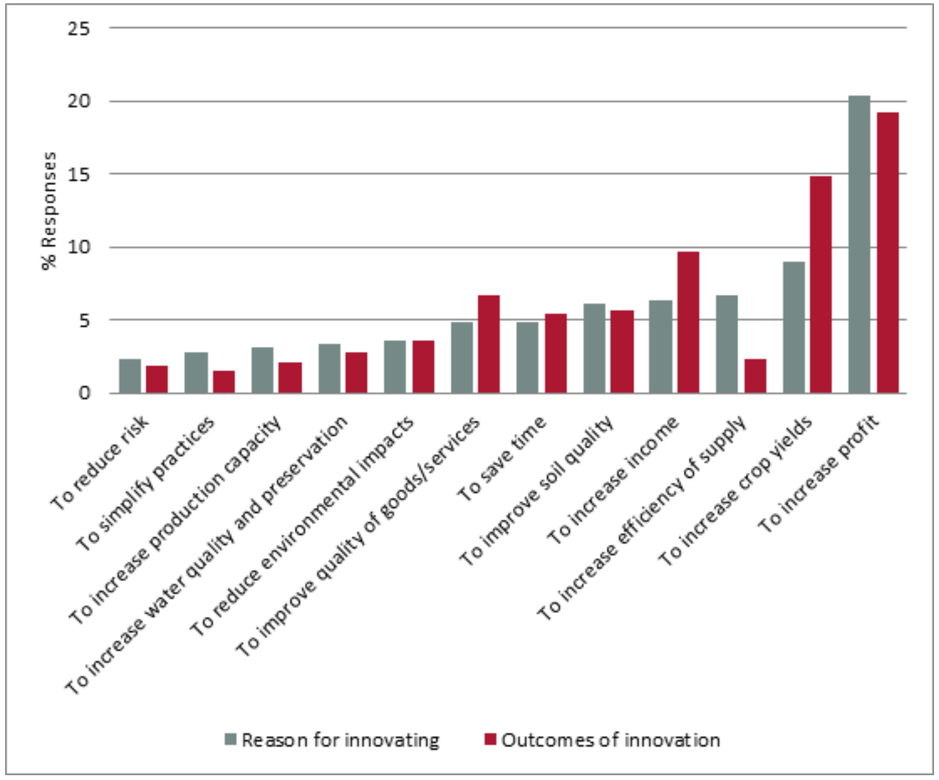


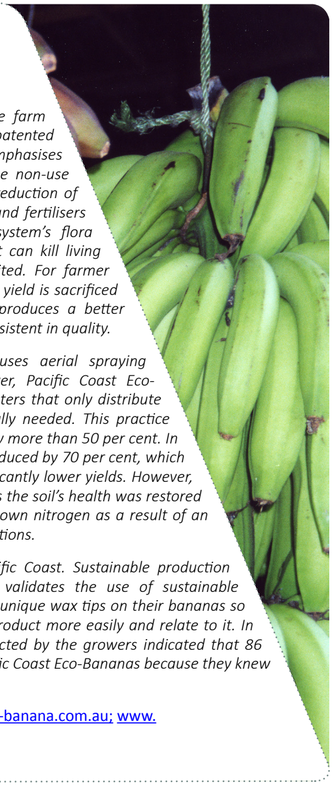


FIGURE 43 REASONS FOR AND OUTCOMES OF INNOVATION




In general the outcomes seem to correspond with the reasons, with a few exceptions. Some growers indicated crop yield improvement to be an important outcome of innovations; however, such an outcome was not an important reason to innovate. The same applies to increased income and quality improvement of products. These three aspects can therefore be described as unintentional outcomes of innovation. The opposite is true for the increasing efficiency of supply, which was important but not achieved.

### BOX 9. PACIFIC COAST ECO-BANANAS PRODUCE ENVIRONMENTALLY FRIENDLY BANANAS



*At Pacific Coast Eco-Bananas the farm owners have developed a patented ecorganic farming protocol that emphasises 'farming with nature', that is, the non-use of pesticides and the significant reduction of organic and synthetic chemicals and fertilisers that can impact upon the ecosystem's flora and fauna balance. Products that can kill living organisms in the soil are prohibited. For farmer owners Dianne and Frank Sciacca, yield is sacrificed for a healthier eco-system that produces a better flavoured product that is more consistent in quality.*

*Typically, the banana industry uses aerial spraying for fungicide application. However, Pacific Coast Eco-Bananas prefer to use ground misters that only distribute the chemical where it is specifically needed. This practice has reduced the use of fungicide by more than 50 per cent. In addition, fertiliser has also been reduced by 70 per cent, which came at a price at first with significantly lower yields. However, yield increased after a few years as the soil's health was restored and the soil began to produce its own nitrogen as a result of an increase in micro-organism populations.*

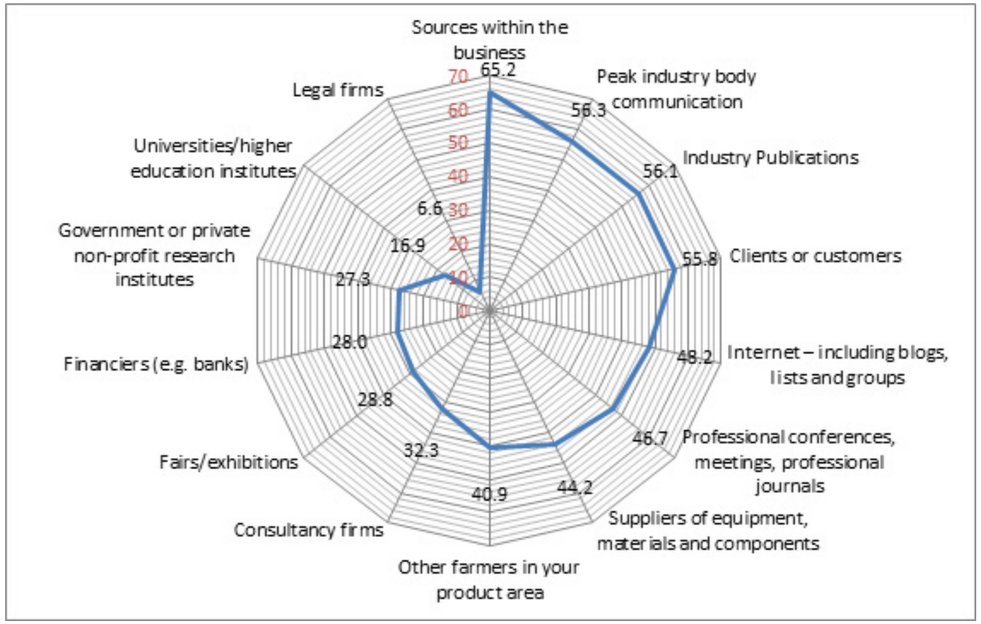
*Marketing is top priority for Pacific Coast. Sustainable production alongside sustainable marketing validates the use of sustainable product claims. The business uses unique wax tips on their bananas so that consumers can identify the product more easily and relate to it. In fact, an independent study conducted by the growers indicated that 86 per cent of customers bought Pacific Coast Eco-Bananas because they knew what they were buying.*

*Sources: Dianne Sciacca;* www.eco-banana.com.au; www.horticulturefortomorrow.com.au

Internal and external sources of information for the adoption or development of innovation are regarded as important determinants of innovation performance. This occurs because the generation and use of knowledge depend on the frequency of the business's interactions with these sources (Varis & Littunen, 2010), which are indispensable for the innovation process (Laursen & Salter, 2006). We investigate these sources by asking respondents to rate the importance of a number of sources on a five-point Likert scale. Only responses of four and five were considered significant enough for this analysis and were thus coded; the results are presented in Figure 44.

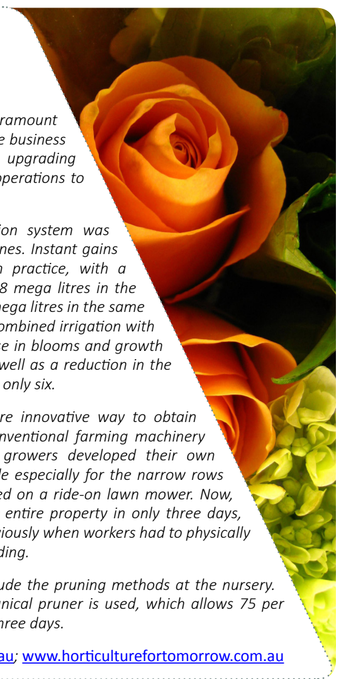


FIGURE 44 SOURCES OF INFORMATION FOR INNOVATION




The most important source of information for innovation originated from within the business. The home-grown "weedicide wagon" of Ruston's Roses is a good example (see Box 10).

### BOX 10. WATER MANAGEMENT AND MECHANISATION AT RUSTON'S ROSES



*At Ruston's Roses, innovation is paramount to improving productivity with the business spending more than $600k on upgrading infrastructure and mechanising operations to date.*

*At the nursery, a new fertigation system was recently installed, using dripper lines. Instant gains were visible from this irrigation practice, with a reduction in water usage from 48 mega litres in the last three months of 2003 to 22 mega litres in the same period in 2004. The system also combined irrigation with fertilising. The effect is an increase in blooms and growth in stem leaves of 50 per cent as well as a reduction in the pruning cycle from eight weeks to only six.*

*The business also needed a more innovative way to obtain access between rose bays as conventional farming machinery was too big. In response, the growers developed their own distinctive weedicide wagon made especially for the narrow rows in the nursery and designed based on a ride-on lawn mower. Now, weeding can be done across the entire property in only three days, compared with three months previously when workers had to physically use their hands to undertake weeding.*

*Other mechanised processes include the pruning methods at the nursery. Now, a specially designed mechanical pruner is used, which allows 75 per cent of the farm to be pruned in three days.*

*Sources:* www.rustonsroses.com.au; www.horticulturefortomorrow.com.au

Our findings correspond well with the findings of Verreynne and Steen (2014) on Australian firms across different sectors (see Figure 45). However, horticulture businesses use external information sources more than other businesses. **Another pertinent difference between horticulture and general business is that the former relies on information from peak industry bodies and industry publications more than the voice of the customer.** Box 11 well exemplifies how horticulture industry bodies can directly impact upon stimulating the creation and diffusion of innovation within the industry. **This finding supports the effectiveness of industry bodies as a supporter of innovation and competitiveness across the sector.**

Horticulture firms are also more likely to engage consultancy firms for information than businesses from other sectors (see Box 12). Results on the importance of professional conferences, meetings and professional journals; fairs or exhibitions; financiers; government or private non-profit research institutes; and universities are almost identical to that of other Australian businesses.

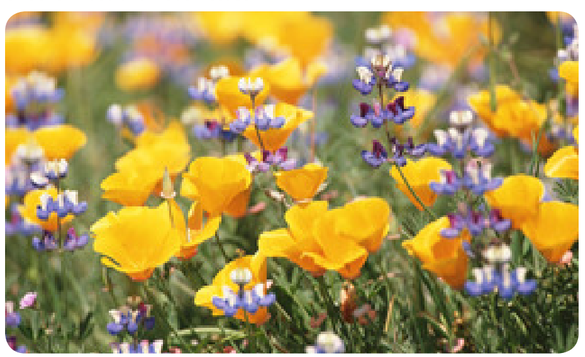
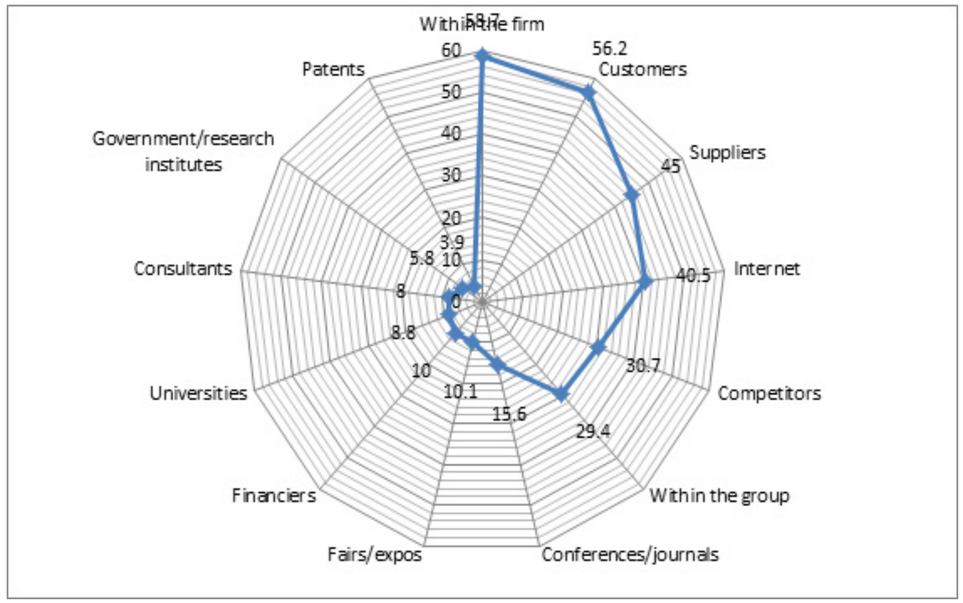


FIGURE 45 SOURCES OF INFORMATION FOR INNOVATION (QLD SURVEY)




### BOX 11. RESEARCH ON PEST MANAGEMENT IN SWEET CORN

*Sweet corn is a vegetable that is highly susceptible to attack by pests. In particular, heliothis and heliothis larvae have affected some crops across Australia so badly that there have been 100 per cent losses reported in some years.*

*In response, Horticulture Innovation Australia and AEC group developed a best management options strategy to control the pests which involved the use of two pesticides – Gemstar and Success. The use of these pesticides on sweet corn crops has seen an increase in gross value of production of close to $16 million. In addition, other impacts have included reduced environmental toxicity due to the shift away from broad pesticides; improvement in supply consistency due to a reduction in crop losses; and reestablishment of export markets as a result of a reduction in quarantine risk.*

*Source:* www.ruralrdc.com.au

### BOX 12. USES FOR WASTE ACCORDING TO APPLIED HORTICULTURAL RESEARCH

*Applied Horticultural Research (AHR) is a company that comprises a group of highly skilled professional researchers that focus on increasing innovation levels in horticulture. In a recent study the team looked at quantities of waste and innovative ways to use this waste in a more sustainable manner. Results from the study found that carrots in particular are the biggest waste industry with over 93000 tonnes wasted each year which equates to over 30 per cent of production.*

*From their findings, AHR put forward a number of smarter ways to utilise waste. First, they suggest using waste to generate electricity as it was found that growers who produce at least 10 tonnes of waste per day could use vegetable waste for on-farm power generation. Second, waste can be used in nutritional supplements or in natural food colourants. The team did note, however, that it is not currently economically viable to extract bio-active compounds from Australian vegetables – although it is an area that is developing. AHR also advocates for using waste as fish food which could have the benefit of helping replenish the world's oceans where fish stock is rapidly decreasing. Last, waste has the potential to be turned into high protein, high nutritional value feeds for cattle and dairy cows, therefore they recommend using waste in the production of animal feed.*

*Sources:* www.ahr.com.au*; Hortlink Summer (2013-2014)*

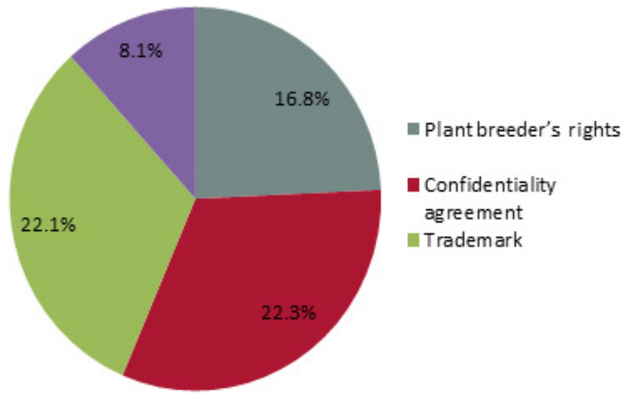


Intellectual property protection was also investigated to not only uncover the strategies that growers adopt to protect their innovations, but also to understand the type of intellectual property and hence also innovations that growers tend to protect through these strategies (Figure 46). The 481 (96%) growers who responded to this question indicated **confidentiality agreements and trademarks to be the most popular strategies followed by plant breeder's rights and trademarks.**

A high proportion indicated that they had some form of intellectual property protection. For instance, 16.8 per cent of growers indicated they had plant breeder's rights (PBRs). PBRs are a form of registered intellectual property protection, which have not proven to be successful as they have not been taken up in many countries, and thus do not offer a comprehensive form of protection. The relatively high number of growers who use PBRs is thus somewhat surprising.

Less surprising is the 22 per cent of grower respondents who use trademarks, as these are typical for product branding in the market. Many would in fact use multiple trademarks for the products from a range of crops. The data shown in Figure 48 indicate a strong innovative output for the horticulture sector and compare well to successful industries across the economy.

FIGURE 46 INTELLECTUAL PROPERTY PROTECTION




## 6.5 The relationships between innovation, competitive advantage, dynamic capabilities and performance in horticulture

### 6.5.1 COMPETITIVE ADVANTAGE AND INNOVATION

Competitive advantage describes a firm's ability to outperform rivals in a competitive market to ensure its survival and growth. Firms are differently endowed with resources with which they build their competitive advantage (Barney, 1991). They aim to build a sustainable competitive advantage that cannot be easily replicated by competitors. Because most growers are micro enterprises or SMEs and hence lack tangible resources, they rely on intangible resources such as innovativeness to enhance competitiveness.

In this section, we first look at what competitive advantages are adopted by which growers. We then investigate the relationships between innovation and competitive advantage. This study asked respondents to indicate on a five-point Likert scale where their competitive advantage lies so as to measure it. Only responses that indicated strong agreement with the variable tested (a score of four or five) were included in the statistical analysis. Figure 47 shows the prevalence of different types of competitive advantage as adopted by micro and SME growers. There is little difference between the types of competitive advantage reported by the two categories of size. Larger growers, by building on their broader range of resources, expectedly reported using more of the options to create competitive advantage than micro enterprises

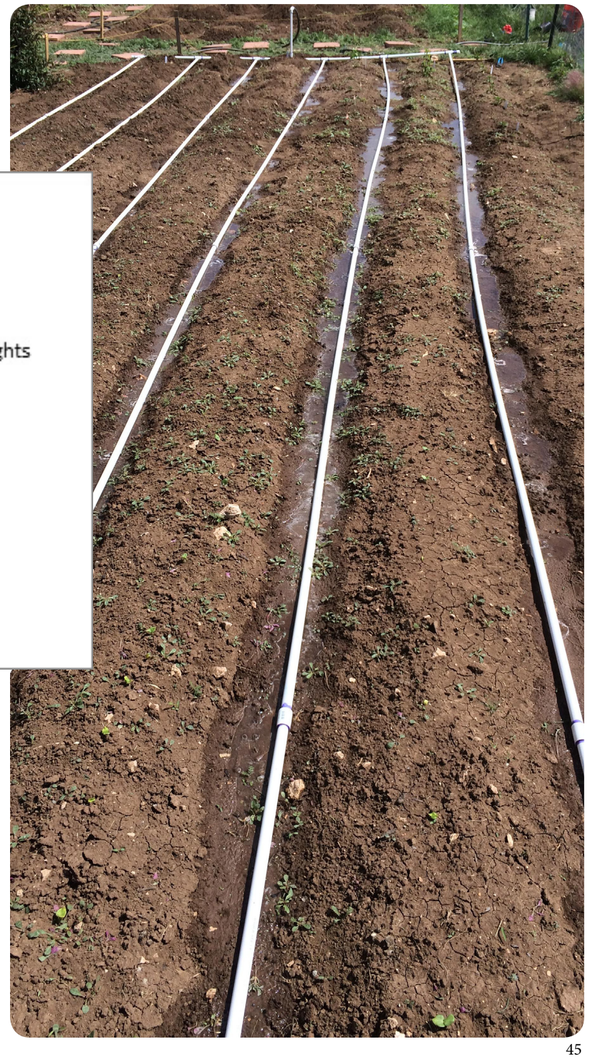
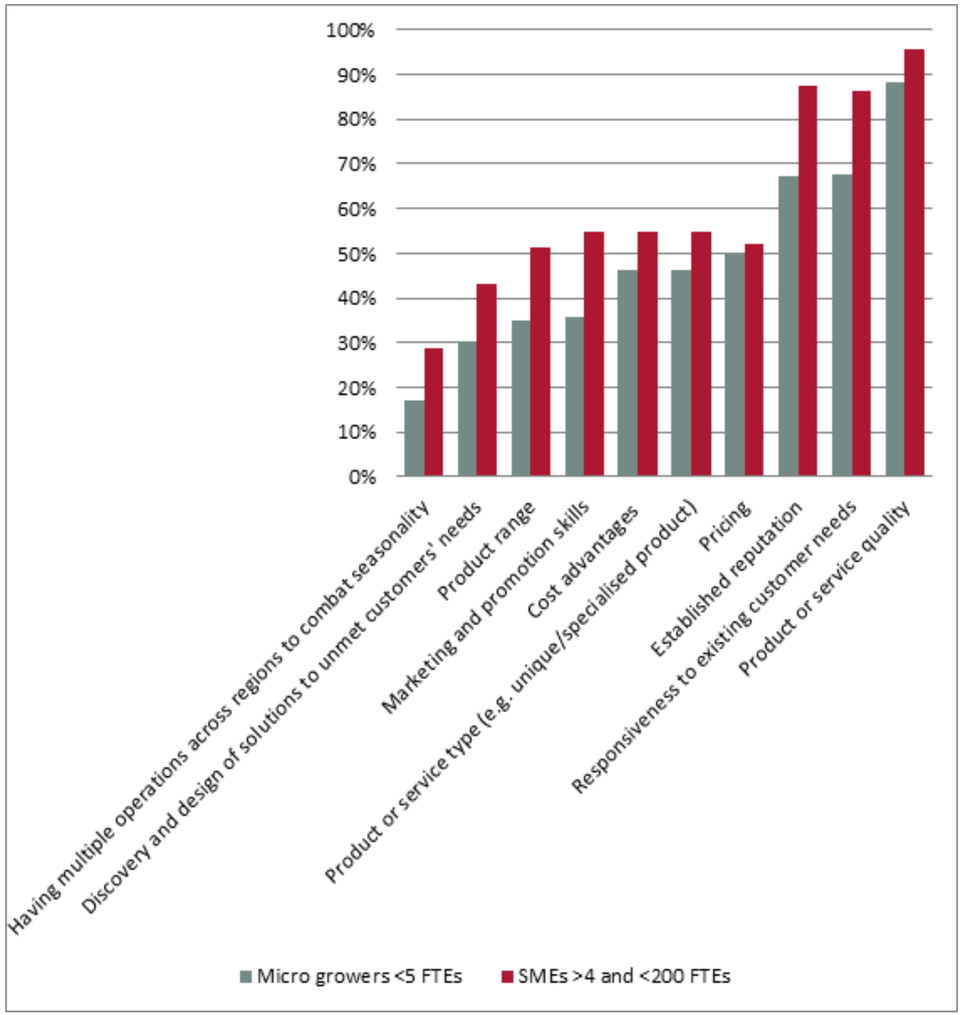


FIGURE 47 COMPETITIVE ADVANTAGES WITH GROWER SIZE

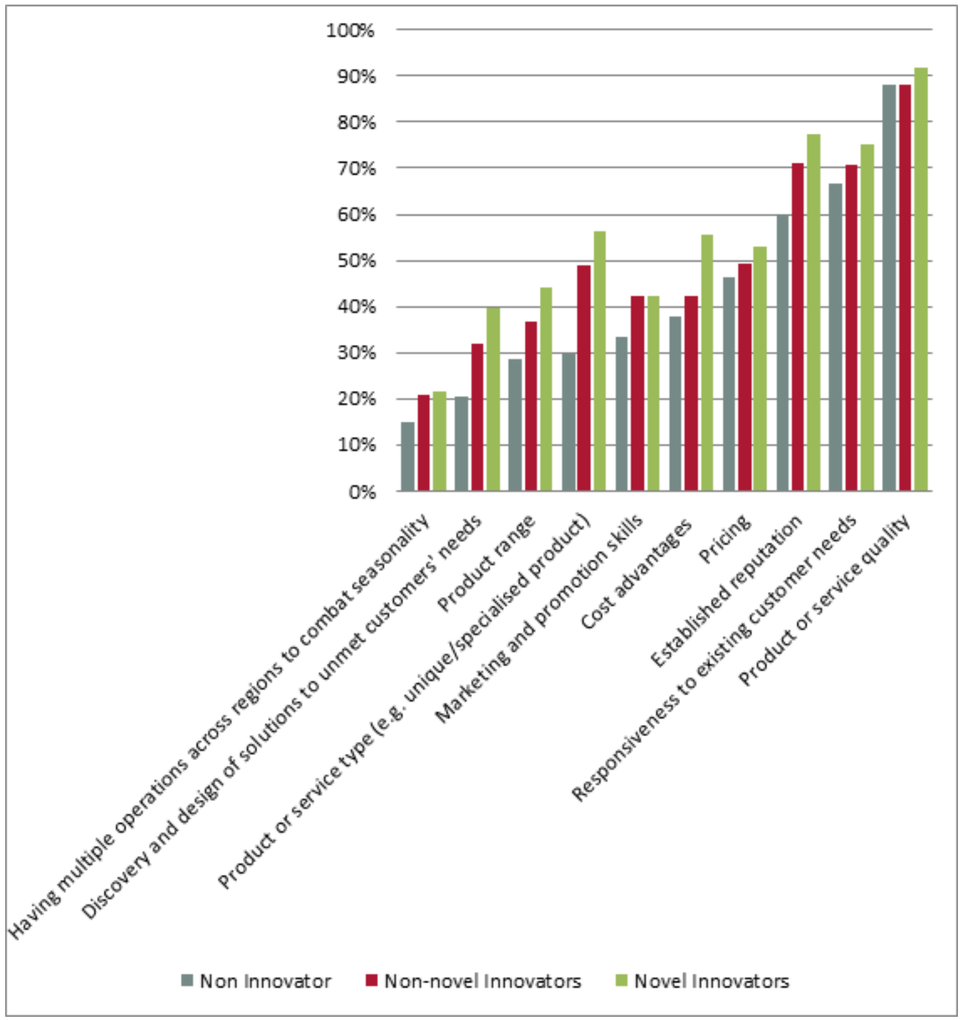



**Chi-square tests indicated significant differences (at the 5% level of significance) for all relations except for pricing, cost advantages and product or service type.**

Figure 48 denotes the cross-tabulation of the sources of competitive advantage with innovation novelty. As expected, novel innovators focused more on their sources of competitive advantage than non-novel innovators and non-innovators. **The data support a direct correlation between innovation novelty and self-reported competitive advantage**. The different use of all the sources of competitive advantage is quite striking, except for product quality which occurs when non-innovators and non-novel innovators place equal emphasis on product quality.



FIGURE 48 COMPETITIVE ADVANTAGES BY INNOVATION NOVELTY

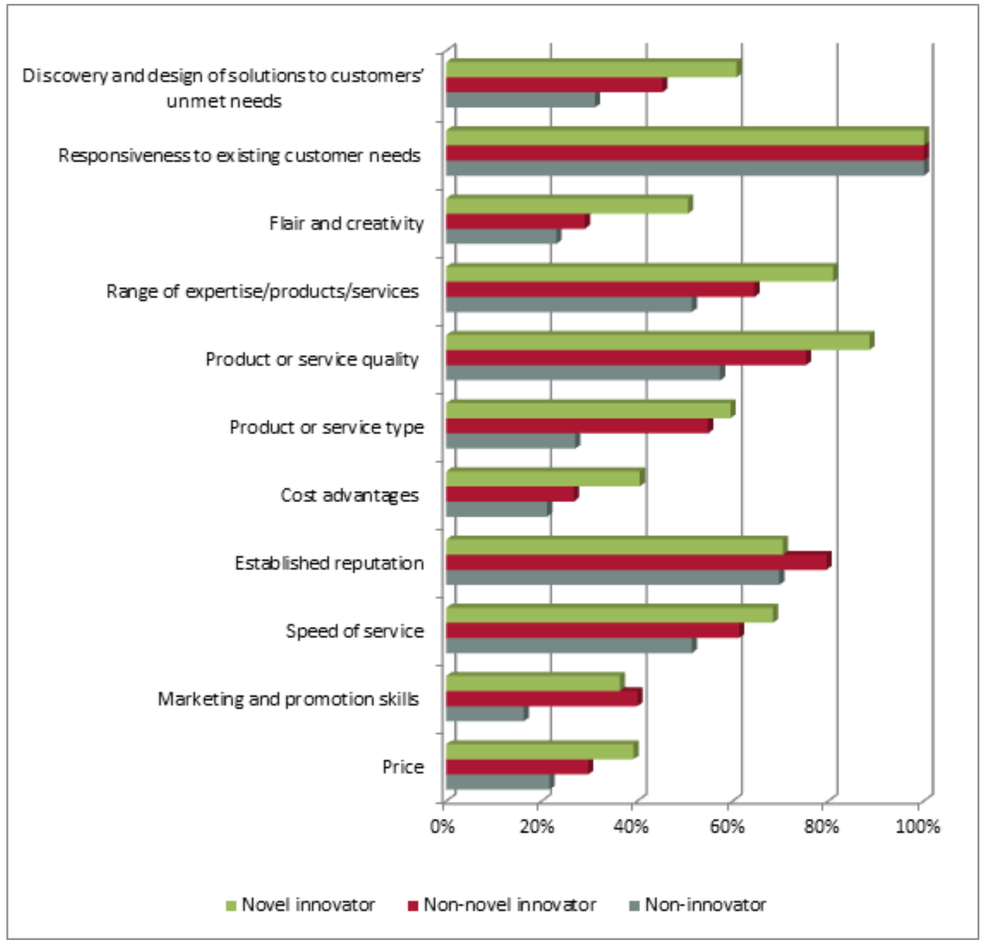



**Chi-square tests indicated significant differences (at the 5% level of significance) for all relations except for pricing, cost advantages and product or service type.**

Comparing the horticulture results with that of the rest of Australian businesses provides some insight into the competitive dynamics of the horticulture industry (Figure 49). **Owing to the homogeneous nature of most horticultural products, most growers focus on ensuring that the quality of their products are on par with or exceed current market expectations or industry standards. This does not leave much room for developing competitive advantage in this area.**

The picture looks very different when looking at businesses across diverse industries. Figure 49 shows that novel innovators tend to focus more on product or service quality than less novel innovators or non-innovators. Within the general business population, responsiveness to consumer needs is the same for all innovator categories whereas it differs for horticulture growers. This is because novel innovators are more responsive to the needs of their customers in their inclination to create and deliver unique or specialised market offerings.

FIGURE 49 COMPETITIVE ADVANTAGES BY INNOVATION NOVELTY (QLD SURVEY)




Pearson's bivariate correlation coefficients were calculated for different types of innovation and competitive advantage. For both levels of innovation novelty, NTF and NTI were used. We focus only on highly significant correlations (p=0.01) in this discussion. The correlation coefficients between the categories of innovation types and the different sources of competitive advantage are presented in Table A.3 in the Appendix.

As explained earlier, product or service quality does not correlate significantly with any of the innovation types. Establishing and leveraging reputation correlates with the novel and non-novel product innovation (Table A.3) as well as with the introduction of new crop types or cultivars at both novelty levels. It has to be noted that these correlations do not imply causation, but merely show a tendency for the two variables to move or vary in relation to each other. It therefore implies that novel crop or cultivar development co-occur and vary with having an established reputation. It could however, (with caution) be argued that firms with the capacity to develop new crop or cultivars would be best suited to follow a strategy directed at building and leveraging a strong reputation. Again with caution, it could also be interpreted that firms with an established reputation would be advised to build or strengthen their new product development capacity.

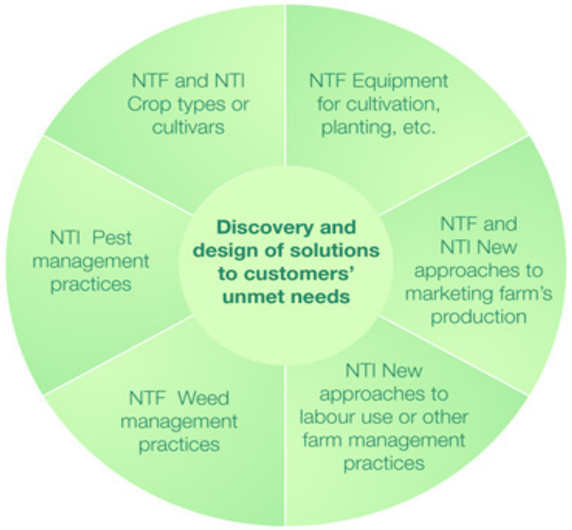


NTF and NTI
New crop types
or cultivars

**Established reputation differentiation advantage**

**Responsiveness to existing customer needs did not correlate highly significantly with any innovations**. Discovering and designing solutions to customers' unmet needs correlated highly significantly with most of the innovation categories (Table A.3), as well as a number of types of innovation at both the firm and industry novelty levels. **Addressing unmet customer needs has the highest number of significant positive correlations with innovation types of all the sources of competitive advantage**. This is therefore a strategy that seems to lend itself to multiple avenues for innovation. One of the most obvious and dominant consumer trends is that consumers increasingly demand that produce are organically produced by growers who embrace sustainable agricultural practices. This is a theme that resonates through most of the innovation case studies presented in this report. They show that the various unique and changing needs of consumers require growers to innovate across a greater spectrum of business areas including sustainable weed and pest management. The case studies also show the importance of providing customers with unique produce that may be specialised to satisfy particular niche applications and combining these with unique marketing approaches to identify and reach those market segments dissatisfied with the status quo. To satisfy the unmet needs in this way would also require not only new equipment to be used but also highly innovative farm management practices.

However, to discover unmet customer needs, growers require a strong relationship with customers. Small growers selling commodity products into a long supply chain are unlikely to have this line of sight through to the customer.

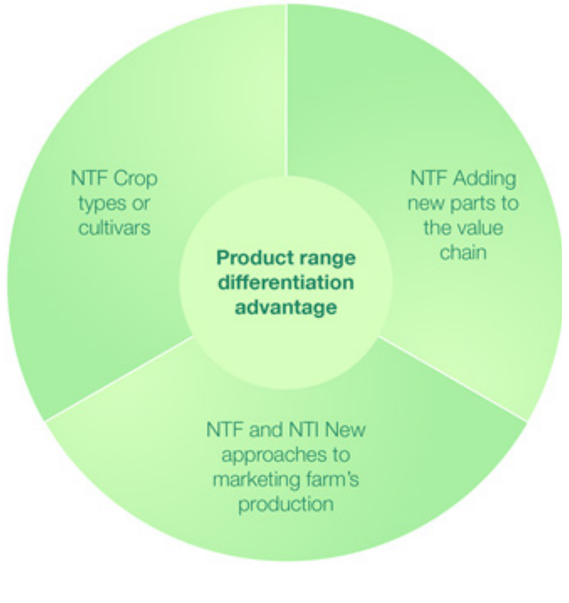



Pricing as a source of competitive advantage did not correlate highly significantly with any innovation type. This may result from the market structure in the horticulture industry where smaller producers are price takers, and have very little leeway to manipulate or set prices for their produce. Multi-site farming correlates with using cost advantages to enhance competitiveness as a way to deal with seasonality. Such farming also mitigates a number of risks associated with horticultural farming. The first rationale for this positive correlation would be that spreading risk improves longer term sustainability of the farm. Secondly, growers who engage in multi-site farming tend to operate larger concerns and may therefore also benefit from economies of scale and synergies between these multi-site operations that would improve cost effectiveness. This was confirmed in our finding significant correlations with return on assets as a performance indicator, as discussed in Section 6.5.6 below .


The ability to develop and produce unique and specialised products (crops or cultivars) is the second most important source of competitive advantage; as seen in its correlation with different types of innovation. Although this ability correlates with seven innovation types, not all correlations are at both the NTF and NTI levels of innovation. This is also the case with the discovery and design of solutions to customers' unmet needs. These two types of sources of competitive advantage are closely related as the discovery and design of solutions to unmet needs normally go hand in hand with differentiating products or services. Therefore, it makes sense that both correlate very highly with different innovation types. Correlated innovations for product development include:


Except for the innovation types already discussed above, soil, irrigation and water management innovations also correlate with product or service differentiation. It therefore seems that, as was the case with addressing unmet consumer needs, a number of innovations could and should be combined to successfully differentiate a grower's market offering within an industry that is dominated by homogeneous offerings. For growers to gain competitive advantage by differentiating their product range, they should consider engaging in the following innovations:

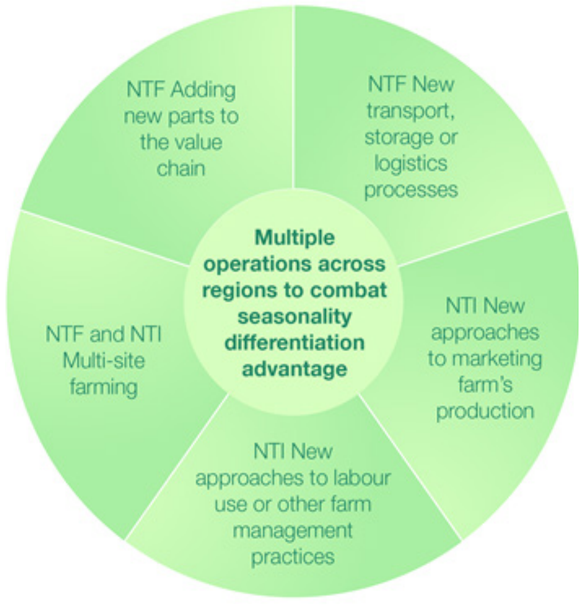





The three types of innovation above are the most important types for creating competitive advantage within the horticulture industry, as discussed at the end of this section. Extending the product range to differentiate a business would require innovating by developing new crop or cultivars.

Interestingly though, such innovations need to be new to the industry as adoption of crop types already in the industry would not provide a grower with any different advantage if other growers already serve the market with such offerings. **To successfully implement a strategy of differentiation in a product range requires more than just new product introductions; new activities should be added to the farm's existing value chain, such as novel approaches to marketing and new distribution channels**. If growers choose to differentiate themselves through marketing and promotional skills, they could consider the following two types of novel innovations that prominently correlate with a number of sources of competitive advantage:


Having multiple operations across regions to combat seasonality correlate highly significant with the following innovation types:



Multi-site farming to deal with seasonality or risk management would be obvious to consider. However, new transport, storage or logistics processes only correlate with this source of competitive advantage if a grower must be diverse logistically to manage multiple, geographically dispersed operations. The same reasoning applies when new approaches to labour use or other farm management practices are required. Mulgowie Farming Company is an Australian vegetable producer that has embraced multi-site farming to gain a competitive edge in the market (See Box 13).

To conclude, new crop types or cultivars, and adding new parts to the value chain and new approaches to marketing are recurring types of innovation which, of all innovation types, correlate most highly with sources of competitive advantage. '**New approaches to marketing' that are novel, and 'additions to the value chain' that are non-novel seems most importance to competitive advantage**, closely followed by new crop types or cultivars. These three types of innovation seem to be very important within horticulture as they have the potential to be used to exploit a number of competitive advantage options.

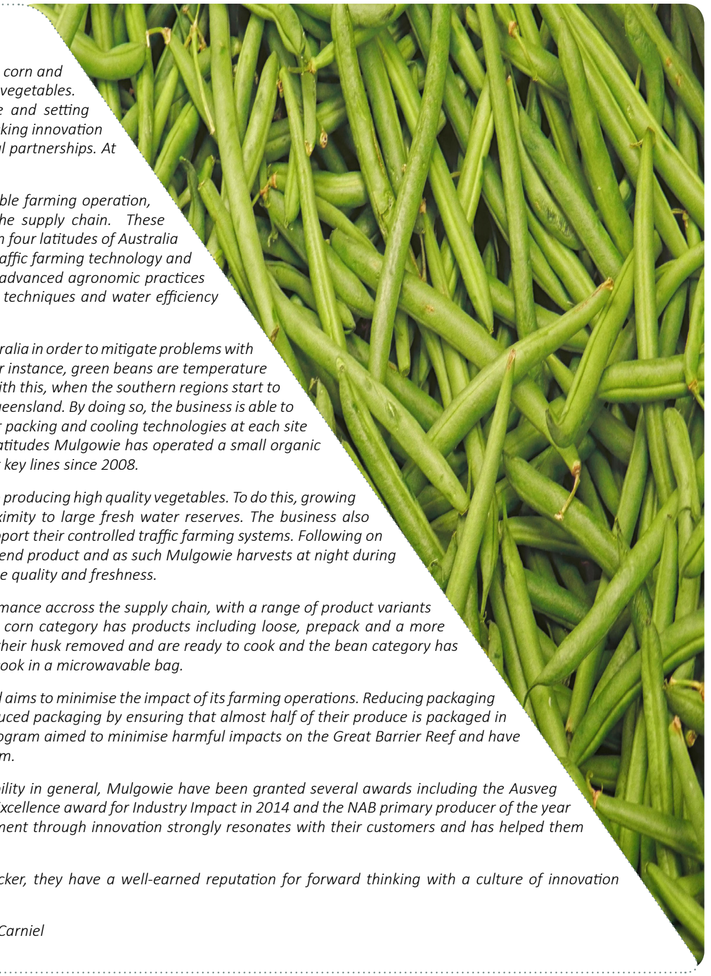
### 6.5.2 COMPETITIVE ADVANTAGE AND PERFORMANCE

From the above discussion, it is clear that innovation is a powerful tool to create differential advantage. The question that needs to be answered is: do the competitive advantages that growers identified as advancing their market position translate to performance benefits? To answer this question, Pearson's correlation coefficients are presented in Table A.4 in the Appendix. **These data show that there is a highly significant (p=0.01) positive correlation between all the sources of competitive advantage and all four performance categories,** apart from the correlations between product and service quality and the growth performance category that are significant at the lower level (p=0.05). This analysis investigates performance by looking at the average, combined importance and satisfaction scores of profit and growth performance as well as labour and capital productivity as explained in Section 6.3 above.

The next sections investigate dynamic capabilities as they relate to horticulture innovation, competitive advantage and performance.



#### BOX 13. FARMING FOR THE FUTURE AT MULGOWIE



*Mulgowie Farming Company is Australia's leading supplier of sweet corn and green beans as well as a key producer of a range of other fresh vegetables. Mulgowie has a strong reputation for providing quality produce and setting national standards for best practice farming techniques, quality, packing innovation to meet consumer needs and creating long-term mutually beneficial partnerships. At Mulgowie, sustainability underlies all strategic objectives.*

*In order to follow through on their mission to maintain a sustainable farming operation, Mulgowie engages in a number of innovative practices across the supply chain. These practices, once deemed successful, are deployed across their sites on four latitudes of Australia which engage state of the art farming equipment, and controlled traffic farming technology and infrastructure to deliver soil sustainability, together with the most advanced agronomic practices such as Integrated Pest Management, Advanced Crop Forecasting techniques and water efficiency systems for irrigation.*

*The business practices multi-site farming across four latitudes of Australia in order to mitigate problems with seasonality and ensure consistent quality supply of our products. For instance, green beans are temperature sensitive and can generally only thrive in warmer seasons. To deal with this, when the southern regions start to cool down, Mulgowie move production to Southern and Northern Queensland. By doing so, the business is able to guarantee fresh produce to customers all year round by utilising our packing and cooling technologies at each site to ensure quality and freshness for their customers. At one of the latitudes Mulgowie has operated a small organic production system alongside conventional farming for some of their key lines since 2008.*

*Mulgowie places strong emphasis on ensuring the soil is conducive to producing high quality vegetables. To do this, growing plots are selected based on the fertility of the soil as well as proximity to large fresh water reserves. The business also carefully monitors the health of soil, and uses GPS technology to support their controlled traffic farming systems. Following on from this, the time of harvesting is also critical to the quality of the end product and as such Mulgowie harvests at night during summer in order to keep the produce as cool as possible to maximise quality and freshness.*

*Mulgowie is a market leader and has grown each categories performance accross the supply chain, with a range of product variants that meet the varying needs of each market segment. The sweet corn category has products including loose, prepack and a more convenient offering of cobbettes in smaller portions that have had their husk removed and are ready to cook and the bean category has recently expanded to include a topped and tailed product ready to cook in a microwavable bag.*

*Mulgowie also considers the environment in which it is operating and aims to minimise the impact of its farming operations. Reducing packaging is imperative across all horticulture businesses. Mulgowie have reduced packaging by ensuring that almost half of their produce is packaged in returnable materials. The business also actively participates in a program aimed to minimise harmful impacts on the Great Barrier Reef and have worked to ensure their farming methods are in line with this program.*

*As a result of their commitment to the environment and sustainability in general, Mulgowie have been granted several awards including the Ausveg Excellence Award for Environmental Management in 2011, Ausveg Excellence award for Industry Impact in 2014 and the NAB primary producer of the year in 2006. Additionally, their focus on quality and constant improvement through innovation strongly resonates with their customers and has helped them build strong relationships with retailers.*

*Mulgowie is a respected and global best practice grower and packer, they have a well-earned reputation for forward thinking with a culture of innovation throughout the business.*

*Sources: www.mulgowie.com.au; www.woolworths.com.au; Leisa Carniel*

### 6.5.3 DYNAMIC CAPABILITIES AND INNOVATION

Dynamic capabilities theory explains why some firms sustain competitive advantage amid rapidly changing environments (Eisenhardt & Martin, 2000). According to Teece, Pisano and Shuen (1997: 517), dynamic capabilities reflect the "firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments. Dynamic capabilities thus reflect an organisation's ability to achieve new and innovative forms of competitive advantage." Seen from this perspective, not only does the innovation enhance firm performance because of increased competitiveness, but the innovation process also transforms the firm's internal capabilities, making it more adaptive to change (Love, Roper & Du, 2009). Innovation is the cornerstone of dynamic capabilities.

Dynamic capabilities in this study were measured by asking respondents to rate their agreement or disagreement on a five-point Likert scale with how their dominant management style is reflected in a series of 23 statements describing dynamic capabilities. They deal with how an organisation to purposefully creates, extends, and modifies its resource base to match and create market change (Hine et al. 2014). We used an exploratory factor analysis (Hair et al., 2010) to reduce the 23 statements into three variables that explained how responding businesses' dominant dynamic capability postures relate to exploration, non-routines and innovation leadership (see Table A.5 in the Appendix).

The first of these new variables, 'exploration', explained how the firm relies on existing knowledge in recognising new business opportunities, how proficient the firm is at applying existing knowledge to new uses, and how important firm activities are in creating opportunities. The second new variable, 'non-routines', explained the firm's propensity to always change their practices, to constantly change their processes and procedures, and innovate by developing new products or services. The third variable, 'innovation leadership', explains how the firm did not follow competitors when deciding about resource acquisitions, how the firm changed the rules of competition in its market, and how the

firm regards its employees as a key source of knowledge for the firm's future activities.

Innovation lies at the heart of dynamic capabilities and as such is expected to correlate with dynamic capabilities. Table A.6 in the Appendix presents the Pearson's correlation coefficients between the NTF and NTI categories and the three identified dynamic capability factors. Dynamic capabilities correlate significantly with all novel innovation categories. This clearly indicates that dynamic capabilities are directed at stimulating innovations that make a difference to the firm's market position in that they build and reconfigure the firms' competencies, thus enabling the business to capitalise on market opportunities and to develop competitive advantages.

The non-routines dynamic capability factor correlated highly significantly with all non-novel and novel innovation categories. This is expected as this dynamic capability is primarily directed at stimulating all forms of innovation in changing existing business routines. Because the exploration dynamic capability factor relates to identifying opportunities in the market, it is outwardly directed, hence its greater association with NTI innovations. The last dynamic capability factor relates to innovation leadership and again correlates more highly with new-to-the-market innovations as it is aimed at reconfiguring the firm's resources to excel beyond just copying best practice and thus to drive best practice, being not only on the innovation frontier, but also pushing it outwards.

### 6.5.4 DYNAMIC CAPABILITIES AND COMPETITIVE ADVANTAGE

Dynamic capabilities reflect the firm's ability to reconfigure organisational processes to attain competitive advantage. We therefore expected a positive correlation between dynamic capabilities and competitive advantage. This is confirmed in Table A.7 in the Appendix, with all correlations positive and highly significant (p=.01). Responsiveness to existing customer needs and the discovery and design of solutions to customers' unmet needs were especially important to exploration and non-routines dynamic capabilities. Therefore, having the ability both to use acquired knowledge to find existing and future opportunities and to constantly change routines enable growers to create competitive advantages by designing solutions to existing and unmet customer needs.

The results also suggest that, having the capacity to decide about acquiring resources by not following competitors and being able to change the rules of competition in the marketplace, was most important in creating solutions for unmet customers' needs and obtaining cost advantages.

### 6.5.5 DYNAMIC CAPABILITIES AND PERFORMANCE

Dynamic capabilities play an integral role in stimulating innovation and in creating sustainable competitive advantages for horticulture growers. Dynamic capabilities are therefore also expected to positively correlate with performance. This was confirmed for all five performance types that we investigated in this report (Table A.8 in the Appendix). Growers can therefore adopt the three dynamic capability types (exploration, inculcating non-routines, and being an innovation leader) to support profit and growth performance, labour and capital productivity, as well as market share and customer satisfaction performance. Similar to the previous section, exploration and non-routines were important in increasing market share, customer satisfaction, and growth through creating an advantage by being more responsive in meeting customer demands, whereas innovation leadership supported profit performance through cost advantages.



The positive links between dynamic capabilities, innovation and competitive advantage are highlighted in the foregoing results and discussion. **Dynamic capabilities enhance the grower's ability to adapt to changing market conditions by introducing innovations to address current and emerging market needs, but also to enter new markets or new parts of existing value chains in building competitive advantages to ultimately enhance their performance** (Kreiser et al., 2013). The next section will investigate the innovation – performance relationship in more detail.

### 6.5.6 INNOVATION AND PERFORMANCE

One of the main objectives of this study is to understand the performance benefits that are associated with horticulture innovation. The relationship between innovation and performance for large firms and SMEs has long been debated, with general consensus being that innovation positively impacts upon firm growth and performance (Dibrell, Craig & Neubaum, 2014; Hull & Rothenberg, 2008; Klomp & van Leeuwen, 2001; Mansury & Love, 2008; Prajogo, 2006). Within the Australian grains industry the productivity gains from high innovation levels are well established (Nossal & Lim, 2011). It is therefore expected that such a positive relationship will also be evident within the horticulture industry.

Notwithstanding evidence of the positive impact of innovation on performance, empirical studies have not reached definitive conclusions about the relationships between different types of innovation and different indicators of firm performance in SMEs (Rosenbusch, Brinkmann & Bausch, 2011). This study therefore attempts to remedy the lack of more detailed evidence by investigating the relationships between the different innovation types as they correlate with different performance measures.

Table A.9 in the Appendix presents the correlation coefficients of all innovation types as well as the four combined innovation categories for non-novel and novel innovations with the five combined performance categories.

Overall, the results confirm that innovation matters for horticulture performance. They also emphasise the importance of novel innovation. This was particularly true for **the novel organisational and managerial innovation category, which was the only innovation category that correlated significantly (p=0.01) with all five performance categories.**

The organisational and managerial innovation category comprises multisite farming, developing a new value chain, and new management practices as innovation types, all three of which correlate broadly with a number of different performance indicators. **New farm management practices (including new approaches to labour use) was the most important type of innovation for horticulture performance in that it correlated significantly with all performance categories except for labour productivity** (Table A.9). Supplementary regression analysis (not reported here) confirmed this and showed that organisational and management innovation significantly explained the variance (B = 1.585, t = 0.668, Sig. = 0.018) in overall performance. Although new farm management practices did not correlate with labour productivity as a performance category (Table A.9), both non-novel and novel management innovations (see Tables A.10 and A.11 in the Appendix) do correlate with improved labour productivity. Management practices are also the only novel innovation type that correlates highly significantly with 'increased profit per employee' (Table A.11).

These data indicate that management innovations are broadly associated with multiple performance indicators. Multisite farming requires investments to be made that would impact upon farm growth. As expected, significant correlations with sales, asset and employee growth, and also with maintaining and growing market share are apparent. The potential benefits associated with multisite farming in using resources more efficiently are also evident in the correlations with return on assets, profit growth and capital productivity.

Section 5.5.1 showed that new products, marketing and value chain innovations are important in exploiting a number of competitive advantage options. This pattern is also visible in the results reported above, but to a lesser extent for new crop or cultivar types. As expected, both marketing and value chain innovations were significantly correlated with sales growth, market share, and customer satisfaction performance indicators at both the non-novel and novel levels (see Tables A.10 and A.11).

In addition marketing innovations also correlated, albeit at a less significant level (p=0.05) with asset growth and improved labour and capital productivity whereas value chain innovation also correlates with profit growth. The importance of both these innovation types is therefore confirmed. Somewhat unexpectedly however, new crops or cultivars as new product innovation had the lowest number of positive significant correlations with performance measures of all four innovation categories (Table A.8) and only correlates significantly (p=0.01) with 'maintaining market share' and less significantly (p=0.05) with asset growth, improved labour productivity, maintained capital productivity and increased market share (Table A.11). It seems therefore that although new product innovations provide opportunities for developing competitive advantages, such innovation is less important for overall grower performance. It also suggests that new product innovations would only translate to improved performance if they were implemented in conjunction with other innovations such as marketing, and organisational and management innovations.

When considering the significant correlations between innovations in equipment with maintaining and improving labour productivity, it could be argued that growers benefit from this innovation by either replacing labour or improving the efficiency or output of existing labour. Pest management innovations were also mostly associated with improved labour productivity and, to a lesser extent, profit, growth and capital productivity. Soil, irrigation and water management practices were associated mainly with growth performance and market share improvements.

Transport, storage and logistic innovations only correlated for non-novel innovations and then also only with sales growth, improved labour productivity and increased market share. **Innovations that correlated least with performance indicators included weed management, multi-cropping and fertiliser application innovations.** Except for a significant correlation between weed management and capital productivity no other correlations were evident.

In general, novel innovations are most important for horticulture performance with new approaches to labour use or other farm management practices, and new value chain and marketing innovations making the broadest impact across different performance indicators. Overall, **horticulture innovations were most important for sales growth and market share performance.** Most growers reported market performance as the most important performance category (see Figure 32). Labour productivity correlated most with pest management innovations whereas capital productivity correlates most significantly with combined organisational and management practices.

When comparing the results of Tables A.9, A.10 and A.11 with Figures 35, 36 and 42, it is interesting to note that the innovation types with the highest number of significant correlations with performance indicators are not necessarily the most prevalent innovations adopted by growers. Neither are they the ones perceived to have the greatest impact (e.g., adding new parts to the value chain). The most popular innovations, or those perceived to have the greatest impact, are therefore not the most beneficial. This is because of the difficulty in building differentiated competitive advantage when market participants adopt the same innovation strategies (e.g., fertiliser application practices and new crop types or cultivars).

In this section we investigated the relationship between innovation and different measures of farm performance including profitability, growth, market share and customer satisfaction, as well as labour and capital productivity. The next section specifically looks at the relationship between multifactor productivity and innovation.

### 6.5.7 INNOVATION AND MULTIFACTOR PRODUCTIVITY

Growth in farm productivity reflects improvements in efficiency when growers combine inputs to produce outputs (Gray, Oss-Emer & Davidson, 2012). This analytical approach also allows attribution of these efficiency gains to identifiable factors. In this study we investigated multifactor productivity comprising both labour and capital productivity. Farmers were asked to rate the importance as well as their satisfaction with maintaining and improving both these types of productivity on five-point Likert scales. The average score of the importance and satisfaction multiples was used as proxy for multifactor productivity. The regression model design, used here, was adapted from a recent study conducted by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) on innovation and productivity in the Australian grains industry (Nossal & Lim, 2011). The ABARES study performed regression analysis on total factor productivity, using objective market data, whereas the present study has perceived multifactor productivity as dependent variable. The use of scales provides a farm based data collection design which permits industry sub-sectors to be analysed and compared.

Innovative growers were categorised as low, medium or high innovators, similar to the measure of innovative effort used in the ABARES study (Nossal & Lim, 2011). The cut-off points for this categorisation were calculated as the third cumulative frequency percentiles of the total number of implemented innovation types. Accordingly, growers that implemented fewer than three types of innovation were deemed to be low innovators, medium innovators implemented between three and eight innovation types, and high innovators implemented more than eight innovation types. Control variables that have previously been shown to impact farm productivity (e.g. ABARES study) included; farm age, farm size (both in hectares and FTEs), grower's level of education, crop types, land use intensity, outsourcing, majority income derived from farm and non-farm activities as well as farm location. Table 1 presents the linear regression results that confirm the findings in Section 6.5.5 above, indicating a statistically **significant positive relationship between high levels of innovation and multifactor productivity.** Model 1 explains nine per cent of the variance in multifactor productivity as evident from the adjusted R2. Model 2 includes profit as an independent variable to enable effect-size comparison with the ABARES findings. The ABARES study (Nossal & Lim, 2011: 35) reported an effect-size of R2 = 0.68, while this study found an R2 = 0.585 (adjusted R2 = 0.518). This high effect-size is expected because **improved efficiency and**

**profit are highly correlated**, leading to results that violate assumptions of independence of variables, hence our preference for Model 1.

In Model 1 farm ages of less than ten years had a positive correlation with multifactor productivity. Farm size, as measured in hectares, did not, while farm size measured by FTEs delivered mixed results with only a significant positive relationship for growers employing between six and ten FTEs. Farms that operate across Australia tend to have higher productivity, confirming the positive impact of multi-site farming practices. Although there were no significant differences between the locations of growers across states, findings indicate that crop types related positively to productivity in in the case of nuts, orchard and stone fruit, and vegetables.

The level of grower educational attainment is normally regarded as a factor that has a positive and significant relationship with productivity growth (Gray et al., 2012). Education is regarded as an indicator of human capital that facilitates the creation and adoption of new technology which in turn improves productivity. There is, however, an alternative argument in that higher education levels are associated with higher engagement in off-farm employment (Goodwin & Mishra, 2004). More educated growers tend to diversify their income streams to manage operational risks, which itself is a form of organisational innovation. This alternative argument is supported in our analyses, and supplementary analyses confirm a significantly positive correlation between post graduate studies and income derived from non-farm activities (0.156, p. = 0.01), and a significantly negative correlation between high school education and non-farm income (-0.238, p. = 0.01).

Another explanation for the negative relationship between education levels and multifactor productivity may be related to the type of education, not accounted for here, in that the qualifications obtained may not be related to horticulture, agriculture or related fields. Contrary to the ABARES study, no significant effects were recorded for land use intensity and outsourcing.

**TABLE 1 REGRESSION ANALYSIS OF MULTIFACTOR PRODUCTIVITY ON INNOVATION**

Dependent variable: Multifactor Productivity (Capital and labour productivity)

| | **Model 1** | **Model 2** |
|---|---|---|
| Constant | 8.501 | 5.820 |
| *Independent variables* | | |
| Medium Innovators | 0.733 | 0.146 |
| High Innovators Profit | 1.628** | 1.340** |
| Profit | | 0.721*** |
| *Control variables* | | |
| Farm age dummis | + Yes, only for young farms (<10 years) | No |
| Size (hectares) dummies | No | No |
| Size (employees) dummies | + Yeas, only for farms employing 6 to 10 FTEs | No |
| Education level dummies | - Yes | - Yes |
| Income derived from farm and non-farm activities (>50%) dummies | income | |
| Land use intensity | No | No |
| Outsourcing | No | No |
| Location (States) dummies | + Yes, only for firms operation across Australia | + Yes, only for NT |
| Grower groups/crop types dummies | + Yes, for nuts, vegetables, orchard and stone fruit | + Yes, for orchard and other fruit |
| Adjusted $R^2$ | 0.090 | 0.518 |
| F | 1.756** | 8.726*** |

Low innovators used as reference category

N = 301 for Model 1 and 289 for Model 2

* p < 0.10, ** p < 0.05, *** p < 0.01

Unstandardised Coefficients



# 7 CONCLUSIONS

**'Our results showed that the growers in our study are more likely to innovate than other typical Australian businesses.'**

Australian horticulture is at a turning point. On one hand there is enormous market opportunity in the growing middle classes in developing economies around the world that demand a wide variety of produce at higher quality and are increasing able to pay. On the other hand, Australia has a fragmented agricultural sector with an aging grower profile and relatively high labour costs.

The report shows that innovation is a prime determinant of competitive advantage and productivity. In many ways this is not surprising because in the long run, all economic growth is underpinned by the innovation that creates new produce lines, varieties, equipment use, land use and so on. If the Australian horticultural sector is to take advantage of the significant market opportunities that will emerge over the next ten years, and improve its operating margins, then the sector must seek to lift its innovation performance.

In addition to the main finding of the importance of innovation for the industry, the report also provides a snapshot of the industry. The average horticulture grower in our study was tertiary qualified, third generation owner, 56 year-old male, farming on a 52 hectare parcel of higher quality land. The average grower managed in a more intensive manner regarding investment, labour requirements, and other inputs than other agricultural industries. He was dependent on the income he derives from his farm and markets his products under his own brand within Australia. He employs two employees and has equipment insured for between $150 001 and $350 000.

The study then provided a deeper understanding of the business practices and innovation activities of these growers. We compared these practices to those reported in previous studies of Australian firms from a broader range of industries. Our results showed that the growers in our study were more likely to innovate than the findings from these previous studies. However, most other managerial practices showed strong similarities to findings from the broader Australian population of firms.

**The study also showed the positive relationship between innovation, dynamic capabilities, competitive advantage, and grower performance, including multifactor productivity**. Innovation, especially novel innovation, was strongly related to the capabilities that the farm possesses that allow it to create change, and to achieve a competitive advantage in their market. These relationships persisted across different types and novelty levels of innovation. However, innovation had a more tenuous relationship with performance. The reason for this finding can be seen in the relationships between dynamic capabilities and competitive advantage with performance, which were again strong. This means that innovation, at least on a cross-sectional basis, needs to be supported by dynamic capabilities and a clear vision of how competitive advantage is achieved to provide a performance advantage to growers.

Finally higher levels of innovation are associated with multifactor productivity gains in the horticulture industry. Tracking these measures over time will be an important indicator of the progress of both the industry and the growers that constitute the industry. Such long term data will also provide an evidence base to argue the case to policymakers to support growers in appropriate ways, and to coordinate industry initiatives that will enhance productivity and innovation.

# 8 APPENDIX

FIGURE A.1 RESPONDENT OWNERS AND MANAGERS

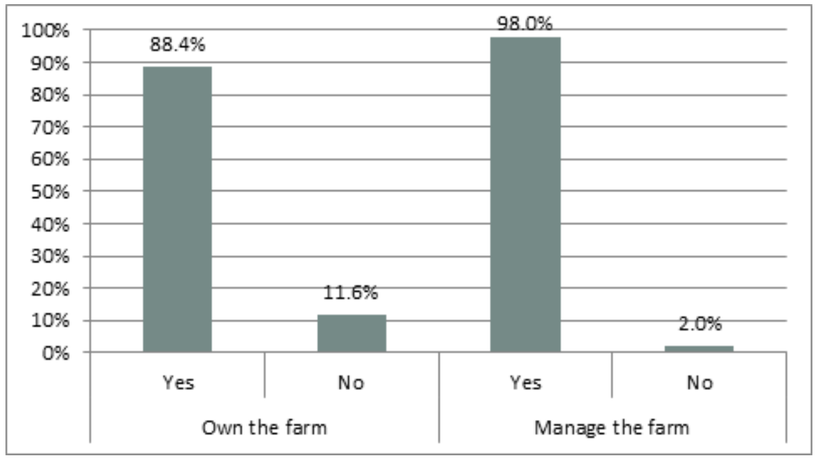
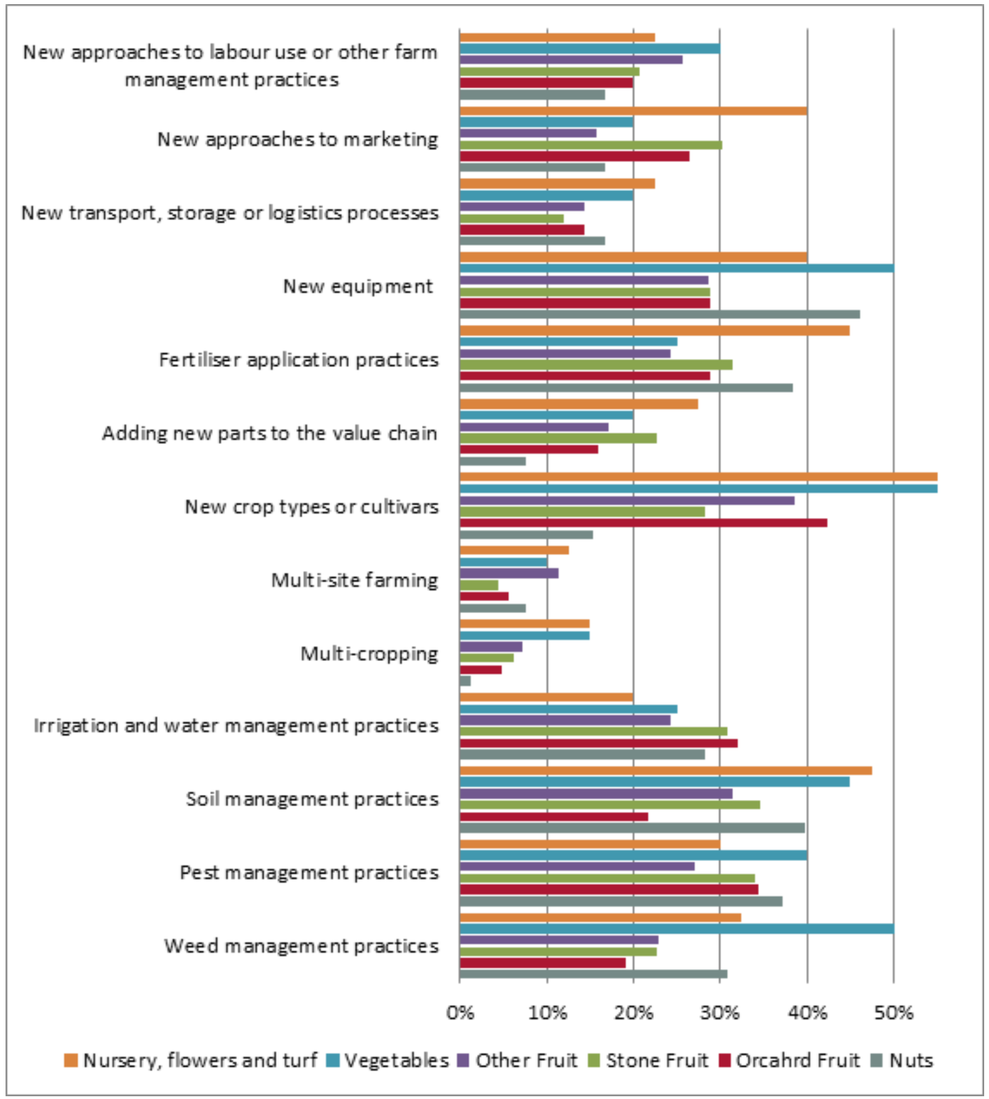
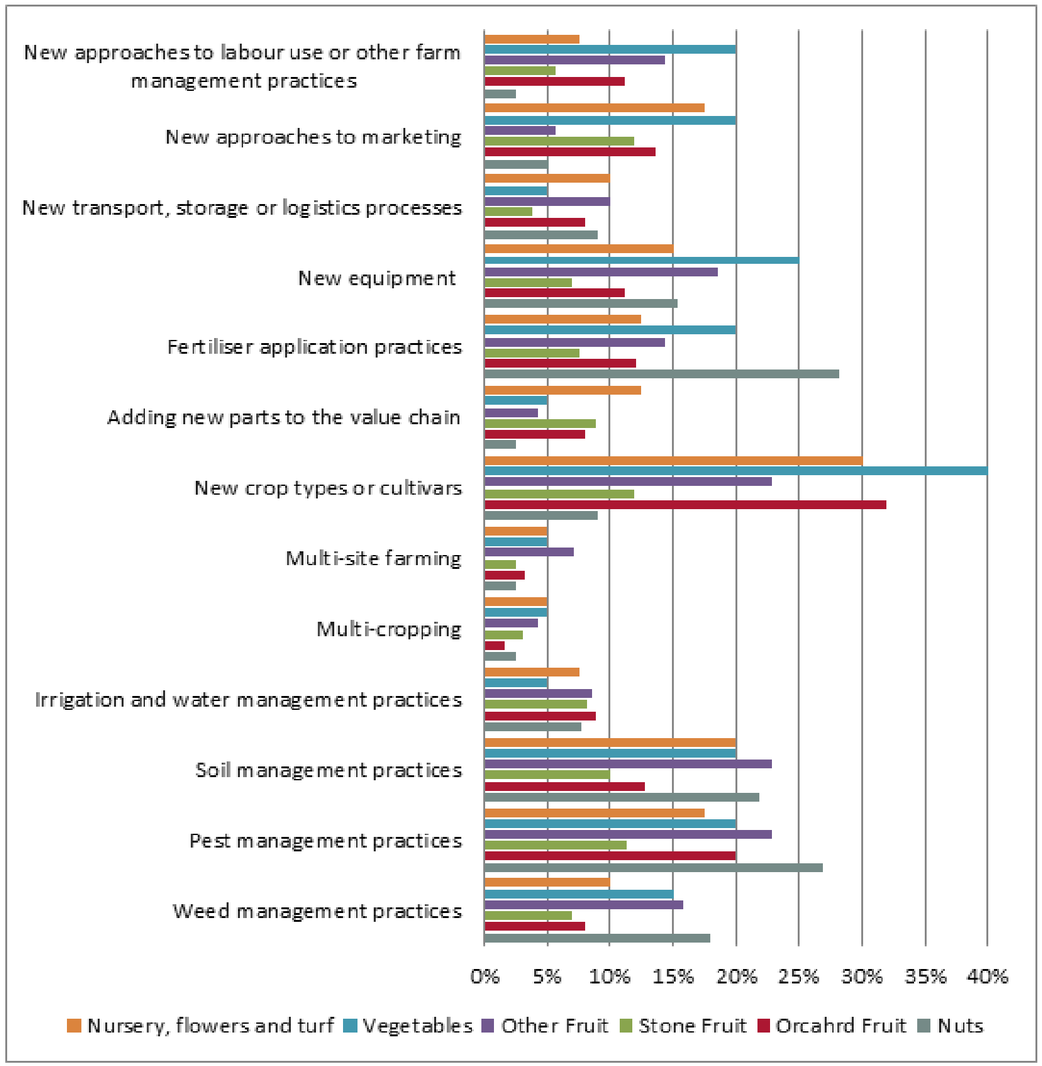



FIGURE A.2 NON-NOVEL INNOVATIONS BY GROWER CATEGORY



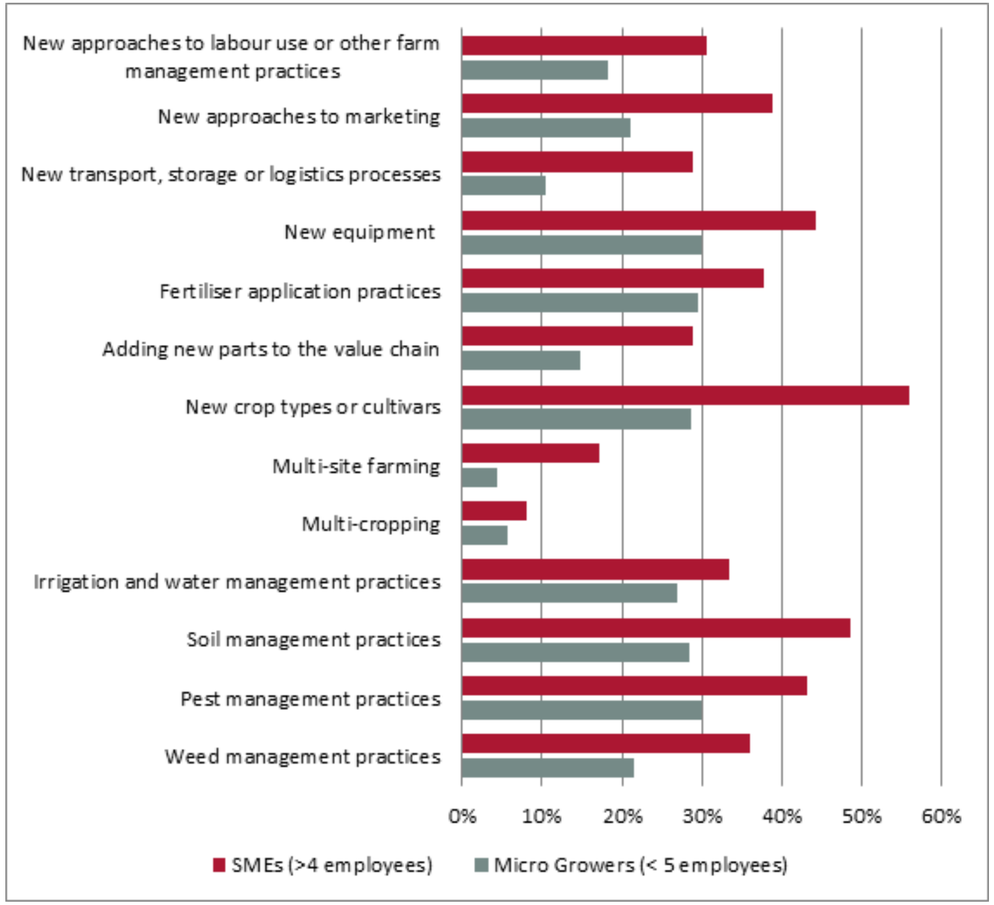

**Chi-square tests indicated significant differences (at the 5% level of significance) for new approaches to marketing, new equipment, new crop or cultivar types, multi-cropping, irrigation or water, soil and weed management practices.**

FIGURE A.3 NOVEL INNOVATIONS BY GROWER CATEGORY



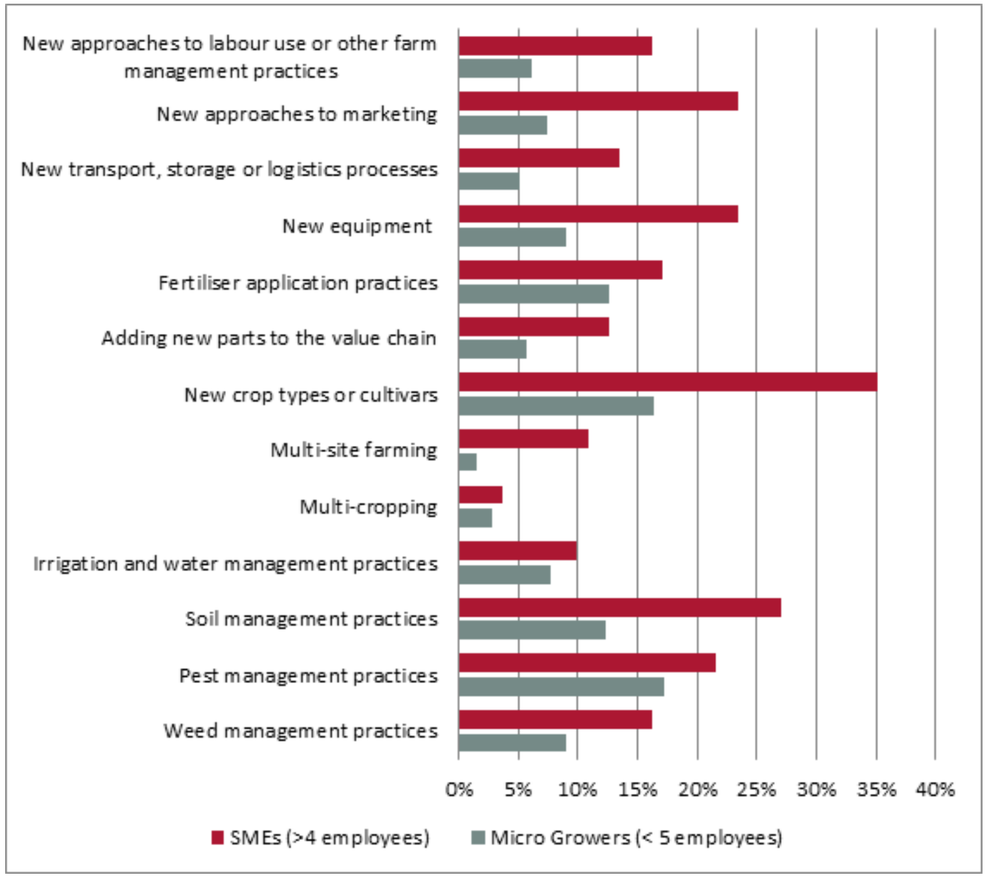

**Chi-square tests indicated significant differences (at the 5% level of significance) for novel approaches to labour use or other farm management practices, fertiliser application practices and new crop or cultivar types between the different grower groups.**

FIGURE A.4 GROWER SIZE WITH NON-NOVEL INNOVATION TYPES




**Chi-square tests indicated significant differences (at the 5% level of significance) for all relationships except for irrigation and water management practices, multi-cropping and fertiliser application practices.**

FIGURE A.5 GROWER SIZE WITH NOVEL INNOVATION TYPES




**Chi-square tests indicated significant differences (at the 5% level of significance) for all relationships except pest, irrigation and water management practices, multi-cropping and fertiliser application practices.**



TABLE A.1 FARM SIZE IN HECTARES

| | Nuts | Orchard fruit | Stone fruit | Other fruit | Vegetables | Nurseries, cut flowers or cultivated turf | Total |
|---|---|---|---|---|---|---|---|
| 1-15 ha | 11.8% | 20.0% | 27.8% | 17.6% | 21.1% | 17.9% | 20.4% |
| 16-30 ha | 28.9% | 12.8% | 16.5% | 19.1% | 5.3% | 17.9% | 17.6% |
| 31-60 ha | 21.1% | 29.6% | 17.3% | 30.9% | 10.5% | 25.6% | 23.7% |
| 61-150 ha | 15.8% | 17.6% | 21.8% | 17.6% | 15.8% | 28.2% | 19.3% |
| 151-300 ha | 9.2% | 13.6% | 8.3% | 7.4% | 26.3% | 7.7% | 10.4% |
| >300 ha | 13.2% | 6.4% | 8.3% | 7.4% | 21.1% | 2.6% | 8.5% |

TABLE A.2 MEANS COMPARISON BETWEEN GROWTH OBJECTIVES AND PERFORMANCE CATEGORIES

| Growth Objectives (Means) | Profit Performance | Growth Performance | Labour Productivity | Capital Productivity | Market Share and Customer Satisfaction |
|---|---|---|---|---|---|
| Become smaller Mean | 10.3871 | 9.3629 | 11.5000 | 11.0143 | 15.1250 |
| Stay same size | 11.7859 | 10.4508 | 12.3008 | 11.2623 | 16.3895 |
| Grow moderately | 12.5491 | 11.5995 | 13.3881 | 12.5485 | 17.1488 |
| Grow substantially | 12.9820 | 13.2700 | 14.0063 | 13.2535 | 17.6314 |

TABLE A.3 PEARSON'S CORRELATION COEFFICIENTS OF COMPETITIVE ADVANTAGE AND INNOVATION TYPES

| | Product NTF | Process NTF | Marketing NTF | Organisational or Management NTF | Product NTI | Process NTI | Marketing NTI | Organisational or Management NTI |
|---|---|---|---|---|---|---|---|---|
| Established reputation | .159** | .109* | .059 | .094* | .124** | .072 | .013 | .097* |
| Product or service quality | .076 | .060 | .047 | .010 | .040 | .064 | .029 | .033 |
| Responsiveness to existing customer needs | .109* | .038 | .101* | .103* | .067 | .042 | .102* | .109* |
| Discovery and design of solutions to customers' unmet needs | .191** | .143** | .147** | .128** | .137** | .114* | .160** | .161** |
| Pricing | .081 | .061 | .019 | .038 | .072 | .082 | -.023 | .093* |
| Cost advantages | .114* | .124** | -.004 | .044 | .116* | .154** | .033 | .067 |
| Product or service type | .132** | .152** | .151** | .088 | .116* | .120** | .126** | .204** |
| Product range | .146** | .097* | .168** | .060 | .105* | .100* | .143** | .142** |
| Marketing and promotion skills | .096* | .060 | .139** | .073 | .058 | .065 | .118** | .128** |
| Having multiple operations across regions to combat seasonality | .044 | .089 | .106* | .102* | .008 | .093* | .126** | .169** |

** Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed)

NTF: Denotes 'New to the Firm' or non-novel innovations; NTI: Denotes 'New to the Industry' or novel innovations.

TABLE A.4 PEARSON'S CORRELATION COEFFICIENTS OF COMPETITIVE ADVANTAGE AND PERFORMANCE CATEGORIES

| | Established reputation | Product or service quality | Responsiveness to existing customer need | Discovery/ design of solutions to customers' unmet needs | Pricing | Cost advantages | Product or service type | Product range | Marketing and promotion skills | Having multiple operations across regions |
|---|---|---|---|---|---|---|---|---|---|---|
| Growth performance | .156** | .100* | .240** | .292** | .285** | .260** | .190** | .147** | .315** | .218** |
| Labour productivity | .160** | .134** | .210** | .298** | .298** | .244** | .161** | .136** | .223** | .171** |
| Capital productivity | .142** | .070 | .222** | .252** | .291** | .247** | .188** | .105* | .316** | .190** |
| Market and customer performance | .220** | .188** | .349** | .286** | .314** | .249** | .258** | .269** | .341** | .250** |

** Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed)

TABLE A.5 DYNAMIC CAPABILITIES FACTOR ANALYSIS, PATTERN MATRIX

| | Exploration | Non-routines | Innovation Leadership |
|---|---|---|---|
| We change the rules of competition in our market | .008 | .020 | .772 |
| Our resources are different from those of our competitors | .097 | -.011 | .766 |
| Our employees are a key source of knowledge for our farm s future activities | -.097 | .035 | .846 |
| We are always changing our practices in our farm | -.160 | .539 | .143 |
| We regularly implement small adaptations to existing products/services | -.135 | .628 | .027 |
| We move first in our market | .024 | .463 | .286 |
| We are proficient at applying existing knowledge to new uses. | .518 | .097 | -.019 |
| We seek to introduce improved, but existing products/services for our market | .460 | .261 | -.129 |
| We don t follow our competitors when making decisions about resource acquisitions | .117 | .074 | .767 |
| We frequently utilize new opportunities in new markets | .236 | .290 | .103 |
| We seek to improve our farm s efficiency at providing existing products/services | .595 | -.048 | .007 |
| New opportunities to serve our customers with existing technologies are quickly captured. | .505 | .297 | .096 |
| Our most important activities are those that create future opportunities | .605 | .171 | .081 |
| We have practices focused on sustainable competitiveness | .628 | .045 | -.035 |
| We experiment with new products and services in our market | .072 | .647 | -.081 |
| We quickly interpret changing market demand for our products/services | .330 | .510 | -.147 |
| Our competitiveness depends on constant change to our processes and resources | .199 | .626 | -.049 |
| Our staff seek to constantly improve their practices | .282 | .013 | .651 |
| Our resource base supports our long term competitiveness | .709 | -.051 | .026 |
| Our activities are focused on our most important competitive resources | .682 | .195 | .029 |
| When recognizing a business opportunity, we can quickly rely on our existing knowledge. | .625 | -.126 | .194 |
| Activities needed to be successful in our market are always changing | .258 | .540 | .126 |
| We invent new products/services | -.002 | .743 | .053 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.



TABLE A.6 PEARSON'S CORRELATION COEFFICIENTS OF DYNAMIC CAPABILITIES FACTORS AND INNOVATION CATEGORIES

| | Product NTF | Process NTF | Marketing NTF | Organisational or Management NTF | Product NTI | Process NTI | Marketing NTI | Organisational or Management NTI |
|---|---|---|---|---|---|---|---|---|
| **Exploration** | .144** | .144** | .080 | .077 | .187** | .156** | .101* | .205** |
| **Non-routines** | .184** | .155** | .215** | .197** | .238** | .215** | .216** | .274** |
| **Inn Leader** | .085 | .068 | .093* | .077 | .146** | .144** | .106* | .174** |

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed);

NTF: Denotes 'New to the Firm' or non-novel innovations; NTI: Denotes 'New to the Industry' or novel innovations.

TABLE A.7 PEARSON'S CORRELATION COEFFICIENTS OF DYNAMIC CAPABILITIES FACTORS AND COMPETITIVE ADVANTAGES

| | Exploration | Non-routines | Innovation Leader |
|---|---|---|---|
| Established reputation | .265** | .187** | .180** |
| Product or service quality | .276** | .175** | .147** |
| Responsiveness to existing customer need | .363** | .335** | .235** |
| Discovery and design of solutions to customers' unmet needs | .325** | .382** | .272** |
| Pricing | .240** | .222** | .237** |
| Cost advantages | .276** | .175** | .264** |
| Product or service type (e.g. unique/specialised product) | .231** | .284** | .227** |
| Product range | .225** | .307** | .210** |
| Marketing and promotion skills | .272** | .302** | .217** |
| Having multiple operations across regions to combat seasonality | .214** | .229** | .157** |

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

TABLE A.8 PEARSON'S CORRELATION COEFFICIENTS OF DYNAMIC CAPABILITIES FACTORS AND PERFORMANCE CATEGORIES

| | Profit Performance | Growth Performance | Labour Productivity | Capital Productivity | Market Share and Customer Satisfaction |
|---|---|---|---|---|---|
| **Exploration** | .320** | .360** | .337** | .328** | .398** |
| **Non-routines** | .315** | .403** | .301** | .310** | .357** |
| **Inn Leader** | .254** | .204** | .315** | .221** | .223** |

** Correlation is significant at the 0.01 level (2-tailed)

TABLE A.9 PEARSON'S CORRELATION COEFFICIENTS OF NON-NOVEL AND NOVEL INNOVATIONS WITH PERFORMANCE INDICATORS AND CATEGORIES

| New to the Firm and Industry Innovations | | Profit Performance | | Growth Performance | | Labour Productivity | | Capital Productivity | | Market Share and Customer Satisfaction | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Product Innovations** | | .019 | .086 | .043 | .082 | .088 | .085 | .046 | .098* | .048 | .109* |
| Process Innovations | Weed management practices | .046 | -.024 | .076 | .080 | .044 | .042 | .079 | .039 | .038 | .027 |
| | Pest management | .104* | .120* | .120* | .117* | .126** | .155** | .100* | .100* | .066 | .072 |
| | Soil management | .022 | .009 | .096* | .109* | .069 | .087 | .044 | .008 | .033 | .096* |
| | Irrigation and water management | .014 | .099* | .096* | .127** | .059 | .084 | .043 | .085 | .032 | .098* |
| | Multi-cropping | .006 | .033 | .030 | .066 | .056 | .012 | -.005 | .044 | .039 | .043 |
| | Fertiliser application practices | -.013 | -.003 | .016 | .018 | .050 | .039 | .005 | -.015 | .003 | -.018 |
| | Equipment | .047 | .001 | .058 | .032 | .097* | .099* | .066 | .018 | -.003 | -.018 |
| | Transport or logistics | .059 | .030 | .109* | .054 | .085 | .056 | .057 | .006 | .095* | .040 |
| **All Process Innovations** | | .098* | .076 | .081 | .078 | .067 | .122** | .094 | .049 | .065 | .073 |
| **Marketing Innovations** | | .024 | .028 | .107* | .135** | -.005 | .069 | .053 | .100* | .137** | .157** |
| Organisational or Management Innovations | Multi-site farming | .084 | .089 | .148** | .132** | .065 | .032 | .090 | .076 | .070 | .120* |
| | Adding new value chain | .000 | .033 | .107* | .138** | .029 | .077 | -.003 | .045 | .134** | .148** |
| | Management practices | .064 | .126** | .134** | .132** | .089 | .085 | .088 | .113* | .080 | .121** |
| **All Organisational or Management Innovations** | | .064 | .148** | .158** | .221** | .086 | .140** | .087 | .136** | .107* | .192** |

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Firm OR Non-Novel innovations are indicated in red (left side column) and Industry or Novel Innovations are indicated in blue (right side column)



TABLE A.10 PEARSON'S CORRELATION COEFFICIENTS OF NON-NOVEL INNOVATION WITH PERFORMANCE INDICATORS

| | Profit margin | ROA | Profit per employee | Sales growth | Asset growth | Employee growth | Profit growth | Maintain labour productivity | Improved labour productivity | Maintain capital productivity | Improve capital productivity | Maintain market share | Increased market share | Maintain customer satisfaction | Increased customer satisfaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New crop types | .007 | .025 | -.003 | .037 | .028 | .024 | .039 | .083 | .088 | .052 | .036 | .096* | .068 | -.012 | .002 |
| Weed management practices | .045 | .032 | .049 | .042 | .031 | .089 | .072 | .043 | .043 | .104* | .054 | .056 | .058 | -.005 | .000 |
| Pest management | .081 | .083 | .089 | .122** | .098* | .057 | .087 | .108* | .137** | .123* | .077 | .059 | .071 | .042 | .044 |
| Soil management | .091* | -.030 | .013 | .078 | .033 | .089 | .088 | .070 | .065 | .051 | .031 | .057 | .061 | -.018 | -.001 |
| Irrigation and water management | .043 | .023 | -.017 | .111* | .054 | .018 | .092* | .041 | .075 | .061 | .026 | .021 | .070 | -.038 | .029 |
| Multi-cropping | -.040 | -.003 | .064 | .035 | -.003 | .047 | .025 | .040 | .068 | -.007 | -.001 | .015 | .011 | .040 | .067 |
| Fertiliser application practices | .045 | -.024 | .003 | .043 | .008 | .034 | -.001 | .032 | .067 | .017 | -.003 | -.026 | -.005 | .019 | .031 |
| Equipment | .086 | .003 | .024 | .051 | .011 | .016 | .078 | .073 | .115* | .075 | .050 | -.025 | .009 | -.004 | -.001 |
| Transport or logistics | .045 | .017 | .043 | .118* | .030 | .084 | .077 | .071 | .093* | .049 | .053 | .090 | .109* | .041 | .057 |
| Marketing | .054 | -.002 | .022 | .129** | .077 | .051 | .071 | -.023 | .015 | .055 | .052 | .098* | .127** | .092* | .126** |
| Multi-site farming | .043 | .102* | .063 | .141** | .120** | .073 | .092* | .067 | .059 | .104* | .073 | .077 | .119* | -.004 | .023 |
| Adding new value chain | .005 | .041 | -.024 | .141** | .035 | .092 | .068 | .021 | .036 | .019 | -.021 | .067 | .108* | .122** | .149** |
| Management practices | .036 | .074 | .066 | .128** | .101* | .101* | .070 | .064 | .107* | .087 | .088 | .062 | .067 | .059 | .081 |

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

TABLE A.11 PEARSON'S CORRELATION COEFFICIENTS OF NOVEL INNOVATION WITH PERFORMANCE INDICATORS

| | Profit margin | ROA | Profit per employee | Sales growth | Asset growth | Employee growth | Profit growth | Maintain labour productivity | Improved labour productivity | Maintain capital productivity | Improve capital productivity | Maintain market share | Increased market share | Maintain customer satisfaction | Increased customer satisfaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New crop types | .069 | .054 | .081 | .062 | .112* | .013 | .067 | .072 | .094* | .113* | .082 | .151** | .093* | .058 | .065 |
| Weed management practices | .003 | -.015 | -.021 | .054 | .065 | .066 | .035 | .053 | .030 | .062 | .016 | .051 | .005 | .020 | -.016 |
| Pest management | .072 | .108* | .107* | .115* | .161** | .024 | .036 | .134** | .165** | .119* | .080 | .062 | .042 | .053 | .058 |
| Soil management | .065 | -.032 | .020 | .094* | .049 | .097* | .070 | .093* | .076 | .024 | -.004 | .118* | .139** | .029 | -.009 |
| Irrigation and water management | .107* | .074 | .060 | .168** | .100* | -.017 | .129** | .083 | .079 | .097* | .070 | .075 | .083 | .069 | .093* |
| Multi-cropping | .002 | .033 | .045 | .065 | .061 | .073 | .042 | .017 | .007 | .043 | .044 | .032 | .042 | .019 | .049 |
| Fertiliser application practices | .071 | -.018 | -.009 | .036 | .030 | -.017 | -.011 | .047 | .030 | .000 | -.026 | -.015 | -.033 | .009 | -.020 |
| Equipment | .012 | .003 | -.014 | .030 | .042 | -.100* | .064 | .093* | .098* | .033 | .006 | -.025 | .008 | -.051 | -.012 |
| Transport or logistics | .007 | .015 | .042 | .074 | .004 | -.022 | .062 | .051 | .056 | .014 | -.001 | .052 | .063 | -.020 | .025 |
| Marketing | .047 | .009 | .020 | .142** | .117* | .062 | .082 | .039 | .094* | .083 | .114* | .151** | .168** | .096* | .089 |
| Multi-site farming | .035 | .107* | .079 | .118* | .133** | .097* | .051 | .016 | .045 | .085 | .063 | .106* | .123** | .083 | .078 |
| Adding new value chain | .057 | .053 | -.003 | .141** | .076 | .062 | .129** | .064 | .084 | .044 | .045 | .135** | .102* | .118* | .135** |
| Management practices | .090 | .098* | .129** | .135** | .108* | .066 | .083 | .065 | .098* | .103* | .119* | .134** | .092* | .076 | .091* |

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)



# 9 REFERENCES


ABS (2012). *Australian Social Trends* (Catalogue No. 4102.0). Canberra: Australian Bureau of Statistics.

ABS (2013). *Population Projections, Australia, 2012 (base)* to 2101 (Catalogue No. 3222.0). Canberra: Australian Bureau of Statistics.

ABS (2014a). *Agricultural Commodities, Australia, 2012-2013* (Catalogue No. 7121.0). Canberra: Australian Bureau of Statistics.

ABS (2014b). *Land Management and Farming in Australia, 2012-13* (Catalogue No. 4627.0). Canberra: Australian Bureau of Statistics.

ABS (2014c). *Value of Agricultural Commodities Produced, Australia, 2012-13* (Catalogue No. 7503). Canberra: Australian Bureau of Statistics.

ABS (2014d). *Characteristics of Australian Exporters, 2012-13* (Catalogue No. 5368.0.55.006). Canberra: Australian Bureau of Statistics.

ABS (2015). *International Trade in Goods and Services, Australia* (Catalogue No. 5368.0). Canberra: Australian Bureau of Statistics.

Audretsch, D. B. (1995). Firm profitability, growth, and innovation, *Review of Industrial Organization*, 10( 5), 579-588.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.

Becheikh, N., Landry, R., & Amara, N. (2006). Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993-2003, *Technovation*, 26, 644-664.

Bhattacharya, M., & Bloch, H. (2004). Determinants of innovation, *Small Business Economics*, 22, 155-162.

CSIRO. (2010). Adaptation science: Opportunities and responses to climate change impacts. Canberra: CSIRO.

Dess, G. G., & Robinson, Jr., R. B. (1984). Measuring organisational performance in the absence of objective measures: the case of the privately-held firm and conglomerate business unit. Strategic Management Journal, 5(3), 265-273.

Dibrell, C., Craig, J. B., & Neubaum, D. O. (2014). Linking the formal strategic planning process, planning flexibility, and innovativeness to firm performance. *Journal of Business Research*, 67(9), 2000-2007.

Dixit, D. (2014). Agricultural Value Chains and Food Security. *Journal of World Trade*, 48(5), 967-981.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal*. 21, 1105-1121.

Fielke, S. J., & Bardsley, D. K. (2014). The importance of farmer education in South Australia. *Land Use Policy*, 39, 301-312.

Galende, J., & de la Fuente, J.M. (2003). Internal factors determining a firm's innovative behaviour, *Research Policy*, 32(5), 715-736. Growcom (2011). Submission on issues paper to inform development of a national food plan. Fortitude Valley: Growcom. Accessed online: http://www.growcom.com.au/_uploads/52524National_Food_Plan_Submission_%28September_2011%29.pdf

Goodwin, B. K., & Mishra, A. K. (2004). Farming efficiency and the determinants of multiple job holding by farm operators. *American Journal of Agricultural Economics,* 86(3), 722-729.

Gray, E. M., Sheng, Y., Oss-Emer, M., & Davidson, A. (2012). Agricultural productivity: trends and policies for growth. *Agricultural commodities*, 2(1), 165-179.Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. 2010. Multivariate data analysis (7th ed.). Upper Saddle River, N.J.: Prentice Hall.

HIA, (2015). *Horticulture Innovation Australia LTD Consultation Paper: Determining the Strategic Investment Priorities for the Australian Horticulture Industry*. Sydney: HIA. Accessed online: www.consultingis.com.au/images/brochures/HIA_Consultation_Green_Paper_27022015.pdf

Hogan, S. J., & Coote, L. V. (2014). Organizational culture, innovation, and performance: A test of Schein's model. *Journal of Business Research*, 67(8), 1609-1621.

Hull, C. E., & Rothenberg, S. (2008). Firm performance: the interactions of corporate social performance with innovation and industry differentiation. *Strategic Management Journal*, 29(7), 781-789.

Kimura, S., & Antón, J. (2011). Risk Management in Agriculture in Australia, OECD Food, Agriculture and Fisheries Papers, No. 39. OECD Publishing. Accessed online: http://dx.doi.org/10.1787/5kgj0d8bj3d1-en

Klomp, L., & van Leeuwen, G. (2001) Linking innovation and firm performance: A new approach, *International Journal of the Economics of Business*, 8(3), 343-364.

Kreiser, P.M., Marino, L.D., Kuratko, D.F., & Weaver, K.M. (2013). Disaggregating entrepreneurial orientation: The non-linear impact of innovativeness, proactiveness and risk-taking on SME performance. *Small Business Economics*, 40 (2), 273-291.

Krishnareddy, M. (2013). Impact of Climate Change on Insect Vectors and Vector-Borne Plant Viruses and Phytoplasma, in Singh, H. C. P., Rao, N. K. S., & Shivashankar, K. S. (Eds.), *Climate-resilient Horticulture: Adaptation and Mitigation Strategies*. Springer, India.

Lin, J. Y. (1991). Education and innovation adoption in agriculture: evidence from hybrid rice in China. *American Journal of Agricultural Economics*, 73(3), 713-723.

Laursen, K., & Salter, A. (2006). Open innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27, 131- 150.

Love, J. H., Roper, S., & Du, J. (2009). Innovation, ownership and profitability. *International Journal of Industrial Organization,* 27, 424-434.

Mallawaarachhi, T., Walcott, J., Hughes, N., Gooday, P., Georgeson, L., & Foster, A. (2009). *Promoting productivity in the agriculture and food sector value chain: issues for R&D investment*. ABARE and BRS report to the Rural R&D Council, Canberra.

Mansury, M. A., & Love, J. H. (2008). Innovation, productivity and growth in US business services: A firm-level analysis. *Technovation*, 28, 52-62.

McCarthy, S., Oliver, B. & Verreynne, M. (forthcoming). Credit rationing in SMEs by banks in Australia. *Australian Journal of Management*.

Moir, B., & Eather, J. (2015). Horticulture Outlook to 2019–20, in *ABARES 2015, Agricultural commodities: March quarter 2015*. Canberra: Australian Bureau of Agricultural and Resource Economics and Sciences, pp. 92-100.

Moir, B., Thompson, N., & Hogan, J. (2012) *Horticulture: Review of the export efficiency powers, ABARES report to client prepared for the Review of Horticulture Australia Limited export regulation powers,* Canberra: Australian Bureau of Agricultural and Resource Economics and Sciences.

Nossal, K., & Lim, K. (2011). *Innovation and productivity in the Australian grains industry.* ABERES research report 11.06. Available from: http://data.daff.gov.au/data/warehouse/pe_abares99010705/RR11.6_InnovationGrainsV1.1.0.pdf

OECD (2013), "Australia", in *Agricultural Policy Monitoring and Evaluation 2013: OECD Countries and Emerging Economies,* OECD Publishing. http://dx.doi.org/10.1787/agr_pol-2013-7-en

Penniceard, C., Vitartas, P., & Charters, K. (2012). Solutions to Contested Land Uses and Our Emerging Landscape, in Kinnear, S. H. W., Charters, K., & Vitartas, P. (Eds.), *Regional Advantage and Innovation*. Springer-Verlag, Berlin Heidelberg.

Prajogo, D. I. (2006). The relationship between innovation and business performance – a comparative study between manufacturing and service firms. *Knowledge and Process Management*, 13(3), 218-225.

Raymond, L., & St-Pierre, J., (2010). R&D as a determinant of innovation in manufacturing SMEs: An attempt at empirical classification, *Technovation*, 30, 48-56.

Rosenbusch, N., Brinkmann, J., & Bausch, A. (2011). Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. *Journal of Business Venturing*, 26, 441-457.

Sharma, J., Upadhyay, A.K., Adsule, P.G., Sawant, S.D., Sharma, A.K., Satisha, J., Yadav, D. S., & Ramteke S.D. (2013). Effect of Climate Change on Grape and Its Value-Added Products, in Singh, H. C. P., Rao, N. K. S., & Shivashankar, K. S. (Eds.), *Climate-resilient Horticulture: Adaptation and Mitigation Strategies*. India: Springer.

Sheng, Y., Zhao, S., Nossal, K., & Zhang, D. (2015). Productivity and farm size in Australian agriculture: reinvestigating the returns to scale. Australian *Journal of Agricultural and Resource Economics*, 59(1), 16-38.

Teece, D. J., Pisano, G., & Shuen, A. (1990). *Firm capabilities, resources and the concept of strategy,* Consortium on Competitiveness and Cooperation Working Paper # 90-9, University of California at Berkeley, Centre for Research in Management, Berkeley, CA.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.

Varis, M., & Littunen, H. (2010). Types of innovation, sources of information and performance in entrepreneurial SMEs. *European Journal of Innovation Management*, 13(2), 128-154.

Verreynne, M. L., & Steen, J. (2014). Queensland business innovation survey 2014 report. Brisbane: Department of Science, Information Technology, Innovation and the Arts (DSITIA). Accessed online: https://www.qld.gov.au/dsitia/assets/documents/qld-business-innovation-report-2014.pdf