The financial and managerial impact of including low-chill apples as an enterprise on a typical wine farm in selected areas

by
Jacobus Francois du Toit

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Supervisor: Dr Willem Hoffmann

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Declaration

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Abstract

The South African wine grape sector is significant to the country's economy. Many wine grape producers have expanded their operations to incorporate other long-term crops as an alternative source of revenue due to the difficulties that the industry has faced, particularly during the past 10 years. The wine grape farmers of the Robertson, Worcester, and Paarl regions have access to a wide range of crop options ideal for this diversification process.

The main objective of this study is to test the inclusion of apples with a minimal cold unit demand (low-chill apples) as a diversification option for wine grape farmers. The lack of proof in the anticipated financial and management results of such a change as well as the potential cash flow impact are major stumbling blocks to implementation. Consequently, the study set out to determine the managerial and financial effects of incorporating low-chill apples into a typical wine grape farm. To address the primary research objective, three specific research goals were pursued: (i) determining the production needs for low-chill apples in the chosen areas; (ii) determining the financial effects of producing low-chill apples; and (iii) determining the financial implications of incorporating a low-chill apple enterprise at farm level for the chosen areas.

Within the framework of the systems thinking methodology, a multi-year whole farm budget was developed. A farm system is complex and made up of many interconnected elements, making it challenging to understand the impact of changing any specific element. The systems thinking method can assist in the simplification of farm-level decision-making through the incorporation of the complexities involved in farming systems. Considering that farming systems are made up of interrelated components, a simulation model can include the interaction that occurs between different components. A model is a representation of a real system that models the socioeconomic, biological, and physical aspects of farming and examines the relationships between its various components. The main goal of this study's research is to determine the predicted managerial and financial effects of incorporating low-chill apples as an enterprise into a typical wine grape farm. For this goal, a budget model will be sufficient.

The model predicts that the wine grape farms in the Robertson, Worcester, and Paarl districts stand to benefit financially from the diversification process. It is anticipated that infrastructure changes won't have a big cost impact. According to the findings, as the area planted with low-chill apples increases, the IRR rises. It also shows how the IRR is significantly improved by automating the harvesting process and reducing the cost of thinning for low-chill apples. This option was considered because low-chill apples would target the juice/cider market, where size and quality are less important. The IRR exhibits substantial sensitivity to changes in the Rand per tonne price and tonne per hectare of apples.

Opsomming

Die wyndruifbedryf in Suid-Afrika speel 'n belangrike rol in die nasionale ekonomie. Hierdie bedryf het onlangs baie uitdagings beleef wat produsente dwing om bykomende alternatiewe bronne van inkomste te vind. Dit impliseer egter nie dat die wynbedryf onvolhoubaar is nie. Weens die druk op die bedryf die afgelope tien jaar het 'n aantal wyndruifboere hul bedrywighede gediversifiseer om ander langtermyngewasse by hul produksie in te sluit. In Robertson, Worcester en die Paarl het wyndruifboere toegang tot 'n wye reeks gewasopsies wat ideaal is vir hierdie diversifikasieproses.

Die hoofdoel van hierdie studie, wat gemik is op die appelsap mark, is die insluiting van appels met 'n minimale koue aanvraag (lae kouebehoefte appels) op ‘n wyndruif plaas. Die gebrek aan bewyse van die impak van so verandering aan die verwagte finansiële en bestuursresultate, sowel as die potensiële verandering in kontantvloei, maak dit moeilik om die verandering te regverdig.

Die hoofdoel van die studie is om die bestuurs- en finansiële uitwerking van die inkorporering van lae kouebehoefte appels in 'n tipiese wyndruifplaas te bepaal. Ten einde die primêre navorsingsdoelwit aan te spreek, is drie spesifieke navorsingsdoelwitte nagestreef: (i) die bepaling van die produksiebehoeftes vir lae kouebehoefte appels in die gekose gebiede; (ii) die bepaling van die finansiële gevolge van die produksie van lae kouebehoefte appels; en (iii) die bepaling van die finansiële implikasies van die inkorporering van 'n lae kouebehoefte appelonderneming op plaasvlak vir die gekose gebiede.

Binne die raamwerk van die sisteemdenkmetodologie is 'n meerjarige heelplaasbegroting ontwikkel. ’n Plaasstelsel is ingewikkeld en bestaan uit baie onderling verwante elemente, wat dit uitdagend maak om die inpak van ‘n verandering in een element te begryp. Die stelseldenkmetode kan help met die vereenvoudiging van plaasvlakbesluitneming scenario's en om 'n beter begrip te hê van die kompleksiteite betrokke by boerderystelsels. 'n Simulasiemodel kan die interaksie tussen onderling verwante komponente van ‘n boerderystelses modelleer. ‘n Model se resultate is ‘n voorstelling 'n werklike stelsel wat die sosio-ekonomiese, biologiese en fisiese aspekte van boerdery modelleer en die verhoudingsverhoudings tussen die verskillende komponente daarvan ondersoek.

Die hoofdoel van hierdie studie se navorsing is om die voorspelde bestuurs- en finansiële uitwerking van die inkorporering van lae kouebehoefte appels as 'n onderneming in 'n tipiese wyndruifplaas te bepaal. Vir hierdie doelwit is 'n begrotingsmodel voldoende aangesien dit komplekse en gesofistikeerde bewerkings kan doen en terselfdetyd gebruikersvriendelike kenmerke insluit.

Die wyndruifplase in die distrikte Robertson, Worcester en Paarl sal finansieel voordeel trek uit die diversifikasieproses. Daar word verwag dat veranderinge in infrastruktuur nie 'n groot koste-impak sal hê nie. Volgens die bevindings styg die IRR namate die oppervlakte beplant met lae kouebehoefte appels vermeerder. Dit wys ook hoe die IRR aansienlik verbeter word deur die oesproses te outomatiseer en die koste van uitdunning vir lae kouebehoefte appels te verminder. Hierdie opsie is oorweeg omdat lae kouebehoefte appels die sapmark sal teiken, waar grootte en kwaliteit minder belangrik is. Die IRR toon ‘n beduidende sensitiwiteit vir veranderinge in die Rand prys per ton en ton per hektaar appels.

This thesis is dedicated to my parents, Zonja and Izak Du Toit, who helped shape who I am and taught me that nothing can stop me from achieving my goals.

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Preface

This thesis is presented as a compilation of 5 chapters.

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Chapter 1: Introduction

1.1 Background to the study

In many countries, agriculture forms the foundation for economic progress (Goldblatt, 2010). For this reason, a robust and productive agricultural system needs to be maintained to provide food security, employment, and overall socio-economic prosperity. In South Africa, agriculture contributed an estimated of 2.43% to the Gross Domestic Product (GDP) of South Africa in 2021 (Ngobeni & Muchopa, 2023).

The COVID-19 pandemic in 2020 had a severe impact on the Western Capes economy, but as seen by the 4.83% GDP growth rate in 2021, the region is recovering (WESGRO, 2022). Despite the pandemic, South Africa's agriculture industry remained robust. The sector experienced considerable growth in 2020, while many other sectors experienced decline and continued to grow in 2021 and 2022 (Stats SA, n.d.). Since the first quarter of 2020, the agricultural sector has increased its relative contribution to the GDP growth of the nation by 28.6%, and in spite of the unfavourable COVID-19 pandemic conditions, it was the sector that performed the best (15.1%) in the second quarter of 2020 (National Agricultural Marketing Council (NAMC), 2020).

According to VINPRO (2022), the South African wine industry ranks as the eighth largest producer in the world in terms of volume produced, contributing 4.2% of worldwide production. Additionally, the wine industry contributed R55 billion to the country's GDP, and it employs roughly 290 000 people (WOSA (4), 2021). More than 911.5 million litres of wine were produced in South African wineries during 2021, of which 42.6% were exported and the remainder consumed locally (SAWIS, 2021). In 2021, there were 90 512 hectares of wine grape vineyards spread across South Africa, the majority of which were located in the Western Cape (SAWIS, 2021). This is 17 558 hectares less than the 108 070 hectares that were planted with wine grapes in 2013. This demonstrates that wine grape farms are incorporating other commodities. However, due to the peculiarities of the soil and climate and the specific needs of crops, diversification possibilities are generally constrained.

This study will focus on three of the ten wine-producing areas in the Western Cape Province, namely Robertson, Worcester, and Paarl. These areas were chosen due to their potential for producing low-chill apples and the fact that wine grape growers in these areas are currently diversifying agricultural production practices.

The integration of apples with a lower chilling requirement (low-chill) into a typical wine farm is a dynamic and protracted process. Wine grape producers that want to diversify their business should consider establishing low-chill apple orchids, production activities, new markets, water requirements and availability, the current cash flow situation of the farm, labour requirements, added infrastructure and moveable equipment requirements. The long-term financial and managerial effects of implementing this diversification process are unclear. This research project is exploratory in nature due to the lack of information on the commercial production of low-chill apples for the juice/cider market in the focus regions.

1.2 Problem statement and research question

The area under wine grapes in the Western Cape Province has declined in recent years, creating room for the production of alternative commodities through the diversion of available resources, specifically land, water, and capital (SAWIS, 2021). The producer would most likely want to replace wine grapes with a permanent commodity rather than a cash crop to maintain the security value of what farming wine grapes gives the producer in terms of the value of the land.

There are several options available to farmers, and low-chill apples are one of them. Before mass adoption in regions with a long history of wine production becomes a reality, there are several wider implications that need to be evaluated. If mass adoption occurs due to low-chill apples being a viable diversification crop, then there might be several detrimental repercussions for the wine business. This could entail, amongst others, but not limited to, the wine industry losing part of its primary source of wine grapes, as well as possible negative environmental effects brought on by increased water requirements and possibly a higher dependence on chemical sprays. There are also potential advantages for the cider industry that could be considered, such as technical modifications to existing wine cellars that would enable the processing of apples into cider, or at the very least, concentrate, without losing efficiency. However, this study will only focus on the production of low-chill apples.

The first and key consideration is understanding the implications at the farm level. Currently there is a lack of knowledge regarding the technical and financial considerations of growing low-chill apples in general and in the Robertson, Worcester and Paarl regions specifically. The key research question for this research is: “What are the expected managerial and financial implications of including low-chill apples as a diversification strategy on a typical wine farm in selected areas?”.

1.3 Main aim and research objectives

The main aim of this study is to evaluate the expected financial and management implications of integrating low-chill apples into a typical wine farm in the areas of Worcester, Paarl and Robertson.

The following specific research goals were identified within the framework of this main aim:

1. Establish the production requirements for low-chill apples in the selected areas.
2. Establish the financial implications of producing low-chill apples.
3. Evaluate the financial implications of incorporating a low-chill apple enterprise at the farm level in selected areas.

1.4 Research method

The systems approach forms the foundation of this study because it involves integrating the expertise of farmers, viticulturists, horticulturalists, geneticists, agronomists, soil scientists, and market stakeholders. With their experience and knowledge, it is possible to better understand the expected practical implications of integrating the system components and considering the interrelationships in a farm system. Currently, there are no established commercial low-chill apple-producing units for the juice market in any of the identified production areas; subsequently, an exploratory research approach is required (Van Graan, 2023).

The underlying complexity of the farming system should be acknowledged and taken into account in the suggested business structure and adjustment options. The farm system simultaneously consists of crop reproductive dynamics, climatic unpredictability, infrastructure needs, and financial requirements. For the purpose of this study, it is assumed that the knowledge and skill set required to produce an alternative crop for the juice market/cider are within practical time constraints for current wine farmers. Therefore, 'school fees' are ignored, and low-chill apples are incorporated at the expected norms. Considering the relational interaction and complexity of farming systems, simulation modelling is a time- and money-efficient technique to construct a representation of a typical farm. Whole-farm budget models simulate the impact of changes in variables impacting on the farm, as well as simulating different scenarios of alternative production practices/enterprises. Equations used in the whole-farm budget models can incorporate physical and biological parameters and socio-economic variables into cost and income numbers. This study proposes to employ the concept of a typical farm that depicts physical aspects that producers from a homogeneous area can relate to when creating whole-farm budget models. To substantiate the effects of the changes and to enhance the validity of the assumptions made, expert knowledge is sought during the model construction and application phases of the project.

To assess the anticipated financial and managerial effects of incorporating low-chill apples into a typical wine farm in the specified regions, a whole-farm, multi-period budget model approach was adopted. This whole-farm, multi-period model incorporates the distinct components of each system with their unique investment needs while considering climate variability. It can also combine biological and physical variables such as yield expectations, input costs, labour activities, and the cyclical nature of the production systems over different growing seasons over the expected lifetime of these crops. In essence, it functions as a budgeting model based on standard accounting principles. Due to the large number of components and interactions that a spreadsheet environment can support, developing budget models can incorporate complex interdependencies. The strategy is not only justified using a model based on accepted accounting principles, but it is also presented in a way that farmers can easily interpret and participate in. A typical farm had to be identified before the whole-farm multi-period budget model could be constructed and therefore serves as the foundation of the whole-farm multi-period budget model.

The point of departure was a literature review that allowed for establishing the growing requirements for low-chill apples. Unstructured expert discussions were used to evaluate the implications of full inclusion as an enterprise in a wine farm. Since this study focuses on three specific areas, unstructured expert discussions were conducted to determine the dimensions of a typical farm for each area. Nevertheless, these discussions were led to produce all the assumptions needed to construct the budged model. To assess and determine the anticipated financial and management impact, low-chill apples were incorporated as an enterprise on a typical wine farm in each region and implemented on a whole-farm, multi-period level. Three scenarios of potential combinations of wine grapes and low-chill apples in terms of hectares in selected regions were simulated and evaluated. The results of this research approach enabled a financial comparison between growing more wine grapes or, instead, cultivating low-chill apples on that hectares, utilising the internal rate of return (IRR) on capital investment.

1.5 Limitations

This study is exploratory, and due to a lack of knowledge and experience of low-chill apple production in the chosen regions, the result of this study is a first attempt to quantify the potential benefits of how low-chill apples can be integrated into a typical wine farm and highlight the potential financial and management implications.

The model cannot be applied directly to any farm but can be modified for a specific farm in the Robertson, Worcester, and Paarl regions. Another limitation of this research is that it only examines the wine industry at the farm level, ignoring of farm processing and trade implications.

Lastly, the study focuses on what is likely to occur given the current structure of the farm's activities, management methods, and financial situation rather than on what should happen to the farm.

1.6 Outline of the thesis

The following chapter offers a brief overview of the wine and apple industries, intriguing statistics, market trends, and some crucial ideas for incorporating low-chill apples into a typical wine farm.

The approach, methods, and strategies utilised to collect data and build a whole-farm budget model are described in Chapter 3. The main goals were to clarify, develop, and demonstrate the application of the budget model. Chapter 4 look at the different land allocations for apples and wine grapes that farmers might utilise in terms of the farm's financial viability, management capability, and impact on the IRR. Scenario modelling is used to achieve this. Chapter 5 is a summary of the study and its main results.

Chapter 2: Overview of the South African wine and apple industries

2.1 Introduction

The study's goal is to evaluate the management and financial consequences of adding low-chill apples as a full enterprise into a conventional wine farm in order to offer a remedy for the unfavourable conditions the wine industry has been dealing with over the past 10 years. Within the framework of this primary goal, the following specific study objectives were developed: to determine the production requirements for low-chill apples in the targeted regions, to generate financial implications for the production of low-chill apples, and to assess the financial implications of introducing low-chill enterprises at the farm level through sensitivity tests. This considers the opportunity of diversifying wine grape farms and does not imply that the wine industry is not sustainable.

Chapter 2 is divided into five sub-sections, each addressing a specific theme. Farm and food production systems are inherently complicated because of the multiple interconnected parts. As a result, in-depth knowledge and an evaluation of the two sectors that this study focusses on are necessary to better comprehend the systems. The baseline for comparison is the wine industry. In the first theme of the chapter the significant trends experienced by the industry since 2011 are discussed. The second theme covers the apple industry in South Africa, the various markets, product distribution, and finally the agricultural circumstances and climate hazards associated with apple production in South Africa. The third theme introduces the low-chill apple market in detail. It expands on crucial facts regarding juice and cider manufacturing in order to better comprehend the introduction of the low-chill apple enterprise at farm level.

The production considerations for incorporating low-chill apples into a typical wine farm are covered in the fourth theme of Chapter 2. This includes the requirements for land, water, labour, and capital, as well as structural needs. Theme five provides a summary of the three regions on which the study focuses: Robertson, Worcester, and Paarl, along with their distinctive characteristics.

2.2 The South African Wine Industry

2.2.1 Background industry dimensions

The Cape Colony of 1655 was the birthplace of the South African wine industry and is the nation's oldest formal agricultural industry (Wines of South Africa [WOSA], 2017). Since then, the sector has expanded its exports and developed a strong focus on international market penetration.

Today, 90 512 hectares of land are planted with vines by about 2 778 growers, 1 493 hectares less than in 2020 (WOSA (1), 2023). In 2021, there were 1 339 103 tonnes of grapes harvested, of which 86% were used to make wine and 319.2 million litres were exported (Vink et al., 2012; Vinpro, 2021; WOSA, 2021). Regarding the volume of wine production globally, Italy is in the lead with 19.3% of the total, followed by France with 14.5%, Spain with 13.6%, and South Africa in 8th place with 4.2% (Vinpro, 2021; WOSA, 2021).

The South African wine industry contributed R55 billion (2019) to the economy of the country (Vinpro, 2021). Primary wine producers' income in 2020 was R5.78 billion. Wine farms and cellars employed 80 173 people and about 269 096 employment opportunities were supported by the sector in 2019 (Vinpro, 2022).

Most of South Africa's vineyards are situated in the Western Cape, with its mediterranean climate (WOSA (2), 2023). Production zones in the Cape winelands are separated into formally delineated geographic divisions, such as regions, districts, and wards, under the aegis of the Wine of Origin Scheme. Cape South Coast, Breede River Valley, Coastal Region, Klein Karoo, and Olifants River are the five geographical regions that make up the Western Cape. Stellenbosch is currently the region with the biggest area under vines, 14 933 ha (WOSA (1), 2023).

The South African wine industry is competing on an uneven playing field. Competing wine-producing nations rely on natural resources, capital, and labour pools with vastly different levels of quality, skill, and cost, as well as varying levels of direct government support. The South African wine industry has unique issues at business, industry, and government levels, which have a direct influence on competitiveness (Esterhuizen & Van Rooyen, 2006).

2.2.2 Important trends since 2011

A significant rise in export volumes since 2011 and increased earnings helped the South African wine industry. However, during the past 20 years, this growth has been weighed down by industry-wide cost increases above inflation, notably those related to labour, transportation, and electricity expenses. There is a limit to passing these cost increases on to customers (Badenhorst-Weiss & Naudé, 2020). Although South Africa's wine grape business is significant to the national economy, it has recently been under financial strain due to a stagnation in the price per ton of wine grapes. In this instance, wine tonne pricing refers to the price that wine-producing merchants pay to farmers. They purchase grapes from the farmers for a price per tonne and use them to make wine. If a company's income growth does not keep up with its expense growth, it cannot be sustained. Expenses are linked to inflation and so steadily rise over time. On the other hand, demand and supply, as well as consumer spending, are related to income. The fact that most South African wine farms only produce grapes and not wine (Vink, 2019) may be a reason for the financial challenges the primary wine sector is experiencing. Farmers are motivated to find new sources of revenue due to the stagnation in the wine price over the past ten years (Vink, 2019). Vink (2019) asserts that the wine business struggled to raise wine prices because of an oversupply. Due to the above-mentioned issues, the area planted with wine grapes has significantly decreased since 2011, as shown in Figure 1.

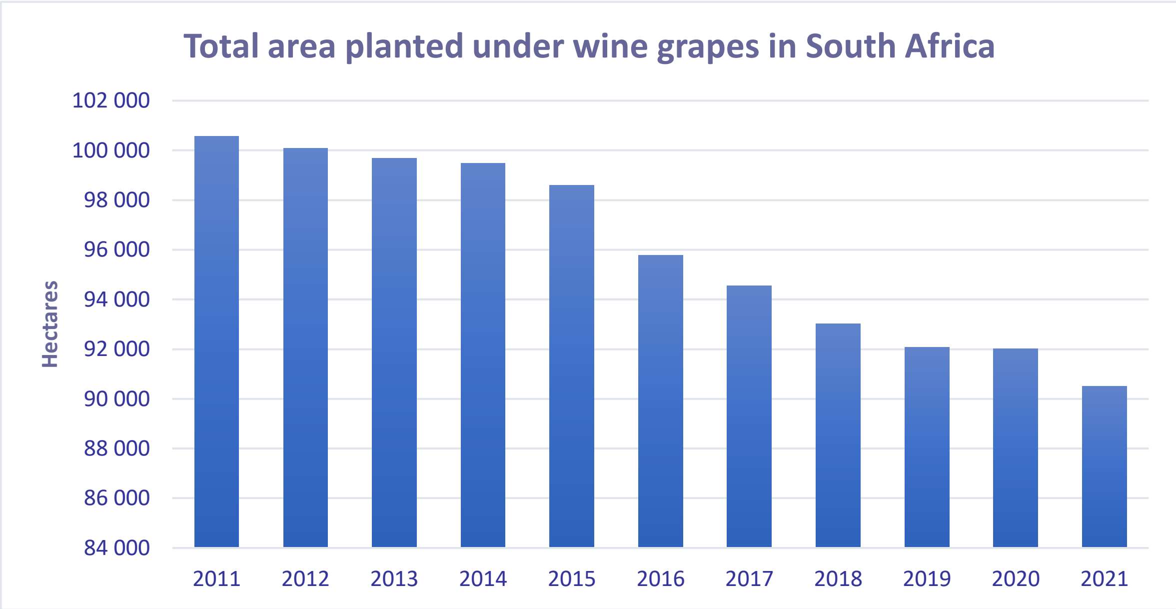

Figure 1: Area planted under wine grapes in South Africa for the period 2011-2021.
Source: WOSA (1) (2023)

This is further illustrated by comparing the differences between newly planted vines and vines that have been uprooted, as shown in Figure 2. The overall number of hectares planted each year is consistently less than the number of hectares being uprooted. This significantly reduces the number of vines that are less than four years old.

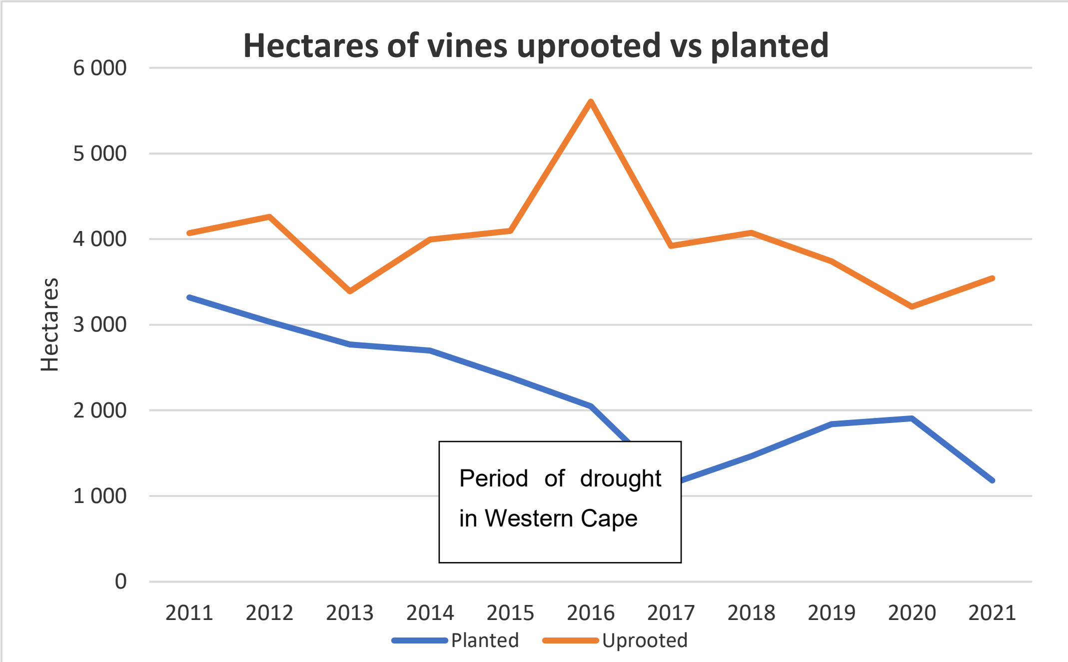

Figure 2: The difference between newly planted and uprooted hectares for the period from 2011-2021
Source: WOSA (2) (2021)

The annual per capita wine consumption in South Africa is relatively low (7.4 litres in 2020) compared to other New World wine producers (Argentenia with 27.6 litres). Thus, South Africa's wine industry relies on the export market (WOSA (2), 2021). The South African political changes post-1996, the consequent economic boom, and the wine industry's own initiatives have all worked together to support the wine industry's expansion and significant economic contribution up to the early 2010s (Vink et al., 2012).

The industry has two main downfalls: the continued diminishing domestic market since 2017 (as shown in Figure 3) and the fact that its exports are predominantly within the lower price ranges. The argument for diversification also holds for brands in the "mid-range" price bracket, even though basic wines have been the driving force behind export performance (and consequently, international competitiveness) (Vink et al., 2012). While the per capita consumption of wine has decreased since 2017, the consumption of ready-to-drink (RTD) alcoholic beverages has sharply increased, especially after the Covid epidemic (SAWIS, 2021).

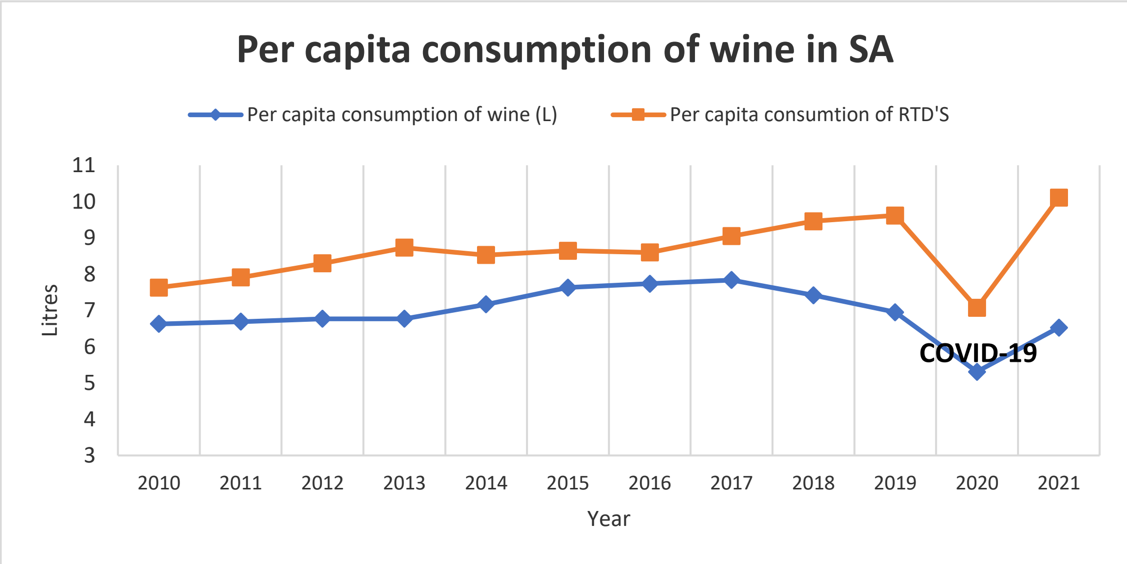

Figure 3: The per capita consumption of wine and RTD beverages in South Africa for the period 2010-2021.
Source: WOSA (2) (2021)

The final factor affecting wine producers' capacity to remain profitable is the excise fee payable to the government. In addition to providing the government with a consistent source of revenue, these taxes and levies also serve to discourage people from using certain goods that are harmful to the environment or people's health. Approximately 10% of the total income the South African Revenue Service (SARS) receives comes from such charges and levies (South African Revenue Service (SARS), n.d.).

2.2.3 Low-chill apples for cider production and grapes for wine production

The afore-mentioned factors and the general pursuit of higher-income alternatives encouraged wine grape growers to explore alternate revenue streams and diversification. Due to the peculiarities of the soil and climate, diversification possibilities are generally constrained. This assertion is supported by the observation that between 2011 and 2021, the area used for cultivating wine grapes declined by 10%, showing that wine grape growers are using their land for other purposes (WOSA (2), 2021).

In the Western Cape, crop production was registered on about 2 million hectares of land in 2017, while wheat was grown on 338 588 hectares (17%). The rest of the area was mainly occupied by ten other crops, ranked from biggest to smallest: wine grapes, canola, barely, rooibos tea, apples, table grapes, pears, oranges, and lupines (Murdoch et al., 2021). These crops are all grown in the Western Cape, and therefore, producers who are thinking about diversifying often consider replacing wine grapes with one of these. To invest in an alternative crop, you need to consider the development of the new crop, new markets, production activities, soil and water requirements, investment requirements, the extent to which the new enterprise can integrate into existing infrastructure, knowledge, skill sets, and the implications of contracting in the current production system. An example of the latter could be financial penalties for non-compliance with quotas at a wine cellar where the producer has membership.

Given that the Western Cape's particular agricultural conditions may be a barrier to diversification, low-chill apples may offer a solution. Compared to standard apple cultivars, these cultivars can produce yields with fewer cold unit requirements (Van Graan, 2023). More importantly, the RTD market is expanding. This creates a sizable opportunity as these apples are produced for the production of cider. Later in this study, the characteristics of these cultivars and the production regions selected for this study will be discussed.

2.3 The South African apple industry

2.3.1 Overview

Apples are part of the deciduous fruit category. Deciduous fruit was introduced in South Africa in 1652 by the Dutch settlement at the Cape of Good Hope (Hortgro, n.d.). Numerous limitations, such as the absence of a well-developed marketing system and infrastructure, as well as the quality of the fruit produced, constrained the early development of the fruit sector. The structured development of the industry dates back to the early 19th century when it reached new heights thanks to the construction of railroads through Mitchell's Pass. This created a direct rail connection between the large production areas and Cape Town harbour, simplifying the export process. Producers were motivated to increase production, as evident from the fact that more fruit trees were planted by the SA apple industry (Beukes, 2009).

Exports, particularly to Great Britain, did not expand significantly until after World War II (Du Toit, 1981). The industry made advancements in the decades following the war. More research was conducted, leading to the development of novel cultivars, enhanced pest and disease management strategies, novel irrigation systems, and considerable improvements in production techniques, and managerial abilities. This caused an increase in apple production, which in turn increased exports to markets in Europe and the United Kingdom. It can be postulated that the demand for South African apples played an important role in the expansion of the deciduous fruit industry. It began very small in the Western Cape in 1652 and has since grown into a globally recognised sector (Du Toit, 1981).

Despite fast-shifting global trade dynamics, South Africa, a top apple-producing nation, is currently driving the creation of a vibrant export-oriented fruit business (Bestbier, 2016). The South African apple industry operates in a dynamic and ever-changing economic climate where supply and demand dictate fresh apple prices, export volumes, and consumer demand.

The industry focuses on export, as approximately half of the country's apple production is exported. Many nations in the northern hemisphere sell South African apples in their winter and spring markets. Most of these consumer sales are made pursuant to contracts with suppliers in leading supermarket networks' selected categories. Additionally, several export businesses or agents work on behalf of the growers or packers to execute this activity through consignment sales. Prices in this sector are set by the forces of supply and demand in an unregulated market (DALRRD, 2020).

Producers in this industry have practically no control over the magnitude or direction of change because of the unpredictable and frequently unstable business environment, which includes policy changes, weather conditions, and other market variations (Lombard & Reynolds, 2012).

The horticulture sector in South Africa has a high economic multiplier. In the circular flow, the multiplier effect happens when an initial injection results in a larger ultimate rise in real national income. The fruit sector, or in this case, the apple industry, makes a considerable contribution to several links throughout the entire supply and value chain. These connections include backward links to wholesalers, retailers, hawkers, and other key players in the supply chain. It also links to input and service providers and industries like chemical, fertiliser, and packaging material suppliers, which in turn also support economic growth, GDP, and the fruit industry's competitiveness. Factors such as foreign exchange profits, employment generation, and connections to support organisations cause apples to be among the most significant deciduous fruits farmed in South Africa. The gross value of all deciduous fruits in South Africa for the 2018–19 season was R18.2 billion, with apples accounting for about 31.3% (R5.7 billion) (DALRRD, 2020).

2.3.2 Apple production in South Africa

South Africa can grow a wide variety of fruit thanks to its varied soil and climatic conditions. The Western Cape Province is the leading apple-producing province in South Africa thanks to its mediterranean climate (Hortgro, 2021). Ceres, Groenland, and Villiersdorp/Vyeboom in the Western Cape Province produce most of South Africa's apples, making up 75% of the country's total production. Langkloof East in the Eastern Cape comes in second, with smaller amounts produced in the Free State, Mpumalanga, the Northern Cape, and KwaZulu-Natal (Hortgro, 2021).

Hortgro (2021) reports that 24 956 hectares were used for apple production in 2021. The apple-growing regions in 2021 are shown in Figure 4. With 7 625 hectares, or 30% of the total South African hectares planted, Ceres was the largest production area in 2021. Groenland was the second largest, accounting for 29% of total hectares under apple cultivation in 2021, with 7 262 hectares planted. Villiersdorp/Vyeboom produced apples on 4 054 hectares, making up 16% of the country's total hectares produced. Langkloof East produces apples on 2 933 hectares, making up 12% of the country's total area planted with apples. In South Africa, the four primary production regions account for 88% of all the hectares planted with apples (Hortgro, 2021). The potential for apple production in the Western Cape is influenced by the regional climate, effects from the coast, mountains, and soils. Although each production area has a distinct environment, the areas are all generally warm, with milder and wetter winters. The Koue Bokkeveld region close to Ceres, a significant apple-producing hub, is significantly higher lying, colder in the winter, and fully dependent on nearby private farm dams. It is warmer in the Elgin-Grabouw-Vyeboom-Villiersdorp (EGVV) region. The consequence of winter rainfall regions in the Western Cape is that rainfall happens outside of the key demand time window for water, which is summer. Water needs to be stored at cost for availability during the summer months. The Western Cape Water Supply System that include public dams, a handful of medium-sized dams, and a significant number of small private farm dams all supply water for irrigation. The Langkloof experiences a colder winter and year-round rainfall, although it has significant seasonal variation (Midgley, 2016).

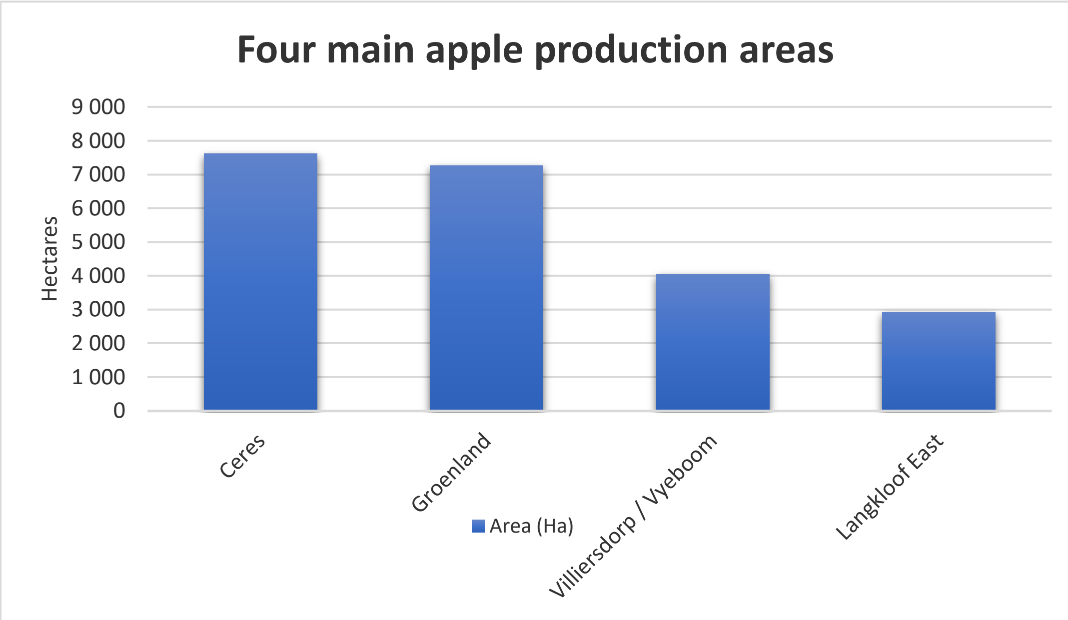

Figure 4: The four main apple production areas in South Africa in 2021.
Source: Hortgro (2021)

Figure 5 illustrates the increase in South Africa's apple production over time. In 2021, apple production in South Africa reached 1 164 105 tonnes. The amount was somewhat higher than the 1 002 455 tonnes produced in the previous year. Production has been increasing since 2012, when apple production in South Africa was estimated at 815 578 tonnes (Hortgro, 2021). Volume declines in production were mainly due to unfavourable weather conditions (drought and heat waves) in some regions (DALRRD, 2020; Cowling, 2023). Since average temperatures increased over the past 10 years, major production areas, particularly those in the Western and Southern Cape, have experienced the effects of global warming. An important threat to the South African apple industry is the rise in average and, especially, minimum temperatures. As greenhouse gas concentrations rise, temperatures will continue to increase, though the rate and magnitude of this increase are unknown (Conradie, 2008).

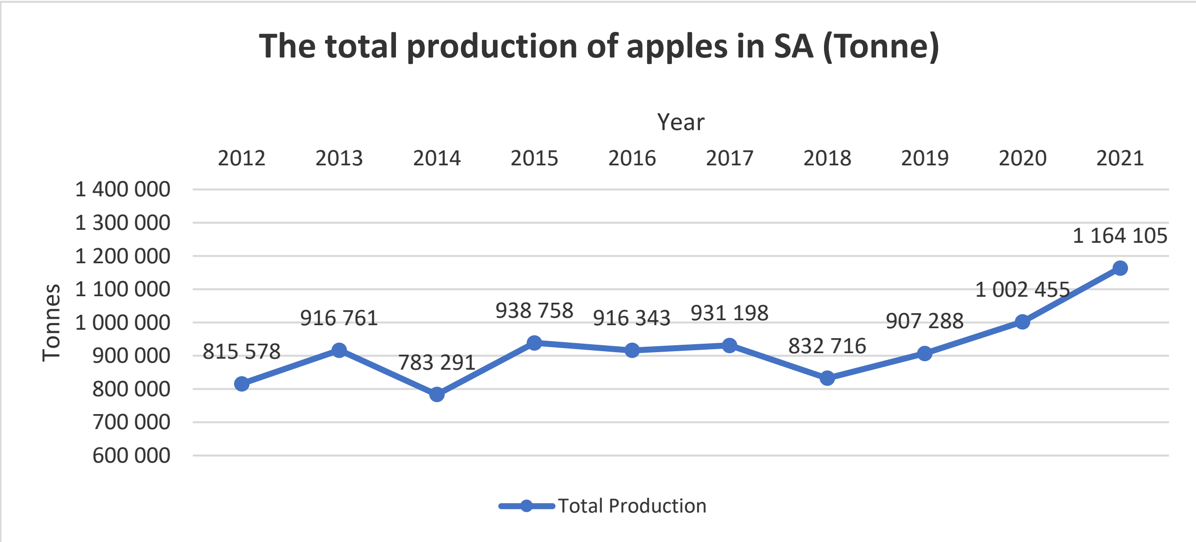

Figure 5: The total production of apples in South Africa for the period 2012-2021.
Source: Hortgro (2021)

The industry's replacement trend is a consequence of the sustainable production of apples. Fruit quality is greatly impacted by the tree's age. Compared to older trees, young trees typically produce fruit of higher quality. Replacement trees (0–3 years) must be held at 10% or greater to ensure a stable, longer-term supply. The facts below show that in 2021, the South African apple industry's producing orchards were not effectively replaced (DALRRD, 2020; Hortgro, 2021). A major cause for concern is the high percentage of South African orchards that are older than 25 years. Older orchards tend to produce fruit of lower quality and quantity, which results in a smaller harvest (Conradie, 2008).

The distribution of apple orchard ages in 2021 was as follows (Hortgro, 2021):

- 2 105 (8%) hectares were in the age category of 0-3 years
- 7 252 (29%) hectares were in the age category of 4-10 years
- 4 046 (16%) hectares were in the age category of 11-15 years
- 4 154 (17%) hectares were in the age category of 16-25 years
- 7 399 (30%) hectares were in the age category of 25+ years

2.3.2.1 Apple varieties grown in South Africa

In South Africa, the most common apple varieties in terms of area planted include Golden Delicious, Royal Gala, Cripps Pink/Pink Lady®, Granny Smith, Fuji, and Topred/Starking (DALRRD, 2020; Hortgro, 2021). Due to shifting customer preferences, South Africa's varietal dispersion has altered dramatically over the past years, much like the majority of the other main producing nations. For instance, Granny Smith (25%) and Golden Delicious (22%) have historically been produced in large quantities in South Africa, making up 47% of the country's total area of apple production in 2006 (Conradie, 2008). However, Royal Gala surpassed Granny Smith and in

2021 accounted for 17% of the total hectares, compared to 12% for Granny Smith (Hortgro, 2021). This is mainly because of global consumer trends towards the consumption of bi-coloured apples; therefore, new plantings were concentrated on varieties such as Royal Gala, Fuji, and Cripps Pink, as illustrated by Figure 6.

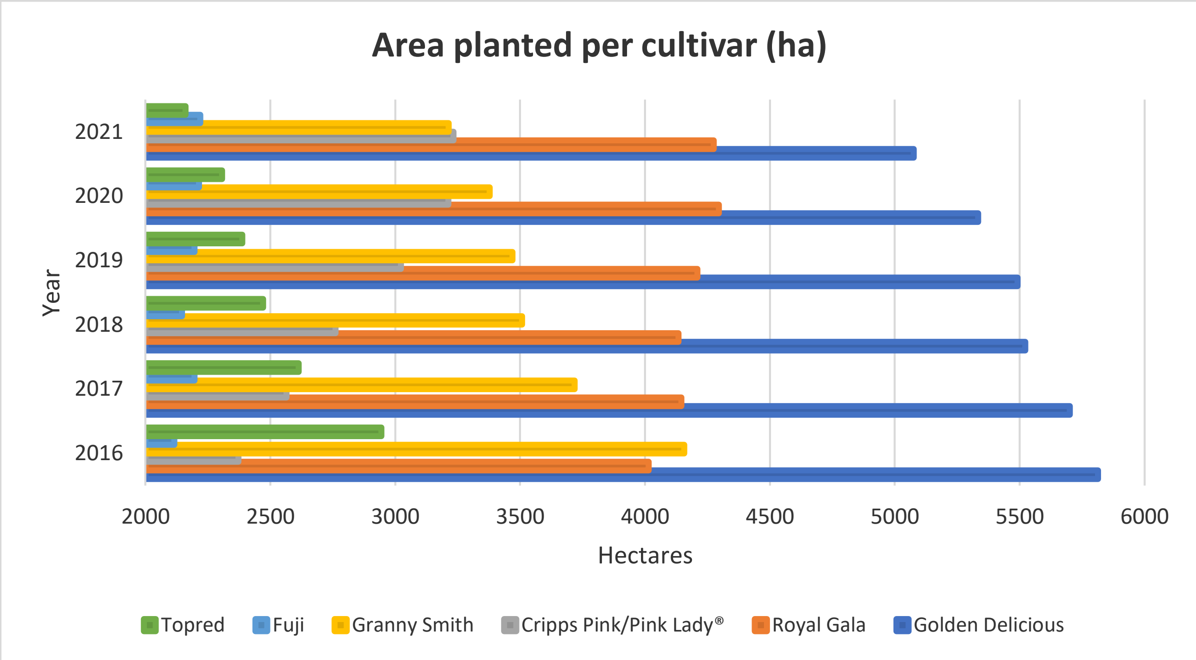

Figure 6: Area planted per cultivar between 2016 and 2021.
Source: Hortgro (2021)

2.3.2.2 Market

South African apple consumption is distributed among a number of markets, including the local market for fresh produce, the export market for fresh produce, the market for processed foods, including juice and concentrate, and the market for dried fruit. In South Africa, apple production is mainly focussed on exports followed by processing and the local market, as seen in Figure 7 (Hortgro, 2021). In terms of volume, the nation exports to a significant number of foreign nations, and apple exports from South Africa have increased over the last ten years. About 46% (559 247 tonnes) of the total crop produced during the 2020/2021 marketing season was exported, 32% (406 983 tonnes) was processed, 22% (196 265 tonnes) was delivered to the local market, and the rest (1 610 tonnes) was dried. In the past ten years, the local market has remained relatively constant, decreasing slightly from 206 271 tonnes in 2012 to 196 265 tonnes in 2021. However, there was a noticeable growth in apple processing and exports from 2019 to 2021.

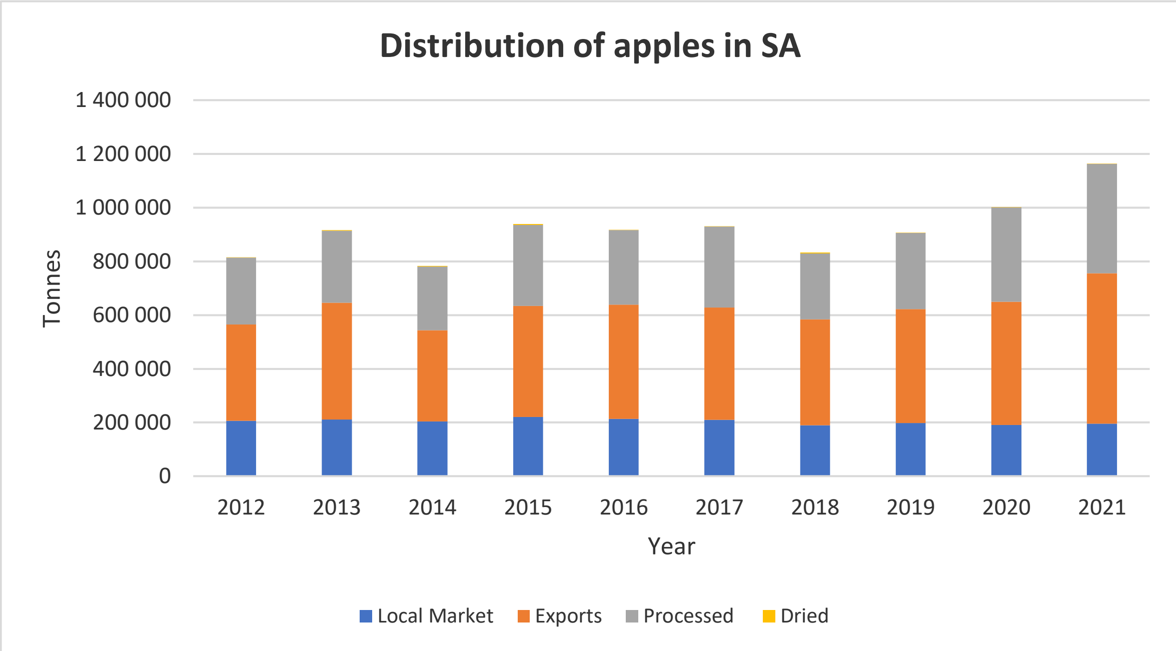

Figure 7: The distribution of apple consumption over the period 2012-2021 in South Africa.
Source: Hortgro (2021)

It is crucial to consider and characterise the apple value chain in order to understand the structure and behaviour of the South African apple sector. The value chain concept is based on the organisational process, or the idea that a manufacturing (or service) organisation is made up of subsystems, each with specific transformation processes, inputs, and outputs (Porter, 1985). Resources such as money, materials, labour, buildings, equipment, land, administration, and management are all used in the purchase and consumption of transformation processes, inputs, and outputs (Porter, 1985). In the apple industry, it consists of suppliers of inputs and farming requisites, producers, fresh produce markets, retailers, processors, cold storage operators and transporters, exporters, the Perishable Products Export Control Board (PPECB), pack house operators, and lastly, terminal and port operators (DALRRD, 2020; Midgley, 2016). The apples are distributed to customers by importers, distributors, market agents, and retailers after they arrive in their destination countries. About half of the income generated along the export value chain stays in South Africa (at delivery to port), and 11% of the international sales price goes to the producer as their share (Midgley, 2016).

Prices and profits are influenced throughout the entire value chain by supply and demand. Significant variations in supply, quality, and price are also passed along the supply chain. For the purposes of this study, only the exporters, fresh produce markets, and processors are briefly introduced.

Exporters are tasked with marketing and selling apples from primary growers at the best market price they can agree upon. The exporters are in charge of maintaining the cold chain, handling produce properly, and guaranteeing the fruit's quality when it reaches the intended market. Therefore, they are in close contact with transporters, agents, cold stores, market inspectors, and regional producer associations, port terminals, the PPECB, and producers.

Figure 8 shows the number of apple cartons exported from South Africa during the last ten years, together with the net realisation. Africa was the main export market during 2021, receiving 29% of exported apple cartons; Asia and the Far East were second with 28% of the apple cartons (Hortgo, 2021).

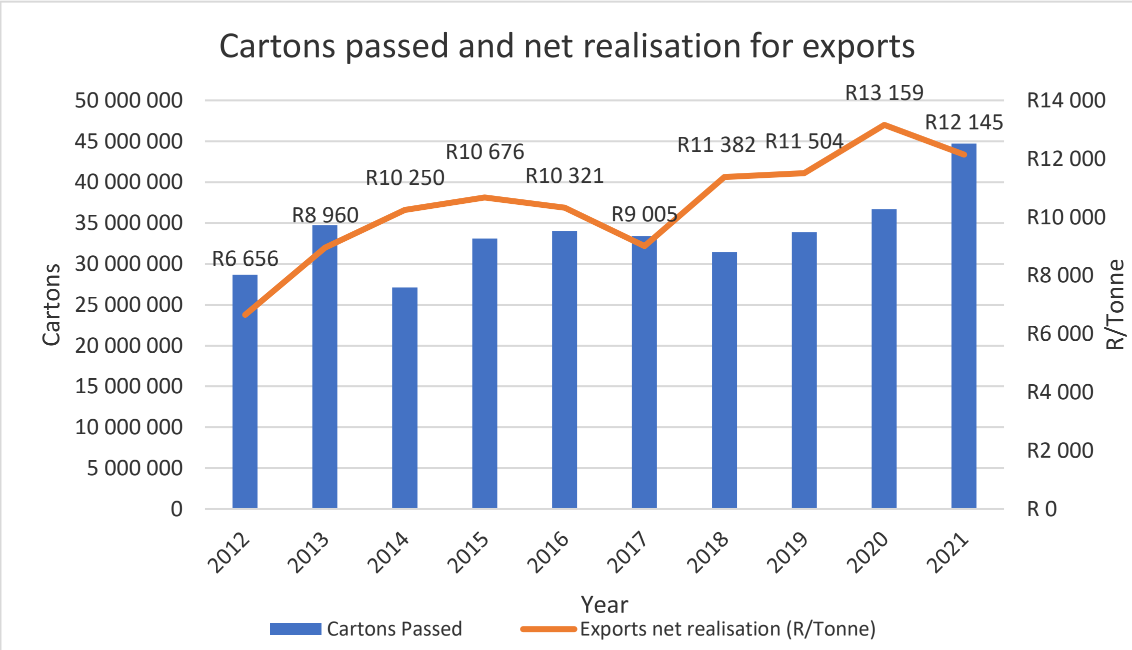

Figure 8: Cartons passed and net realisation for exports of South African apples for the period 2012-2021.
Source: Hortgro (2021); Hortgro (2017)

In the South African apple and fresh fruit and vegetable (FFV) market, fresh produce markets (FPMs) are dominant wholesale outlets. However, other forms of supply do exist, including farmers selling directly to retailers and consumers, independent wholesalers, supermarkets, and wholesaling subsidiaries. The seasonality of production, the perishability of goods, and the quantity of apples shipped all have a significant impact on local market prices. Cold storage facilities, which make sure that there will always be an ample supply of apples for local markets, help to somewhat lessen the influence of seasonality. Prices are also influenced by factors related to demand, including per capita income, product substitution, and customer behaviour.

With an increased distance from the location of surplus, price disparity across markets widens (DALRRD, 2020). For instance, the Cape Town FPM, situated in an apple-producing region with a surplus, experience the least amount of price fluctuation. The FPMs in Johannesburg, Tshwane, and Durban, all located in regions with a deficit in apple production far from the Western Cape, are more prone to price fluctuations. Figure 9 shows local apple market quantities and price patterns from 2012 to 2021.

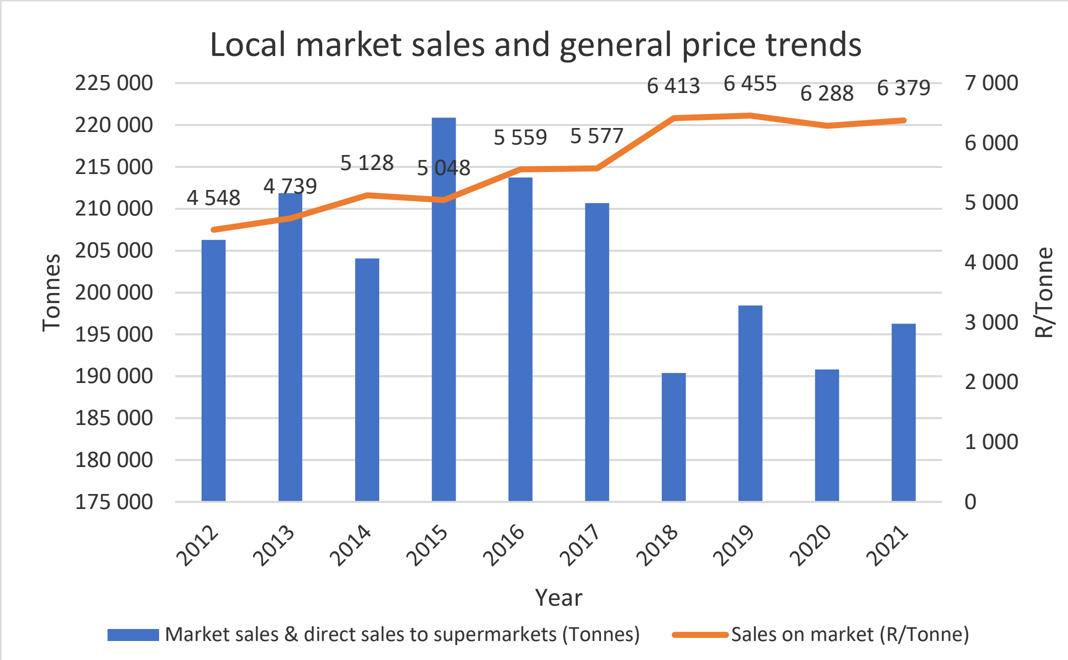

Figure 9: Local market sales and general price trends for apples in South Africa for the period 2012-2021.
Source: Hortgro (2021)

The second-biggest market for South African apples, as shown in Figure 7, is the processed market. Almost all processed apples are susceptible to post-harvest processes that alter their physical and chemical properties. These include classifying, cleaning, chopping, shredding, waxing, combing, and polishing the product, as well as heating, chilling, and freezing the product into its constituent elements. Apples can be juiced, canned, and, if desired, fermented to create pectin, cider, vinegar, or apple juice. Spirits are created by distilling apple cider, and one can also make apple wine. Many winter desserts, including apple pie, apple crisp, and apple cake, have apples as a key ingredient. Apples can also be dried and eaten or reconstituted (soaked in water, alcohol, or another liquid) for later use (DALRRD, 2020).

Apples deemed unfit for the fresh fruit market are used for juice processing. They usually have a diameter of less than 57 mm (Bates et al., 2001). Apple cultivars prone to uneven ripening are typically used to make apple juice. This affects the juice's quality and composition, jeopardising its ability to be sold internationally (Alberti et al., 2016). The objective when processing apples for juice is to ensure a quality product as close to freshly squeezed juice as practically possible. According to Yi et al. (2017), flavour and colour are considered key determinants of a quality juice. Due to their high nutritional value and good sensory quality, cultivars like Fuji and Gala are among the most popular cultivars used for apple juice (Alberti et al., 2016). These two cultivars were initially developed to produce apples for eating, but because of their similar sensory qualities to those that customers seek in apple juice, Fuji and Gala have also become widely used for juice production.

Apple juice comes in two varieties: clear juice and cloudy juice (Figure 10 shows the different conditions needed to create clear juice). Cloudy juice is preferred to clear juice because of its higher phenolic content and related health benefits (Włodarska et al., 2016). Cultivar/genotype, environmental factors, and the fruit ripening stage all affect the phenolic composition of apples and apple juice (Bizjak Bat et al., 2017; Panzella et al., 2013; Wu et al., 2007).

The first juice collected after extraction is cloudy juice, which includes press aid and apple fragments (Bates et al., 2001). Clear juice is then obtained when the extracted (cloudy) juice is processed with pectinases to extract, clarify, and alter the juice. Additionally, apple juice can be used to make apple cider. It is important to remember that while cloudy, unfermented, and unpasteurized apple juice is referred to as "cider" in the United States of America (USA) and Australia, the term "hard cider" (also known as "cider" in Europe and Africa) refers to a fermented, alcoholic beverage (primarily made from apples) with an alcohol content between 1.2 and 8.5%. (Heikefelt, 2011; Laaksonen et al., 2017). Due to the restricted availability of particular cider cultivars, cider producers employ a blend of dessert apples such Royal Gala, Red Delicious, and Cripps Pink to obtain the necessary balance and hasten the fermentation process (Girschik et al., 2017).

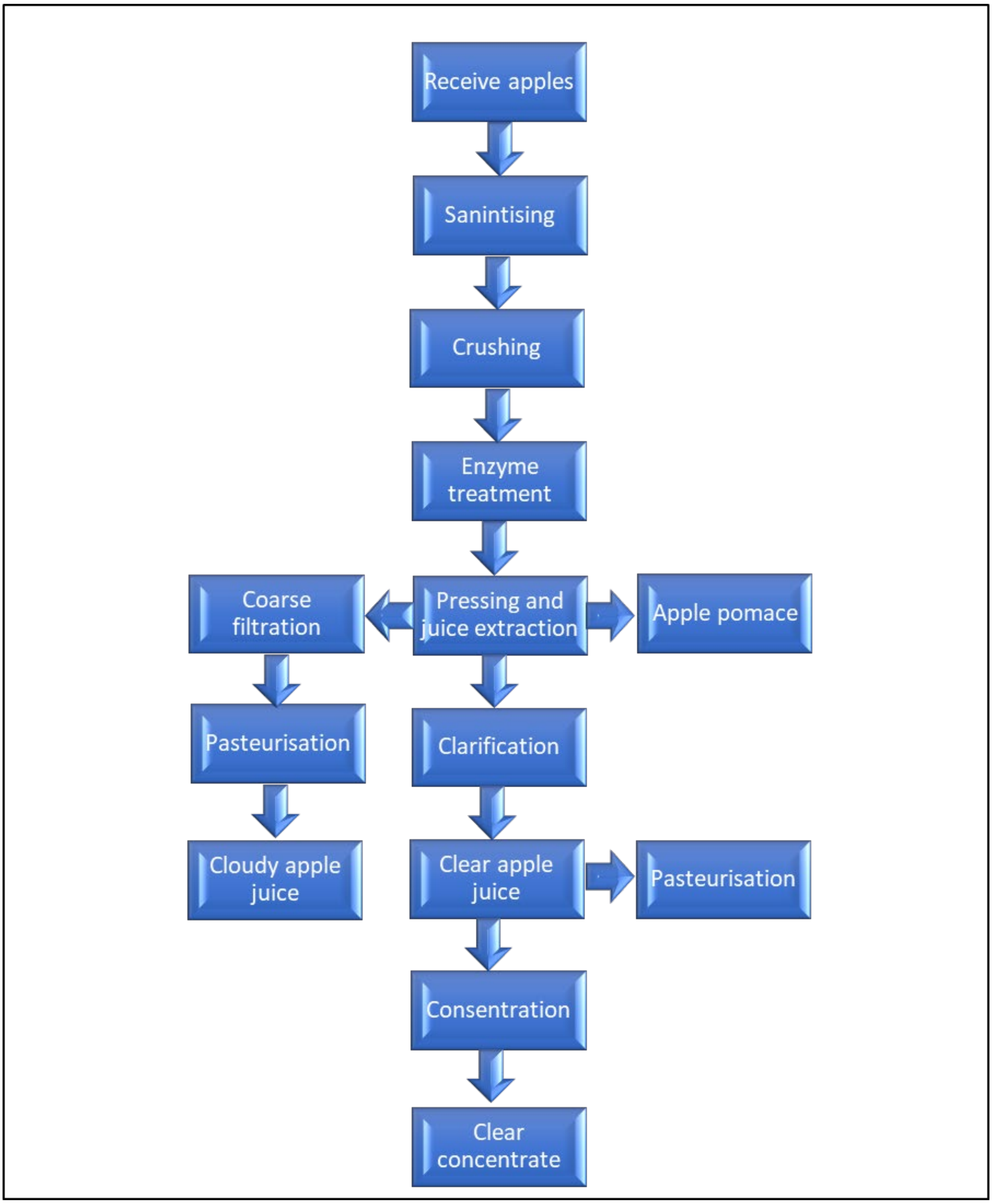

Figure 10: Process for producing clear and cloudy apple juice
Source: Adapted from Rupasinghe and Thilakarathna (2016)

According to Figure 7, the amount of apples distributed for processing increased from 351 193 tonnes in 2020 to 406 983 tonnes in 2021. This growth corresponds with an increase in local market volume from 2020 to 2021 (see Figure 9). Figure 11 demonstrates that prices for apples bought for processing are responsive to the supply and demand principle, as they decreased during the 2016-17 and 2020-2021 seasons when the supply of processed apples increased. In contrast, during the 2015-2016 and 2017-2018 seasons, a decrease in supply resulted in an increase in the price per ton (Hortgro, 2021).

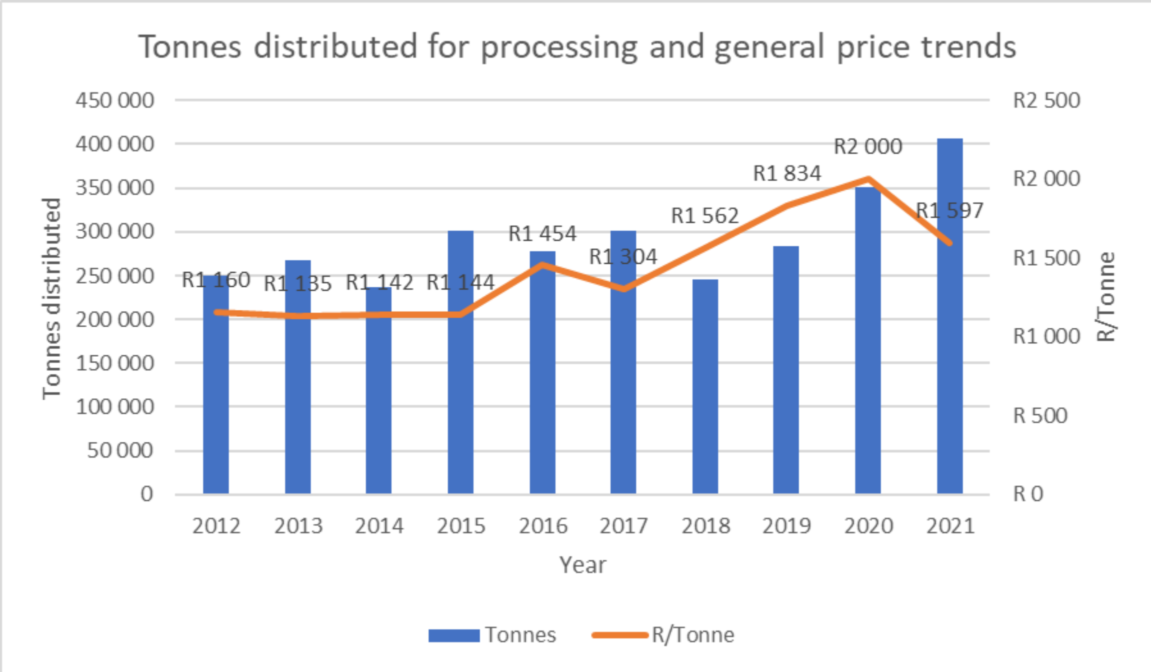

Figure 11: Tonnes distributed for processing and general price trends for South African apples for the period 2012-2021.
Source: Hortgro (2021)

2.3.2.3 Required agricultural conditions and climatic risks

Extreme weather events and climate change have the potential to significantly affect apple income and output. The domestic market would be under pressure and require a greater capacity for fresh fruit consumption and fruit processing due to quality issues with second- and third-grade fruit. The primary risks that climate change holds for production include a lack of winter cold units, especially in arid regions, heat stress and unfavourable temperatures during critical developmental stages, environments that favour pests and diseases, a lack of water for irrigation, hailstorms and flooding, and conditions that encourage pests and diseases (Midgley, 2016).

The fruit size is determined by crop load and genetic biological carrying capacity. However, the environment in which the fruit grows attenuates this potential, with the aim to maximise the financial benefits from commercial apple orchards. A fairly broad range of temperatures and latitudes supports the commercial cultivation of apples, and a variety of factors can significantly affect production and fruit quality. It is important to understand the effects of variables (Warrington et al., 1999), such as the length of the growing season, seasonal radiant energy accumulation, and the distribution of accumulated growing temperatures (Stanley et al., 2000).

Apple trees thrive in temperate climates with cold (high-chilling) winters and hot, dry summers. They shouldn't be planted in places where late frost is likely. Like most fruit trees, the adaptability of an apple cultivar will depend on how many cold units exist in the region in question. A deciduous fruit tree needs a certain amount of cold hours or days each year to produce flowers and fruit, which are measured in "cold units." Cold unit requirements are high for apples (900 to 1 200 or more). Inadequate cold units may delay foliation, which normally results in poor growth and yield (African Farming, n.d.).

Apples should not be grown in acidic or sandy soils. They require fertile, well-drained soil that has been prepared and has a potential root depth of at least 600 mm. It is best to drain soil or avoid soil that exhibits evidence of recurring or ongoing moisture (African Farming, n.d.).

How much and how frequently a farmer should irrigate depends on a variety of factors, including climatic conditions, soil type, water availability, the age and size of the trees, and the method of irrigation utilised. While clay soils require more water delivered at longer intervals, sandy soils only require a little water administered frequently. Generally, immature trees require 300 to 400 mm of water annually, and mature, fully bearing trees require 500 to 700 mm (African Farming, n.d.).

A variety of climate models predict that warming and changes in seasonal and rainfall characteristics, including the possibility of both more and less rain, will occur in the key apple production regions as a result of climate change. Significant reductions in winter chilling, increased heat stress, more frequent water shortages in storage dams that result in irrigation water restrictions, an increase in postharvest issues like scald and bitter pit, changing hailstorms, and pest outbreak risks are changes that could harm apple farming the most (Midgley, 2016). A change in the dates of flowering and harvesting could cause marketing windows to close (Midgley, 2016). The need for and price of energy for production (pumping irrigation water), packing, cold storage, refrigerated shipping, processing, and cooling merchant shelves would all increase with a warmer climate (Gindaba and Wand, 2005; Gouws and Steyn, 2014).

Almost all fruit cultivation in South Africa is irrigated due to the country's typically low and irregular rainfall levels and the high value of fruit crops (Gush and Taylor, 2014). It is expected that climate warming will increase soil water evaporation and plant transpiration. More frequent restrictions on irrigation water would result from projected reductions in winter and annual precipitation, the potential for more frequent and/or severe droughts, and the risk of dams not filling sufficiently (DEA, 2013). Orchards would subsequently be under stress, which would lower yields and fruit quality (Midgley, 2016).

Energy use and costs will rise as energy demand for cooling and irrigation increases. The fresh apple value chain includes cooled storage and packing houses, refrigerated container trucks, cold stores at South African ports, refrigerated containers on ships, cold stores upon arrival in foreign ports, and refrigerated distribution to retailers and markets (DAFF, 2014). Maintaining the cold chain is crucial in all of these stages. The current situation, in which increasing risks and costs are either carried by farmers or transferred to merchants and ultimately reflected in the price of fruit, is expected to continue. Those in the value chain who will likely bear the brunt are farmers and consumers.

Due to rising water prices, processors (juicing and canning) will face higher risks, which may affect decisions on water allocation. Energy prices are expected to rise as a result of the national requirement to cut energy demand and move to a low-carbon economy. This will also have an effect on the transportation element of the value chain (Midgley, 2016).

According to Midgley et al. (2014), climate change will result in significant changes, such as moving the frontal storm tracks that bring rain south during the winter. Weather data indicates that there has already been a steady increase in temperatures (0.2°C per decade) with the summertime being more pronounced. Additionally, some regions have experienced fewer rainy days during the summer, autumn, and early spring (August) but more rainy days during the early summer (November to December). This could mean that the rainy season will begin and end later (Midgley, 2016).

2.4 Low-chill apples

2.4.1 Background and market

Apple cultivars that can be produced in warmer climates must be developed in response to climate change. The reality is that traditional apple-growing countries are becoming less suitable for apple cultivars that have high chilling requirements. This is already being experienced in several global production regions, including South Africa (Soeker, 2015) and Australia (Parkes et al., 2020). The minimum amount of cold weather required to break bud dormancy and trigger blooming is referred to as the "chilling requirement." For the South African apple industry, low-chill requirement (LCR) apple cultivars have been developed to reduce climate change-related hazards to fruit production and to allow planting in places that weren't previously thought to be viable (Kim et al., 2019; Labuschagne et al., 2000). Customers can acquire fresh apples during the early harvest season of LCR varieties, which occurs in South Africa from mid-December to early February when growing circumstances are favourable (Soeker, 2015).

Since these cultivars only maintain their soft, crunchy texture for a short time in cold storage (up to two months), they show potential for use in the manufacturing of apple juice/cider. Pink-fleshed (PF) apple varieties, prized for their pink or red juice with high phenolic concentration (Février et al., 2017; Malec et al., 2014; and Rupasinghe et al., 2010), are another non-traditional apple cultivar of interest to the beverage industry.

These apple varieties are referred to by the common name "Low-Chill". It is more accurately defined as low winter chill requirement apples because they require a small number of chilling hours between 4°C and 7°C to break their winter rest (Stander, 2020). Additionally, Kim et al. (2019) and Labuschagné et al. (2000) reported that their cultivation lowers the hazard of fruit production brought on by climate change. These varieties vary slightly in look and eating quality, but they are all generally sweet-tasting, juicy apples with a rather limited shelf life given their soft, crunchy texture (up to eight weeks).

Currently, the most common LCR apple cultivars planted in South Africa are African Carmine (196.12 ha), Afri-Glo (76.33 ha), Afri-Star (72.07 ha), African Red (64.06 ha), Afri-Blush (39.75 ha), Afri-Coral (10.14 ha), Afri-Rose (7.57 ha), Afri-Sunrise (3.50 ha) and Afri-Ruby (2.52 ha) (Anderson, 2023). Juice yield improves their juicing capability as compared to commercial apple cultivars used to manufacture juice. This is a crucial factor in terms of the economics of the product, as are quality parameters like total soluble solids (TSS), pH, individual sugar concentration, titratable acidity (TA), and colour. Their phenolic composition and sensory profile may also play a role in cultivar selection (Stander, 2020). Research on LCR apples from the 2015–2016 growing season by an independent evaluation company revealed that these cultivars have a sweet flavour and a low to medium acid content. These apple varieties' ripe apple skin is typically striped or flushed red with a yellow background. Although these cultivars generally have a limited shelf life, they are renowned for their crisp texture when harvested (Stander, 2020).

The profitability of apple orchard operations is impacted by fruit yield, the price of the product, establishment costs, and operational costs. One of the concerns apple producers have is the future availability of labour to prune trees, thin out flowers or fruit, and pick fruit. Like fresh market apples, a long-term sustainable production plan for cider apples may involve the use of technology for labour-intensive processes like fruit pruning, thinning, and harvesting (Miles et al., 2020). The most important of these activities is harvesting, which can add 30% or more to the cost of production when done by hand (Farris et al., 2013; Klonsky and Stewart, 2014; and Miles and King, 2014). Since cider apples are used to produce juice, mechanical harvesting methods may differ from those of fresh market apples. Punctures and bruising caused by the shock of mechanical harvesting could be acceptable, although post-harvest storage life would be shortened (Alexander et al., 2016). Recovering lost fruit from the orchard floor for use in cider may become acceptable because the alcohol in the fermented product should inhibit microbial growth (Ewing and Rasco., 2018).

Traditional cider apples contain characteristics that add significant and distinctive qualities to the finished cider. These qualities include bitterness and astringency, sweetness, sharpness, and flavour. Hard cider can be produced by combining juice from two or more cultivars, each of which has a subset of these qualities, or by using a single cultivar that possesses all these qualities (Miles et al., 2020).

The intensive and profitable cultivation of high-quality fresh market fruit with highly structured and expensive orchard designs may be challenging in certain areas of South Africa due to agricultural conditions (mainly heat); therefore, low-chill apple cultivars might be a solution. It's possible that the development of mechanised pruning and harvesting techniques for these cider market apples may have the biggest influence on profitability and orchard design.

2.5 Integrating low-chill apples into a typical wine farm

The major goal of this study is to assess the expected management and financial effects of incorporating low-chill apples into a typical wine farm in particular areas. When integrating low-chill apples into a typical wine farm, it is important to assess the differences in management and production requirements. For the farm business to be successful, the infrastructure is a crucial component in the production process. It will be necessary to modify or adapt the infrastructure when farms diversify their production to include low-chill apples. For wine grape growers to be successful in producing apples, they will certainly need to invest in additional technology, labour, and equipment.

2.5.1 Production considerations

2.5.1.1 Land and water

The region in which the vines are grown is thought to influence the quality and taste of the wine. A terroir is a collection of uniform environmental units, or naturally occurring terroir units, based on the commonality of the produced goods (Van Leeuwen and Seguin, 2006). It is viewed as a cultivated ecosystem in which the vine interacts with natural environment variables such as soil and climate (Van Leeuwen et al., 2018). As a result, it is an illustration of a site's capacity for agriculture because of the interaction of many environmental factors. These environmental factors include topography (slope, exposition, sunlight exposure, and landscape form), soil (mineralogy, compaction, soil water reserve, granulometry, depth, and colour), and climate (relative humidity, rainfall, air temperature, direction, soil temperature, and intensity of dominant winds) (Van Leeuwen and Seguin, 2006). Since each of these elements interacts with the other, it is hard to determine which combination is best. For example, it is impossible to discuss the appropriate environment for making premium wines without considering the cultivar and local soil type (Van Leeuwen et al., 2018).

There are many different types of vineyard soils, and each type affects the quality of the wine. The variety of these soils is surprising considering that they are all found on quite affluent estates. High-quality potential vineyard soils can have a range of properties, including a fine or coarse texture, a high or low pH, and a high or low level of organic matter. This shows that there is no straightforward relationship between soil type and wine quality (Van Leeuwen et al., 2018), but Roby et al. (2010) did find evidence of a relationship between soil type and wine quality.

If the quality of the soil affects the composition of the grapes and the wine, the vine must obviously be a conduit for that influence. It is necessary to consider interactions between the soil and the vine (as well as possible changes in climate) to understand how terroir affects the composition of wines. The soil offers the vine support, nutrients, water, and a certain temperature range in the root zone. Thus, the dynamics of vine development, phenology, and grape ripening must be considered in relation to the effects of soil water, soil temperature, and soil mineral supply on terroir (Van Leeuwen et al., 2018). Growers aiming for the best terroir expression adjust their choice of grapevine variety to the local climatic circumstances by planting early-ripening varieties in cool to high-chill regions and late-ripening varieties in warm climates (Van Leeuwen and Seguin, 2006). Energy balance, which is correlated with soil colour, the percentage of sunlight reflected off the soil, slope steepness, and slope direction, determines soil temperature. Due to water's large specific caloric capacity, wet soils warm up more slowly than dry soils (Tesic et al., 2002).

Climate (rainfall), the soil's capacity to hold water, the rate of transpiration, the depth of the roots, and irrigation methods—when used—all have an impact on the water status of vines. The fraction of coarse components and rooting depth both have a significant impact. According to Van Leeuwen et al. (2009), the soil water holding capacity of vineyards varies greatly, ranging from 50 mm in relatively shallow soils with a sandy texture and a high percentage of coarse components to over 350 mm in silty soils that permit deep rooting (Van Leeuwen et al., 2018). Wine quality, fruit composition, and vegetative and reproductive growth are all significantly influenced by the water status of the vine.

The presence of mild water deficiencies, especially in red wines, is one of the key driving elements terroir expressions. Complete irrigation is incompatible with the expression of terroir. Extreme water stress can lower yields and possibly even grape quality potential in very dry places. To achieve commercially viable yields and prevent significant damage to vines and grapes in dry conditions, irrigation is widely used in New World production zones (Van Leeuwen et al., 2018).

Vine roots are frequently shallow in irrigated vineyards, and the water supply to the plants is rarely buffered, so water becomes abruptly available right after an irrigation event and quickly decreases once the applied water is absorbed (Van Leeuwen et al., 2018). For soil scientists and viticulturists, the concept of soil depth has a distinct connotation. For soil scientists, the depth of the soil is a representation of the weathered layer above the parent rock. The root system typically explores this stratum when vines are established. For viticulturists, soil depth is equivalent to rooting depth, which, in cases when the parent material is either soft or cracked, can go beyond the weathered soil layer. Deep rooting is required in sandy soils with significant gravel concentration since the soil's ability to retain water is so limited, putting plants under excessive water stress during dry summers (Van Leeuwen et al., 2018).

On the contrary, there is a negative correlation between rooting depth and wine quality. Deep rooting gives vines access to less water and possibly nitrogen, which boosts vine vigour and output. As a result, the grapes' quality characteristics, particularly the tannins and anthocyanins needed to make red wine, are reduced. The top 20 cm of the soil is typically overly nitrogen rich, making it undesirable to establish roots in this area. As a result of possible dilution of the grape components, roots close to the soil surface may also absorb water from rainfall events close to the harvest date (Van Leeuwen et al., 2018). Roots are less likely to colonise the layer just below the soil surface when the vineyard floor is managed using cover crops or mechanical weed removal (tillage).

Man has a significant impact on how terroir is expressed because this environment is cultivated. Through the selection of plant material and management techniques, he or she can direct the expression of terroir. This makes it feasible to control terroir and maximise its expression in each place (Van Leeuwen et al., 2016). High-quality red wine production necessitates a slight water deficit. Inadequate water deficits frequently have a detrimental impact on red wine vines. As there are no obvious indications in the vines, growers may easily ignore them.

The same principles also apply to the production of apples. This is a key consideration, as the crop will differ but not the orientation or purpose of the production system. The frequency and level of irrigation for apples depend on a variety of factors. These include climatic conditions, soil type, water availability, the age and size of the trees, and the method of irrigation used (African Farming, n.d.). The annual volume restrictions, flow rates, and places where water can be used are all considerations that growers need to be aware of to assess whether their water supply is suitable for the site and size of the intended orchard.

Wine grapes require between 4 000 and 5 500 m^3 of water per hectare annually. This is much less than apples, which are water-intensive and need between 9 000 and 11 000 m^3 for irrigation (Bezuidenhout, 2020). Irrigation efficiency, specifically targeting the root system, is promoted by drip and macro irrigation systems (Camp, 1998). The producer’s water and soil resources, the layout of their orchard, and their financial situation will all influence the type of irrigation system selected. Highly effective orchard irrigation methods are increasingly used as water supplies become more limited. Microsprinklers are effective, offer options for fertigation, and, when set correctly, may adequately cover trees even in soils with pores. Through a reduction in canopy moisture, these devices can help stop the spread of disease.

Sprinkler irrigation systems are the most effective irrigation methods to disperse water evenly and reduce water loss (Dasberg and Or, 2013). Due to its ability to prevent issues like soil aeration and its suitability for providing supplemental irrigation, drip irrigation is the best approach for vineyards (Dasberg and Or, 2013). The flow rate and effectiveness of the irrigation system will affect the amount of water required to irrigate orchards. The efficiency of sprinkler and drip systems utilised in most orchard applications ranges from 75% to 90% (Montana State University, n.d.).

Before selecting a location, growers should consider the soil and the microclimate. Fertile and well-drained soil is ideal for apple growing, and poor growth has been reported in alkaline and low-elevation areas. There are nine variables that might affect apple growth: soil type, drainage, pH, rainfall, land cover, present land use, mean temperature, slope, elevation, and the orientation of slope (Admasu et al., 2022).

2.5.1.2 Labour

There is no labour shortage in South Africa, and both apple and wine farms employ permanent and seasonal workers. For the purpose of this thesis, the term "permanent jobs" refers to the tasks carried out by formally hired labourers as permanent employees on a specific farm. In addition, farms employ a sizeable number of on-farm workers who perform "regular employment" alongside permanent workers on an "as needed" basis. These workers are frequently the female partners or dependents of permanent male workers (Du Toit and Ally, 2003). A seasonal farmworker is one who works primarily in agriculture on a seasonal basis. For planting, maintaining, harvesting, and processing crops for human use, farmers rely on this type of workforce (Anthony et al., 1987).

The permanent employees' job descriptions on a wine vineyard typically include activities like pruning, machine operating, canopy management, spraying, irrigation maintenance, weed control, harvesting, fertilising, and maintenance of infrastructure. Seasonal labour is needed for large-scale agricultural activities like harvesting, canopy control, and pruning. Vine pruning occurs between June and August, after the harvest season. Harvesting runs from middle January to middle April, and canopy control runs from October to middle December.

On apple farms, pruning should be done when a plant is dormant (from mid-July to the end of August). Removing water shoots during summer pruning (both after and before harvest) is an efficient approach to increasing the amount of sunlight reaching the centre of the trees. The manipulation of young trees takes place from middle December to middle January. When the growth conditions are favourable, low-chill apple cultivars will be harvested from mid-December to early February in South Africa (Soeker, 2015). For apple production, seasonal labour is needed for thinning, tree manipulation, pruning, and harvesting.

All of the above are important considerations when integrating low-chill apples into a typical wine farm. There won't be a need for more permanent labour because the present wine farm's permanent workers will already be employed. Yet, seasonal labour will be required more frequently and in greater quantities throughout the year. The fact that the vines and apples' harvest seasons don't overlap is a potential benefit for incorporating low-chill apples into a typical wine farm.

2.5.1.3 Capital and structural requirements

Capital requirements and structural changes are important considerations when incorporating low-chill apples into a typical wine farm. This is despite the seasonal labour for harvesting, pruning, thinning, and tree manipulation. The farmer will require ladders, folk lifts, bin trailers, and sprayers to harvest, prune, and thin the apples when integrated into the wine farm. Sometimes there might be a few additional requirements.

In Chapter 4, the structural and financial requirements will be described in detail.

2.6 Selected areas

2.6.1 Overview of the specific areas

The Robertson, Paarl, and Worcester areas were selected for the purposes of this study (Figure 12). These locations are all in the Western Cape. Each has access to adequate water to enable the production of apples, and there are low-chill apple trial sites that can be used as a reference point as new data becomes available. According to the total amount of land used for wine grapes, Worcester has 6 417 ha, Robertson has 12 690 ha, and Paarl has 14 631 ha (SAWIS, 2021). The following sections presents more detail on each of the areas indicated in Figure 12.

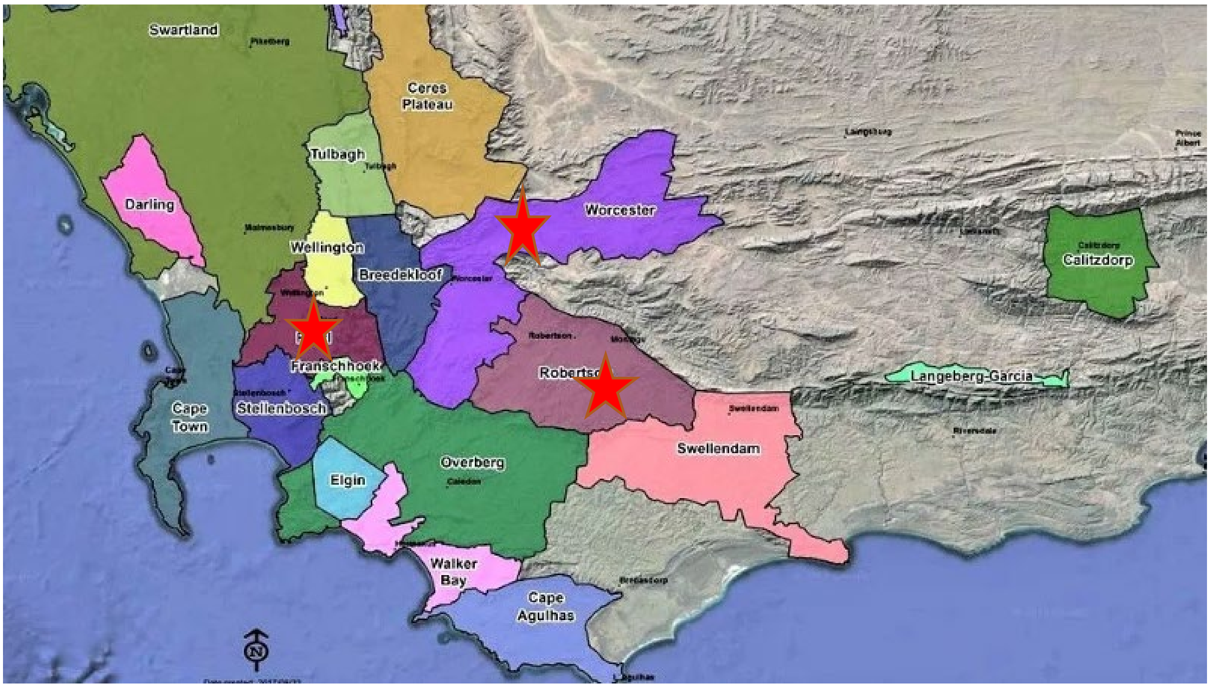

Figure 12: Map of the main wine districts in the Western Cape (the stars indicate the areas included to assess the financial impact of including low-chill apples into the production system).
Source: SAWIS (2022)

2.6.2 Robertson

2.6.2.1 Background

Robertson is the largest town in the Langeberg area, rich in history, and actually called the Valley of Wine, Horses, and Roses. With Victorian and Georgian homes and cottages along the streets, the town, which was founded in 1853, has a significant and well-preserved architectural legacy. Robertson is the western entrance to The Heart of Route 62 and only one and a half hours from Cape Town. It is geographically located in the shadows of the Langeberg, and irrigation comes from the Breede River (Robertson, n.d.).

Robertson is part of the Breede River Valley region and is made up of fourteen wards, namely, Agterkliphoogte, Ashton, Boesmansrivier, Bonnievale, Eilandia, Goedemoed, Goree, Goudmyn, Hoopsrivier, Klaasvoogds, Le Chasseur, McGregor, Vinkrivier, and Zandrivier (WOSA (3), 2021).

2.6.2.2 Agricultural conditions

The Robertson district, known as the "valley of vineyards and roses," is ideally suited for cultivating wine due to its lime-rich soils. The Breede River runs through this area and feeds it, as it has relatively low rainfall. Despite the possibility of high summer temperatures, the valley receives moist air from cooling southerly winds (WOSA (3), 2021). The Robertson Wine Route is the Cape's largest irrigation-based wine region and a Wine of Origin location. Robertson is one of South Africa's top wine-producing areas, consisting of eleven cooperatives, fourteen estates, and six private growers. Vineyards and orchards encircle and expand into the town's centre from the surrounding farmlands (SA Places, n.d.).

Robertson is renowned for high-quality wines. The area is distinguished by its peculiar characteristics of diurnal temperature changes that produce rich and distinct flavour profiles and pockets of limestone similar to the French region of Chablis (Robertson, n.d.). While it has historically been associated with white wines and is best known for its Chardonnays and more recently for Sauvignon Blanc, it also produces some of the best red wines in the Cape, notably Shiraz and Cabernet Sauvignon, as well as the distinctive fortified dessert wines for which it was first renowned (WOSA (3), 2021). The region's total wine production covers 12 690 hectares and makes up 14% of SA's wine grape vineyards (SAWIS, 2021).

The weather is generally clear all year, with hot, dry summers and cold, damp winters. The temperature rarely drops below -0.5°C or rises above 38°C and normally fluctuates between 4.44°C and 32.2°C (Weather Spark, n.d.). Robertson receives most of its water from the Dassieshoek and Koos Kok Dams in the Langeberg Mountains, the Robertson (Brandvlei) Irrigation Canal, and the Hoops River Irrigation System. For the town's potable water needs, water from the mountains, together with water from the Hoops River and the Irrigation Canal, is used. The other water sources are used for garden irrigation (Langeberg Municipality, n.d.). Breede River Valley has little yearly precipitation, which results in hot temperatures with dry summer breezes in the Robertson region. The vineyards located along the flood plains of the area benefit from a variety of soil types, ranging from gravelly, lime-rich alluvial soils to red, Karoo, and clay loam soils, producing fruity, approachable wines (Greatest Africa, n.d.).

2.6.3 Worcester

2.6.3.1 Background

In 1842, Worcester received municipal status after being founded in 1820. It is a well-known centre for viticulture, and its economic foundations include wool milling, brandy distillation, fruit processing and canning, and light manufacturing.

Worcester is located in the middle of the Boland and is part of the Breede River Valley region. It consists of four wards, namely, Hex River Valley, Nuy, Scherpenheuvel, and Stettyn (WOSA (3), 2021). The total wine production in the region covers 6 417 hectares and represents 7% of all SA wine grape vineyards (SAWIS, 2021).

Worcester is located in the heart of the Cape Winelands, which consist of a variety of wineries.

2.6.3.2 Agricultural conditions

This area is the most significant brandy-producing region in South Africa, and the location of the largest distillery of its sort in the southern hemisphere is located in the historic town of Worcester. The Worcester Wine Route contributes over one-fifth of the nation's vineyards and more than a quarter of the nation's total wine and spirits production, making it a prominent participant in this industry (South African History, n.d.). Many of the cellars in this area bottle premium wines under their own labels. This district is made up of various wards (WOSA (3), 2021). Worcester is a part of the Cape Winelands and is administered by the Breede River Valley Municipality. The Worcester region has been making wine for many generations and is renowned nationally for its Cabernet Sauvignon, Chenin Blanc, and the less well-known Columbar. Yet Worcester is home to a diverse range of agricultural activities, including orchards, table grapes, and livestock, in addition to wine.

There are three private and 24 cooperative wine cellars on the Worcester Wine Route, as well as two brandy cellars and distilleries (SA Places, n.d.).

Summer and winter are respectively hot and dry and cold and damp, with the occasional snow on the mountain peaks. The average annual temperature ranges between 4.44°C and 33.33°C, rarely falling below 0°C or rising above 39°C (Weather Spark, n.d.). The local climate is generally mild, warm, and temperate. Worcester experiences an average annual temperature of 16.6 °C, with February being the hottest month of the year with an average temperature of 22.3 °C. The coldest month is July, with average temperatures of 11.0 °C. However, Worcester has a significant annual rainfall of 487 mm per year (Climate Data, n.d.).

2.6.4 Paarl

2.6.4.1 Background

Paarl is South Africa's third-oldest European settlement. As a result of its unique past, it has an exceptionally multicultural community (Cape Town Travel, n.d.). When French Huguenot settlers arrived in Paarl in the 1680s, they planted orchards and vineyards, establishing the region's long wine-making tradition. Due to its famed red wines, the Paarl Wine Route, commonly known as the "Red Route," is now one of South Africa's top wine-producing regions (SA Places, n.d.).

Paarl is a part of the Cape West Coast subregion, which is a part of the Cape Coast (coastal region). The Simonsberg-Paarl, Agter-Paarl, and Voor Paardeberg wards, located on the desirable foothills of the Simonsberg, are all part of the Paarl district (WOSA (3), 2021). A total of 14 631 hectares, comprising 16% of the SA wine grape vineyard surface, are distributed throughout the region's wine production (SAWIS, 2021).

2.6.4.2 Agricultural conditions

The Berg River, which flows through Paarl, is the lifeblood of this region. Its borders are the Groot Drakenstein and Wemmershoek mountains. Prior to harvest, during the hot growing season, the valley needs additional irrigation. Vineyards on the eastern slopes, where higher water retention occurs, usually require no additional irrigation (SA Places, n.d., WOSA (3), 2021). In Paarl, a wide range of grape varieties are planted, with Cabernet Sauvignon, Shiraz, Pinotage, Chardonnay, and Chenin Blanc being the most prevalent (WOSA (3), 2021).

The Paarl wine region has three primary types of soil: Table Mountain sandstone, decomposed granite, and Malmesbury shale. The vines are cultivated on the sandy soil of this sandstone along the Berg River, which flows through Paarl from south to north in the eastern sector. Similar to Stellenbosch, the soils in the Paarl district have low pH levels, necessitating thorough ploughing and heavy applications of agricultural lime (SA Places, n.d.).

The winters are long, cold, wet, and occasionally cloudy in Paarl, whereas the summers are warm, dry, and primarily clear. The average annual temperature ranges from 5.55 to 30.55 degrees Celsius, rarely falling below 1°C or rising over 36°C (Weather Spark, n.d.). With an average temperature of 22.5 °C, February is the warmest month of the year. July has the lowest average temperatures of the year at 10.5 °C, while 821 mm of rain falls annually (Climate Data, n.d.).

2.7 Conclusion

The chapter included an overview of the wine grape and apple farming industries in South Africa to highlight trends and the sector's significance for both the domestic economy and the global economy. Some alarming trends in the wine sector were highlighted, prominent among them the significant decline in the area planted with wine grapes during the past ten years.

Hence, the low-chill apple farming environment was analysed in this chapter, with the primary objective of this study being to assess the anticipated financial and operational implications of integrating low-chill apples into a typical wine farm in specific areas. This covers some crucial information regarding the market for these apples as well as the sector. Finally, certain crucial considerations must be made when low-chill apples are used to diversify wine grapes. Apples are a crop with a very high water intensity, so it is important to carefully consider the water availability while adding them to a wine farm. Apple farming requires a little more labour than wine farming; therefore, a typical wine farmer would need to have access to additional labour. Nonetheless, there are benefits to growing low-chill apples and wine grapes together, including the fact that certain tasks, such as harvesting, do not clash.

Only three major areas—Robertson, Worcester, and Paarl—are subject to this study. So, this chapter concluded by providing a brief history of each of these regions and outlining the specific agricultural conditions related to each of them.

Chapter 3: Approach and methods

3.1 Introduction

Agricultural production systems and decisions are complicated due to the high level of uncertainty, even though information is available to help farmers with their decision-making process. Due to the interdependence of enterprise, regional, and worldwide systems in agricultural production, the environment in which decisions are made is more complicated (Banson et al., 2015). The variety of crops and livestock, the use and adoption of new technology, and the fluctuation of product and input prices, among a range of other factors, all contribute significantly to the increasingly complex structure of farming systems (Hoffmann, 2010).

Without thorough knowledge of the systems utilised in management activities, farmers are continuously faced with the risk of needing to predict outcomes. This has motivated economists to search for improved frameworks and techniques to help evaluate and clarify agricultural systems. From this, the systems approach and methods to construct models and develop simulation techniques have been expanded for the agricultural environment (Hoffmann, 2010). To better understand the farm management decision-making environment, a whole-farm systems approach is implemented.

The previous chapter emphasised the wine grape and apple industries. In this chapter the objective is to present a technique for quantifying the expected financial implications. The systems thinking method is used to evaluate the complex scenario of including a new enterprise on farm level. The types of models that can be used are discussed, with special attention given to deterministic simulation models. An overview of the whole-farm budget model's structure is provided. The method for data collection is also described. Finally, the model's various components are introduced and described. In this study, one key financial indicator—the Internal Rate of Return on Capital Investment (IRR)—serves as a primary measure of whole-farm profitability for different scenarios.

3.2 Orientation of research

This study is exploratory in nature, as low-chill apple production is currently not common in these regions. As a result, there is no data available on the performance of low-chill apple production for the juice market in these areas (Van Graan, 2023). This type of research is both exploratory and hypothesis-generating rather than testing since it is impossible to predict in advance whether the findings will be innovative. Exploratory research is described as research conducted to address an issue that is not yet well understood. It is carried out to gain a deeper understanding of the current issue, but it won't produce definitive findings but rather guidelines for production and decision-making. As a result, the purpose of this study is limited to exploring the research questions. It is not aimed at providing definitive, comprehensive answers or solutions about the managerial and financial impacts of integrating low-chill apples into a typical wine farm.

3.3 Research approach: systems thinking

The systems thinking approach was used due to the complexity of agricultural production systems. Negative trade-offs have impeded agricultural development over the past century. As a result, systems theory was developed to provide concepts and techniques to better comprehend complex systems (Schiere et al., 2004). The development of the systems thinking approach dates back to the 1950s and 1960s (Bosch et al., 2007; Checkland, 1988).

One can attempt to better comprehend the underlying causes of these complex behaviours, predict them, and ultimately modify their effects by utilising systems thinking. The exponential expansion of systems in our environment has increased the demand for systems thinkers to address these challenging issues (Arnold and Wade, 2015). The systems thinking school of thought created the idea that organisations should be viewed as a collection of interconnected parts. System thinkers look beyond specifics towards the larger context, focusing on the interactions they form part of. Systems thinking acknowledges changes in one aspect of a system that may have a negative or positive effect on other components or on the outcome of the total system. As a result, it encourages self-organisation and emergence at all levels, meaning that the system works to maintain its internal equilibrium to prevent the silo effect (Banson et al., 2015). It was also crucial to the advancement of agricultural research since it compelled the sub-disciplines of agricultural science (animal, soil, and plant) to unite and be seen as parts of a whole-farm business.

The systems thinking approach is critical to achieving the objectives of this study due to the multiple aspects that affect the profitability of the whole farm and to avoid the risk of evaluating a component in isolation. First, the physical and biological components will be examined, and then all inputs and variables will be integrated for the financial result.

3.3.1 Systems approach

A system is a collection of parts that interact with one another, enabling it to carry out certain tasks that are simultaneously impacted by external influences. The components of a system provide structure, while the interrelationships between these components provide function. The idea that systems operate as an integrated whole and are inseparable is a key concept in the working definition of a system (Hassan et al., 2020). When a system receives a stimulus, the underlying relationships that exist within its boundaries affect the behaviour of the system as a whole, which leads to an outcome. The stimulus can be received throughout the system or just in specific areas.

The fact that the system's features, traits, and properties do not exist in the system's individual components is one of the key reasons why the systems approach is necessary (Ikerd, 1993). Adopting a systems-thinking approach is essential because it gives you the knowledge and skills you need to see a situation from multiple angles or to understand the whole picture. This helps to uncover the underlying presumptions and mental models, as well as the hidden linkages and connections involved (Hassan et al., 2020).

A systems perspective integrates rather than isolates aspects and sees the parts and relationships within systems as interrelated. Systems analyses can be carried out in a number of ways, but the two most significant are qualitative systems analysis, which employs diagrams, and quantitative systems analysis, which uses simulations and optimisation modelling (Nel, 2019). Quantitative systems analysis is used in this research in the form of simulation modelling.

Farmers have difficulties in the ‘real world’ when coping with changes as well as predicting upcoming prospects and effects. This has encouraged agricultural economists and other stakeholders to develop better techniques, answers, and strategies for assessing and illuminating ideas in agricultural systems. Systems thinking, which is at the core of model development and simulation techniques, was developed and refined as a result. This can help resolve issues that develop in intricate agricultural circumstances (Hoffmann, 2010).

3.3.2 Systems approach in agriculture

Diversifying farm systems reduces risk and unpredictability. Changes in weather patterns, international competition, the impact of exchange rates, the socioeconomic environment, and the political environment all affect risk and uncertainty in farm systems. Additionally, elements unrelated to farm systems can also have an effect (Hoffmann, 2010). Factors such as the ability to make decisions, skills, and preferences complicate farming operations. Hence, using the systems approach is crucial for successful operations (Hoffmann, 2010).

As agriculture progressed over the past few decades, the system thinking method gained popularity among farmers and researchers. A system is described as a cohesive whole made up of connected, interdependent subsystems (Rana, 2019). The systems method was employed to manage governments and armies and more recently, during the Industrial Revolution of the 19th and 20th centuries, for the management of philosophy and science (Rana, 2019).

A farm’s structure is complex. Systems are employed to investigate a particular area of the real world. Agricultural systems are made up of different interconnected physical, biological, socioeconomic, and other systems comprised of physical, biological, and chemical processes constantly interacting. Living systems are made up of numerous parts and subsystems, each of which has its own special behaviour and traits. All of the aforementioned factors play a role in the overall structure and operation of the farming system. This calls for a tool that can combine these components rather than separate them. The systems approach is geared to accomplish this integration and show how changes in one component affect the functioning of the entire farm system.

Systems do not exist in and of themselves; they are defined in relation to the specific objectives of the analyst. First, a farming system should be described to ensure clarity. The second justification is to enhance the system once it has been understood, and in conclusion, the system can be modified when objectives or conditions change (Kelly and Bywater, 2005).

Furthermore, systems thinking enables the systematic and quantitative examination of agricultural systems (Kropff et al., 2001). This makes it possible to gain insight into how the farming system functions as a whole and enhance its effectiveness. When making decisions on the type of enterprise and the use of technology, the entire farm is considered. It covers the farmer's enterprises, how they interact with one another, and how a farm affects the environment. To increase enterprise production, modifications in farming practices can be made with the help of the systems approach (Knott, 2015). This approach can also assess whether these adjustments are more profitable and lasting.

Applying a systems approach to agriculture is crucial to ensuring the efficient use of all resources, the sustainability of the enterprise, and boosting profitability. Theoretical support for a systems approach is provided by several specific elements, including simulation modelling, expert systems, databases, linear programming, and geographic information systems (GIS) (Kropff et al., 2001). Systems-based research has become increasingly practical rather than being theoretical. By applying a systems approach, it is possible to predict prospective yields as well as crop growth and development, apply different production techniques, and understand the effects of climate change (Murthy, 2004). Simulation models, which are covered in Section 3.4.3, will be used in this research. Crop simulation models have three different types of applications: the first is strategic, the second is practical, and the third is used in forecasting (Murthy, 2004). For the purposes of this study, a forecasting application approach will be employed. It is more applicable and in line with the goals of examining the anticipated financial and management implications of incorporating low-chill apples as an enterprise on a typical wine farm.

A systems approach is necessary to address complexity and the fact that farms have many different aspects (Hoffmann and Kleynhans, 2011). The different components lose their fundamental characteristics when the whole is considered. This is known as the irreducibility principle of systems. The advanced capital budgeting technique, used to determine the profitability of possible investments, calculates the expected Internal Rate of Return (IRR) on Capital Investment. The IRR is a typical and well-used norm for profitability used in capital budgeting. Earlier research by Hoffmann and Kleynhans (2011) supports the IRR's suitability as an indicator of a farming system's financial viability. The IRR is especially useful where alternative options on the same farm (in other words, capital investment) are compared.

3.4 Research method: financial simulation modelling

3.4.1 Financial modelling as a research method

Farming is the attempt to manipulate natural systems with deliberate resource supply and interventions (seed, pesticides, etc.) to harvest products for sale (grains, etc.). Agriculture is based on the intricate interplay of processes governed by nature and influenced by humans. In other words, the farm system is the manipulation of physical and biological processes to achieve business outcomes. Vice versa, it is a business that is structurally dependent on physical and biological processes that are inherently complex and often unpredictable. The farmer acts as a production manager by deciding when to perform technical activities (such as tilling, planting, irrigating, harvesting, etc.) and how to combine and carry out interventions to meet his goals. The farming industry is vulnerable because the results of operations are dependent on unforeseen natural occurrences. These include yield-limiting factors such as climate (drought, cold, drainage and heat) and yield-reducing factors (pests and diseases). This system is also exposed to shifting economic conditions (price fluctuations for inputs and outputs) (Martin-Clouaire, 2009).

Models are crucial practical research tools for farmers since their application can help producers gain insight into and make more informed decisions (Hoffmann, 2010). A model is a representation of how systems behave in real-world conditions that aids in system explanation, comprehension, or performance improvement (Murthy, 2004). A model is a condensed version of reality that cannot be replicated. This simplification makes it possible to fully describe each issue that arises, but it might be challenging to convey a reality that is both operational and understandable (Murthy, 2004). Consequently, based on assumptions and observations, models reflect the actual world in terms of farm production. In agricultural system studies, models are frequently used. Depending on the kind of model farmers plan to utilise, models can organise knowledge, demonstrate efficient production techniques, and reveal shortcomings. Models are also ideal because of the development of software technology, as several computations can be performed to assess potential outcomes by modifying input data and system characteristics (Knott, 2015).

Practical considerations, such as the fact that it would be too expensive and time-consuming to plant and integrate these low-chill apples in each of the selected areas, were one of the primary factors that led to the use of financial modelling as the research method for this study. This will assist in establishing if it will be financially sustainable for farms in each respective area without having to plant the trees and wait for them to reach full production.

3.4.2 Types of models

A model is an abstract or simplified depiction of a small portion of reality, created for a specific use and based on data and assumptions (Wilson and Morren, 1990). A model can also be thought of as a comparison or explanation that aids in conceptualising something that is typically not perceptible directly. Models can be divided into two basic categories, namely stochastic and deterministic. The kind of model to be employed will depend on the system being simulated and the goal of modelling the system. According to Kelly and Bywater (2005), a model is an abstraction that conceptualises reality and is built on data and assumptions for a specific goal. Making assumptions about the study's goal and gathering data are necessary when designing a model. In general, models can be changed to accomplish specific goals. Models thereby provide a reduced, abstract representation of reality for a certain purpose (Kelly and Bywater, 2005).

Supporting farmers' decision-making is one of the key goals of creating a farm model (Pannell et al., 2000). Farmers consider several options while keeping two main goals in mind. The primary goal is to stay in agriculture despite the different shocks that characterise it. Among the common shocks that farmers experience are shifts in policy, shocks to the market and weather, as well as shifts in technology and social situations (Pannell et al., 2000). Farming is also a profession where money accumulation is the second main goal.

With reference to the key output variables (KOVs), multi-period whole-farm budgets can be divided into two categories. These output variables, which frequently include operating costs, yields, and prices, are chosen because it is believed that their values will have a major impact on the budget outcome or performance measurement. These variables may have constant or changing values. A deterministic budget is one where the KOVs are fixed. The budget is referred to as stochastic if the KOVs are randomly varied and continuously changed within a set range. As previously noted, probability distributions dictate the values of stochastic KOVs (Steyn, 2020). By incorporating random variables and assigning profitability distributions to the variables, stochastic models ensure that risks are taken into consideration (Rauff and Bello, 2015). The results of using these models typically vary and enable comparisons in various circumstances. The relationships within a system remain constant because deterministic models allow for the calculation of precise results without using random variation, which is consistent with a systematic approach (Rauff and Bello, 2015). Variability in system-related risks is ignored by deterministic models, and the focus is on the outcomes of specific alternatives.

Deterministic models are used in researching the financial and managerial effects of incorporating low-chill apples into a typical wine farm because they have the capacity to assess explicit variables or simulate certain scenarios. These models work in combination with a systems approach that makes use of predetermined variables and relationships that have consistent values. Probabilities are not used in deterministic models (Strauss, 2005).

To analyse a certain outcome for a given collection of variables (inputs), deterministic models will be employed in this study. However, deterministic models come in a variety of forms. For the purposes of this study, simulation models are most suitable.

3.4.3 Simulation models

The existing literature has a sizable number of definitions and techniques for modelling and simulation. The definition by Johnson and Rausser (1977) fits this study and agriculture the best: “Building a representation of a system is part of the modelling process, and using that representation to experiment with other systems is part of simulation” (Johnson et al., 1977). For the resolution of many real-world situations, simulation is an essential problem-solving method. When describing and evaluating a system's behaviour, posing hypothetical "what-if" scenarios, and helping with the design of actual systems, simulation is often employed. Simulation can be used to model both actual and hypothetical systems. Hence, simulations suggest that some sort of testing is taking place with the aim of modelling or duplicating a specific interaction between elements, individuals, and objects in a real-world system. This can subsequently be used to forecast the most probable behaviour of the system's elements, users, or objects (Strauss, 2005). Creating a model that accurately portrays the system being studied and evaluating how the model responds to changes are the two separate procedures that make up simulation. A model is therefore a depiction (mimic) of a real system. However, the borders or limits of the model, which are supposed to represent the system, are immediately a source of concern. Considering farming systems consist of interconnected parts, a simulation model will help to understand the interaction that takes place (Attonaty et al., 1999).

Farm-level modelling distinguishes between a negative (normative) and a positive (simulation) approach. Many techniques have been applied to the positive approach. These techniques include production-oriented models, budget models, farm simulation models, and enterprise simulation models. A target function is optimised by the normative method of farm-level modelling, which demonstrates what "should" occur in a given system. The normative approach employs five primary techniques: mathematical statistics, production functions, input-output analysis, mathematical programming, and network analysis. The key distinction between positive and normative is that, in contrast to simulation, normative specifies the behavioural assumption. Both methods use sets of equations and/or inequalities that were developed to replicate the production, marketing, and financial operations that take place at the farm level (Makhuvha, 2015).

In farm management, a variety of models are used, from traditional budgeting techniques to decision models based on mathematical and statistical equations that try to optimise resource allocation in order to achieve a specific goal. The most commonly used quantitative models are budgeting models, simulation models, estimation models, and linear models (Hoffmann, 2010).

The biggest disadvantage to using a simulation model is that it enables the incorporation of large numbers of conditions and variables from the outset. The compiler of a simulation model should be familiar with modelling this and how it functions. A crucial aspect is the role of the specialists, who provide the essential trans-disciplinary information to build the models (Hoffmann, 2010). Another shortcoming of simulation models is that, while multiple possibilities can be assessed and even compared, there is no assurance that the best results will be found (Hoffmann, 2010). The key benefit is that spreadsheet-based budget models may take into account and integrate a huge number of variables and parameters. It can demonstrate the results of various crop combinations and the procedure for changing from one system to another. Although there are many alternative techniques for simulating agricultural systems, the procedures or processes to be followed generally remain the same, as shown in Figure 13.

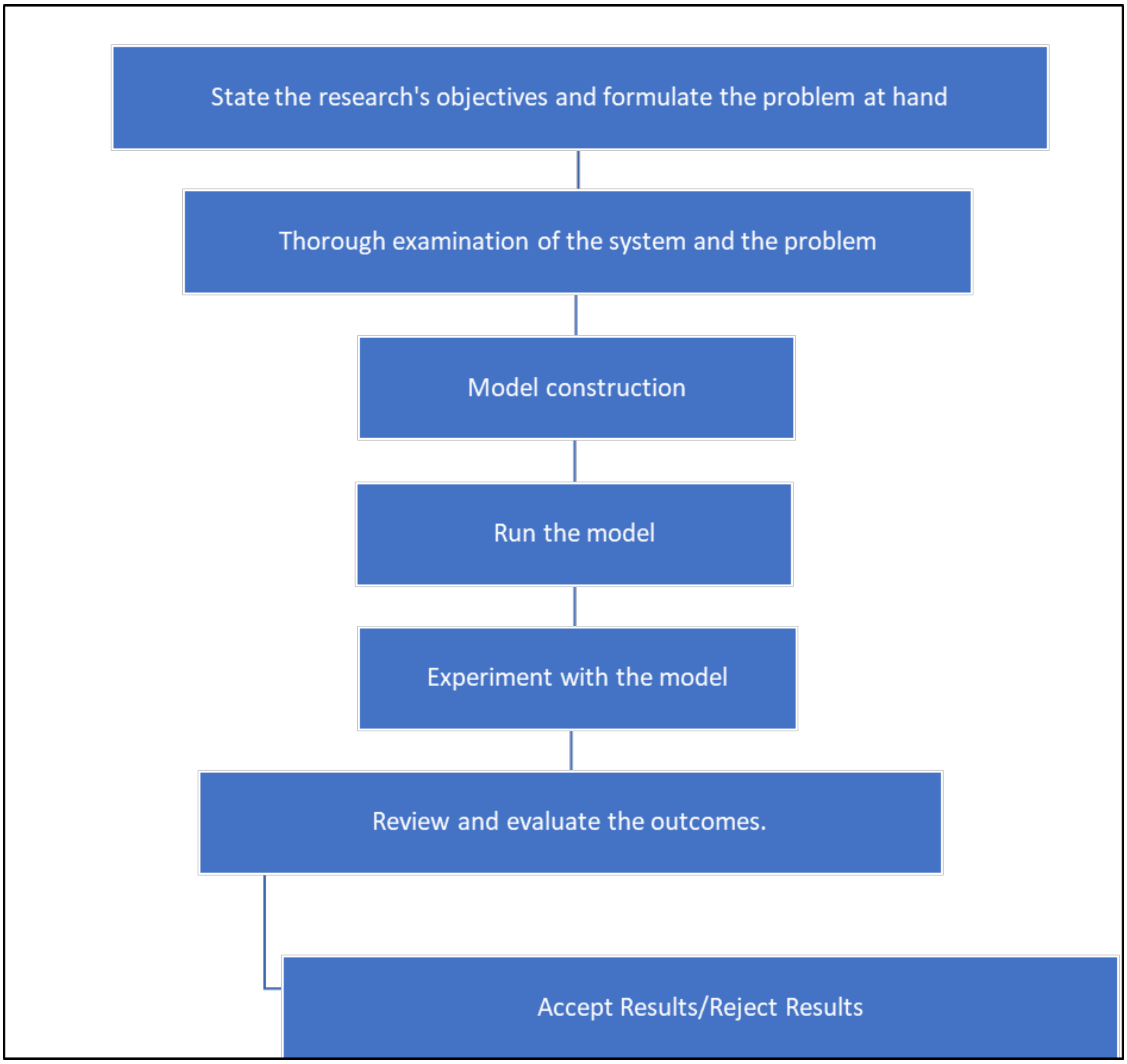

Figure 13: An ordered architecture that shows the simulation process
Source: Adapted from Strauss (2005)

To consider vineyard and orchard re-establishment cycles and the switch from wine grapes to low-chill apples, a standard multi-period budget model will be utilised in this study. To include the managerial and financial effects of switching (or integrating) to low-chill apples on machinery, labour, and infrastructure, the model also encompasses the whole-farm approach. A whole-farm, multi-period budgeting model will be used to achieve the goals of this study.

3.4.4 Whole-farm systems approach

The development of powerful mainframe computers in the 1950s, enabled the examination of more complicated interactions in whole-farm systems (Schilizzi and Boulier, 1997). Initially, whole-farm modelling was used to determine the most profitable farm structure given limited resources. Since then, whole-farm modelling has also been used by researchers to examine and understand whole-farm challenges. This is one of the techniques used by non-farmers to evaluate the effects of changes in agricultural systems on the entire farm (Pannell, 1996).

There are certain goals that each farmer has in mind. These goals, which combine commercial and non-profit targets, represent a compromise between the different competing aims that exist within a farming operation. The effective implementation of whole-farm management can be attributed to the farm owner's aims and objectives being met (Kelly and Bywater, 2005). However, farmers have to make decisions on a daily basis. These choices are typically made in the face of considerable uncertainty and with little information. If farmers have access to the necessary knowledge, they can make informed decisions, use their resources more effectively, and better forecast results. Farmers can benefit from using the whole-farm system's approach to make better decisions on managing their people, physical, and financial resources. They will eventually adopt the behaviours needed to accomplish their goals and objectives as a result. To model the specific system of interest, the entire farm system should be studied rather than just one aspect in isolation.

3.4.5 Whole-farm budgeting model

The process by which businesses forecast their sales, costs, profits, and cash flows for the next accounting period is known as budgeting. The primary instrument for management accounting and control is the budget. The budget illustrates the financial effects of the plans for the period and tries to assist the business in efficiently allocating and managing its financial resources. Budgets are widely recognised as useful management tools because they help businesses operate more effectively, efficiently, and economically (Tanase, 2013). It is a planning tool that gives the leadership perspective and ensures that the business is headed in the right direction by planning all the company's activities. According to Hoffmann (2010), budgeting is a non-optimising strategy that assesses plans in both physical and monetary terms. Budget models are frequently employed as a method of financial planning since they are easy to use. Budget models are a key component of benchmarking and are utilised as comparable quantitative tools. Additionally, budgets provide a framework for assessing performance. By looking into the causes of the differences that occur within the budget period, action can be taken. Finally, budgets can inspire managers and workers by establishing precise and defined goals (Subbotina, 2014).

The complexity of budgets lies not in the use of complex mathematical procedures but rather in the number of variables that can be integrated through a series of equations. A budget is a useful decision-making tool since it can be combined with other management tools like crop simulators, labour management systems, certification requirements, and the financial record-keeping system (Bezuidenhout, 2020).

The ability of budget models to absorb specifics and be adaptable increases their complexity and sophistication. In this study, it is crucial to do this to accommodate working producers and provide a user-friendly model for everyone. A lot of variables and relationships can be accommodated by whole-farm budgeting, which can incorporate all information from the farm system (Hoffmann, 2010). Budget models are simulation models, typically created using spreadsheet tools, which is a key characteristic. In spreadsheet programmes, the number of interrelationships that can be combined can be used to express complex and sophisticated computations and interactions (Dorward et al.,1997).

Below is a summary of the key reasons why budgets are frequently used as a tool for participatory research:

- They are clear and straightforward enough for people of all educational levels to understand.
- Budgets can be created using any resources, not only financial ones.
- Although sophisticated mathematical equations can be included in budgets, they are not required.
- Budgets can include many variables and interrelated equations.
- The budget's creators are free to select the performance measures they believe are pertinent

The ability of the whole-farm budget model to present each component of the farm system as a single interconnected unit facilitates the ability to understand the farm system as a whole (Hoffmann, 2010). A whole-farm budget model is the method used to link physical and financial aspects. By deducting fixed expenses from the total farm gross margin value, whole-farm budgets assist in illustrating net farm income and loss.

The simulation and optimisation techniques for whole-farm modelling can be divided into two main areas when it comes to computer farm modelling. Net farm income (NFI), the internal rate of return on invested capital (IRR), and cash flow metrics are a few examples of profitability criteria that are typically calculated in whole-farm budgeting. The optimisation of the whole-farm gross margin is the second quantitative method applied for this kind of budgeting.

Whole-farm budgets incorporate both monetary and physical constraints and frequently produce profitability metrics like net farm revenue and cash flow. Whole-farm budgets measure and deduct fixed costs to generate a net farm revenue value (Hoffmann, 2010). These models may potentially be expanded in the future to compute returns on capital invested and profitability metrics like the internal rate of return on capital investment (IRR) or the net present value (NPV) by incorporating various adaptation factors (Hoffmann, 2010).

Computer spreadsheets that display the links between the many components in the whole farm allow for simple computations. Budgets are helpful for benchmarking since they can be compared and have the power to make complicated farm systems simpler. Budgets also have the benefit of allowing for a lot of factors to be considered while still allowing for linkages. Budget modelling is a tool that farmers should be comfortable with and familiar with (Hoffmann, 2010). The need to simulate the entire farm derives from the potential impact that changing from one enterprise to another can have on infrastructure, etc.

A thorough grasp of the farming system is beneficial because it can improve whole-farm budget performance as long as it is well structured and trusted by participants (Hoffmann, 2010). The key question in this situation is how to anticipate the financial effects of incorporating low-chill apple enterprises into a standard wine grape farm. A budget model is sufficient for this goal. It can estimate the projected financial and managerial impact of a decision like this.

3.4.5.1 A typical farm approach in the systems thinking method

The typical farm approach can be used as a tool to assess the profitability of the entire farm as well as the impact of modifying variables on farm-level profitability (Hoffmann, 2010). Nuthall (2011) argues that there needs to be a study unit when farming systems are built and studied. He advises choosing a typical farm as the study unit because it will be representative and share many characteristics with other farms. The typical farm theory research methodology is viewed as a research instrument for various farm systems that complements the farm system approach. According to Strauss et al. (2008), decision makers use a typical farm as the unit of study because it is not practically possible to analyse each individual farm.

The size of the farm is important in a typical farm description since it affects other crucial elements like investments and fixed improvements. The size of the farm affects variables including production area, land use, mechanisation needs, capital investment needs, the number of permanent workers, and fixed expenses. Other aspects would alter if the size of the farm changed. Because a typical total farm situation has integrated physical and financial components where particular interactions exist, it is crucial to define it (Hoffmann, 2010).

Farmer households are essentially unique since they have unique resources and encounter unique difficulties. They are prone to experiencing special decision-making issues that require special solutions. Additionally, there are a wide range of aspects that have an impact on a farmer's net income. These aspects include management ability, financial and economic conditions, soil and physical qualities, and agricultural resources. No two farms are the same when it comes to the variables affecting net income. As a result, whole-farm systems research developed a typical farm method (Carter, 1963; Köbrich et al., 2003).

This will be applied to factors including farm size, overall farm profitability, management quality, market accessibility, cropping systems, and cultivation methods (Hoffmann, 2010). Although direct comparisons within a single farm are not possible because a typical farm runs hypothetically, a typical farm model enables comparisons between managerial actions and options

(Knott, 2015). Typically, trends, strategies, and fundamental policy options have an impact on a farm's profitability (Hoffmann, 2010), but for a typical farm model to remain valid, certain general presumptions like management, technology, and market access are required (Carter, 1963).

The idea of a typical farm is used to reduce the impact of discriminating between farms operating significantly above average and farms not performing as well (Knott, 2015). To construct the elements that make up a typical farm model, producers' knowledge and perspectives must be consulted (Knott, 2015). A team of specialists in the specific subject should verify the validity of each component. In this context, it's crucial to clarify that the term "typical farm" refers to the industry's mode rather than an average. A mode is the data point that shows up most frequently in a data set (Hoffmann, 2010). The construction of a typical farm serves as a representation of the study's region because production practices and environmental factors can vary from region to region.

3.4.5.2 Delphi technique: data collection and validation

The two most popular group discussion techniques are the Delphi method and the idealised design method. Compared to the idealised design technique, the Delphi method was more appropriate for the goals and objectives of this study because it does not begin without constraints. Skulmoski et al.'s definition of the Delphi method from 2007 is as follows: The Delphi method is an iterative procedure to gather and condense the anonymous expert judgments utilizing a variety of data collecting and analysis approaches combined with feedback. A group of people from several specialized disciplines can use the Delphi approach to improve communication. The Delphi approach is a good tool for helping to produce forecasts and to increase awareness of the issues, opportunities, and solutions (Skulmoski et al., 2007).

In this study, the parameters and presumptions of a typical Robertson, Worcester, and Paarl farm’s budget model were validated using the Delphi research approach. One main unstructured group discussion was used in this study to verify data, clarify the issue at hand, and explore potential remedies. To extract relevant information of a homogeneous nature from this meeting, this technique calls for a group of specialists on a certain issue. The participants are recognised as authorities in their respective fields. This project includes producers, soil scientists, viticulturists, agricultural economists, and horticulturists. After all the relevant agricultural role players and specialists offered their insightful opinions, an agreement was reached.

After this meeting, key role player interviews, semi-structured interviews, and in-person site visits were all part of the data collection process. Direct conversations were held with pre-selected respondents, including viticulturists, agricultural economists, horticulturists, farmers, farm managers, and other experts from related agricultural industries. These important informants and the researcher can freely exchange information during interviews.

After the model for this research study was assembled, verification was completed by showing the model to professionals in the field to receive their feedback. This was done with a group of producers, including producers of wine grapes who have diversified into other crops, producers of wine grapes who are thinking about diversifying, and producers who are still producing wine grapes in the study's chosen regions. This group assessed the model’s content and determined whether the price presumptions for certain key variables were valid. The model structure and the precise method by which the data for each component was gathered are both described in the next section.

3.5 Methods of application and structure of the whole-farm model

A whole-farm, multi-period budget model with a 25-year projection term was compiled. The model was created in a way that allows the person using it to select their preferred region of interest (Robertson, Paarl, or Worcester). Therefore, the data of a typical wine farm in the Robertson region is used and serves as the model's baseline when that person selects, for example, Robertson. The individual is then able to adjust a particular variable in accordance with the circumstances of his or her farm and see how this change affects the farm's IRR.

3.5.1 Physical description of a typical farm

The physical characteristics that producers can relate to in each of the three regions were reflected in the typical farm construction for each area. The information for the physical and monetary dimensions of the multi-period whole-farm budget was gathered from both primary and secondary sources. The size of the farm serves as the model's primary premise for a farm business because other variables are dependent on it and fluctuate as it does (Hoffmann, 2010). These variables include the area that is farmed, the land that is used, mechanisation, the need for labour, and fixed improvement requirements (Knott, 2015).

The distribution of land and its use are two additional physical factors that are considered in the multi-period whole-farm budget and have an impact on a farm's financial performance. Both owned and rented land make up the distribution of the land. However, for this model, it is assumed that all land is owned. The amount of rented land will have an impact on the model's factor cost component. Total farm size, land distribution, and land utilisation were among the farm structure details required for the farm description. Uncultivated land is used for dams, roads, riverbeds, houses, and infrastructure. The number of hectares used for cultivation of each crop in the production system is indicated by the term "land utilisation”. The farm structure was decided upon after unstructured meetings with numerous industry professionals. To confirm validity, telephonic consultations with wine grape growers and specialists in each region were conducted.

3.5.2 Calculation

The multi-period, whole-farm budget model's calculation component is relatively complicated because of the many interrelated input factors that are used to create a sequence of equations that produce outputs. The equations in the calculation component are used to convert physical and biological components and activities into financial results. Standard accounting principles are applied to ensure the validity and accuracy of the model. For instance, the input component is where the information comes from to determining the gross margin per hectare of a specific crop.

The inputs are described using concrete measurements such as tonnes of yield, litres of chemicals and fuel, kilogrammes of fertiliser, and labour hours. Values and quantities are separated during model development, allowing for independent manipulation of either or both. To determine the cost of an input, the model's equations multiply the price of each physical unit by the applicable price and the application level. All the cost items involved in the production process for the whole season are added, and the sum is subtracted from the gross production value for that specific vineyard or apple orchard. These profit margins are calculated by subtracting the cost items associated with each profitability term according to standard accounting principles. Following that, the gross margins are incorporated into the multi-period whole-farm budget calculations that determine the farm's overall IRR. This is just one illustration of the numerous interconnected calculations that have been structured into the budget model.

3.5.3 Inventory

A farm's financial description is a statement of how much money the farm is worth. Many stakeholders, including investors, require a thorough description of a farm's tangible assets, and as a result, inventories must be accessible and as accurate as possible (Knott, 2015). The detailed asset register, or inventory, that was created for this study's budget model includes items related to both low-chill apple farming and wine farming.

Land, fixed improvements, machinery, equipment, and vehicles are among the item types that are commonly included in the inventory of a wine grape and fruit farm (Hoffmann, 2010). The quantity and size of each item are closely related to the size of the current farm when viewed at the level of the entire farm. The valuations of all the physical items included in an inventory must be reliable because they are largely used to determine the capital required for the farm as a business unit. An accurate inventory will improve the farm’s capacity to obtain financing and its ability to maintain its financial viability.

The inventory is significant due to the anticipated changes in mechanisation when low-chill apples are introduced to a wine grape farm. These anticipated modifications are brought on by sprayers, harvesting bin trailers, ladders, picking bags, and other harvesting equipment, as well as potential adjustments to the irrigation system. Despite the higher water requirement of low-chill apples, it was discovered during the farm validation phase that the irrigation systems installed in wine grape production farms are adequate to irrigate low-chill apples.

The information used for the various items in the inventory is derived from a wide range of sources. Based on discussions with fruit and wine grape growers in the chosen areas, the inventory's assumed land size and fixed improvements were determined. The 2022-2023 VINPRO Cost of Mechanisation was used to determine the cost of vehicles, equipment, and machinery. The producers acknowledged that the Vinpro data can be utilised for this purpose, and this information is based on industry norms that are generally accurate. To confirm the general layout of a typical farm, a group of specialists was approached to identify the requirements for the machinery, vehicles, and equipment and confirm the prices.

3.5.4 Variable costs: allocated and non-allocated

The predicted profitability of the farm business is computed using the input prices. Production inputs, including pesticides, fertilisers, plant material, and seeds are included in the general production costs and labour components for both the production of wine grapes and low-chill apples (Knott, 2015). Repairs and maintenance, labour costs, fuel, advisories, harvest expenses, irrigation costs, drainage system costs, the cost of soil preparation, as well as water and energy costs, are some additional production costs (Knott, 2015). These prices were obtained from secondary sources, including SAWIS, Vinpro and Hortgro, and were agreed upon by experts.

3.5.5 Gross margin

A whole-farm multi-period budget model was created for a period of 25 years with the intention of establishing the financial and managerial effects of adding low-chill apples as an enterprise on a wine farm. This budget has separate enterprise budgets for wine grapes and low-chill apples. An enterprise budget details annual costs and returns as well as the investment requirements for a certain crop (Engle and Stone, 2007). Enterprise budgets are detailed financial and physical strategies for a single commodity. The financial plan is crucial because it assigns expenses to each commodity's production inputs. Aside from the fact that enterprise budgets are calculated per hectare, they also contain directly and indirectly allocated costs and gross production values.

The gross margin per hectare was computed for each commodity by subtracting the directly allocated and non-directly allocated costs from the gross production value. This gross margin calculation also incorporates a replacement schedule for each production block on the farm, which is established at various ages and is replaced based on the set lifetime of both low-chill apples and wine grapes. The gross margin is then factored into the 25-year capital budget to evaluate whole farm profitability. The data for calculating the gross margin value for each commodity were derived from the model's information components. This contains all input costs, physical inputs and levels of application, establishment costs, and yields per hectare.

3.5.6 Fixed costs

The set amounts that a farm is accountable for, regardless of the quantity or intensity of production, are included in the overhead and fixed costs of the farm business. Licences, insurance, electricity, permanent labour, auditors' fees, bank charges, taxes, maintenance and repairs on fixed improvements, water board membership, communication costs, and administrative costs are examples of overhead and fixed costs (Knott, 2015). The reports created by SAWIS, Vinpro, and Hortgro provided information for the overhead and fixed expenses components for apples and wine grapes. Their reports include a per-hectare cost for overhead and fixed costs.

3.5.7 Profitability of the whole farm

The final component of the model required the development of a capital budget over a 25-year period to account for the replacement of wine grapes and low-chill apples and thus meet the study's primary objective. All the elements that were covered are combined in the capital budget. To calculate whole-farm profitability, the calculation structure is based on accepted accounting principles, and cost allocation is carried out in accordance with those principles. A multi-period simulated whole-farm budget model was created to analyse the financial and managerial effects of incorporating low-chill apples into a typical wine farm. Knowing the financial situation is important since it tells wine grape farmers whether they might be able to diversify. In the calculation, the impact of inflation is considered for both income and costs during the course of the 25-year period.

Within the capital budget, the components that have been stated are inextricably linked. The gross margin of each enterprise is added to determine the farm's overall gross margin. The component of fixed cost assumptions is used to compute the total fixed costs. The inventory calculates the total capital expenditure flows. The life expectancy (year) and age at the start of the calculation period are used to determine when machinery and equipment need to be replaced. The monetary worth of a machine is calculated by subtracting its salvage value from the cost of the replacement component.

The calculation of the net annual flow of income comes at the end of the capital budget. This is computed by deducting capital investment, overhead, and fixed costs from the overall farm gross margin. Through the IRR, the percentage of capital investment returns and the whole-farm profitability are calculated using the net yearly flow of money. For the model to determine whether diversification for the wine grape farmers will be profitable, the effects of various changes, such as diversifying, were included. In this case, the same farm serves as the starting point for comparing several land-use scenarios with various subsequent infrastructural needs. It involves placing the different outcomes in order of anticipated profitability. However, the IRR is also presented to demonstrate monetary worth in addition to the yield on investment.

3.5.8 Simple spreadsheet and sensitivity analysis

A spreadsheet including the key variables was created to make the model more approachable. This enables the user to alter these settings to suit his or her preferences. These factors include the applicable region (Robertson, Worcester, and Paarl), the trellis system, the percentage of fresh market apple production, the mechanisation of apple harvesting, the inflation rate, R/tonne and tonne/ha, the irrigation system, and finally the number of low-chill apple hectares included in the typical wine farm of 100 hectares. Thus, the user is given the option to change these variables and observe the effects on the IRR with and without inflation.

A sensitivity analysis was created to further improve the model's user friendliness. The R/tonne and Tonne/ha of low-chill apples and wine grapes are the two factors that were considered in the sensitivity analysis. The IRR, which is directly related to the IRR that was attained because of the changes made in the simple spreadsheet, is used to measure sensitivity.

3.6 Conclusion

This study aims to assess the financial and managerial effects on the whole farm when wine grape farmers add low-chill apples as an enterprise to their typical wine farm. This chapter provided an application of a suitable method that is necessary to determine the financial and managerial implications. An agricultural system is complicated since it contains numerous interconnected parts. The systems approach is used, allowing for the encouragement of better-informed decisions on the profitability of the whole farm.

The subsequent chapters of this study will use whole-farm budget modelling; therefore, this technique is discussed. Budgeting is a non-optimising strategy for assessing plans in terms of their physical and monetary feasibility. Budget models are a crucial component of benchmarking and are utilised as a similar quantitative technique. They were created using spreadsheet tools and are classified as simulation-type models. Budgets for the whole farm consider both financial and physical factors, and they frequently produce profitability indicators like net farm income and cash flow. In spreadsheet programmes, budgeting enables the capture of the intricate interactions present in agricultural systems and the linking of those interactions to profitability outcomes via a series of equations.

A multi-period, whole-farm budget model for 25 years was simulated for the purposes of this research project. By computing the IRR, the result determines the anticipated whole-farm profitability. This model allows for different crop combinations, ranging from the cultivation of wine grapes to a diversified farm with low-chill apples. For validity and accuracy, all computations are based on accepted accounting principles. The model is made up of three basic components: an input component (e.g., production cost), a calculation component, and the capital budget output component. Both primary and secondary sources of data were employed in this study. Using the Delphi method, a panel of professionals verified all presumptions and the structure of the typical farm.

Chapter 4: Managerial and financial considerations of incorporating low-chill apples into a typical wine farm in selected areas

4.1 Introduction

A multi-period whole-farm budget model that can be manipulated according to farm-specific parameters was constructed over a 25-year period in order to assess the financial performance of a typical farm in the selected regions. This was done to determine the managerial and financial impact of diversifying to low-chill apples from wine grape production.

A typical farm's physical characteristics, including farm size, land use, land value, and water listings, are described in the financial and management results. The financial dimension is presented in the form of the capital investment requirements for farming assets as well as the variable costs identified in the study. These costs are shown, along with the applicable overhead and fixed costs in the whole-farm context. The overall gross margin for the production of low-chill apples and wine grapes is presented, followed by the whole-farm profitability and projected IRR. Three scenarios related to the research topic and goals are provided and incorporated into the cash flow forecasts to show the underlying impact of including low-chill apples with wine grapes on the IRR.

4.2 Physical characteristics of the typical farm

The idea of a typical wine grape farm for the selected regions was applied in this research study, as discussed in Paragraph 3.4.5.1. This enables adjustments to model parameters to determine the anticipated effects of various crop mixtures and other variables on overall farm profitability. Using a typical farm allows the weighing of alternatives, but it shouldn't be applied directly to a specific farm without appropriate adjustments. As farms are idiosyncratic, the results only apply to the farm for which the modelling is done. The model developed for the thesis was constructed and tested, but only for generic correctness and functionality and not applied to a specific farm. Table 1 shows the information of a typical farm area planted (ha) as well as the irrigated area (%) for all three regions, entirely owned by the wine grape producer with no additional rented land, included in this study (Vinpro, 2022). Based on the primary cultivars identified by SAWIS for each region, the proportion of red to white cultivars was considered typical for each region. This is because the aim is to have something representative to compare the integration of low-chill apples against.

Table 1: Typical farm area planted with wine grapes, irrigated area %, land value, owned-to-rented ratio, and water listing for a typical farm in the selected regions

Area	Typical farm area planted with wine grapes (ha)	Irrigated area (%)	R/ha (Established with infrastructure)	Owned to rented land ratio		Water listing (m^3 /ha/year) for the summer months
				Own	Rented	
Paarl	77	95	R400 000	100%	0%	5000
Worcester	112	100	R550 000	100%	0%	7450
Robertson	113	100	R550 000	100%	0%	7450

Source: Own research, Vinpro, 2022

The values of the water listings and agricultural land were validated by a group of experts. The value per hectare varies from one region to another due to variations in water availability and soil quality. Paarl has the lowest Rand value per hectare (R400 000) for agricultural land due to the Bergrivier's water listing, which fluctuates from 4000 m^3/ha/year to 6000 m^3/ha/year for the summer months, and Paarl's lower soil quality compared to Robertson and Worcester. In comparison to Robertson and Worcester, commercial farming is less advanced in the Paarl region. However, because Paarl is closer to well-known tourist destinations like Cape Town, Franschhoek, and Stellenbosch, it is more suited to foreign tastes and lifestyle preferences. The Brandvlei dam supplies Robertson and Worcester, with the water listing from the Breede river being 7 450 m^3/ha/year in the summer months. On the other hand, the Le Chasseur and Goree water canals are listed at 10 000 m^3/ha/year.

4.2.1 Differences in farm structure due to water requirements

This section includes capital investment requirements. The model in this study must be able to incorporate both low-chill apples and wine grape production practices since only one multi-period budget model was constructed. It should also be possible to alter the typical farm in accordance with various agricultural practices for wine grapes and low-chill apples, such as water requirements and management.

When considering diversification by including low-chill apples as an enterprise, water usage should be given high priority because it is higher for low-chill apple production than for wine grape production. Wine grapes only require 2 600 m^3 per hectare per year, compared to low-chill apples' 7 100 m^3. Water requirements vary from farm to farm based on their methods and the availability of water; therefore, they should only be used as a guideline. Since the model allows for this variation and allows the user to change the requirement, it can be adjusted in accordance with each farm's unique circumstances. These changes will be linked throughout the model to determine the costs.

For this diversification process to be successful, the farm must have the necessary water available. It's possible that the grower won't be able to plant as many hectares of low-chill apples as he would have been able to with wine grapes. The model was built to alter the water requirement in accordance with the number of hectares planted with low-chill apples.

The group of specialists validated the following hypotheses, allowing for the computation of the cost of irrigation for low-chill applications:

- 1 gallon of water = 4.546 litres
- 10 000 gallons of water per hour = 45 460 L/h
- 15 kW pump @ 30m = gives 10 000 gallons of water per hour
- Therefore, 7 100 cubic metres per year = 7 100 000 litres (7 100 × 1 000)
- Hours of irrigation needed per hectare: 7 100 000/45 460 = 156.18 hours
- Cost of irrigation: 156.18 hours × R/kWh × pump size (kW)

4.2.2 Differences in management structure

The model allows the user to make alterations to meet the needs of their own farm because the management of a wine grape farm differs from that of a low-chill apple farm. The variations in the fruit sector include labour, structural modifications, harvesting equipment, improvements in labour competency, and contractual duties.

4.3 Inventory

The inventory component calculates the required capital investment for the farm. The elements that make up capital investments include land, vehicles, fixed improvements, equipment, and machinery. Since only one model was used in this study, it had to be designed to allow participants to select the components under each of the elements listed above that applied to their farm if they wanted to diversify by including the production of low-chill apples. For instance, the user can decide how many tractors they have and will require.

The capital investment total is made up of the sum of the land value for 100 hectares, fixed improvements, vehicles, equipment, and machinery. Table 2 lists the components that have been added under each capital investment element as a result of the diversification process to include low-chill apples.

Table 2: Additional vehicles, machines, implements, and equipment for low-chill apple production

Vehicles and machines	Implements and equipment
Orchard and Vineyard Tractor (bigger tractor for larger sprayers)	Bins
Fork lifters	Ladders
Truck (optional)	Picking bags
	Bin waggons
	Sprayer (bigger with higher spray power for trees)

Source: Du Toit, 2023

4.4 Fixed Costs

It is generally accepted that overhead and fixed expenses are independent of production and remain constant. Items like permanent labour, bank fees, water rights, electricity, communication, auditors' fees, maintenance of fixed improvements, manager salaries, licencing, and insurance are examples of overhead and fixed costs. The ratio between the production of apples and wine grapes was taken into account while adjusting some of these costs. It is crucial to remember that fixed-cost items will remain constant.

Of the three regions used in the study, Paarl has lower fixed costs than Robertson and Worcester, primarily due to permanent labour and water rights. The Worcester region has the highest fixed costs, mainly because of the high cost of permanent labour. Producers in this area frequently employ more permanent workers than seasonal workers. The cost of permanent labour in the Robertson and Paarl regions is comparable but differs from the Worcester region by almost R4 000 per hectare.

Due to numerous pumping schemes in the area, water rights in Robertson and Worcester are higher than those in Paarl. However, the key factor is that there is a large component of dryland farming in the Paarl region, so much less physical irrigation is required. This is followed by the electricity cost, which is also the lowest in the Paarl region.

4.5 Input components

4.5.1 Gross production values

The total gross production value of the enterprise's cultivars included in the whole-farm budget makes up the total gross production value of the farm. This is calculated by multiplying the output (tonne/ha) by the price (R/tonne). The gross value is frequently impacted by factors including production volume, export volume, exchange rate, and international market prices. The price per tonne and the production per hectare can be changed to examine what impact they will have on the farm’s IRR, as the model can be altered in accordance with the user's personal preferences. As a result, there is a choice of R/tonne and tonne/ha for the cultivation of wine grapes and low-chill apples. To demonstrate the effects of these pricing and output variations, three different scenarios are presented in Section 4.9, linked to the capital budget of the whole farm.

These price and output options for both enterprises are included as two of the primary variables in the simple spreadsheet to make the model more user-friendly. Given that this study focuses on the potential to grow low-chill apples for the cider market due to their short shelf life, it is important to keep in mind that the low-chill apples Rand value per tonne is the juice price and not the fresh market price. Therefore, compared to the fresh market, the R/tonne for apples won't be as high. For the sensitivity analysis that will be covered in Section 4.8, a variety of R/tonne values were chosen after unstructured group discussions with industry experts. Similarly, discussions with producers and industry experts were held regarding the price and yield of wine grapes. The model does not include all of the various wine grape cultivars and low-chill apple cultivars. The price and output for both low-chill apples and wine grapes are average R/tonne and tonne/ha respectively.

4.5.2 Establishment costs

In addition to the wide range in the cost of land, labour, machinery, and materials, starting and running an orchard can be expensive depending on the location and the operator. During the first several years of establishing an orchard, capital expenses such as land preparation, labour, trees, support system materials, and pest management materials are the key expenditures. With an average life expectancy of 25 years, starting an orchard is a long-term commitment (Planning, 2009). Establishing an orchard must be carefully planned, including the selection of the site, the planting, and the maintenance of the trees. Planning and planting errors can be exceedingly expensive and challenging to fix in the future. The importance of paying close attention to site selection, soil preparation, tree quality, cultivar selection, and early tree care cannot be overstated (Planning, 2009).

For the purpose of this study, the cost of establishing low-chill apples has been constructed in a way that allows the user to select the activities and quantities they wish to employ during the establishment phase. Additionally, the user has the option of choosing between irrigation and trellis systems. In order to make the model more user-friendly, the user can estimate the number of trees and poles they will need based on their chosen planting density. The total cost of the establishment is R461 529 per hectare, which was adjusted from the Hortgro 2021 crop budget after unstructured meetings were held with industry experts (Hortgro, 2021). The norm used by Vinpro in their cost guide for 2022-2023 serves as the foundation for the establishment costs for wine grapes, which were verified by experts. Wine grapes have an establishment cost of R293 708 per hectare.

4.5.3 Variable costs

4.5.3.1 Wine grapes

Production costs are included in the calculation of total variable costs. These costs cover seasonal labour, hired transportation, organic fertiliser and material, fertiliser, crop protection, herbicide control, repair and binding material, and fuel. Table 3 shows the proportional percentage contributions of the variable expenses incurred by the farming business in each region. The VINPRO annual cost guide for 2022-2023 was used to determine the cost of producing wine grapes.

Table 3: The proportion of different inputs that make up total variable costs in the selected regions

	Seasonal labour	Fertiliser	Crop protection and herbicide control	Maintenance	Fuel	Hired transportation
Robertson	23.77%	19.17%	20.87%	21.18%	11.26%	3.74%
Paarl	32.68%	8.51%	21.13%	19.71%	12.28%	5.69%
Worcester	8.07%	26.71%	26.05%	21.47%	14.88%	2.82%

Source: Own research

Seasonal labour and fertiliser are two categories that show a clear difference between the regions. According to the observations of wine grape experts, farmers in the Worcester and Robertson regions tend to use more fertiliser annually, mostly after harvesting. The fertiliser product that is used depends on the specific advice from fertiliser consultants and has a significant impact. The producer's objective is another consideration when it comes to fertiliser use. While many producers in Paarl aims for lower-production, higher-quality when it comes to production targets, growers in the Robertson and Worcester regions are targeting higher production. With the fertiliser application having a significant impact on production, the producers in the Robertson and Worcester regions would have a higher fertiliser cost than the Paarl region producers.

Seasonal labour is the second factor that varies significantly between the areas. It's important to remember that the Worcester area has the second-highest level of mechanisation in the industry (88%), which lowers labour costs. The Worcester region also tends to employ more permanent labour than seasonal labour. The Robertson region's producers are diversified, using seasonal labour for other long-term crops and to complete work in the vineyard. Conversely, the Paarl region uses much more labour and hand motions because it is less mechanised (34%).

4.5.3.2 Low-chill apples

Low-chill apples are often sweet-tasting, juicy apples with a very short shelf life due to their soft, crisp texture (up to eight weeks), as discussed in Chapter 2. The availability of these low-chill varieties during times of need, when other fresh apple varieties cultivated in South Africa aren't readily available, is an important consideration.

Low-chill apple varieties can be produced in warmer regions such as Robertson, Worcester, and Paarl, as they don't require as many cold units as “normal” apples that are produced for the fresh market, which is mostly exported. The South African juice market is the primary market for the production of low-chill apples. Producing apples for the juice industry is a little different than that for the dessert market since quality is less of a concern. Therefore, certain production cost adjustments were made after having unstructured discussions with experts in the field of apple production.

Farming for the juice industry allows for financial savings in labour and spraying programs. Since the apples' quality is of lesser importance when being harvested, it would be even more financially sustainable if the process could be automated because labour accounts for a sizable portion of the production cost in the harvesting component. The same is true for the thinning procedure. Since apple size is not of much importance, the cost of thinning can practically be cut in half. The model was created so that the participant could use all of these options and determine how they would affect the whole farm's IRR.

4.6 Enterprise gross margin

An enterprise budget was created for both wine grapes and low-chill apples. The gross margin for each enterprise is determined by deducting the total variable costs from the gross production value. An enterprise budget for low-chill apples and wine grapes applicable to Worcester is presented in Annexure A. The gross margin for the first five years is indicated in Table 4, assuming there are 50 hectares of low-chill apples and 50 hectares of wine grapes and that the set ages are as in Annexure A.

Table 4: Gross margin for the first 5 years in Worcester

Enterprise	Gross margin				
	Year 1	Year 2	Year 3	Year 4	Year 5
Low-chill apples	R 3 117 072,36	R 4 199 964,41	R 5 144 466,69	R 5 753 121,78	R 6 031 405,78
Wine grapes	R 2 553 764,85	R 3 063 849,44	R 3 345 919,34	R 1 589 303,99	R 3 102 376,04

Source: Own calculations

The participant may alter all the input cells (indicated in green) in Annexure A, using the enterprise budget to determine how such changes would affect the gross margin. These cells include the following:

- The expected production return (%) in each year until full production
- % of full production costs applicable in the years before full production is reached
- Age of each of the 10 equal-sized production blocks

Changes to the tonne/ha, R/tonne, cost, and price inflation rates, which are all considered to be important variables, are available in the simple spreadsheet to make it more user-friendly.

4.7 Capital budget

The model developed for the purposes of this research study covered a time period of 25 years. As a result, the profitability of the whole farm is calculated over a 25-year period. Chapter 3 provides detail on the procedure for creating the multi-period whole-farm budget. The IRR is the primary financial indicator used for whole-farm profitability. This was determined using the capital budget's net cash flow. Only after analysing various scenarios can the effect of the diversification process on the profitability of the whole farm to include low-chill apples as an enterprise be assessed. Annexure D provides an example of a capital budget for a 100% low-chill apple farm, whereas Annexure C shows the capital budget for a 100% wine grape farm.

4.8 Simple spreadsheet and sensitivity analysis

The model utilised in this study needed to be user-friendly so that any farmer could use it. To make the model as close to their own farm as possible, the participant is allowed to modify all the green cells in accordance with their individual preferences. The key variables are summarised in the simple spreadsheet, so if a user is only interested in the key variables and doesn't want to go through the entire model, changes to the few variables can be made to see the impact on the IRR.
The following variables are listed on the spreadsheet:

- Hectares of low-chill apples and wine grapes (maximum 100 hectares)
- Choice of region
- Choice of trellis system
- % Low-chill production for the fresh market and juice market
- Mechanisation or hand labour for apple harvesting
- Inflation rate
- R/tonne and tonne/ha for low-chill apples and wine grapes
- Irrigation system

A sensitivity analysis was created to determine the sensitivity of the IRR % to a change in the price per tonne and the tonne per hectare. However, because the sensitivity analysis only considers R/tonne and tonne/ha, the participant must first work through the simple spreadsheet and indicate preferences for the other key variables. The different price per tonne alternatives are plotted along the horizontal axis in Annexure B, while the tonne per hectare is plotted along the vertical axis. The coloured values represent the IRR% that will be obtained at the specified level of production and tonne pricing. The #NUM! error indicates an extremely low IRR, with a greener cell indicating a better IRR and a redder cell indicating a lower value.

Table 5: Current IRR for a 100% wine farm in each region

	R/Tonne	Tonne/ha	IRR (%)
Worcester	R3 600	25	0.49
Robertson	R3 600	25	-0.75
Paarl	R3 600	25	3.28

Source: Own calculations

4.9 IRR for different scenarios

4.9.1 Scenario descriptions

4.9.1.1 Scenario 1

A 50/50 split between wine grapes and low-chill apples for the juice market is used in the first scenario to assess the effects of diversifying wine grape production to include apples, i.e., 50 hectares of low-chill apples and 50 hectares of wine grapes. Secondly, the effect on IRR of mechanising the low-chill apple harvest process will be assessed by contrasting the IRR % with the percentage when low-chill apples are harvested by hand. This scenario is focused on the Worcester and Robertson regions.

4.9.1.2 Scenario 2

The second scenario includes only low-chill apples, and it will have the same production per hectare and Rand per tonne as Scenario 1. Thus, it will be easier to comprehend the effects of eliminating all wine grapes and replacing them with low-chill apples. Scenario 2 is focused on the Worcester and Paarl regions. As all of the produce is destined for the juice market, this scenario will also assess the effects of automating the low-chill apple harvest process and lowering the thinning process.

Additionally, this scenario will include the option where the farm only produces either wine grapes or low-chill apples in order to demonstrate the differences in IRR between 100 hectares of wine grapes and 100 hectares of low-chill apples.

4.9.1.3 Scenario 3

The final scenario will be a sensitivity analysis of 100% low-chill apples for a change in Rand per tonne in the Paarl and Robertson region. This will take into account the effects of an R200/tonne increase for low-chill apples at a yield of 85 tonnes/hectare. Mechanisation and a reduction in thinning costs will also be added to this scenario to emphasise their impact.

4.9.2 Summary of scenario descriptions

Table 6: Summary of scenarios

	Ratio between wine grapes: low-chill apples	R/tonne & Tonne/ha	Impact being assessed	Annual inflation rate for 25 years
Scenario 1	50:50	Wine grapes: 25 t/ha @ R3 600/tonne Low-chill apples: 85 t/ha @ R2 500/t	Mechanization vs Labour	Cost: 7% Price: 5.5%
Scenario 2	100:0 & 0:100	Wine grapes: 25 t/ha @ R3 600/tonne Low-chill apples: 85 t/ha @ R2 500/t	Mechanisation vs Labour ½ thinning costs	Cost: 7% Price: 5.5%
Scenario 3	0:100	Low-chill apples: 85 t/ha @ R2 500/t vs R2 700/t	Change in the price per ton ½ thinning costs Mechanisation vs. Labour	Cost: 7% Price: 5.5%

The annual cost inflation rate is set at 7% for all scenarios, and the annual price inflation rate is set at 5.5%. Therefore, it's important to keep in mind that while the IRR may appear low, this is primarily due to the fact that cost inflation is outpacing price inflation. For low-chill apples and wine grapes, the targets were 85 t/ha and 25 t/ha, respectively, for sustainable production at full bearing age of the orchard or vineyard. Since it could vary from farm to farm and between regions, this was considered as an average for all three regions.

4.9.3 Scenario results

The replacement ratio between wine grapes and low-chill apples is adjusted per hectare to determine the impact on whole-farm profitability. The ratio in the first scenario is 50/50. Accordingly, the 100-hectare farm consists of 50 hectares of low-chill apples and 50 hectares of wine grapes. The second scenario is the 100:0 and 0:100 ratios, i.e., the whole farm is either covered with wine grapes or with low-chill apples. The change in IRR caused by these various replacement ratios, as well as the other variables that were altered in each scenario, are shown in Tables 7, 8, and 9.

Table 7: Scenario 1 results

50/50 Juice market low-chill apples and wine grapes Wine grapes: 25 tonne/ha @ R3 600/tonne Low-chill apples: 85 tonne/ha @ R2 500/tonne	
Worcester	
Mechanised apple harvest	Hand labour for apple harvest
IRR = 7.93%	IRR = 3.17%
Robertson	
Mechanised apple harvest	Hand labour for apple harvest
IRR = 8.27%	IRR = 3.71%

A significant portion of the cost of producing apples is related to the harvest. Even though apples only occupy 50% of the total production hectares in this scenario, the producer's capacity to minimise that cost can have a significant impact on the profitability of the whole farm. Quality is not a major consideration when producing exclusively for the juice industry, as was previously stated. So it is possible to explore mechanised methods for harvesting these apples.

In Scenario 2, where the entire farm is planted with low-chill apples, the effects of automated harvest are more pronounced. However, the IRRs in Robertson and Worcester are not significantly different from one another.

Table 8: Scenario 2 results

Worcester		
100% Low-chill apples for the juice market Low-chill apples: 85 tonne/ha @ R2 500		
Hand labour for apple harvest	Mechanised apple harvest	½ The thinning and mechanised apple harvest
IRR = 9.79%	IRR = 16.87%	IRR = 18.25%
100% wine grapes 25 tonne/ha @ R3 600/tonne		
IRR = 0.5%		
Paarl		
100% Low-chill apples for the juice market Low-chill apples: 85 tonne/ha @ R2 500		
Hand labour for apple harvest	Mechanised apple harvest	½ The thinning and mechanised apple harvest
IRR = 19.15%	IRR = 25.85%	IRR = 27.40%
100% wine grapes 25 tonne/ha @ R3 600/tonne		
IRR = 3.28%		

Scenario 2 clearly shows that the whole farm is able to achieve a higher IRR percentage when fully planted under low-chill apples instead of fully planted with wine grapes. This shows that integrating a typical wine grape farm in Worcester and Paarl with low-chill apples, produced only for the juice market, have a positive effect on the profitability of the farm. The impact of incorporating low-chill apples to a typical wine farm is further demonstrated by comparing the IRR values of mechanised apple harvest in Worcester between scenarios 1 and 2. Moving from a 50/50 wine grapes to low-chill apples ratio to 100% low-chill apples results in an 8.94% increase in IRR.

An IRR increase of more than 7% in Worcester further highlights the effects of automated apple harvesting. The cost of thinning can be reduced since size and quality are not as important when producing for the juice industry. This was advised by a professional in the field. When the cost of thinning is cut in half, the labour component also reduces; however, if the producer uses chemical thinning, the labour component can be even further reduced.

As previously indicated, the fixed cost component is smaller in the Paarl region than it is in Robertson and Worcester, which results in a greater IRR percentage. The main reasons for this are that Paarl has lower permanent labour and water rights costs. However, because Paarl's permitted water listings are a little bit lower than apples' water requirements, the producer can only grow as many hectares as the availability of water permits.

Table 9: Scenario 3 results

100% Juice market apples			
Paarl			
85 tonne/ha @ R2 500/t	85 tonne/ha @ R2 700/t	85 tonne/ha @ R2 700 with ½ Thinning	85 tonne/ha @ R2 700/t with mechanised harvest and ½ thinning
IRR = 19.15%	IRR = 25.22%	IRR = 26.81%	IRR = 32.69%
Robertson			
85 tonne/ha @ R2 500/t	85 tonne/ha @ R2 700/t	85 tonne/ha @ R2 700 with ½ Thinning	85 tonne/ha @ R2 700/t with mechanised harvest and ½ thinning
IRR = 11.98%	IRR = 17.54%	IRR = 18.91%	IRR = 23.77%

Scenario 3 is an excellent representation of how the producer can maximise the IRR% and how important the market influence is in terms of price per tonne, indicating the significant impact a little change in the Rand per tonne has on the IRR. In Robertson, the IRR rises by 5.56%, with an average increase of R200/tonne for the product. For this scenario, the IRR in Paarl is higher than it is in Robertson.

In Table 10, the sensitivity of the IRR to changes in the Rand per tonne and tonne per hectare for the Robertson region with human labour and full thinning is further displayed. When there is no value, the IRR percentage is too low.

Table 10: Sensitivity analysis for scenario 3 in Robertson

Low-chill apples with human harvest and full thinning: Robertson							
		R/Tonne					
Tonne/ha		1700	2000	2300	2600	2900	3200
	30	-	-	-	-	-	-
	40	-	-	-	-	-	-
	50	-	-	-	-	-	-
	60	-	-	-	-	-	-
	70	-	-	-	-	7.29%	15,92%
	80	-	-	-	10,06%	18,25%	24,42%
	90	-	-	9,58%	18,80%	25,62%	31,94%
	100	-	4.72%	17.68%	25,38%	32,40%	39,35%

4.10 Conclusion

This study's primary goal was to determine the financial effects of diversifying a wine grape farm to grow low-chill apples in certain regions. This was further broken down into smaller goals, such as determining the production requirements for low-chill apples in the chosen regions, determining the financial costs associated with producing low-chill apples, and determining the financial costs associated with establishing a low-chill apple enterprise at the farm level for the chosen regions. To calculate the anticipated financial implications using the IRR, a 25-year whole-farm budget model was constructed. A group of experts determined that a typical farm size for this research project is 100 hectares, and they confirmed the data that was utilised to build the model. Utilising a typical farm enables comparisons with other projects and the effects of model modifications.

The required capital investment is R66 415 726.43, which includes the value of the land, fixed improvements, vehicles, machinery, and other equipment. When low-chill apples were introduced as an enterprise, the financial results showed a sizable improvement in the total predicted gross margin as well as the gross production value of the whole farm. When the diversification process was implemented, the wine grape farm's profitability also grew significantly. In Scenario 2, the IRR percentage increased by more than 9% in the Worcester region when switching from 100% wine grapes to 100% low-chill apples, and this was based on the assumption that apple harvesting would involve human labour and full thinning. However, between the three regions, Paarl has shown the highest IRR due to some fixed cost differences compared to Robertson and Worcester. However, producers will not be able to produce 100 hectares of low-chill apples where they uprooted 100 hectares of wine grapes due to water availability. In Robertson and Worcester, the water listing is 7 450 m^3/ha/year, and it ranges between 4 000 and 6 000 m^3/ha/year in Paarl. Therefore, because apples require 7 100 m^3/ha /year of water, the grower is constrained by water availability.

Chapter 5: Conclusions, summary, and recommendations

5.1 Conclusions

To maintain long-term profitability, farmers need to adopt strategies and tactics to compensate for changes in economic, environmental, social, and political circumstances that occur on a global scale. Farmers use various techniques to adapt, of which diversification is one. Agricultural diversification is seen as altering conventional production, resource use, or targeting new markets for operational success. Farmers often diversify because the unique challenges such as poor or deteriorating financial results or opportunities such as technological advancements, improved financial management systems, new and alternative production techniques, and lucrative alternative market options. There are several ways to diversify, such as increasing the range of products produced, modifying the agricultural system to take advantage of synergies, structurally improving asset mix portfolios to reduce overhead costs, or using resources like adding crops with higher water efficiency or revenue-generating (higher value) businesses. Farmers are innovative in combining various types of diversification options. Innovative diversification often results in positive effects on the environment and increased farm profitability.

This research investigated the financial and managerial implications of integrating low-chilling requirement (low-chill) apples into a typical wine grape farm in potentially suitable geographical areas. Three specific research goals were pursued to address the main research aim. These include (i) determining the production requirements for low-chill apples in the chosen areas, (ii) determining the financial implications of producing low-chill apples, and (iii) determining the financial implications of incorporating a low-chill apple enterprise at farm level for the chosen areas.

Profitable wine grape farming has been under pressure for the last decade, driving wine grape growers to search for alternative sources of income. This does not imply that the wine industry is unsustainable overall. Wine grape producers have a range of possible enterprises potentially appropriate for diversification in Robertson, Worcester, and Paarl. The genetic development of low-chill apples suitable for mass production and aimed at the juice market in warmer areas is an exciting new development that could benefit producers. The strategic and tactical inclusion of low-chill apples is the primary focus of this study. Low-chill apples provide several advantages over competing products, including an early harvesting period that does not conflict with the harvest of wine grapes. This enables better utilisation of equipment, labour, and irrigation water. The primary limitation is that low-chill apples need more water than wine grapes, but the early harvest time frees up water for wine grapes during the key ripening phase. Depending on the water supply on a given farm, the farmer may not be able to replace the wine grapes he uprooted with the same number of hectares of apples.

A farm system is complex and multi-faceted, consisting of many interconnected components. Better knowledge of the intricacies involved in farming systems will improve decision-making. The systems thinking technique is appropriate for the analysis of complex systems. The definition of a system and the application of a systems approach to farming complexity, as discussed in Section 3.3, are practical ways of integrating horticultural/viticultural knowledge with the farm's financial system. This approach allows for the use of a model to simulate the incorporation of low-chill apples into the existing wine grape farm. A model is a representation of an actual system that is reasonably inexpensive and time-efficient to construct compared to the actual experimental planting of apples. It simulates or mimics the physical, biological, and socioeconomic aspects of farms and accommodates the relational interactions between its various parts. One of the key goals of constructing a farm model is to assist farmers in making decisions. The development of the whole-farm budget model was done within the framework of systems thinking. The complexity of budget models is determined by the number of variables considered and the accurate reflection of changes to the variables on expected profitability. The variety of equations that can be connected to explain the financial effects of a physical or biological system helps to achieve this. Farmers easily associate using budget models, which, once developed, are relatively simple to modify to accommodate different farm-specific scenarios.

It was essential to view the whole farm to understand the broader consequences of system modifications. The interactions between crops over time must be viewed over the long term. For this purpose, a multi-period budget model at the whole-farm level was constructed. The multi-period budget model was developed and tested with input from experts in agricultural economics as well as apple and grape producers. The participants' inputs were crucial for the development and approval of the farm model structure and its assumptions.

One benefit of using budget models is the large number of variables and complex interactions that can be accommodated within a spreadsheet program. The model consists of input assumptions, calculations, and output parameters that convert agronomical data into financial information. The term typical farm was used, with "typical" referring to most farms in a relatively homogeneous area. The typical farm concept was used as a simulation tool so that most of the farmers could relate to it. Based on the criteria for the typical farm, a whole-farm-level model was created using the data for each enterprise through gross margin calculations. For each of the chosen regions, a typical farm model was created, and the financial results were expressed in terms of IRR (internal rate of return on capital investment). The whole-farm multi-period model's dynamics made it possible to incorporate a variety of interrelated variables into a single operational "farm business" model.

The model was created with the option for users to alter the number of hectares of low-chill apples and wine grapes to suit individual preferences, measure expected financial performance, and highlight the financial implications of diversification. Different scenarios that examined the effects of changes to the system were formulated. The model was used to create scenarios for changes in certain key variables like the low-chill apple and wine grape ratio, production output, price, and harvest mechanisation. The selected systems' financial performance, as determined by IRR, is the main outcome.

A 50/50 ratio between wine grapes and low-chill apples planted on the typical farm, with apples being produced for the juice industry, makes up Scenario 1, focusing on the Worcester and Robertson areas. Through this, the influence of mechanising the low-chill apple harvest as well as the effect of diversifying wine grapes with low-chill apples were evaluated. For Scenario 2, the whole farm was planted with low-chill apples and aimed at the Worcester and Paarl areas. In this scenario, the effects of automating low-chill apple harvesting and lowering apple thinning expenses are also assessed. The scenario also assesses the financial outcome for the base case where the farm is entirely planted with wine grapes, assessing the diversification process. Finally, in Scenario 3, the impact of mechanising the harvest and a decrease in the cost of low-chill apple thinning are assessed along with a sensitivity analysis of 100% low-chill apples for a change in Rand per tonne in the Paarl and Robertson regions.

Based on the results, the expected IRR is higher when increasing the area planted with low-chill apples in all three regions. Therefore, incorporating low-chill apples at the farm level increases the sustainability and profitability of a typical Robertson, Worcester, and Paarl wine farm. It also demonstrates that automating the harvest process and lowering the cost of thinning low-chill apples has a significant impact on the IRR. This option was considered because low-chill apples will be earmarked for the juice market, where size and quality are less important. The IRR's sensitivity to changes in the price (Rand per tonne) may also be seen in Scenario 3.

To conclude, the anticipated financial effects of diversification by including low-chill apples are favourable for wine grape farms in the Robertson, Worcester, and Paarl regions. All regions were not, however, covered in every scenario. Infrastructure modifications are anticipated, but with insignificant financial consequences. The results are based on the assumption that wine grape growers have a basic understanding of apple production and that management would be optimal for cider apple production. It can be difficult to combine low-chill apples with wine grapes since it requires different production, irrigation, and harvest procedures.

5.2 Summary

In the past decade, several wine grape producers have diversified their operations to incorporate other enterprises into their production as a result of pressure on the sector. This raises the prospect of widespread adoption of low-chill apple production. The anticipated financial and management impact of such a change, as well as the potential cash flow challenges of the shift away from wine grape production, remain.

The financial viability of this move was considered. Therefore, the goal of this study's research was to assess the managerial and financial effects of diversifying a wine grape farm in the Paarl, Worcester, and Robertson regions to grow low-chill apples in addition to wine grapes.

There are three major concepts introduced in Chapter 2. The South African wine industry is briefly described with background industry characteristics and the significant changes as of 2011. To determine the significance of the wine industry to the South African economy, it is crucial to understand its background. The wine industry has been experiencing challenges in recent years, which is why these developments are being highlighted. Due to the numerous difficulties in the South African wine grape business, producers were pressed to find additional or other sources of income. As a result, low-chill apples have been presented as a potential source of diversification.

An in-depth investigation of the apple sector in South Africa is the second major discussion. This thesis introduces South African apple production, apple varieties grown, markets, necessary agricultural conditions, climate hazards, and finally the low-chill apple sector. To determine if low-chill apple production would be sustainable, it is crucial to understand the South African apple industry, particularly the markets. Dessert apples need lower-degree cold units, which makes low-chill apples a better choice, especially given the climatic dangers the dessert apple industry continues to face. The prospects of a low-chill apple industry are covered, along with the production issues that arise when low-chill apples are introduced on a typical wine grape farm. The three areas selected for this study are briefly covered in the chapter's conclusion.

Chapter 3 provides an outline of the approach that was used. It is challenging to fully comprehend the functionality of a farm system if the complexity of its interconnected parts is neglected. An approach called systems thinking integrates the parts and relationships inside the farm system as a whole to deal with such complexity. Additionally, this might help farmers increase their knowledge so they can make more accurate decisions. Whole-farm budgets are simulation models because they may take into account a variety of factors as well as the underlying links between them. An overview of the many parts that make up the whole-farm budget model is provided in the chapter's conclusion. It's crucial that the data used in a simulation model be accurate. Industry experts' inputs were sought to gather and validate data and test the model structure, along with the assumptions that replicate the various production techniques with and without low-chill apples.

The model results and study findings are presented in Chapter 4. The results consider the physical size of a typical farm and the results of the diversification process in terms of profitability across all segments. Within the context of whole-farm systems, the dynamics of the model enable the incorporation of complex and numerous connected variables. To incorporate the influence of crop rotation, the model was created such that it considers a long period of time. The system was subjected to three scenarios that examined potential results in the future. It considered modifications to the relationship between wine grapes and low-chill apples as well as price, production, and mechanisation, with an emphasis on the systems' financial performance as determined by IRR.

Although the anticipated financial results were positive, the predicted ratios of replacement were not always practical. This was because low-chill apples require more water than wine grapes, yet some farms may have the necessary water to plant the same number of hectares of low-chill apples as they have removed wine grapes.

5.3 Recommendations

The results of this research study led to a number of recommendations. The first recommendation is that wine grape producers should consider diversifying their operations by growing alternative crops like low-chill apples to ensure sustainability, profitability, and growth. The wine grape industry was compelled to explore new alternative revenue streams due to the existing state of the sector and the effects of the various trends discussed in Chapter 2.

The second recommendation would be that this method be adopted for similar investigations into the viability of diversification because it was successful in examining the financial and managerial consequences of diversification for wine grape farmers in the selected areas, albeit for low-chill apples only. This approach is simple to comprehend and explain, enables the measurement of impacts on particular variables to produce realistic results, and is user-friendly.

The third recommendation is to conduct additional research on the diversification of wine grape farms in the Worcester, Paarl, and Robertson regions, with a particular emphasis on the water schemes and their effects on the production of low-chill apples. This will make it possible to more accurately calculate a realistic replacement ratio.

A further recommendation would be that when more information is available on low-chill apple production in South Africa, a similar study needs to be done to ensure more accurate answers since there was limited information available for this study. Lastly, it is recommended that research be done on how existing wine cellars can be modified to handle the juicing tasks for these low-chill apples, as this will assist in improving wine cellar sustainability and be even more profitable. This is conceivable in some wine-producing regions where the harvest begins a little later so that there is sufficient time to turn these apples into juice prior to the arrival of the wine grapes.

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Addenda

Annexure A: Enterprise budget for low-chill apples and wine grapes applicable to the Worcester region

Vineyard

	Plant year																								
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
R/Ton	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00	R 3 600,00
Ton/Ha	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Expected return (%)	0%	0%	30%	70%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gross production value per hectare	R -	R -	R 27 000,00	R 63 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00
Direct allocated costs																									
Esteblishment Costs	R 293 708,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Soil Preperation	R 35 493,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Fertilizer	R 16 320,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Irrigation	R 48 775,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Trellising	R 97 103,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Plantmaterial	R 77 465,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Labour	R 18 552,00																								
% of total allocation:	0%	30%	70%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Variable costs	R -	R 5 503,80	R 12 842,20	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00	R 18 346,00
Organic Fertilizer and material	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00	R 599,00
Fertilizer	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00	R 4 302,00
Crop protection	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00	R 3 363,00
Herbicide control	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00	R 1 417,00
Repair and binding material	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00	R 407,00
Hired Transport	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00	R 517,00
Repair, parts and maintenance	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00	R 3 531,00
Fuel	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00	R 2 729,00
Seasonal labour	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00	R 1 481,00
Harvesting Costs	R -	R -	R 329,40	R 768,60	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00
Harvesting Machine	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00	R 1 098,00
Other directly attributable costs	R 14 685,40	R 275,19	R 658,58	R 955,73	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20
Miscellaneous and unforeseen costs 5%	R 14 685,40	R 275,19	R 658,580	R 955,73	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20	R 972,20
Total Costs:	R 308 393,40	R 5 778,99	R 13 830,18	R 20 070,33	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20

Gross Margin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Gross Income	R -	R -	R 27 000,00	R 63 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00	R 90 000,00
Direct allocated Costs	R 308 393,40	R 5 778,99	R 13 830,18	R 20 070,33	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20	R 20 416,20
Gross Margin	-R 308 393,40	-R 5 778,99	R 13 169,82	R 42 929,67	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80	R 69 583,80

Block life expectancy (years)																											
20	Total Ha	Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Block size	50,00	Age (years)																									
Block 1	5,0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6
Block 2	5,0	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8
Block 3	5,0	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Block 4	5,0	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9
Block 5	5,0	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Block 6	5,0	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8
Block 7	5,0	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11
Block 8	5,0	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Block 9	5,0	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7
Block 10	5,0	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2

Block number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00
2	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
3	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
4	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
5	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
6	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
7	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
8	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00
9	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00
10	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95	R 65 849,10	R 214 648,35	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	R 347 919,00	-R 1 541 967,00	-R 28 894,95
Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Gross Margin:	R 2 553 764,85	R 3 063 849,44	R 3 345 919,34	R 1 589 303,99	R 3 102 376,04	R 3 197 120,09	R 3 345 919,34	R 1 589 303,99	R 3 102 376,04	R 1 307 234,10	R 2 969 105,39	R 1 307 234,10	R 2 969 105,39	R 3 197 120,09	R 1 456 033,34	R 3 102 376,04	R 1 307 234,10	-R 810 666,60	R 553 606,20	R 515 079,60	R 2 553 764,85	R 3 063 849,44	R 3 345 919,34	R 1 589 303,99	R 3 102 376,04

LC-Apples: Cider

Hectare under production:	1		Year planted																							
Year			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Yield (Ton / ha)			85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Price (R / ton)			R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00	R 2 500,00
Expected return (%)			0%	0%	12%	31%	71%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gross production value per hectare			R -	R -	R 25 500,00	R 65 875,00	R 150 875,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00

Directly allocable costs	2nd year cost (% of first year)		Year planted																							
Establishment costs per hectare:		Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Soil preparation			R 65 910,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Drainage			R 27 150,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Trellis system			R 54 850,85	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Plant material	8%		R 185 925,00	R 14 874,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Irrigation system			R 31 353,37	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Planning			R 8 500,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Orchard removal			R 62 500,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Windbreaks			R 2 340,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Labour			R 23 000,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
			R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Total:			R 461 529,22	R 14 874,00	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
		% of total allocation:	0%	20%	50%	85%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Pre-harvest costs per hectare:		Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Polination			R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36	R 2 726,36
Spraying			R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02	R 5 988,02
Herbicide			R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00	R 602,00
Fertilizer			R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25	R 7 166,25
Consultant			R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02	R 1 483,02
Fuel			R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52	R 9 989,52
Maintenance and repair			R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21	R 13 699,21
Labour (Thinning and Pruneing)			R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00	R 18 425,00
Irrigation (Electricity)			R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13	R 3 651,13
Other			R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53	R 4 166,53
			R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Total:			R -	R 13 579,41	R 33 948,52	R 57 712,48	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03	R 67 897,03

Harvest costs per hectare:		Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Packages			R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Cold room costs			R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Labour (Picking)			R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00
Harvesting machine			R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
Total:			R -	R -	R 2 352,00	R 6 076,00	R 13 916,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00	R 19 600,00

Other directly attributable costs		Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Miscellaneous and unforeseen costs	5%		R 23 076,46	R 1 422,67	R 1 815,03	R 3 189,42	R 4 090,65	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85	R 4 374,85
Total			R 484 605,68	R 29 876,08	R 38 115,54	R 66 977,90	R 85 903,68	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88

Gross margin		Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Gross income			R -	R -	R 25 500,00	R 65 875,00	R 150 875,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00	R 212 500,00
Direct allocable costs			R 484 605,68	R 29 876,08	R 38 115,54	R 66 977,90	R 85 903,68	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88	R 91 871,88
Gross margin per hectare:			-R 484 605,68	-R 29 876,08	-R 12 615,54	-R 1 102,90	R 64 971,32	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12	R 120 628,12

Block life expectancy (years)																											
25	Total Ha	Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Block size	50,00	Age (years)																									
Block 1	5,0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1
Block 2	5,0	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3
Block 3	5,0	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3	4	5	6	7	8	9
Block 4	5,0	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3	4
Block 5	5,0	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3	4	5	6	7	8	9	10	11	12	13
Block 6	5,0	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3
Block 7	5,0	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3	4	5	6
Block 8	5,0	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2	3	4	5	6	7	8	9	10	11
Block 9	5,0	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1	2
Block 10	5,0	17	18	19	20	21	22	23	24	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Block number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1		-R 149 380,38	-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41
2		-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71
3		R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58
4		R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71	-R 5 514,51
5		R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58
6		-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71
7		R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58
8		R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58
9		-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38
10		R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	-R 2 423 028,41	-R 149 380,38	-R 63 077,71	-R 5 514,51	R 324 856,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58	R 603 140,58
	Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Gross Margin:		R 3 117 072,36	R 4 199 964,41	R 5 144 466,69	R 5 753 121,78	R 6 031 405,78	R 6 031 405,78	R 6 031 405,78	R 6 031 405,78	R 3 005 236,80	R 5 278 884,82	R 5 365 187,49	R 5 422 750,69	R 2 726 952,80	R 5 278 884,82	R 2 339 018,51	R 4 670 229,73	R 2 060 734,51	R 4 670 229,73	R 5 086 903,49	R 2 396 581,71	R 5 000 600,82	R 2 339 018,51	-R 1 382 108,23	R 555 692,58	R 311 624,17

Annexure B: Sensitivity analysis

No inflation (#NUM! ERROR means the value is to low)

Cider Apples (Ton/ha & R/Ton)						
10,71%	1700	2000	2300	2600	2900	3200
30	-4,22%	-3,42%	-2,62%	-1,79%	-0,96%	-0,11%
40	-2,75%	-1,65%	-0,54%	0,61%	1,77%	2,95%
50	-1,24%	0,18%	1,62%	3,10%	4,61%	6,14%
60	0,32%	2,07%	3,85%	5,68%	7,53%	9,42%
70	1,92%	4,01%	6,14%	8,32%	10,53%	12,76%
80	3,56%	5,99%	8,48%	11,00%	13,57%	16,16%
90	5,22%	8,01%	10,85%	13,73%	16,66%	19,62%
100	6,92%	10,05%	13,25%	16,49%	19,79%	23,14%

Fresh Apples (Ton/ha & R/Ton)						
	3900	4800	5700	6600	7500	8400
30	-0,65%	-0,01%	0,64%	1,29%	1,95%	2,61%
40	0,28%	1,14%	2,02%	2,91%	3,81%	4,71%
50	1,22%	2,31%	3,43%	4,56%	5,71%	6,86%
60	2,17%	3,51%	4,87%	6,25%	7,64%	9,05%
70	3,13%	4,71%	6,32%	7,95%	9,60%	11,27%
80	4,11%	5,94%	7,80%	9,68%	11,59%	13,52%
90	5,10%	7,17%	9,29%	11,43%	13,60%	15,78%
100	6,09%	8,42%	10,79%	13,19%	15,62%	18,08%

Wine grapes (Ton/ha & R/Ton)						
	3000	3800	4600	5400	6200	7000
17	9,26%	10,03%	10,80%	11,58%	12,36%	13,15%
18	9,43%	10,25%	11,06%	11,89%	12,72%	13,55%
19	9,60%	10,46%	11,32%	12,20%	13,07%	13,95%
20	9,76%	10,67%	11,58%	12,50%	13,43%	14,36%
21	9,93%	10,89%	11,85%	12,81%	13,79%	14,77%
22	10,10%	11,10%	12,11%	13,12%	14,14%	15,18%
23	10,27%	11,31%	12,37%	13,43%	14,50%	15,59%
24	10,43%	11,53%	12,63%	13,74%	14,86%	16,00%

With inflation (#NUM! ERROR means the value is to low)

Cider Apples (Ton/ha & R/Ton)						
	1700	2000	2300	2600	2900	3200
30	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
40	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
50	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
60	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	5,15%
70	#NUM!	#NUM!	#NUM!	-7,59%	8,57%	13,26%
80	#NUM!	#NUM!	-1,28%	9,71%	14,64%	18,58%
90	#NUM!	#NUM!	9,32%	14,89%	19,26%	23,16%
100	#NUM!	7,19%	14,08%	19,02%	23,36%	27,44%

Fresh Apples (Ton/ha & R/Ton)						
	3900	4800	5700	6600	7500	8400
30	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
40	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
50	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
60	#NUM!	#NUM!	#NUM!	#NUM!	-18,79%	3,42%
70	#NUM!	#NUM!	#NUM!	#NUM!	5,76%	10,31%
80	#NUM!	#NUM!	#NUM!	6,04%	10,99%	14,54%
90	#NUM!	#NUM!	4,53%	10,65%	14,68%	18,03%
100	#NUM!	-2,41%	9,20%	14,00%	17,80%	21,17%

Wine grapes (Ton/ha & R/Ton)						
	3000	3800	4600	5400	6200	7000
17	4,28%	7,14%	9,24%	10,98%	12,51%	13,91%
18	5,01%	7,77%	9,85%	11,60%	13,16%	14,59%
19	5,67%	8,35%	10,43%	12,20%	13,78%	15,25%
20	6,27%	8,91%	10,98%	12,77%	14,39%	15,89%
21	6,82%	9,43%	11,51%	13,33%	14,97%	16,51%
22	7,34%	9,92%	12,03%	13,87%	15,55%	17,12%
23	7,82%	10,40%	12,52%	14,39%	16,11%	17,72%
24	8,28%	10,86%	13,00%	14,90%	16,65%	18,30%

Annexure C: Capital budget of 100% wine grape farm in the Worcester region

Capital budget	Total Apples (Ha)	Cider (Ha)	Frash Market (Ha)	Vineyard (Ha)	Farm Size (Ha)			2,4%	IRR																	
	0	0	0	100	100				0,49%																	
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Gross margin LC Apples: Cider	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
Gross margin: Vineyards	R 5 107 529,69	R 6 435 137,81	R 7 383 217,36	R 3 482 438,30	R 7 550 196,27	R 8 168 149,91	R 8 978 567,16	R 3 880 221,08	R 9 174 572,00	R 3 167 937,04	R 9 653 335,40	R 3 241 454,65	R 10 625 782,87	R 12 027 052,62	R 3 887 937,16	R 12 854 010,82	R 3 259 487,38	-R 9 185 790,77	-R 558 199,37	-R 1 098 894,05	R 13 167 674,37	R 16 767 260,87	R 19 321 124,86	R 4 421 821,91	R 19 664 785,35	
Gross margin LC Apples: Fresh market	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
Total farm gross margin (a)	R 5 107 529,69	R 6 435 137,81	R 7 383 217,36	R 3 482 438,30	R 7 550 196,27	R 8 168 149,91	R 8 978 567,16	R 3 880 221,08	R 9 174 572,00	R 3 167 937,04	R 9 653 335,40	R 3 241 454,65	R 10 625 782,87	R 12 027 052,62	R 3 887 937,16	R 12 854 010,82	R 3 259 487,38	-R 9 185 790,77	-R 558 199,37	-R 1 098 894,05	R 13 167 674,37	R 16 767 260,87	R 19 321 124,86	R 4 421 821,91	R 19 664 785,35	
Fixed costs																										
Labor	R 1 042 200,00	R 1 115 154,00	R 1 193 214,78	R 1 276 739,81	R 1 366 111,60	R 1 461 739,41	R 1 564 061,17	R 1 673 545,45	R 1 790 693,64	R 1 916 042,19	R 2 050 165,14	R 2 193 676,70	R 2 347 234,07	R 2 511 540,46	R 2 687 348,29	R 2 875 462,67	R 3 076 745,06	R 3 292 117,21	R 3 522 565,42	R 3 769 145,00	R 4 032 985,15	R 4 315 294,11	R 4 617 364,69	R 4 940 580,22	R 5 286 420,84	
Water rights	R 220 400,00	R 235 828,00	R 252 335,96	R 269 999,48	R 288 899,44	R 309 122,40	R 330 760,97	R 353 914,24	R 378 688,23	R 405 196,41	R 433 560,16	R 463 909,37	R 496 383,03	R 531 129,84	R 568 308,93	R 608 090,55	R 650 656,89	R 696 202,87	R 744 937,07	R 797 082,67	R 852 878,46	R 912 579,95	R 976 460,54	R 1 044 812,78	R 1 117 949,68	
Electricity	R 441 400,00	R 472 298,00	R 505 358,86	R 540 733,98	R 578 585,36	R 619 086,33	R 662 422,38	R 708 791,94	R 758 407,38	R 811 495,90	R 868 300,61	R 929 081,65	R 994 117,37	R 1 063 705,58	R 1 138 164,97	R 1 217 836,52	R 1 303 085,08	R 1 394 301,03	R 1 491 902,11	R 1 596 335,25	R 1 708 078,72	R 1 827 644,23	R 1 955 579,33	R 2 092 469,88	R 2 238 942,77	
Other Overheads (Admin,Bank charges,General repairs,Taxes,Postage,Auditing ect.)	R 694 600,00	R 743 222,00	R 795 247,54	R 850 914,87	R 910 478,91	R 974 212,43	R 1 042 407,30	R 1 115 375,81	R 1 193 452,12	R 1 276 993,77	R 1 366 383,33	R 1 462 030,17	R 1 564 372,28	R 1 673 878,34	R 1 791 049,82	R 1 916 423,31	R 2 050 572,94	R 2 194 113,05	R 2 347 700,96	R 2 512 040,03	R 2 687 882,83	R 2 876 034,63	R 3 077 357,05	R 3 292 772,04	R 3 523 266,09	
Provision for renewal & depreciation of fixed improvements	R 169 400,00	R 181 258,00	R 193 946,06	R 207 522,28	R 222 048,84	R 237 592,26	R 254 223,72	R 272 019,38	R 291 060,74	R 311 434,99	R 333 235,44	R 356 561,92	R 381 521,26	R 408 227,74	R 436 803,69	R 467 379,94	R 500 096,54	R 535 103,30	R 572 560,53	R 612 639,76	R 655 524,55	R 701 411,27	R 750 510,05	R 803 045,76	R 859 258,96	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
Total Fixed Cost (b)	R 2 568 000,00	R 2 747 760,00	R 2 940 103,20	R 3 145 910,42	R 3 366 124,15	R 3 601 752,84	R 3 853 875,54	R 4 123 646,83	R 4 412 302,11	R 4 721 163,26	R 5 051 644,69	R 5 405 259,81	R 5 783 628,00	R 6 188 481,96	R 6 621 675,70	R 7 085 193,00	R 7 581 156,51	R 8 111 837,46	R 8 679 666,08	R 9 287 242,71	R 9 937 349,70	R 10 632 964,18	R 11 377 271,67	R 12 173 680,69	R 13 025 838,34	
Factor cost																										
Rented management	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
Rented land	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
Total factor cost (C)	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	
Capital items																										Resale value
Land	R 55 000 000,00																									R 55 000 000,00
Fixed improvements																										
Farm house	R 1 000 000,00																									R 1 000 000,00
Workers Housing:	R 1 800 000,00																									R 1 800 000,00
Manager	R 600 000,00																									R 600 000,00
Permanent workers	R 1 200 000,00																									R 1 200 000,00
Farm Buildings and Installations:	R 1 493 333,33																									R 1 493 333,33
Storage facility	R 1 300 000,00																									R 1 300 000,00
Chemical Storage Room	R 33 333,33																									R 33 333,33
Pump Houses	R 160 000,00																									R 160 000,00
Other Fixed Improvements	R 28 800,00																									R 28 800,00
Total fixed improvements	R 4 322 133,33																									R 4 322 133,33
																										R 59 322 133,33
Vehicles and machines	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
2 wheel motorcycle	R 54 091,96	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 83 935,80	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 83 935,80	R 54 091,96
Bakkie																										
LAA 2.4 Diesel	R 313 280,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 396 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 313 280,00
Trucks																										
8t Dropsides	R 225 760,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 489 600,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 225 760,00
4Ton	R 85 680,00	R 0,00	R 0,00	R 0,00	R 0,00	R 275 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 85 680,00
Other self-propelled equipment																										
Vineyard Harvesting Machine	R846 363,64	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R2 205 000,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R 846 363,64
Tractors																										
Orchard & Vineyard	R 372 470,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 563 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 372 470,00
Orchard & Vineyard	R 287 960,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 563 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 287 960,00
Orchard & Vineyard	R 252 080,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 331 200,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 252 080,00
Orchard & Vineyard	R 314 880,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 345 600,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 314 880,00
Orchard (harvesters) used second hand	R 302 250,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 351 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 302 250,00
Orchard	R 288 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 405 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 288 000,00
Fork lifters	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total vehicles and machines	R 3 342 815,60	R 0,00	R 0,00	R 0,00	R 0,00	R 335 066,21	R 0,00	R 2 901 629,57	R 670 051,41	R 921 360,69	R 0,00	R 0,00	R 902 021,55	R 674 354,77	R 573 531,24	R 0,00	R 657 416,42	R 673 194,41	R 802 223,34	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 215 152,99	R 3 342 815,60
Implements:																										
Sprayers																										
Towing type (1) 1500l	R 67 500,00	R 0,00	R 0,00	R 243 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 243 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 67 500,00
Towing type (2) 1500l	R 50 000,00	R 0,00	R 180 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 180 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 50 000,00
Turbmatic 1500l	R 30 800,00	R 0,00	R 158 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 158 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 30 800,00
Three-point 400l (weed control)	R 19 800,00	R 0,00	R 0,00	R 81 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 81 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 19 800,00
Tillage implements																										
Scraper (Andrag)	R 320,00	R 0,00	R 0,00	R 1 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 320,00
Disc	R 8 225,00	R 0,00	R 0,00	R 0,00	R 31 500,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 31 500,00	R 8 225,00
Ghrop	R 10 100,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 18 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 10 100,00
Other																										
Tip Wagon (Harvest) 3Ton single axle	R 52 060,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 68 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 52 060,00
Ordinary wagon double axle 6Ton dropsides	R 40 670,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 88 200,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 40 670,00
Bin wagons	R 262 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 324 000,00	R 0,00	R 0,00	R 262 800,00
Rovic Lime Spreader	R 11 900,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 18 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 11 900,00
"Bossieslaner"	R 10 100,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 18 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 10 100,00
Electric mobile water pumps	R 17 850,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 27 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 17 850,00
Contents of workshop and tools	R 143 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 234 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 143 000,00
Orchard tools (stairs, picking bags, pruning shears)	R 24 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 28 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 24 800,00
Bins	R 852,50	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 990,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 852,50
ZIP 30 Moving Machine	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total Implements:	R 750 777,50	R 0,00	R 366 013,44	R 366 480,69	R 36 850,54	R 0,00	R 0,00	R 0,00	R 120 707,79	R 0,00	R 53 288,79	R 360 232,25	R 72 046,45	R 0,00	R 704 445,98	R 437 629,27	R 55 796,11	R 0,00	R 164 091,14	R 0,00	R 0,00	R 0,00	R 767 853,69	R 0,00	R 80 744,08	R 750 777,50
Total:	R 4 093 593,10	R 0,00	R 366 013,44	R 366 480,69	R 36 850,54	R 335 066,21	R 0,00	R 2 901 629,57	R 790 759,20	R 921 360,69	R 53 288,79	R 360 232,25	R 974 068,00	R 674 354,77	R 1 277 977,22	R 437 629,27	R 713 212,53	R 673 194,41	R 966 314,48	R 0,00	R 0,00	R 0,00	R 767 853,69	R 0,00	R 295 897,07	R 4 093 593,10
Total Capital (d)	R 63 415 726,43	R 0,00	R 366 013,44	R 366 480,69	R 36 850,54	R 335 066,21	R 0,00	R 2 901 629,57	R 790 759,20	R 921 360,69	R 53 288,79	R 360 232,25	R 974 068,00	R 674 354,77	R 1 277 977,22	R 437 629,27	R 713 212,53	R 673 194,41	R 966 314,48	R 0,00	R 0,00	R 0,00	R 767 853,69	R 0,00	R 295 897,07	
Net annual flow (a-b-c-d)	-R 60 876 196,74	R 3 687 377,81	R 4 077 100,72	-R 29 952,81	R 4 147 221,57	R 4 231 330,86	R 5 124 691,62	-R 3 145 055,33	R 3 971 510,70	-R 2 474 586,91	R 4 548 401,92	-R 2 524 037,42	R 3 868 086,86	R 5 164 215,89	-R 4 011 715,76	R 5 331 188,56	-R 5 034 881,66	-R 17 970 822,64	-R 10 204 179,94	-R 10 386 136,76	R 3 230 324,67	R 6 134 296,69	R 7 175 999,50	-R 7 751 858,78	R 69 758 776,38	

Annexure D: Capital budget of a 100% low-chill apple farm with production aimed at cider market in the Worcester region

Capital budget	Total Apples (Ha)	Cider (Ha)	Frash Market (Ha)	Vineyard (Ha)	Farm Size (Ha)	2,4%	IRR
	100	100	0	0	100		9,79%

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Gross margin LC Apples: Cider	R 6 234 144,71	R 8 737 705,08	R 11 168 835,78	R 13 047 415,10	R 14 282 493,88	R 14 887 393,09	R 15 512 917,11	R 16 159 315,16	R 6 817 681,58	R 15 214 674,39	R 16 088 718,01	R 16 838 455,55	R 5 786 963,29	R 17 714 728,54	R 4 083 029,62	R 16 472 318,31	R 2 235 564,09	R 17 602 557,25	R 20 155 112,00	R 2 309 119,27	R 21 082 516,24	R 1 039 230,59	-R 28 107 326,63	-R 11 014 949,53	-R 14 031 313,78
Gross margin: Vineyards	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Gross margin LC Apples: Fresh market	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total farm gross margin (a)	R 6 234 144,71	R 8 737 705,08	R 11 168 835,78	R 13 047 415,10	R 14 282 493,88	R 14 887 393,09	R 15 512 917,11	R 16 159 315,16	R 6 817 681,58	R 15 214 674,39	R 16 088 718,01	R 16 838 455,55	R 5 786 963,29	R 17 714 728,54	R 4 083 029,62	R 16 472 318,31	R 2 235 564,09	R 17 602 557,25	R 20 155 112,00	R 2 309 119,27	R 21 082 516,24	R 1 039 230,59	-R 28 107 326,63	-R 11 014 949,53	-R 14 031 313,78
Fixed costs																									
Labor	R 1 042 200,00	R 1 115 154,00	R 1 193 214,78	R 1 276 739,81	R 1 366 111,60	R 1 461 739,41	R 1 564 061,17	R 1 673 545,45	R 1 790 693,64	R 1 916 042,19	R 2 050 165,14	R 2 193 676,70	R 2 347 234,07	R 2 511 540,46	R 2 687 348,29	R 2 875 462,67	R 3 076 745,06	R 3 292 117,21	R 3 522 565,42	R 3 769 145,00	R 4 032 985,15	R 4 315 294,11	R 4 617 364,69	R 4 940 580,22	R 5 286 420,84
Water rights	R 220 400,00	R 235 828,00	R 252 335,96	R 269 999,48	R 288 899,44	R 309 122,40	R 330 760,97	R 353 914,24	R 378 688,23	R 405 196,41	R 433 560,16	R 463 909,37	R 496 383,03	R 531 129,84	R 568 308,93	R 608 090,55	R 650 656,89	R 696 202,87	R 744 937,07	R 797 082,67	R 852 878,46	R 912 579,95	R 976 460,54	R 1 044 812,78	R 1 117 949,68
Electricity	R 441 400,00	R 472 298,00	R 505 358,86	R 540 733,98	R 578 585,36	R 619 086,33	R 662 422,38	R 708 791,94	R 758 407,38	R 811 495,90	R 868 300,61	R 929 081,65	R 994 117,37	R 1 063 705,58	R 1 138 164,97	R 1 217 836,52	R 1 303 085,08	R 1 394 301,03	R 1 491 902,11	R 1 596 335,25	R 1 708 078,72	R 1 827 644,23	R 1 955 579,33	R 2 092 469,88	R 2 238 942,77
Other Overheads (Admin,Bank charges,General repairs,Taxes,Postage,Auditing ect.)	R 694 600,00	R 743 222,00	R 795 247,54	R 850 914,87	R 910 478,91	R 974 212,43	R 1 042 407,30	R 1 115 375,81	R 1 193 452,12	R 1 276 993,77	R 1 366 383,33	R 1 462 030,17	R 1 564 372,28	R 1 673 878,34	R 1 791 049,82	R 1 916 423,31	R 2 050 572,94	R 2 194 113,05	R 2 347 700,96	R 2 512 040,03	R 2 687 882,83	R 2 876 034,63	R 3 077 357,05	R 3 292 772,04	R 3 523 266,09
Provision for renewal & depreciation of fixed improvements	R 169 400,00	R 181 258,00	R 193 946,06	R 207 522,28	R 222 048,84	R 237 592,26	R 254 223,72	R 272 019,38	R 291 060,74	R 311 434,99	R 333 235,44	R 356 561,92	R 381 521,26	R 408 227,74	R 436 803,69	R 467 379,94	R 500 096,54	R 535 103,30	R 572 560,53	R 612 639,76	R 655 524,55	R 701 411,27	R 750 510,05	R 803 045,76	R 859 258,96
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total Fixed Cost (b)	R 2 568 000,00	R 2 747 760,00	R 2 940 103,20	R 3 145 910,42	R 3 366 124,15	R 3 601 752,84	R 3 853 875,54	R 4 123 646,83	R 4 412 302,11	R 4 721 163,26	R 5 051 644,69	R 5 405 259,81	R 5 783 628,00	R 6 188 481,96	R 6 621 675,70	R 7 085 193,00	R 7 581 156,51	R 8 111 837,46	R 8 679 666,08	R 9 287 242,71	R 9 937 349,70	R 10 632 964,18	R 11 377 271,67	R 12 173 680,69	R 13 025 838,34
Factor cost																									
Rented management	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Rented land	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total factor cost (C)	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00

Capital items	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Resale value
Land	R 55 000 000,00																									R 55 000 000,00
Fixed improvements																										
Farm house	R 1 000 000,00																									R 1 000 000,00
Workers Housing:	R 1 800 000,00																									R 1 800 000,00
Manager	R 600 000,00																									R 600 000,00
Permanent workers	R 1 200 000,00																									R 1 200 000,00
Farm Buildings and Installations:	R 1 493 333,33																									R 1 493 333,33
Storage facility	R 1 300 000,00																									R 1 300 000,00
Chemical Storage Room	R 33 333,33																									R 33 333,33
Pump Houses	R 160 000,00																									R 160 000,00
Other Fixed Improvements	R 28 800,00																									R 28 800,00
Total fixed improvements	R 4 322 133,33																									R 4 322 133,33
																										R 59 322 133,33
Vehicles and machines	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
2 wheel motorcycle	R 54 091,96	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 83 935,80	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 83 935,80	R 54 091,96
Bakkie																										
LAA 2.4 Diesel	R 313 280,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 396 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 313 280,00
Trucks																										
8t Dropsides	R 225 760,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 489 600,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 225 760,00
4Ton	R 85 680,00	R 0,00	R 0,00	R 0,00	R 0,00	R 275 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 85 680,00
Other self-propelled equipment																										
Vineyard Harvesting Machine	R846 363,64	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R2 205 000,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R0,00	R 846 363,64
Tractors																										
Orchard & Vineyard	R 372 470,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 563 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 372 470,00
Orchard & Vineyard	R 287 960,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 563 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 287 960,00
Orchard & Vineyard	R 252 080,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 331 200,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 252 080,00
Orchard & Vineyard	R 314 880,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 345 600,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 314 880,00
Orchard (harvesters) used second hand	R 302 250,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 351 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 302 250,00
Orchard	R 288 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 405 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 288 000,00
Fork lifters	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total vehicles and machines	R 3 342 815,60	R 0,00	R 0,00	R 0,00	R 0,00	R 335 066,21	R 0,00	R 2 901 629,57	R 670 051,41	R 921 360,69	R 0,00	R 0,00	R 902 021,55	R 674 354,77	R 573 531,24	R 0,00	R 657 416,42	R 673 194,41	R 802 223,34	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 215 152,99	R 3 342 815,60
Implements:																										
Sprayers																										
Towing type (1) 1500l	R 67 500,00	R 0,00	R 0,00	R 243 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 243 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 67 500,00
Towing type (2) 1500l	R 50 000,00	R 0,00	R 180 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 180 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 50 000,00
Turbmatic 1500l	R 30 800,00	R 0,00	R 158 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 158 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 30 800,00
Three-point 400l (weed control)	R 19 800,00	R 0,00	R 0,00	R 81 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 81 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 19 800,00
Tillage implements																										
Scraper (Andrag)	R 320,00	R 0,00	R 0,00	R 1 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 320,00
Disc	R 8 225,00	R 0,00	R 0,00	R 0,00	R 31 500,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 31 500,00	R 8 225,00
Ghrop	R 10 100,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 18 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 10 100,00
Other																										
Tip Wagon (Harvest) 3Ton single axle	R 52 060,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 68 400,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 52 060,00
Ordinary wagon double axle 6Ton dropsides	R 40 670,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 88 200,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 40 670,00
Bin wagons	R 262 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 324 000,00	R 0,00	R 0,00	R 262 800,00
Rovic Lime Spreader	R 11 900,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 18 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 11 900,00
"Bossieslaner"	R 10 100,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 18 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 10 100,00
Electric mobile water pumps	R 17 850,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 27 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 17 850,00
Contents of workshop and tools	R 143 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 234 000,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 143 000,00
Orchard tools (stairs, picking bags, pruning shears)	R 24 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 28 800,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 24 800,00
Bins	R 852,50	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 990,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 852,50
ZIP 30 Moving Machine	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00	R 0,00
Total Implements:	R 750 777,50	R 0,00	R 366 013,44	R 366 480,69	R 36 850,54	R 0,00	R 0,00	R 0,00	R 120 707,79	R 0,00	R 53 288,79	R 360 232,25	R 72 046,45	R 0,00	R 704 445,98	R 437 629,27	R 55 796,11	R 0,00	R 164 091,14	R 0,00	R 0,00	R 0,00	R 767 853,69	R 0,00	R 80 744,08	R 750 777,50
Total:	R 4 093 593,10	R 0,00	R 366 013,44	R 366 480,69	R 36 850,54	R 335 066,21	R 0,00	R 2 901 629,57	R 790 759,20	R 921 360,69	R 53 288,79	R 360 232,25	R 974 068,00	R 674 354,77	R 1 277 977,22	R 437 629,27	R 713 212,53	R 673 194,41	R 966 314,48	R 0,00	R 0,00	R 0,00	R 767 853,69	R 0,00	R 295 897,07	R 4 093 593,10
Total Capital (d)	R 63 415 726,43	R 0,00	R 366 013,44	R 366 480,69	R 36 850,54	R 335 066,21	R 0,00	R 2 901 629,57	R 790 759,20	R 921 360,69	R 53 288,79	R 360 232,25	R 974 068,00	R 674 354,77	R 1 277 977,22	R 437 629,27	R 713 212,53	R 673 194,41	R 966 314,48	R 0,00	R 0,00	R 0,00	R 767 853,69	R 0,00	R 295 897,07	
Net annual flow (a-b-c-d)	-R 59 749 581,72	R 5 989 945,08	R 7 862 719,14	R 9 535 023,99	R 10 879 519,18	R10 950 574,04	R 11 659 041,56	R 9 134 038,76	R 1 614 620,27	R 9 572 150,45	R 10 983 784,53	R11 072 963,49	-R 970 732,71	R 10 851 891,80	-R 3 816 623,30	R 8 949 496,04	-R 6 058 804,94	R 8 817 525,38	R 10 509 131,44	-R 6 978 123,44	R 11 145 166,54	-R 9 593 733,59	-R 40 252 451,99	-R 23 188 630,21	R 36 062 677,24	