DECISION SUPPORT SYSTEMS ADOPTION BY EMERGING FARMERS IN THE WINE INDUSTRY: A CASE STUDY OF THE WESTERN CAPE, SOUTH AFRICA

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by

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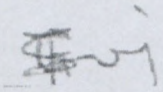
DECLARATION

I, Godwishes. T. Simbanegavi, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.



13 November 2012

Signed **Date**

ABSTRACT

The wine industry is complex hence the farmers and emerging farmers who operate in it are faced with environmental, social and economic constraints. Even though various issues have been pointed out to be contributing to the slow uptake of ICT by emerging farmers (Cox, 1995), McCartney (2007) however pointed out that DSSs can enhance gains in economic, social and environmental benefits. This study investigates how wine farmers use ICTs to support decision making in order to assist emerging farmers adopt and use the ICTs for decision making. Decision making is crucial; it is one of the most important tasks of management in running a successful business (Dralega, 2007). Emerging farmers have to operate in a complex environment and ICT use can lead to the effective use of information to support decision making in the industry. Experienced farmers use ICT tools to support decision making and use information to make informed decisions in their operations. Emerging farmers are at a distinct disadvantage as they have no previous knowledge of farming and have to find their way on a day to day basis. This has the potential of reducing profitability and sustainability of the emerging farmers who have entered the industry. The main research question is: "how can emerging farmers utilise ICT for decision making in the wine industry in the Breede River Valley region in the Western Cape?" Interviews were done to gather primary data. In this case it is information about the technological and information needs of farmers which might help them in decision making. The literature is reviewed in this study to gather secondary data. The study took an inductive approach and the epistemological stance in this study is interpretivism. The case study was used as strategy for the study. The interviewees emphasised the importance of ICTs in their decision making; they mentioned that without the use of ICTs in decision their businesses will crumble. In order to prosper in their business, emerging farmers need to invest in ICTs as this will also assist in improving livelihoods of the farmers and their workers.

Keywords: Agriculture, Decision Support Systems, Information and Communication Technologies, decision making, emerging farmers, wine industry.

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RESEARCH ACHIEVEMENTS

The following papers were achieved through this study

- Simbanegavi, G., Tembo, R. & Owei, V. Factors influencing the use of ICT by farm employees in the Western Cape commercial agriculture: A case study of the wine industry. *IST-Africa, 2010* , vol., no., pp.1-7, 19-21 May 2010 **Print ISBN:** 978-1-905824-15-1
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- Simbanegavi, G. & Andre de la Harpe. "Decision Support Systems in Commercial Agriculture: Case Study on ICT adoption and use to support decision making by farmers in the Western Cape Wine Industry." Paper accepted for the *DSS 2012, Annavissos, Portugal – June 2012.*

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GLOSSARY

Acronyms and Abbreviations	Definition/Explanation
DSS	Decision Support Systems
aDSS	Agricultural Decision Support Systems
ICT	Information Communication Technology
DoA	Department of Agriculture
NEPAD	New Partnership for Africa's Development
CAADP	Comprehensive Africa Agriculture Development Programme
SAWIS	South Africa Wine Industry Information & Systems
GDP	Gross Domestic Product
WOSA	Wine of South Africa
NGO	Non Governmental Organisation
LWRRDC	Land and Water Resources Research and Development Corporation
SAITIS	South African Information Technology Industry Strategy
DBSA	Development Bank of Southern Africa
NDA	National Department of Agriculture
SDP	Standard Decision Problem
IPM	Integrated Pest Management
ENSO	El Nino-southern Oscillation Phenomenon
ES	Experts Systems
AI	Artificial Intelligence
PF	Precision Farming
GPS	Global Positioning System

GIS	Geographical Information Systems
PAR	Participatory Action Research
DOI	Diffusion of Innovations
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action
IS	Information Systems
SABC	South African Broadcasting Corporation
MMS	Multimedia Messaging Service
ISP	Internet Service Provider
VoIP	Voice over Internet Protocol
LAI	Leaf Area Index
ERP	Enterprise Resource Planning systems (ERP)

Definition of terms

Decision support systems

Computer based tools developed (generally by researchers, but no exclusively so) to provide analysis and advice to decision makers.

Precision agriculture or precision farming

Makes use of new technologies such as global positioning systems (GPS), sensors, satellites or aerial images and information management tools to assess and understand variations in the field for optimum profitability, sustainability and protection of the land resource.

Global Positioning System

Any system which enables a mobile receiver to determine its precise location based on signals received from satellites.

Viticulture

The science, production and study of grapes which deals with the series of events that occur in the vineyard. When the grapes are used for winemaking, it is also known as viniculture/oenology.

Standard Decision Problem

This is when the decision maker does not fully internalise the feedback from actions to psychological states (reference points, beliefs, emotions, aspirations, temptations, moods etc). The decision maker then chooses an action and as a consequence a psychological state that maximises the underlying preferences.

Novel decisions

These are complex and are not encountered often, hence the need to critically execute them.

E-banking

The use of the internet to perform banking transactions.

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CHAPTER ONE
GENERAL INTRODUCTION

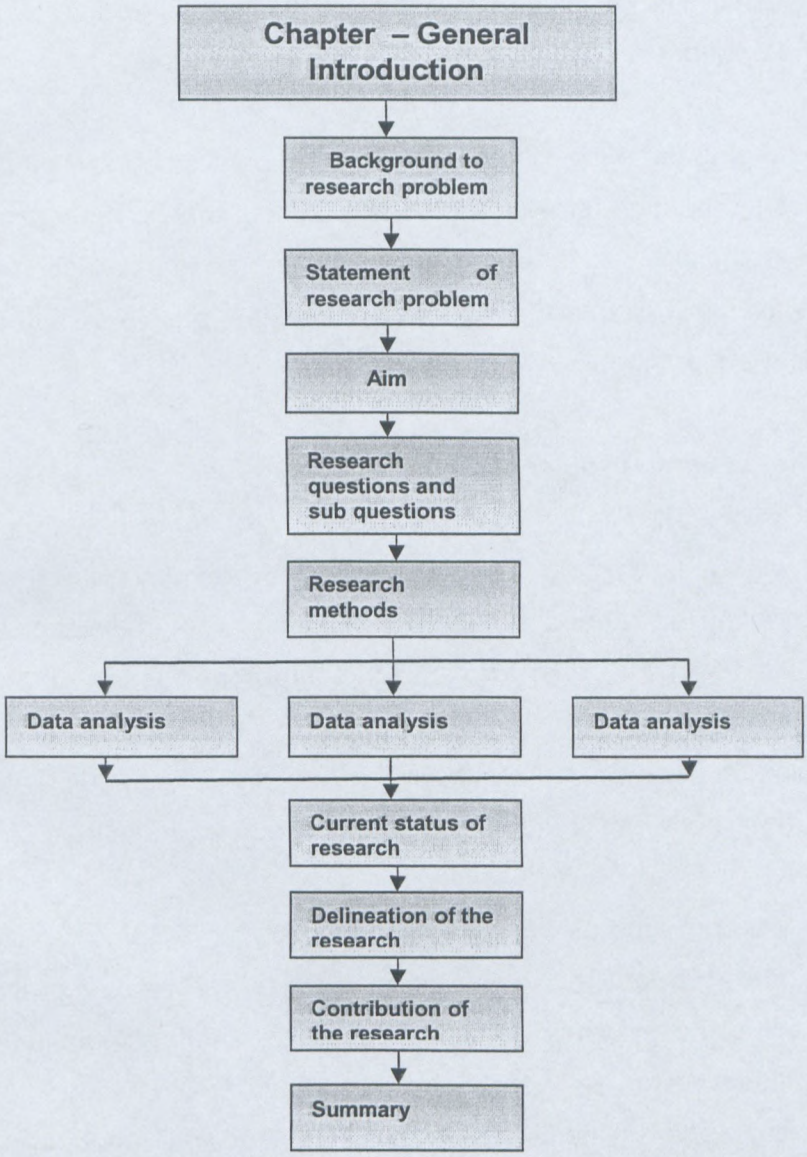

Fig 1.1: Diagram of the structure of Chapter 1

1.1 Introduction

In South Africa, new farmers are entering the agricultural sector. These farmers, also called emerging farmers, are aspiring to establish themselves in the agricultural industry. They are entering a complex environment with little or no knowledge of the complexity of the industry and/or environment. As a result they run a high risk of failure. One of the ways to mitigate

the risk, is to find quality information through technology in order for them to make quality decisions.

Madolo (2010) defines emerging farmers as farmers of all racial groupings that grow fruit and/or vegetables that are currently exported or have the potential (grown to standards with the intention) of being exported. The definition of Madolo (2010) is very specific for a part of the agricutlral industry and excludes any other farming section or category.

Different categories of emerging farmers exist, some operating on a small and others on a large scale. The small scale emerging farmers are usually without much infrastructure and technologies. On the other hand large scale emerging farmers are newly established farmers with more infrastructures available to them. These can be wealthy people or corporations venturing into for example wine farming.

1.2 Background to the research problem

Emerging farmers in the wine industry operate in a complex environment, where they are exposed to many environmental, social and economic constraints. They have to operate in an environment involved with high costs, changing environmental conditions and many other factors, many times outside the control of the farmer. This creates difficulty in decision making at large. The decisions are even more difficult if taking into consideration that wine and fruit farmers need to make decisions that have an impact stretching more than 25 years.

Tools to support decision making such as decision support systems (DSSs) help structure the decision processes and support the complicated analysis of resource allocation problems, environmental and socio-economic constraints as well as management objectives. DSS tools can also enhance gains in economic, social and environmental benefits (McCartney, 2007). Decision support systems (DSSs) are computer applications along with a human component that can mine through large amounts of data and pick between the many choices (tech-faq.com, 2010). Matthews, Schwarz, Bucha, Rivington and Miller (2008:150) define DSSs as computer based tools developed to provide analysis and advice for decision makers. In agriculture,when using DSSs the term aDSSs is used (Matthews et al., 2008).

According to McCown (2002), DSSs fill a calculator role, making complex but well-structured calculations or inferences and encapsulate knowledge that is difficult to derive from experiential learning. Moreover, McCown (2002) highlights that DSS tools are intended to assist in the adoption of best management practises and often address environmental issues

(for example the Your Farm and NVZ's DSS, designed to assist UK farmers in complying with nitrate vulnerable zone (NVZ) regulations (McCown, 2002; Matthews et al., 2008:151).

DSSs such as Farm MS are more and more being used by farmers (Matthews, et al., 2008). Decision support tools such as DSSs have been employed in a number of industries, most notably manufacturing and finance (Anger, Rodriguez & Ali, 1994). However, DSS tools uptake has been slow in agriculture and various issues have been pointed out to be contributing to the slow uptake including the lack of relevance, complexity, fear of using computers and lack of end user involvement (Nguyen, Wegener & Russell, 2006:2).

Prior research done in the wine industry in the Western Cape concludes that commercial farmers use Information Communication Technologies (ICTs) for production, marketing and communication (Tembo, 2008). Tembo (2008) outline that farmers use ICT in production and for marketing their products, both locally and internationally as well as communicating with other stakeholders in the business. However, the results from the research by Tembo (2008) in the Western Cape wine industry did not clearly spell out the use of decision support tools by the farmers.

The ongoing global economic crisis which results in the fluctuation of the Rand (monetary unit) as well as job losses force consumers to spend less. This instability adds to the complex decision making by farmers in order for them to survive and achieve the best results.

1.3 The research problem

Decision making is crucial; it is one of the most important tasks of management in running a successful business (Dralega, 2007). Emerging farmers have to operate in a complex environment and ICT use can lead to the effective use of information to support decision making in the industry. Experienced farmers use ICT tools to support decision making and use information to make informed decisions in their operations. Emerging farmers are at a distinct disadvantage as they have no previous knowledge of farming and have to find their way on a day to day basis.

1.4 Problem statement:

The environment emerging farmers operate in is complex and they are at a distinct disadvantage as they have no previous knowledge of farming. Emerging farmers do not have the experience, knowledge and tools to make quality decisions. This has the

potential of reducing profitability and sustainability of the emerging farmers who have entered the industry.

1.5 Aim

This study seeks to explore to what extend emerging farmers need ICT to support them in decision making.

1.6 Research question and sub-questions

1.6.1 Research question

How can emerging farmers utilise ICT for decision making in the wine industry in the Breede River Valley region in the Western Cape?

1.6.2 Research sub- questions

a) What type of decisions do the farmers make?
b) How do farmers make their decisions?
c) What information is required to support the identified categories in decision making?
d) What technologies are suitable to support farmers in decision making?
e) What are the farmers' requirements for ICTs to support decision making?
f) Why is there slow uptake of decision support systems by emerging farmers?

1.7 Objectives of the study

The overall research objective is to explore how the ICT infrastructure could support emerging farmers in decision making. A further objective is to propose a guideline for emerging farmers to use to determine how, when and where they can use ICT to improve their farming operations. Table 1.1 shows a summary of research questions and objectives.

Table 1.1: Summary of research question, sub questions and objectives

Research Problem	The environment emerging farmers operate in is complex and they are at a distinct disadvantage as they have no previous knowledge of farming. Emerging farmers do not have the experience, knowledge and tools to make quality decisions. This has the potential of reducing profitability and sustainability of the emerging farmers who have entered the industry.	
Research Question	How can emerging farmers utilise ICT in decision making in the wine industry in the Breede River Valley region in the Western Cape?	
Research sub-question	**Objectives**	**Research method(s)**
1. How do farmers make decisions?	To establish how farmers reach a decision in their farming operations	Literature analysis Interviews
2. What decisions do they make?	To establish what broad categories of decisions they make	Literature analysis Interviews
3. What information is required to support the identified categories in decision making?	To determine what information farmers require to support them in decision making	Interviews
4. What technologies are suitable to support farmers in decision making?	To determine what technologies farmers require to support them in decision making	Literature analysis Interviews
5. What are the farmers' requirements for ICTs to support decision making?	To find out the ICT infrastructure farmers need to support their decision making	Literature analysis Interviews
6. Why is there slow uptake of decision support systems by emerging farmers?	To investigate why there is slow uptake of decision support tools by emerging farmers	Literature analysis Interviews

1.8 Research methodology

The aim of this research is to explore and therefore a qualitative research method is more suitable than other methods (Terre Blanche, Durrheim & Painter, 2006). Qualitative research is more subjective than quantitative and uses different means of collecting information which includes interviews, observations and open ended questionnaires (Myers, 2009). The epistemological stance is interpretivism (Saunders, Lewis & Thornhill, 2007:106). Collected data is not subjected to formulaic analysis for the purpose of generating the solution. The study takes an inductive approach.

Interviews were used to gather data. The strategy was used to identify what decisions farmers make and what information and technologies they require to support them in decision making. The results were used to identify the requirements for an ICT infrastructure to support farmers in decision making.

Interviews were done to gather primary data. In this case it is information about the technological and information needs of farmers which might help them in decision making. The literature is reviewed in this study to gather secondary data.

1.9 Unit of analysis

The unit analysis of this study was the emerging and established farmers in the wine industry in the Western Cape of South Africa. The specific units being farm management, farm owners and any stakeholders involved in decision making.

1.10 Data collection

1.10.1 Primary data

Interviews were used to gather data. Interviews involved face-to-face semi-structured questioning of target respondents conducted individually (Terre Blanche et al., 2006). Interviews assisted in the gathering of in-depth data concerning the technologies and information the farmers require to support their decision making. Open-ended questions were asked as it gives room for further explanation or outlining of opinions by respondents while closed questions guided the respondent by only giving them options to choose from.

1.10.2 Secondary data

Secondary data were obtained through analysis of the literature from sources such as reports, publications, from universities, research institutions and also from other stakeholders such as officials from Department of Agriculture (DoA) and agriculture policy makers. The secondary data is useful to augment the primary data in identifying the information and technological requirements to support decision making. It helps to clarify the views and perceptions of farmers about the use of ICT in supporting decision making.

1.11 Data analysis

Data analysis is a practice in which raw data is ordered and organized so that useful information can be extracted from it. It involves breaking up the data into manageable themes, patterns, trends and relationships (Mouton, 2001). The data was analysed according to themes, summarised, categorised and presented as findings (Saunders, et al., 2007).

The following methods were used to analyse the data:

1.11.1 Hermeneutics

Hermeneutics which can be treated as both an underlying philosophy and a specific mode of analysis was used (Myers, 2009). As Myers (2009) points out it is primarily concerned with the meaning of a text or text-analogue (an example of a text-analogue is an organization, which the researcher comes to understand through oral or written text). In hermeneutics, interpretation attempts to make clear and to make sense of an object of study which must therefore be a text or text-analogue. This is a suitable analysis tool to use to interpret the data gathered from the interviews and the literature.

1.11.2 Conversation analysis

Conversation analysis is used in the formal analysis of everyday conversations (Flick, 2007). As Grey (2009) articulates it includes the analysis of natural texts (often the result of transcribed tape recordings) and seeks to specify the formal principles and mechanisms with which participants express themselves in social interactions. Conversation analysis is less concerned with the formal analysis of language *per se*; it is focused on the issue of context. Originally limited to the study of everyday conversations or family conversations this

technique has been extended to meetings and various kinds of interviews. Therefore conversation analysis was used to analyse the interviews with farmers.

1.12 Data Presentation

The analysed data from the data analysis techniques above are presented to show the ICT infrastructure farmers need to support their decision making. Summary values and graphical presentations are used to present the data from the descriptive analysis.

1.13 Current status of the research area

1.13.1 Introduction

Agriculture is the science or practise of farming including the growing of crops and the rearing of animals (*Concise Oxford English Dictionary*, 2004:14). It is the process of producing food, feed, fibre and other goods by the systematic raising of plants and animals. It made an important contribution to the development that led to the rise of human civilisation; with the husbandry of domesticated animals and plants (i.e. crops) creating food surpluses that enabled the development of more densely populated and stratified societies (Ball, 2010:1).

Agriculture encompasses a wide variety of specialties and techniques. There are many different types of farming e.g. arable (growing crops and cereals), pastoral (production of animals), mixed farming (combination of arable and pastoral), horticulture (production of fruit, vegetables, flowers or ornamental flowers), market gardening (production of fruit and vegetables) and viticulture (grapes) (The Encyclopaedia of Earth, 2010:1).

Agriculture is an important economic activity, providing food, employment and livelihoods for many people and serving as the basis for many industries with about 56,6% of the total world labour force engaged in agricultural labour in 2002 (Cleveland, 2007:1). This author states that in most African countries, agriculture supports the survival and well-being of up to 70 percent of the population. Cleveland (2007:1) also highlights that Africa spends between US$15 and 20,000 million on food imports annually, in addition to the US$2,000 million it receives in food aid annually, amounts of money that the region cannot afford to externalize and could be used to revitalize agriculture. The use of ICTs in decision making could help revitalise agriculture in Africa.

1.13.2 Types of agriculture in Africa

Even though 70% of the rural poor in Africa depend on subsistence farming, agriculture is not limited to subsistence food crops and livestock production but includes crops grown for sale, such as tobacco, cotton and rubber. Figure 1.1 shows the following types of farming practised in Africa: plantation agriculture, subsistence crops with livestock rearing, irrigated agriculture, livestock rearing, nomadic herding, oases (date cultivation), and primary forest (some rudimentary agriculture) as well as Mediterranean agriculture.

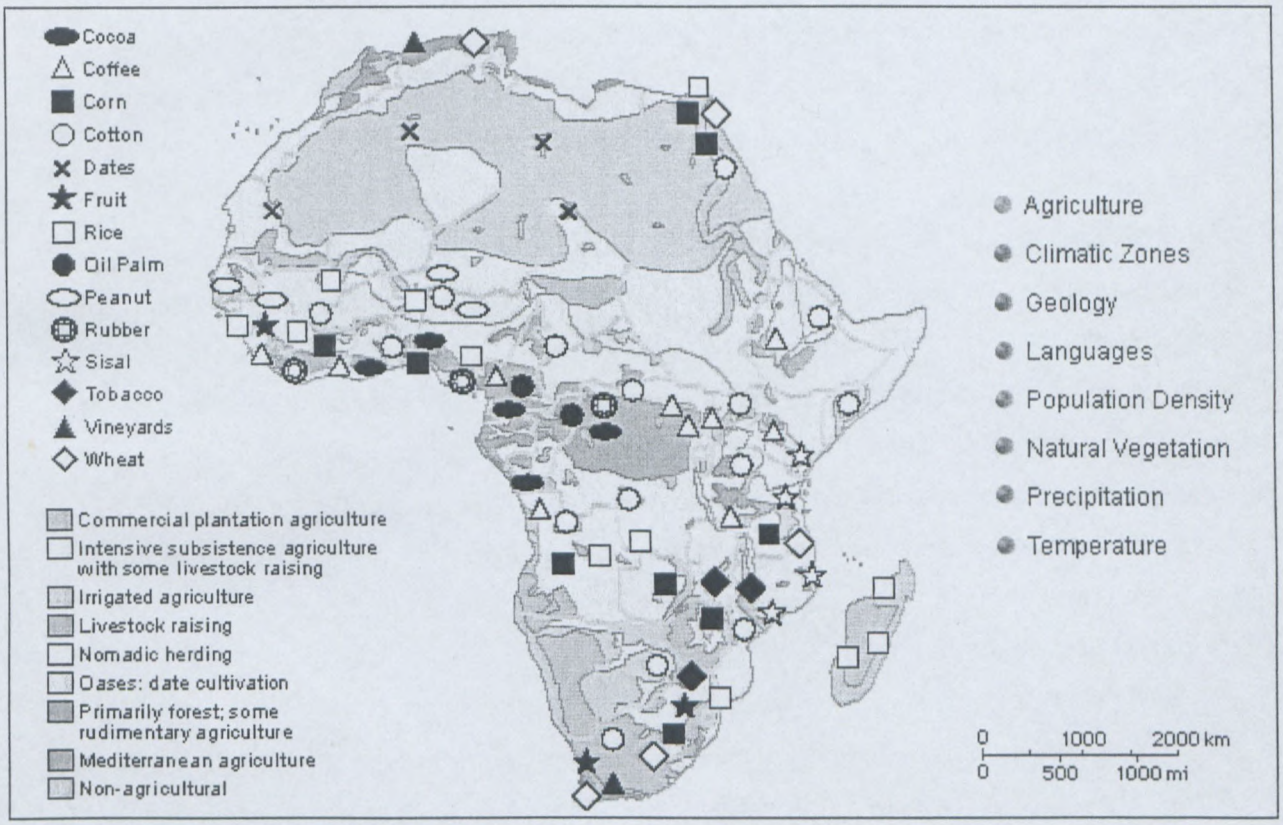

Figure 1.2: Map showing the types of agriculture in Africa (www.go-passport.grolier.com)

In late 2002, in their bid to reverse the downward slide in agriculture and help boost production and enhance food security, African governments in the context of the New Partnership for Africa's Development (NEPAD) came up with the Comprehensive Africa Agriculture Development Programme (CAADP). The CAADP has three immediate "pillars" and one long-term pillar which together can help tackle Africa's agricultural crisis (Cleveland, 2007:1). The long-term pillar to achieve accelerated gains in productivity is agricultural research together with technology dissemination and adoption. Among the requirements of the long term pillar are technology delivery systems that quickly bring innovations to farmers

and agribusinesses through appropriate use of new information and communication technologies (Cleveland, 2007:1). This study is in line with the NEPAD long term pillar to achieve gains in productivity.

1.13.3 Wine farming/viticulture

Viticulture and the art of wine making were introduced to India, Egypt and Persia by the Arians centuries BC (van Zyl, 1987:32). Viticulture is the science, production and study of grapes and deals with the series of events that occurs in the vineyard (Johnson, 1989). When the grapes are used for winemaking, it is also known as viniculture/oenology. It represents one branch of the science of horticulture (Johnson, 1989).
Viticulture supplies the population with fresh and dried grapes and the wine and canning industries with raw material. Thus, viticulture has four production aims:

1. Table viticulture - production of fresh grapes for local use, export, and storage;
2. Viticulture as the raw-material base for the production of dried grapes - growing currant and raisin varieties;
3. Viticulture as the raw-material base of the wine industry - cultivation of wine varieties of grapes to supply raw material for manufacturing plants specializing in production of various types of wine, champagnes, and wine products used in making brandy; and
4. Viticulture as the raw-material base for the canning industry - production of raw material for juices, compotes, jams, pickled grapes, and other non-alcoholic products
(Encyclopaedia Britannica, 2010:1)

The Encyclopaedia Britannica (2010:1) further states that viticulture is a profitable branch of agriculture. However it requires intensive cultivation, large capital investments and considerable labour input, thus wine farmers operate in a complex environment which requires them to make informed decisions in their operations. Figure 1.2 shows the wine regions of the world.

Figure 1.3: Map showing world wine regions (www.thediningguy.com)

1.13.4 South Africa viticulture/wine farming

South African wine farming dates back to 1659, and at one time the wine estate Constantia was considered to produce one of the greatest wines in the world. Access to international markets in the post-apartheid era created new energy resulting in new investment and production concentrated around Cape Town. The South African wine industry encompasses wine (natural, fortified and sparkling), distilling wine, brandy and other spirits distilled from distilling wine, and grape juice and grape juice concentrate for use in wine and non-alcoholic products (South African Wine Industry Information & Systems SAWIS, 2010).

Wine Of South Africa (2010) reports that 101 325 hectares of vines producing wine grapes are under cultivation in South Africa over an area some 800 square kilometres where white varietals constitute 56% of the plantings for wine and red varietals account for 44% of the national vineyard. In their December 2009 publication, the South African Wine Information and Systems reports that R26,2 billion of the gross domestic product (GDP) was contributed by the wine industry to the regional economy, with R4,3 billion generated indirectly through wine-tourism activities centred in the wine lands. WOSA (2010) through their website mention that in terms of world wine production, South Africa ranks as number eight (in 2010) in overall volume of wine production and produces 3.0% of the world's wine.

Of the 1 033.4 million litres produced in 2009, 805.1 million litres was devoted to making wine, 71.4 million litres to making wine for brandy, 122.1 million litres to distilling wine and 34.8 million litres to the production of grape juice concentrate and grape juice. Total exports of wine for the 2009 calendar year reached 395.6 million litres, with natural wine accounting for 389.1 million litres, fortified 0.3 million litres and sparkling 6.2 million litres.

The graph below (Fig 1.3) shows the area under cultivation for wine grape vineyards in South Africa as well as the map (Fig 1.4) showing wine growing areas of South Africa and the research area is circled in red.

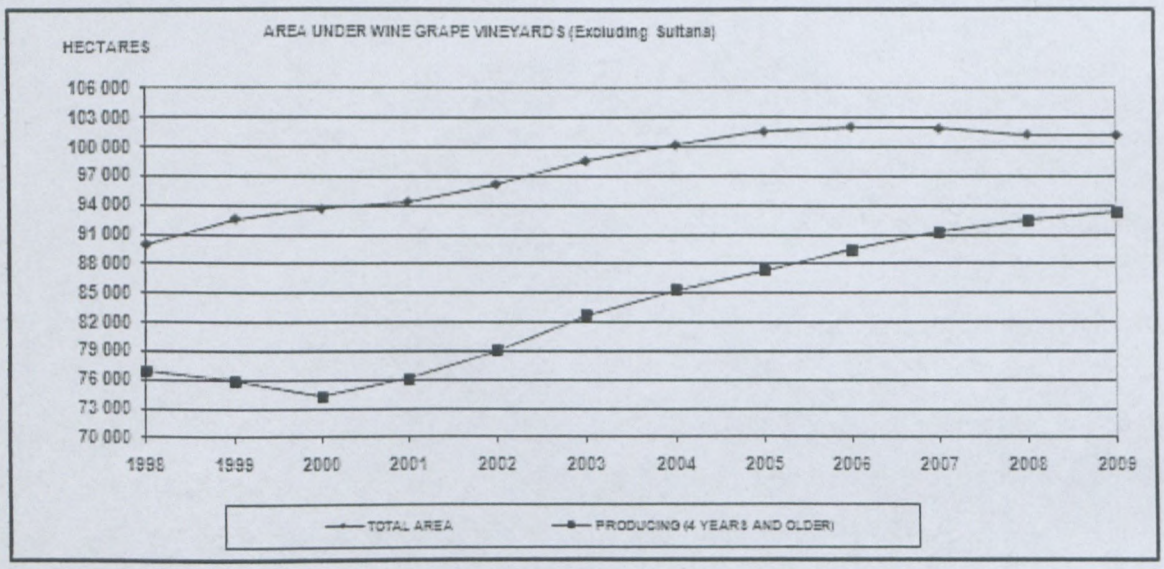

Figure 1.4: Area under wine grape vineyards for South Africa (SAWIS, 2010)

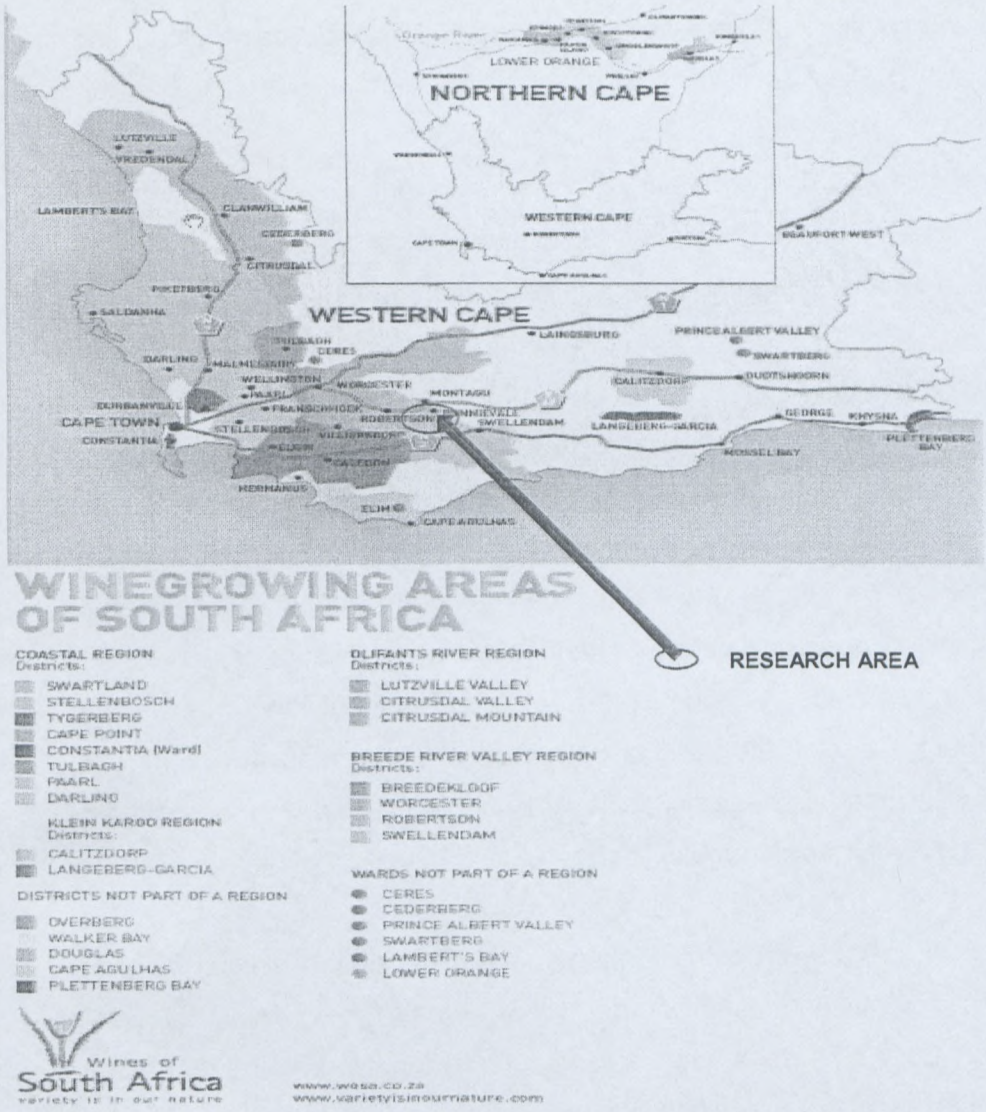

Figure 1.5: Map showing wine growing areas of South Africa (WOSA, 2010)

1.13.5 What decisions do farmers make?

McCartney (2007) articulates that appropriate use of decision support systems and participation of stakeholders to assist in planning and operation of dams, can contribute to the mitigation of dam related conflicts and to ensuring sustainable projects. Farmers also use decision support tools to support the complicated analysis of allocation problems, environmental and socio-economic constraints as well as conflicting management objectives.

Rao (2006:495) mentions that farmers make critical decisions throughout the year, "these decisions include those based on choice of inputs (crop varieties and seeds, water, power, fertilizers and pesticides) and market transactions related to them, farm operations (tillage, sowing, water management, fertilizer management, pest management, harvest), post-

harvest operations and transactions (storage, transport, marketing, processing, etc.) and others".

Bath, Coleman and Rossouw (2005) indicate that farmers use decision support tools in management of water containing waste. Mackay (1993) shows that they use DSS tools to make informed decisions in the management of the natural environment of rivers.

1.13.6 Farmers' information needs

Phrases such as "better information leads to better decisions" and "what managers require is more information" dominate the literature on decision support tools (Hayman 2003:7). However, Fountas, Wulfsohn, Blackmore, Jacobsen, and Pedersen (2006:193) articulated that farmers need to think systematically about their information needs, the costs of information, alternative sources and the value of the information, identifying what is the necessary information. Fountas et al. (2006:193) also mention that recent advances in ICTs allow farmers to acquire vast amounts of site-specific data for their fields, with the ultimate aim being to reduce uncertainty in decision-making.

Farmers need information to assist them in the management of the natural environment of rivers as well as to assess crop planting options in their very risky farming environment (Bath et al., 2005; Nguyen et al., 2006). Farmers use decision support tools to obtain information to support the complicated analysis of allocation problems, environmental and socio-economic constraints as well as conflicting management objectives (McCartney, 2007).

Hayman (2003:5) highlights that farmers need information in operational decision making (spraying, sowing, harvesting decisions), tactical decisions (which crop, what area and level of inputs) and strategic (pasture to crop enterprise mix, purchasing extra land).

1.13.7 ICT and decision making in agriculture

Rao (2006:495) mentioned that farmers make critical decisions throughout the year. Rao (2006:495) articulates that at the household level, a number of non-farm decisions are made related to consumption, savings, investments, education, health, etc., which impact farm operations. Mackrell, Kerr and von Hellens (2009) support Rao (2006) stating that typically farmers rely on accumulated experience and the support of local organizations and consultants (e.g., input suppliers, rural credit agencies, extension services, NGOs) for information related to both farm and non-farm decisions. In addition the farmers also receive

information from radio and television broadcasts by experts and professionals from more distant sources. However the author goes on to suggest that often, this system is inadequate and many decisions are made with limited information. The decisions are also subject to high transaction costs and time delays. The role of ICTs in such a scenario is to provide timely information, increase choice, reduce transaction costs, and contribute to improving the efficiency of decision making to raise incomes (Rao, 2006).

The uptake of technologies to support decision making such as agriculture decision support systems (aDSS) by farmers is slow. Various issues contribute to this, including the fear of using computers, time constraints, poor marketing, complexity, lack of local relevance, lack of end-user involvement, and mismatched objectives between developers and users (Nguyen et al., 2006). The authors also suggest that the future prospect for the development of these tools is generally regarded to be poor.

With the growing use of computers by farmers, this situation is set to change. Rao (2006) states that ICTs and their convergence with conventional media is expanding all the time. Rao suggests that not including ICTs in agricultural development planning, can have serious negative consequences for the economy in a globalizing world. Fernandez and Trolinger (2007) in addition point out that the rapid development, since the mid-1990s, of the Internet and the World Wide Web has created great opportunities to develop new approaches for the transfer of technology to farmers in the form of online computer-assisted decision support systems.

Parker and Campion (1997:1-6) note an increasing interest in the potential of decision support tools for crop production. They state that attempts to provide such tools up to 1997 were not very successful due to lack of farmer interest. Encouraging farmers to change their information management has not been as easy and straightforward as expected. For instance, farmers have shown a low rate of management software adoption and its effective use relative to farmers' adoption behaviour of technical innovations (Alvarez & Nuthall, 2006).

ICTs have transformed the face of agriculture in many developed countries. ICTs can become key enablers of the agro-food sector by making dynamic and real-time global level exchange of data, information and knowledge quick, interactive and easy throughout the agricultural value chain. Their effective deployment can lead to increased agricultural competitiveness through cuts in production and transaction costs, raising production

efficiencies and farm incomes, conserving natural resources, and by providing more information, choice and value to stakeholders (Rao, 2006).

Cox (1995) articulates that there is increasing concern by research and development funding bodies that investment in the development of decision support tools such as DSSs to improve agricultural practice has been largely wasted because these products have not been widely taken up by producers. The impact of the software on better decisions, greater competitiveness, or improved sustainability is only rarely documented, and there have been few attempts to quantify its effects.

1.13.8 Use of ICTs to support decision making in agriculture in Africa

The South African Information Technology Industry Strategy (SAITIS, 2002) in their study outline that the South African agriculture industry has been a major user of ICT more than other sectors. It is noted that ICT is among other technologies, used for farm support operations, data collection, mapping and communication with stakeholders.

McCartney (2007) mentions that appropriate use of decision support systems and participation of stakeholders to assist in planning and operation of dams can contribute to the mitigation of dam related conflicts and ensuring sustainable projects. The author goes on to add that the use can also enhance gains in economic, social and environmental benefits. Therefore according to McCartney (2007) the use of decision support tools assists the farmers involved in the building of dams to gain competitive advantage in the industry. The authors in the same paper go on to suggest that there has been considerable effort made into the development of decision support tools such as DSSs to assist managers to make well informed decisions. These help to structure the decision processes and support the complicated analysis of allocation problems, environmental and socio-economic constraints as well as conflicting management objectives.

Bath et al., (2005) outlines that the application of controlled release as a method for the management of water containing waste is relatively new in South Africa. Meaning the use of ICTs in supporting decision-making has not been a common practice.

A project was proposed to develop a prototype decision support system for the Kruger National Park Rivers Research programme. It aimed to show how decision support tools such as DSS can be used to structure and improve communication between researchers, managers and stakeholders (Mackay, 1993). The project also aimed at providing information

regarding management of the natural environment of rivers through the decision support tool.

Mackay (1993), Dralega (2007) and McCartney (2007), indicate in their studies that use of DSS in agriculture can enhance gains in economic, social and environmental benefits. However Nguyem et al. (2006) believe the future prospect of DSS development is poor. They attributed this to factors such as the fear of using computers and the complexity of computer systems.
However with the growing use of computers and the involvement of users in developing DSSs, their use is likely to increase.

1.13.9 Contributing factors to lack of optimisation and use of decision support tools in commercial agriculture

Anger et al. (1994) wrote that decision support tools such as DSSs have been deployed in other industries, most notably manufacturing and finance, but as noted below the uptake has been slow in agriculture. The factors contributing to this slow uptake are discussed next.

Cox (1995) notes the following five main reasons for lack of uptake of DSS:

1.13.9.1 Failure to support more than the exceptional circumstance

Here Cox referred to old generation decision support tools based solely on one technology not applicable to a different farming method. However, current model-based software supports more than one circumstance, rendering this reason not appropriate.

1.13.9.2 Computerisation

Palmer (1992) reports that computerisation was out of the question for many farmers for two basic reasons: firstly, the hardware and software were too expensive and soon outdated; and secondly the necessary computer expertise was not available on the farm. This was supported by Gibbon and Warren (1992). However according to recent research this is changing. A survey done in the UK revealed that there was a notable increase in the use of computers and farmers promising to acquire more Parker (1996). Moreover Tembo, Simbanegavi and Owei (2010:1-7) reveal that farmers in the wine industry in South Africa use computers in production, marketing and communicating with stakeholders.

1.13.9.3 Complexity

Cox highlights that expert evaluations and user interviews suggest that complexity is undoubtedly a major contributor to the failure of DSSs. He notes that complexity results from failure to adopt good software design practice and translate it from a scientific to a farming mindset easier understood by farmer. Sciefer (1992) and Eleveld et al. (1992) also echo the same sentiments on complexity. However a simple, friendly interface is not a guarantee of success, it will still fail to win users if the developer has not given thought to the nature of the inputs the user will have to provide (Cox, 1995). This highlights the need for developers to work hand in hand with the farmers to guarantee that the decision support tools developed meets the users' needs and is easy to use.

1.13.9.4 Inputs

Since most models require their users to enter values for certain variables like weather data or sowing date, there is some evidence that these variables contribute to the failure of DSS, either because they are unavailable to the user or are inconvenient or difficult to collect. Scientists use many uncommon measurements, e.g. relative humidity and leaf wetness using custom-built sensors placed in the crop. The use of these variables, which may be ideal for the development of an accurate and predictive model, is likely to cause problems for the grower or farmer because they are difficult or too expensive to measure on a farm wide basis. Consequently the farmers end up not using DSS (Cox, 1995).

1.13.9.5 Failure to show cost benefits

The use of any computer tool requires an investment in time and money on the farmer's part and initially a certain amount of faith. Therefore there has to be a fairly obvious cost saving inherent in its use to take the user from polite interest to purchase and use.

From the foregoing it is seen that:

1. Using ICTs in supporting decision making is important in agriculture. The information the decision support tools provide act as an empowerment tool to farmers and gives them the ability to make informed decisions in their operations, as Dralega (2007) noted.
2. Decision support tools help structure decision processes and support the complicated analysis of allocation problems, environmental and socio-economic constraints as well as conflicting management objectives, as explained by McCartney (2007).

Parker (1996), states that a list of publicly available agricultural decision support systems in the UK, over 20 in total, does not contain a single name in common use on the farm. Parker and Campion (1997) wrote that the reason for the debate as to use and/value of decision support tools is the seeming lack of interest in such systems when they are packaged and presented for use by the consultant and farmer.

According to Nguyen et al. (2006) the uptake of DSS by farmers has been slow. Various issues are said to be contributing to the slow uptake, and these include as noted earlier fear of using computers, time constraints, poor marketing, complexity, lack of local relevance, lack of end-user involvement, and mismatched objectives between developers and users.

However as already explained, earlier studies on the use of ICT in the agriculture industry in South Africa, specifically in commercial wine farming does not reveal the use of decision support tools in critical aspects of the wine production and value chain. This study is therefore, aimed at addressing the ICT infrastructure farmers need to support them in decision making.

1.14 Delineation of the research

This study will focus on the use of ICT to support decision making by emerging farmers in commercial agriculture. However it is not going to cover every sector of commercial agriculture but will be confined to the wine industry. The research is restricted to the wine industry in the Breede River Valley region in the Western Cape province of South Africa.

1.15 Contribution of the study

Very few studies have been done in developing countries on the use of ICT in decision making. The research contributes to the general body of knowledge in commercial agriculture and use of ICT for decision support. In the area of agriculture, only a few studies have been done on use of ICT to support decision making in South Africa. This study aids emerging wine farming decision makers to make informed decisions in their business. This in turn could result in a competitive advantage for the farmers through increased productivity, market share and profits.

In addition the research provides information to stakeholders as to the issues which need to be addressed for the successful utilisation of ICT to support decision making in commercial

agriculture and the importance of ICT in decision making. Moreover the research provides knowledge into the current use of ICT in commercial agriculture. It also provides knowledge into the use of ICT in supporting decision making, the challenges and issues of importance on the utilisation of ICT to support decision making in commercial agriculture which can be used by government, research institutions and other stakeholders. Hence, it informs policy makers in government and aid them formulate and implement development programmes.

The study also provides ground for further study into the use and effectiveness of ICT in supporting decision making in commercial agriculture.

CHAPTER TWO

LITERATURE REVIEW

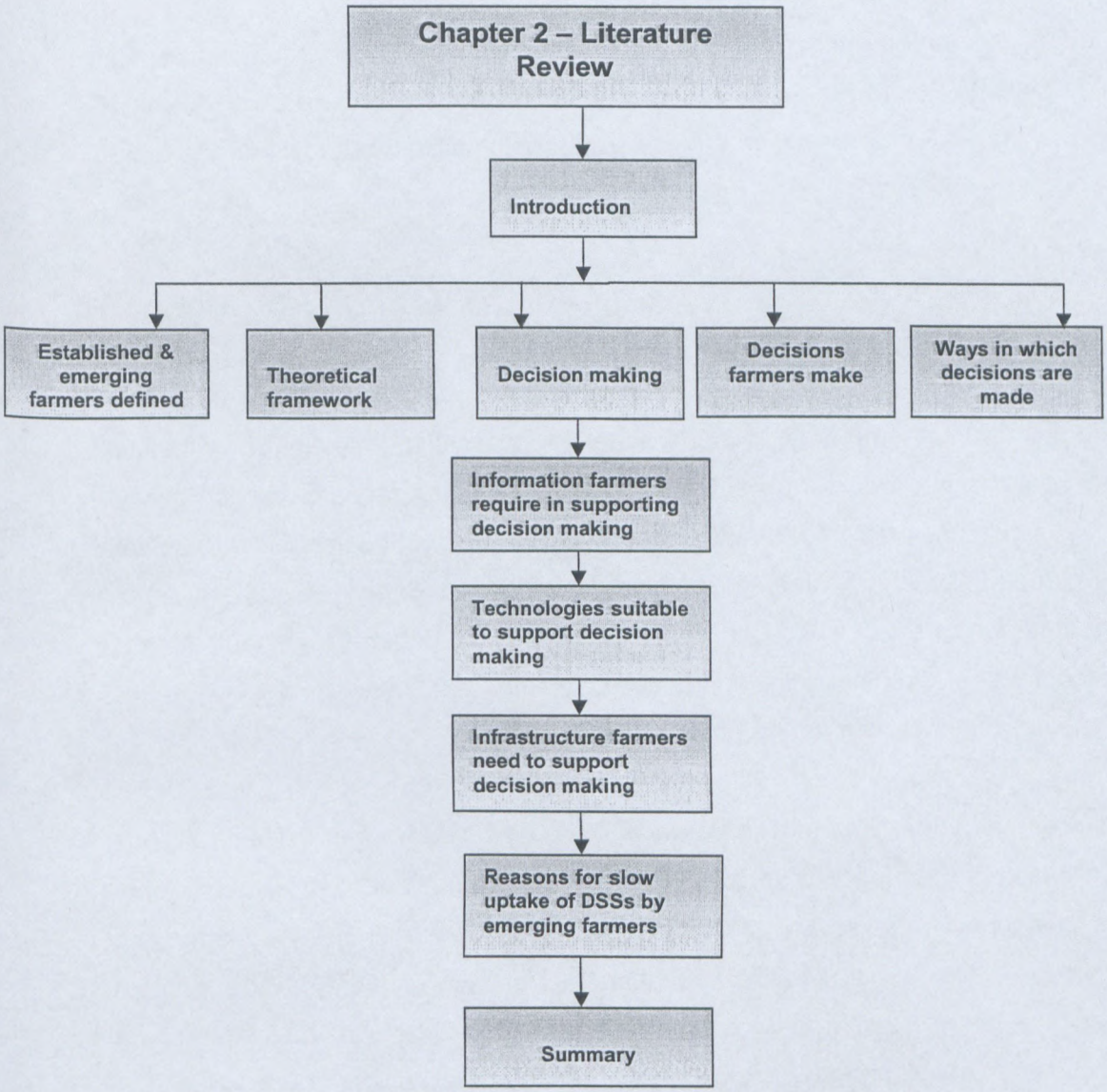

Figure 2.1: Graphical representation of Chapter 2

2.1 Introduction

Chapter one defined the problem statement and objectives of the study. In addition it also covered the background to the research problem, research questions as well as a brief discussion of the research methodology. Chapter 2 is a review of the literature of the decisions making processes farmers make and how farmers reach a decision in their

operations. The discussion in this chapter also highlights the type of information and technologies farmers require to support their decision making as well as the infrastructure farmers need to support their decision making and the slow uptake of decision support systems by farmers is also discussed.

While this study focuses on emerging farmers, literature on farmers in general is discussed. This contributes towards the understanding of what established farmers are doing to make quality decision on their farms and how emerging farmers can utilise this knowledge to make quality decisions on their farms.

2.2 Emerging farmers defined

The term 'emerging farmer' has a long history, traceable to the designs of the apartheid-era, where agricultural officials attempted to implement commercialisation programmes with little success in the Bantustans envisaging a small sector of successful farmers forming a new black middle class (Rother et al., 2008:406). Hall and Williams (2003) and Rother et al. (2008: 399-424) report that by the late 1980s the Development Bank of Southern Africa (DBSA) designated farmers as 'subsistence', 'emerging' and 'commercial', indicating a continuum of degrees of commercialisation and assuming that severely disadvantaged farmers could move from one stage to the next.

Various terms are used in the literature to describe the smallholder farmers. These include small-scale farmers, resource-poor farmers, subsistence farmers, peasant farmers, food-deficit farmers, household food security farmers, land reform beneficiaries and emerging farmers (Machethe, Mollel, Ayisi, Mashatola, Anim & Vanasche, 2004:8). The authors mention that despite widespread reference to the smallholder farmer in the literature on agricultural and rural development, few analysts attempt to define or describe the smallholder farmer. Some of the possible reasons for this lack of definitions for the smallholder are (a) assumption that everybody knows who the smallholder farmer is (b) argument that there is no need for a precise definition of a smallholder farmer and (c) acknowledgment that smallholder farmer means different things depending on the country and, therefore, no single definition would suffice (Machethe et al., 2004:8).

Various criteria are used to classify farmers as small scale or emerging, including land size, purpose of production, income level etc., as Machethe et al. (2004:8) pointed out. However, Van Averbeke and Mohamed (2006:137) report that the SA Department of Agriculture (2001) as having mentioned that in post-apartheid South Africa, smallholder farmers are commonly

categorised into three groups. These are 'subsistence farmers', who make up the large majority, 'commercial farmers', a small minority, and a third group called 'emerging farmers'. The loose definition of 'emerging farmers' contributes to the difficulties in establishing their exact numbers (Rother et al., 2008:406).

Writing on decision making and innovation among small-scale yam farmers in Jamaica, Beckford (2002:249) defines small-scale farmers as those farmers who typically cultivate areas of up to 5ha. Van Zyl et al. (1991) and Machethe et al. (2004:8), define emerging farmers as those who cannot function (participate) in the market economy because of restrictions in the economic environment. Machethe et al. (2004:9) also cites Catling and Saaiman (1996) as having defined a small scale farmer as a historically disadvantaged individual or group having access to land which normally supports a small or medium agricultural enterprise. In the same article Botha and Treurnicht (1997) are cited as having identified a category of farmers called emerging commercial farmers. Machethe et al. (2004:9) articulates that within the South African (SA) context, smallholder farmers are black farmers most of whom reside in the former homelands[1]. Not every black farmer is a smallholder farmer and smallholder farmers are not a homogeneous group, they added. Despite smallholder farmers being heterogeneous there are no clear criteria for assigning farmers to the different categories of smallholder farmers. Machethe et al. (2004) identified two categories of smallholder farmers i.e. resource-poor farmers - those whose sources of livelihood include farming and nonfarm activities and have total assets and annual income whose value does not exceed that of a household which would be considered as poor in terms of the country's criteria. Then the middle-income farmers - these are farmers whose main source of livelihood is farming and have total assets and annual income worth more than that of a poor household but not enough to be classified as rich.

By the late 1990s, with the emphasis of land reform shifting to commercial farming, the word 'emerging' was used to describe both existing and new black farmers (Rother et al. 2008:405). The authors further articulated that emerging farmers aspire to become commercial farmers. According to Rother et al. (2008:405) the term 'emerging farmer' conveys a vision of capital-strapped new farmers succeeding by coming to resemble the established white commercial farming sector. Earlier on, Hall and Williams (2003) as cited in Rother et al. (2008:399-424) wrote that an emerging farmer is thus an aspirational category denoting the ambitions of a farmer producing within the constraints of limited secured access

[1] A homeland in South Africa is a territory set aside for black inhabitants of Southern Africa as part of the policy of apartheid

to capital, production inputs, markets, land, labour and skills. Makhura, Coetzee, and Goode (1996) cited in Van Averbeke and Mohamed (2006:137) mention that within limits, the three categories of smallholders are seen as representing evolutionary steps on a linear development trajectory from subsistence farmer via emerging farmer to commercial farmer. However, the assumption that empowerment will lead to the progression of subsistence farmers to emerging or commercial farmers is not expected to occur over the short to medium term (Van Averbeke & Mohamed, 2006:152).

Mphahlele (2007:23) states that small scale-farmers are resource-poor farmers who in most cases farm to sustain their families and sell excessive produce. They have little or no access to information and new technology or they have to travel to other places to access available information.

Table 2.1 lists some definitions of emerging farmers in South Africa.

Table 2.1 – Defining emerging farmers in Africa (Rother et al., 2008:399-424)

Definition	**Expert description (2008)**
Emerging farmers are individuals who want to grow bigger and really get into the mainstream of agriculture	Official, DoA, Western Cape
An emerging farmer aims to become a commercial farmer, and is in the process of building up the necessary capacity	Regional official, Southern African Development Community
An emerging farmer is someone with basic experience and skills, but still aspire(s) to become a fully competent farmer	Director, civil society, Western Cape
Emerging farmers are previously disadvantaged farmers who are coming from subsistence farming, trying to practice commercial farming	Agricultural extension officer, Eastern Cape
I think a better description than earlier definitions would probably be to call them 'resource poor farmers'. Many of them have been involved with farming for many years and are not new or emerging. They are just	Official, DoA, Western Cape

limited by a lack of resources, for example, money, land, skills, opportunities and markets	
'Emerging farmer' as 'someone who produces a crop for sale, commercial gain, who has not been making a profit in the past five years' – although, ironically, 'not making a profit' applies equally to a substantial portion of white commercial farmers	Pesticide industry representative in Gauteng

Cited in Moloi (2008:3) the South African National Department of Agriculture (NDA, 2006) defines an emerging farmer as a farmer who is a beneficiary of one of government's land reform programmes or a farmer who is mainly dependent on the state or semi-state organisation for support and finance or as a farmer who consumes and sells some portion of the harvest. Tembo (2008:72) writing on ICT use in commercial agriculture in the wine industry in the Western Cape referred to black and coloured farmers without adequate ICT infrastructure as emerging.

Senyolo et al. (2009:208) report that emerging farmers in South Africa emanate from the group of smallholder farmers who were previously excluded from the mainstream of the economy. They include beneficiaries of land reform programmes and new entrants who took advantage of opportunities to enter into agriculture. Senyolo et al. (2009) refer to emerging farmers as those from traditional tribal areas and rural areas. The authors further mention that while these smallholder farmers provide livelihoods to some 20 million people, they still face a number of difficult conditions for example poor infrastructure, as Taragola and Gelb (2004), Blom (2006) as well as Tembo (2008) mentioned. Senyolo et al. (2009) also point out that the lack of technological infrastructure is an impediment to adoption of ICTs by farmers.

In support of Rother et al. (2008:399-424) who describe emerging farmers as aspirational and ambitious, Madolo (2010) states that emerging farmers are newly established farmers aspiring to grow their business in the industry. Contrary to most scholars (Hall & Williams 2003; Machete et al., 2004; Rother et al., 2008; Tembo, 2008; Senyolo et al., 2009) who describe emerging farmers as blacks or non-whites from disadvantaged backgrounds, Madolo (2010) further states that emerging farmers include farmers of all racial groupings that grow fruit and/or vegetables that are currently exporting or has potential (grown to standards with the intention to export) to export.

Emerging farmers may come from other industries wanting to invest in the wine industry or they have few years in operation but cannot be described as established commercial farmers (for the purpose of this study established farmers are farmers with at least 5 years experience in the wine industry) yet. Contrary to some definitions which describe emerging farmers as those with friends, families and local businesses as target markets they can export their products the same way established farmers may do.

Different categories of emerging farmers exist, some operating on a small scale and some on a large scale. Generally small scale are newly established and usually without much infrastructure and technologies and also operating on a not so large area. On the other hand large scale emerging farmers are newly established operating on a large area with the required technologies and infrastructure. Majority of our target group falls in the middle income smallholder farmers identified by Machethe et al. (2004). For this study an emerging farmer is defined as ***any farmer coming into existence or coming to maturity in the wine industry of the Western Cape, South Africa***.

Table 2 shows some definitions of emerging farmers from several authors.

Table 2.2 Definitions of emerging farmers

Definition	Author(s)	Year	Location
Defined emerging farmers as those who cannot function (participate) in the market economy because of restrictions in the economic environment	Van Zyl et al.	1991	South Africa
The concept of smallholder farmers is attributed to the past policy of racial oppression	Lipton & Lipton and Lipton et al.	1993 1996	South Africa
Defined a small scale farmer as a historically disadvantaged individual or group having access to land which normally supports a small or medium agricultural enterprise	Catling & Saaiman	1996	South Africa
Refers to farmers who have a 'desire' to increasingly commercialise their production	Niewoudt	2000	South Africa
As those farmers who typically cultivate areas of up to 5ha	Beckford	2002	Jamaica
Refer to the black farmers who produce sugarcane in commercial areas as small-scale farmers. These farmers have been the most marginalised in terms of their access to resources as compared to other racial groups	Bates & Sokhela	2003	South Africa

An aspirational category denoting the ambitions of a farmer producing within the constraints of limited secured access to capital, production inputs, markets, land, labour and skills	Hall & Williams	2003	South Africa
Smallholder farmers are black farmers most of whom reside in the former homelands. Not every black farmer is a smallholder farmer and smallholder farmers are not a homogeneous group Identified two categories of smallholder farmers i.e. resource-poor farmers and middle-income farmers	Machethe et al.	2004	South Africa
Refer to the emerging farmers as black farmers or the previously disadvantaged	Chauke & Oni	2004	South Africa
A farmer who is a beneficiary of one of the government's land reform programmes, or a farmer who is mainly dependent on the state and semi-state organization for support and finance or as a farmer who consumes and sells some portion of the harvest	National Department of Agriculture (NDA)	2006	South Africa
Small scale-farmers are resource-poor farmers who in most cases farm to sustain their families and sell excessive produce. They have little or no access to information and new technology or they have to travel to other places to access available information	Mphahlele	2007	South Africa
Describe emerging farmers as black farmers who are operating in disadvantaged circumstances compared with their white counterparts, regardless of their intention of engaging in large-scale commercial production	Rother et al.	2008	South Africa
Black and coloured farmers without adequate ICT infrastructure as emerging	Tembo	2008	South Africa
Defined an emerging farmer as previously disadvantaged farmer beginning to participate in the market and have no intentions to produce and sell more	Moloi	2008	South Africa
Referred to emerging farmers as those from traditional tribal areas and rural areas, they still face a number of difficult conditions for example poor infrastructure	Senyolo et al.	2009	South Africa
Emerging farmers are newly established farmers aspiring to grow in the industry. Includes farmers of all racial groupings that grow fruit and/or vegetables that are currently exporting or has potential (grown to standards with the intention to export)	Madolo	2010	South Africa

2.3 Decision making

As Dralega (2008) mentioned, decision making is one of the most important tasks of management in running a successful business. Decision making is the ability to select an advantageous response from among an array of available options; it is a mechanism which underlies the selection of good from bad options (Bechara et al.,1998). Bechara et al. (1998) suggest that for a person to choose a good option there has to be some kind of criterion or mechanism he or she uses to make the choice, hence the need to look at how farmers reach a decision in their operations in this chapter.

Writing on shared decision making for patients with diabetes, Peek et al. (2008) define decision making as a joint endeavour in which patients and physicians agree on a treatment plan. An endeavour is defined as a purposeful or industrious undertaking according to the WordWeb dictionary (2006). The above definition shows that the process of decision making is not just undertaken but is made with a purpose towards a desired outcome. McShane and Von Glinow (2010) wrote that decision making is a conscious process of making choices among one or more alternatives with the intention of moving toward some desired state of affairs.

Figure 2.2 represents the stages of decision making (Sidgwick & Jackson, 1986). Here the stages are described starting at the problem, finding alternatives, evaluating the consequences and then making the decision.

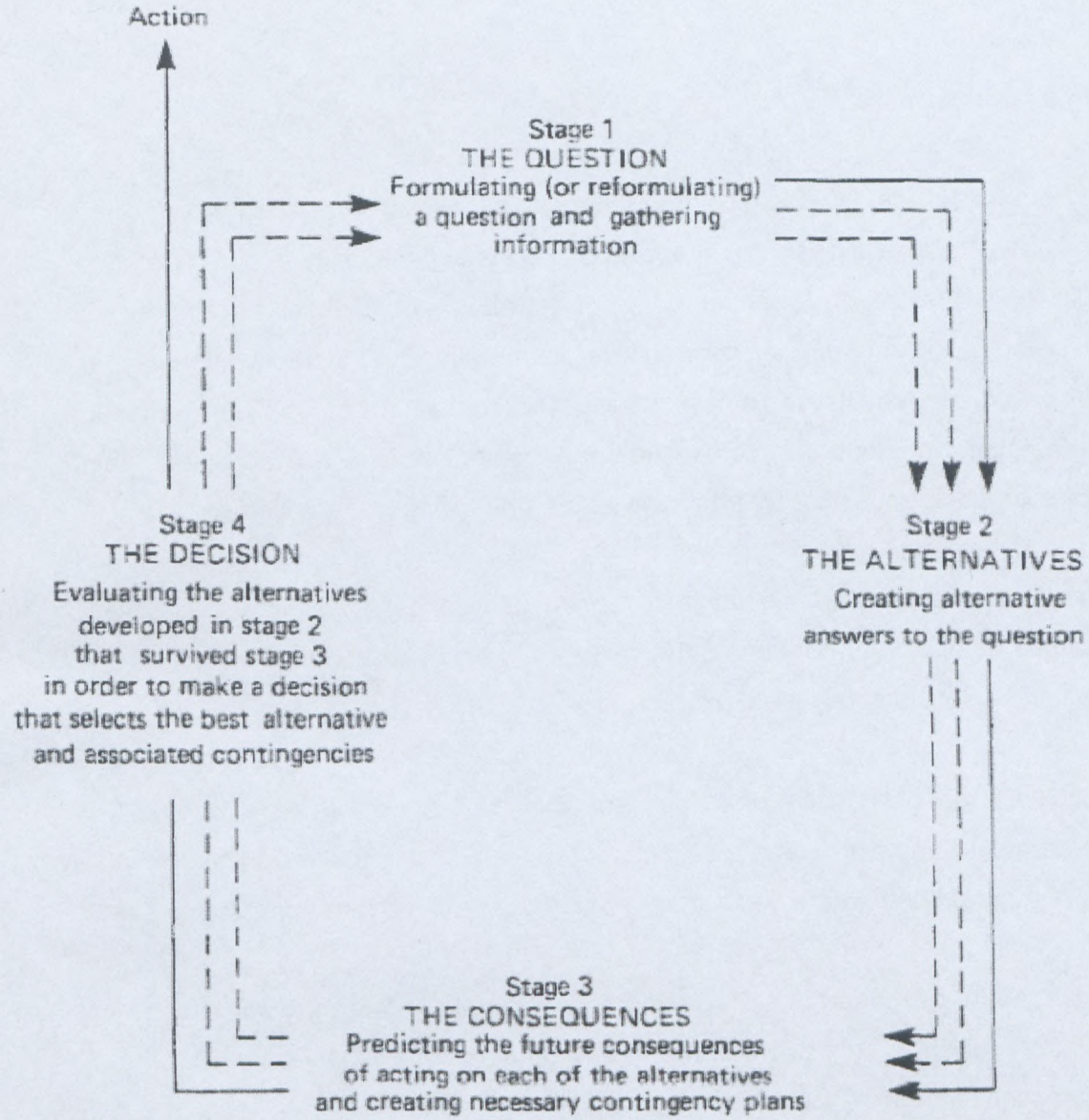

Figure 2.2: Stages in decision making adopted from Jeffers (1988) - Source: Redrawn from 6. Heirs, The Professional Decision Thinker, Sidgwick & Jackson, London, 1986.

Fig 2.2 shows four stages in the decision making process. Stage 1 entails formulating and reformulating the question as well as gathering information. The next stage involves creating alternative answers to the formulated question. The third stage entails predicting the future results of action taken on each of the alternatives at stage two as well as creating necessary contingency plans. The final stage is the decision itself that is evaluating the stage 2 alternatives that survived stages 3 in order to make a decision that selects the best alternative (Sidgwick & Jackson, 1986).

2.4 Decisions farmers make

Pickering et al. (1990) identify the two major types of decisions farmers make namely standard and novel. Standard decisions are familiar, range in complexity and can be solved by the application of rules or formulae. However, Dalton and Ghosal (2010) describe Standard Decision Problem (SDP) as when the decision maker does not fully internalise the feedback from actions to psychological states (reference points, beliefs, emotions, aspirations, temptations, moods etc). The decision maker chooses an action and as a consequence a psychological state that maximises the underlying preferences.

To solve simple problems, decision makers require knowledge[2] of a limited number of variables such as date, crop or pest and apply over broad agricultural regions making use of farm manuals and extension bulletins (Pickering et al., 1990).

Complex problems are defined as often site specific involving more variables and may involve considerable numerical analysis such as integrated pest management (IPM) which involves complex problems and are concerned with managing more than one crop or pest.

Pickering et al. (1990) describe novel decisions as being unique and may not have a finite set of alternatives and are unstructured. These require creative solutions. Akin and Lin (1995) also describe novel decisions as non-routine decisions which are critical for the progress of the entire decision making process. Decision makers and consultants compare similarity of a novel situation with others they experienced before and use the experience to resolve important characteristics of the current situation (Pickering et al.,1990). Novel decisions are complex and are not encountered often, hence the need to critically execute them unlike standard ones which he or she is faced with on a usual basis. Pickering et al. (1990) postulate that novel decisions indeed require creative solutions based on insight and experience due to their nature.

Parker and Campion (1997) report that farmers make decisions on optimising the use of chemical inputs as well as selecting a variety of a given crop, generating weather patterns to predict when a crop will be ready or the earliest and latest dates when pest infestation might

[2] Knowledge is defined as a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experience and information (Davenport & Prusak, 1998).

occur. Hayman and Easdown (2002:58) report that farmers make decisions on the choice of planting time, varietal development pattern, fertiliser application as well as decide on the best strategy to employ to optimally utilise the environment. In addition they also identified protecting crops from frost damage either by forward sell or taking frost insurance as well as seeking advice on herbicide application for wild oat control as other types of decisions farmers make in the north east Australian grain belt.

CottonLOGIC as a decision support system (DSS) suite is made up of tools to assist farmers in different categories of decisions they make. Deutscher et al. (2001) state that NutriLOGIC is used for assisting with decisions on cotton nutrition. According to Richards and Bange (2003), HydroLOGIC is used for cotton irrigation management while EntomoLOGIC for insect pest management (IPM) as reported earlier on by Deutscher and Plummer (1998). Farmers predict life stage development and mortality of pests, which is identifying future pest numbers using weather data, indicating when pest numbers are over defined economic thresholds (Bange et al., 2004). These will lead to decisions as to when and how to control pests and beneficial insects in pest management.

Fraisse et al. (2004) identify three categories of decisions farmers make. These categories are identified as price-based, weather based and climate-based decisions. "Price-based decisions are associated with changes in the price of output or inputs that may eventually occur and require a broad understanding of markets both domestic and international." (Fraisse et al., 2004:1). They identify weather based decisions as being generally operational by nature and usually involve activities that should happen in the near future, mostly less than a week. Examples of weather based decisions entail decisions on irrigation, freeze protection or harvesting. Climate-based decisions are described as normally pre-season decisions. Climate-based decisions tend to be more strategic in nature for example choosing a variety to plant, acreage allocation, pre-season purchase of inputs and marketing. The El Nino-southern oscillation phenomenon (ENSO) is also used to forecast both rainfall and steam flow (Ritchie, 2004).

Jha (2004) highlights some decision making examples. The author postulates that decision making entails a consideration of all other tasks - how they are to be scheduled, who is to perform them, who is to contribute resources to accomplish them and what resources are to be mobilised and so on. In Balinese agriculture in an irrigation community called Subak decisions are made in water allocation, ordering fertiliser, purchase of implements like Rototiller (plough tractor) or pesticide sprayer, getting water released from the dam, determining what to plant and coming up with a timetable for planting (Jha, 2004). The

author adds that the other types of decisions the farmers make are decisions on mobilising collective labour or engaging contract labour.

Rao (2006) articulates that farmers make decisions on choice of inputs that is crop varieties and seeds, water, power, fertilizers and pesticides. They also make decisions on market transactions related to them as well as farm operations such as tillage, sowing, water management, fertiliser management and pest management. Rao (2006) mentions that decisions are made on post harvest operations and transactions which include storage, transport, marketing, processing among others.

Another example of decisions farmers make is dam planning and operation. McCartney (2007) wrote that DSSs assist in planning and operation of dams. Moreover, in the same article McCartney (2007) reports that DSSs can help mitigate dam related conflicts and ensuring the sustainability of projects. DSSs support complicated analysis of allocation problems (resource allocation), environmental and socio-economic constraints as well as supporting conflicting management objectives (McCartney, 2007).

Mackrell et al. (2009) indicate that types or categories of decisions farmers make include seasonal comparisons of the location and density of heliothis eggs and caterpillars (grubs) as beneficial insects. Insect pressure simulation, soil and yield monitoring as well as yield monitoring are also some of the decisions farmer decisions farmers make (Mackrell et al., 2009).

To summarise, farmers make decisions on socio-economic factors, seasonal predictions of weather, markets, yields, environmental factors, operations, marketing, and financial such as insurance, future trading, and capital intensive projects (Mackay, 1993; Deutscher & Plummer, 1998; Deutscher et al., 2001; Richards & Bange, 2003; Bange et al., 2004; Fraisse et al., 2004; Jha, 2004; Rao, 2006; McCartney, 2007; Mackrell et al., 2009). Table 2.3 shows decisions farmers make as mentioned by the farmers and in the literature as well.

Table 2.3: Decisions farmers make

Decisions farmers make	Author	Year
Standard and Novel	Pickering et al.	1990
Optimising the use of chemical inputs as well as selecting a variety of a given crop, generating weather patterns to predict when a crop will be ready or the earliest and latest dates when pest infestation might occur	Parker and Campion	1997
Insect pest management (IPM)	Deutscher and Plummer	1998
Decisions on cotton nutrition	Deutscher et al.	2001
Decisions on the choice of planting time, varietal development pattern, fertiliser application as well as decide on the best strategy to employ to optimally utilise the environment, protecting crops from frost damage either by forward sell or taking frost insurance	Hayman and Easdown	2002
Cotton irrigation management	Richards and Bange	2003
Predicting life stage development and mortality of pests that is identifying future pest numbers using weather data, indicating when pest numbers are over defined economic thresholds, decisions as to when and how to control pests and beneficial insects in pest management	Bange et al.	2004
Price-based, weather based and climate based decisions	Fraisse et al.	2004
Water allocation, ordering fertiliser, purchase of implements, getting water released from the dam, determining what to plant and coming up with a timetable for planting As well as decisions on mobilising collective labour or engaging contract labour	Jha	2004
Decisions on choice of inputs that is crop varieties and seeds, water, power, fertilizers and pesticides. They also make decisions on market transactions related to them	Rao	2006

as well as farm operations such as tillage, sowing, water management, fertiliser management and pest management. Decisions on post harvest operations and transactions which include storage, transport, marketing, processing among others		
Dam planning and operation	McCartney	2007
Seasonal comparisons of the location and density of heliothis eggs and caterpillars (grubs) as beneficial insects. Insect pressure simulation, soil and yield monitoring as well as yield monitoring are also some of the decisions farmer decisions farmers make	Mackrell et al.	2009

2.5 Different ways in which farmers make decisions

Farmers do not always rely on external sources of information in their decision making; they also use accumulated knowledge and intuition. Mackrell et al. (2009) report that farmers use accumulated knowledge and intuition for making heuristic[3] decisions. The farmers use decision support system software with record keeping modules for historical purposes thus enabling them to make informed seasonal comparisons (Mackrell et al., 2009). Mackrell et al. (2009) reveal that some farmers rely on accumulated knowledge of their partners and consultants for decision making and see no need for a DSS.

Farmers rely on accumulated experience and the support of local organizations and consultants (e.g. input suppliers, rural credit agencies, extension services, NGOs) for information related to farm decisions (Rao, 2006; Kerr, Mackrell & von Hellens, 2009). Rao (2006) further mentions that the farmers also receive information from radio and television broadcasts by experts and professionals from more distant sources. The author suggests that often, this system is inadequate since the advice might not apply to their specific area and many decisions are made with limited information. The decisions are also subject to high transaction costs and time delays. The role of ICTs in such a scenario is to provide timely information, increase choice, reduce transaction costs, and contribute to improving the efficiency of decision making to raise incomes (Rao, 2006).

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web dictionary (2006) defines heuristic as a common sense rule (or set of rules) intended to increase the probability of some problem.

Although farmers rely on partners, consultants and their accumulated knowledge and experience; they also use information about current market requirements, prices, nature of the target field and variety as well as disease pressure in the area to make decisions (Parker & Campion, 1997).

In addition to gathering information on disease pressure in their area, farmers also try and predict future pest numbers. Bange et al. (2003) report that decision makers in Australian agriculture use software models to predict future pest numbers using weather data and indicating when pest numbers are over defined economic thresholds. By understanding the pest's development and population dynamics caused by natural mortality under the various climatic conditions farmers will be in a position to make better decisions as they grow their cotton. The farmers make use of "crop scouts" who monitor fields at least twice a week during growth of the crop and help collect information on insect population. The information is the entered into the DSS or given to decision makers directly which they use in decision making (Bange et al., 2003).

Bange et al. (2003) further mention that the DSS CottonLOGIC also has crop operations record keeping, reporting capabilities as well as insect identification library. These play a very important role in aiding the decision makers as they use the necessary information from the records and library in decision making. EntomoLOGIC makes use of average or forecasted daily maximum and minimum temperatures for specific regions to predict pest's life stage development and mortality for the next 3 days. The system then compares pest densities of the predicted life stages to industry standard or user defined pest thresholds (Bange et al., 2003).

To help decision makers deal with standard decisions as identified above (2.4), the use of Experts Systems (ES) can also be implemented. Turban and Watkins (1986) writing on ES and DSS integration reported that ES emerged as a practical application of research in Artificial Intelligence (AI). The authors further asserted that ESs combine knowledge of a particular application area with an inference capability to enable the system to reach a level of decision making performance comparable to (or even exceeding) that of human experts in some specialised areas. Jeffers (1988) defined ES as knowledge based computer programs capable of giving intelligent advice for which the basic can be readily explained, have shown themselves to be valuable in drawing together a wide range of experience into a usable system.

The author further suggests that the only way forward to a fuller consideration of the available options for land use in Britain, lies in the creation of such ESs to inform and guide those who have to make decisions about land use policies and management practices at all levels. Cowell et al. (2007) state that ES are attempts to crystallise and codify the knowledge and skills of one or more experts into a tool that can be used by non-specialists, usually in some form of computer program. The authors corroborated that ES consists of 2 parts summed up in the equation:

Expert System = knowledge base + inference engine

Iancu and Mates (2009) also define ES as program products that emulate the human experts' behaviour, solving problems from the real world associated to a particular domain of the knowledge. With the help of the inference engine, using a set of rules will offer suggestions regarding the specific procedures that could be undertaken.

ESs emulate human experts' behaviour in solving real world problems and thus helping in decision making in a specialised area. ES call for unsuitable actions in unanticipated situations and can operate only within design restrictions (Pickering et al., 1990:276). Pickering et al. (1990) further report that ESs can only operate within design restrictions and are best suited for standard decisions and not for novel decisions. Novel decisions are restricted to allow rules to respond correctly, they can be managed by systems containing several expert systems interconnected by database management, decision support and simulation modelling modules. These systems are centrally implemented on specialised computers beyond the affordability of most small farmers. The systems need to collect site specific information and deliver results. Parker and Campion (1997) add that decision makers use rule based ES designed to encapsulate experts' knowledge of agriculture systems.

O'kefee (1986) mentions that simulation and expert systems are remarkably similar. Simulation and ESs both employ various representations to model some aspect of an uncertain world, with the model being formed as a piece of computer software, he added. The author further articulated that the model is then employed to aid decision making. Farmer et al. (1999) wrote that simulation supports decision making and planning, design of systems and infrastructure. In the same year Kellner et al. (1999) described a model as an abstraction i.e. simplified representation of a real or conceptual complex system. It is designed to display significant features and characteristics of the system which one wishes to study, predict, modify or control. Model provides useful insights, predictions and answers

to the questions it is used to address. Having described the system as above Kellner et al. (1999) define a simulation model as a computerised model possessing the characteristics described above and that represents some dynamic system or phenomenon. Earlier on Kops et al. (1996) describe simulation modelling as use of models to experiment i.e. depicting the real system.

In crop growth simulation models it is considered that the impact of meteorological variables (radiation, temperature, wind, humidity etc.) on specific processes such as photosynthesis, transpiration or respiration can be adequately simulated by means of a set of mathematical equations which are based on experiments or available knowledge of the particular process (Baier, 1979). However, on systems based on simulation models, users can manipulate the inputs to a model of biological system and observe the impact on relevant outputs such as costs and yields. For example, manipulating the software that models the reaction of pest populations to spray regimes and observe the effect of reducing levels or of using fewer sprays; therefore software provides the grower with the means to optimise the use of chemical inputs (Parker &Campion, 1997). The authors suggested that alternatively the best and worst case scenarios could be generated to predict when a crop will be ready or the earliest and latest dates when pest infestation might occur. In simulating crop yields for different levels of nitrogen fertiliser, structured comparison of probability distribution of gross margins for each Nitrogen (N) is done (Hayman, 2003). Mackrell et al. (2009) add that simulation models of pest pressure thresholds as basis for spray decisions are used and decision makers depend on accuracy of information to make decisions. It can be seen from the above references that simulation modelling plays a great role in aiding decision making.

In addition to ESs and simulation modelling precision agriculture is another technology which farmers use to aid them in decision making. The US National Research Council (1997) refers to precision farming as a management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production. Precision agriculture or precision farming (PF) which makes use of new technologies such as global positioning system (GPS), sensors, satellites or aerial images and information management tools to assess and understand variations in the field for optimum profitability, sustainability and protection of the land resource Singh (2005). Batte et al. (2002) earlier on articulate that PF has the potential to help farmers improve input allocation decisions thereby lowering production costs or increasing outputs and potentially profits. Batte et al. (2002) state that farmers credit benefits to PF for a wide variety of decision types. Cotton growers use soil yield monitoring by GPS, field mapping by geographical information systems (GIS) as well as insect pressure simulation by decision support systems to make decisions

(Mackrell et al., 2009).

Not only do farmers rely on PF, ES and simulation modelling, El Nino Southern Oscillation (ENSO) is also used. The (ENSO) phenomenon which results from two way interactions between ocean and atmosphere in the tropical Pacific Ocean is used for agricultural decision making in Argentina (Podesta et al., 2002). For effective use of climate information or forecasts (ENSO related or otherwise), three simultaneous processes are involved according to Roger Pielke framework (Hooke and Pielke, 2000; Pielke, 2000). Podesta et al. (2002) further mention that it is often assumed that ENSO related climate forecasts will benefit the agricultural sector by allowing farmers to mitigate potential negative consequences of climate variability or potentially capitalise on potentially beneficial effects. Thus farmers use information from the ENSO related climate forecasts to help them in decision making and help reduce potential negative consequences of climate variability. ENSO impacts on agronomic outcomes can be explored through statistical analysis of historical crop data at various scales (Podesta et al., 2002), thus the statistics of crop data at various scales and information from ENSO climate forecasts will enable farmers to make better decisions.

2.6 Information farmers require supporting the categories in decision making

In 1990, Pickering et al. wrote that knowledge of a limited number of variables such as date, crop or pest over a broad agricultural region helps farmers when making decisions. The authors noted that farmers can get this information from manuals or extension bulletins. Decision makers need to be aware of rules and formulas they use with the variables. The rules and formulas are used when dealing with standard decisions. When faced with a novel situation where a novel decision is needed, the farmers need information on similar novel situation(s) to help resolve important characteristics of current situation (Pickering et al., 1990). Furthermore, they mention that weather data collected, previous pesticide use and scouting results are used to support novel decision making.

Parker and Campion (1997) corroborate that farmers rely on information about current market requirements, prices, nature of target field and variety and disease pressure. They affirmed that such information support farmers as they make decisions. Information on earliest and latest dates when pest infestation might occur aids decision makers in pest control (Parker & Campion, 1997).

According to Bange et al. (2003) farmers need information on the weather to predict future pest numbers. They added that understanding the pests' development and population

dynamics is of great importance in supporting the decision makers in pest control. Information on pest population collected by crop scouts was found to be of great value in supporting farmers when making decisions on pest control. In addition information on previous pests that affected the crop which can be obtained from DSSs with record keeping capabilities and insect identification library supports farmers in pest control (Bange et al., 2003). They further mentioned that in EntomoLOGIC (a DSS tool), decision makers make use of average or forecasted daily maximum or minimum temperatures for specific regions to predict pests' life stage development and mortality for the next 3 days.

Rao (2006) as well as Mackrell et al. (2009) agree that farmers use their accumulated knowledge as well as their partners' and rely on it to support them in making heuristic decisions. Farmers in the Breede River Valley also rely on their accumulated experience, as well as their neighbours' to support decision making. Mackrell et al. (2009) in addition report that farmers also use intuition when solving heuristic decisions. In the same paper the authors added that the DSS software used has record keeping modules. Data from these modules support the farmers in decision making.

Information on pest control and weather patterns is kept in these modules. They added that information on pressure thresholds from simulation models supports decision making on pest control in the Australian cotton industry. Information on soil yield monitoring (from GPS), field mapping by GIS and insect pressure simulation by DSSs is used in aiding farmers in decision making (Mackrell et al., 2009). Table 2.4 shows the information farmers require to support decision making.

Table 2.4: The information farmers require to support decision making

Information farmers need	Author	Year
Knowledge of variables such as date, crop or pest over a broad agricultural region helps farmers when making decisions. Information from manuals or extension bulletins, rules and formulas they use with the variables, information on similar novel situation(s) to help resolve important characteristics of current situation. Weather data collected, previous pesticide use and scouting results are used to support novel decision making.	Pickering et al.	1990
Information about current market requirements, prices, nature of target field and variety and disease pressure. Information on earliest and latest dates when pest infestation might occur aids decision makers in pest control.	Parker and Campion	1997
Information on the weather to predict future pest numbers. Understanding the pests' development and population dynamics in pest control. Information on pest population collected by crop scouts as well as information on previous pests that affected the crop. Average or forecasted daily maximum or minimum temperatures for specific regions to predict pests' life stage development and mortality for the next 3 days.	Bange et al., 2003	2003
Accumulated knowledge as well as their partners' and rely on it to support them in making heuristic decisions.	Rao Mackrell et al.	2006 2009
Data from record keeping modules of the software used	Mackrell et al.	2009
Information on pest control and weather patterns	Mackrell et al.	2009
Information on pressure thresholds from simulation models supports decision making on pest control	Mackrell et al.	2009
Information on soil yield monitoring (from GPS), field mapping by GIS and insect pressure simulation by DSSs	Mackrell et al.	2009

2.7 Technologies suitable to support farmers in their decision making

Decision making is becoming increasingly difficult for land managers, scientists, politicians and the public. Issues surrounding decision making are complex and debated frequently (Mills & Clark, 2001:189-198). An example could be, if farmers decide to use pesticides which help them control pests but has negative environmental effects. Other stakeholders such as scientists or politicians might not support the idea. The authors further mentioned that the complexity of the issues poses new challenges for scientists to actively engage the debate. This calls for the adoption of technologies which are suitable to support farmers in decision making without negatively affecting other stakeholders.

One of the technologies adopted by north eastern Australian farmers is WHEATMAN – a computerised decision support system for winter cropping decisions. We found that WHEATMAN has had a significant impact on how many advisers structure their thinking and much of their advice on winter cropping (Hayman & Easdown, 2002). Bange et al. (2003:131-147) postulate that "*DSSs are widely accepted in the Australian cotton industry for assisting with integrated pest management (IPM), crop nutrition and other aspects of information transfer.*". They gave EntomoLOGIC part of the CottonLOGIC suite as an example.

Bange et al. (2003) further corroborate that for many years users have requested an electronic device that can be taken into the field to streamline the data entry process, run models of pest development, generate infield reports of pest status, access historical data for insects and crops and most of all save time. To address this most of the pest management components of the DSS were developed for handheld devices running the Palm operating system Bange et al. (2003). This technology help users save time. Instead of inputting data collected in the field on paper cards then copy to their desktop computers, associated software was developed to manage transfer of data between the handheld devices and existing DSS software Bange et al. (2003). The writers further mentioned that it's (DSS) value to users has been established by extensive field testing and independent evaluation; it helped maintain data integrity, consistency and time saving.

The CottonLOGIC suite is more suitable since it is made up of different categories in crop production. As put forward earlier on by Deutscher et al. (2001), NutriLOGIC assist with cotton nutrition while HydroLOGIC deals with irrigation management as Richards and Bange (2003) asserted. The EntomoLOGIC tool addresses insect pest management (IPM) (Deutscher and Plummer, 1998). In addition the CottonLOGIC suite has crop operations,

record keeping and reporting capabilities as well as an insect identification library.

In a related article, Kuhlman and Brodersen (2001) suggest that requirements for DSS acceptance are changing and that farmers are more inclined to employ DSSs as devices for crop input and yields and retrospective calculations rather than for forward farm planning. They further recommended reducing the credibility gap of farmers through greater engagement by training and education and using simpler models which match the farmers' expertise. This was proved by the success of the Farmscape program for decision support with its Participatory Action Research (PAR) approach as it resulted in improved outcomes for end-users of DSS technology in Australia (Mackrell et al., 2009). Mackrell et al. (2009) also noted the same sentiments when they acknowledged that the PAR compliments Rogers' technology diffusion model by encouraging user participation.

The use of El Nino-southern oscillation (ENSO) phenomenon is one technology suitable to support decision making by farmers. Ritchie et al. (2004) reported that it is now accepted that there is a significant relationship between ENSO and rainfall and stream flow variability in the wider and regional global climate. In addition Chiew et al. (2000) and Abawi et al. (2001) state that the ability to use this knowledge to forecast both rainfall and stream flow is becoming increasingly recognised. Ritchie et al. (2004) further mention that in their assessment, opportunities exist for incorporating seasonal climate forecasting (SCF).

Besides the ENSO phenomenon GIS is another technology used to support farmers in decision making. ESRI (2007), a GIS manufacturer reports that all sectors of the agriculture industry use GIS technology to share data, increase yields, predict outcomes and improve business practices. They assert that producers use GIS to better manage their farms by creating information-dense reports and maps giving them a unique perspective of their operations. Combined with remote sensing technology, GIS can be used to precisely determine and control inputs, saving preventive expense and reducing the amount of harm to the soil (ESRI, 2007). The report suggests that GIS support people working in agriculture by providing among others better understanding of risk factors, better resource management and most importantly more accurate support for decision making.

In the same article writing on vineyard inspection – Washington State, ESRI (2007) reports that to keep the grapes growing at peak levels, crews routinely inspect the vineyards using ESRI's ArcPad mobile platform. The remotely captured data is stored centrally in a geodatabase allowing analysis of a vast amount of information relating to the numerous conditions that affect the health of its vines such as weed growth, disease presence and pest

infestation (ESRI, 2007). They further report that the field collected data is then synchronised with the winery's centrally stored data. This technology is more suitable since it allows for ease capturing of field data and its synchronisation allowing decision makers to analyse the day synchronised and help them in decision making. The data stored is also used in future decision making.

It is not only simulation modelling (discussed earlier on) farmers implement but econometric modelling as well. Strauss et al. (2008) corroborate that econometric modelling has proven to be effective in facilitating and understanding of change at the sector level. They further argue that linkage of such models offers a tool for decision makers which have the ability to simulate the impact of change both at the sector and farm level.

Positivistic farm level models that have the potential to be linked to sector level models that exist in South Africa (Strauss et al., 2008). The link with the sector model enables users of the farm-level model to analyse the impact of changes in policies and markets on the financial position of a representative farm (Strauss et al., 2008). The authors in addition affirm that development of such an integrated system of a sector level and farm level model could assist decision makers in analysing alternative market and policy situations and resulting impacts on both sector and farm level and thereby should assist in making decisions.

On the general use and development of agriculture DSSs, Cox (1995) suggests that there is need for an analytical phase in the system implementation. He recommends insertion of an analytical phase between construction and adoption of the system. Nguyen et al. (2006) suggest that a DSS need to be location specific and gain strong support from initial users. Table 2.5 shows technologies suitable to support farmers in decision making.

Table 2.5: Technologies suitable to support farmers in decision making

Technologies suitable to support decision making	Author	Year
Computerised decision support systems	Hayman and Easdown Bange et al.	2002 2003
Handheld mobile devices	Bange et al.	2003
Farm specific software	Bange et al.	2003
El Nino-southern oscillation (ENSO) phenomenon	Ritchie et al.	2004
GIS	ESRI	2007
Remote sensing technology	ESRI	2007
Simulation and modelling	Farmer et al.	1999
Expert systems	Pickering et al	1990
Econometric modelling	Strauss et al.	2008

2.8 ICT infrastructure farmers need to support decision making.

Besides looking only at technologies farmers need, it is necessary to also look at the ICT infrastructure they need to support decision making. Farmers require systems that apply over a broad agricultural region not one restricted to a confined region. Pickering et al. (1990) assert that decision makers require knowledge of a limited number of variables to solve simple problems and apply over broad agricultural regions. They also point out that farmers require technologies that have the capacity to be updated as old ways fail to work like pesticide resistance or as better techniques become available.

Rao (2006) as well as Mackrell et al. (2008) state that farmers strongly rely on their knowledge and accumulated experience and support of local organisations and consultants when making farm and non-farm decisions. Therefore there is need for the ICTs these farmers use in decision making to very much compliment with the farmers' knowledge and experience. Mackrell et al. (2008) mention that some farmers are wary of DSSs and if the DSS contradicts their experience, it is most likely that the farmers will not be keen on adopting the DSS. Hence, it is important for the ICTs to in some way complement with the farmers' knowledge and experience without losing the objectivity and credibility of the DSS offering.

As observed initially by Cox (1996) and Ison (1998); Hayman and Easdown (2002) report

that a common limiting factor for adoption of DSSs is a failure to engage with end-users from early stages of development. This indicates that for a DSS to be well accepted by farmers they want to be involved in its development. This creates a community of trust among the program, the authors suggested. Hayman and Easdown (2002) further affirm that farmers need the best information available and they need to have it delivered quickly, reliably and efficiently. They also add that a key element in the success of the DSS is the development of a community who trusted in its reliability and utility. Hayman and Easdown (2002) suggest that farmers need demonstrations and software libraries, having the technology demonstrated to them before they are requested to buy and adopt it. Farmers require an ICT that gives new value to their activities than one which doesn't bring any new value. Table 2.6 shows the ICT infrastructure farmers need to support decision making.

Table 2.6: ICT infrastructure farmers need to support decision making

ICT infrastructure farmers need	Author	Year
Systems that apply over a broad agricultural region not one restricted to a confined region	Pickering et al.	1990
Technologies that have the capacity to be updated as old ways fail like pesticide resistance or as better techniques become available	Pickering et al.	1990
ICTs which compliment with the farmers' knowledge and experience	Mackrell et al.	2008
ICTs involving users from early stages of development	Cox Ison Hayman and Easdown	1996 1998 2002
ICTs that gives new value to their activities	Hayman and Easdown	2002
A reliable ICT infrastructure	Hayman and Easdown	2002

2.9 Reasons for the slow uptake of decision support systems by emerging farmers

Anger et al. (1994) wrote that decision support tools such as DSSs have been employed in other industries, most notably manufacturing and finance, but their uptake has been slow in agriculture. Nguyen et al. (2006) also add that, the uptake of DSS by farmers has been slow.

Parker and Campion (1997) wrote that the reason for the debate as to the use and/value of decision support tools is the seeming lack of interest in such systems when they are packaged and presented for use by the consultant to the farmer. Parker (1996) states that a list of publicly available agricultural decision support systems in the UK, over 20 in total, does not contain a single name in common use on farms.

Cox (1995) identified the following reasons for the slow uptake:

2.9.1 Failure to support more than the exceptional circumstance

Cox (1995) refers to old generation decision support tools based solely on one technology not applicable to a different farming method. However, current model-based software supports more than one circumstance, rendering this reason not appropriate.

2.9.2 Computerisation

Palmer (1992) reports that computerisation was out of the question for many farmers for two basic reasons: firstly, the hardware and software were too expensive and soon outdated; and secondly the necessary computer expertise was not available on the farm. This is supported by Gibbon and Warren (1992). However according to some studies following the research, this is changing. A survey done in the UK highlighted that there is a notable increase in the use of computers and farmers promising to acquire more (Parker, 1996). Tembo (2008) reports that farmers in the wine industry in South Africa use computers in production, marketing and communicating with stakeholders but did not address their use for decision support.

2.9.3 Complexity

Cox (1995) highlights that expert evaluations and user interviews suggest that complexity is

undoubtedly a major contributor to the failure of DSSs. He notes that complexity results from failure to adopt good software design practice and translate it from a scientific to a farming mindset easier understood by farmer. Sciefer (1992) and Eleveld et al. (1992) earlier on also reiterate that complexity contributes to failure of DSSs. However a simple, friendly interface is not a guarantee of success, it will still fail to win users if the developer has not given thought to the nature of the inputs the user will have to provide wrote Cox (1995). It then highlights the need for developers to work hand in hand with the farmers to guarantee that the decision support tools developed meets the users' needs and is easy to use.

2.9.4 Inputs

Since most models require their users to enter values for certain variables like weather data or sowing date, there is some evidence that these variables contribute to the failure of DSS, either because they are unavailable to the user or are inconvenient or difficult to collect. Scientists use many uncommon measurements, e.g. relative humidity and leaf wetness using custom-built sensors placed in the crop. The use of these variables, which may be ideal for the development of an accurate and predictive model, is likely to cause problems for the grower or farmer because they are difficult or too expensive to measure on a farm wide basis.

2.9.5 Failure to show cost benefits

The use of any computer tool requires an investment in time and money on the farmer's part and initially a certain amount of faith. Therefore there has to be a fairly obvious cost saving inherent in its use to take the user from polite interest to purchase and use. Cox (1996) wrote that many problems can be solved very well without using DSSs. He went further to add that the marginal benefit does not justify the cost of developing and maintaining them (DSSs). This kind of mentality if promoted leads to the slow uptake of DSSs and lack of their use therefore.

As cited in Hayman and Easdown (2002), Sage (1991) suggest that perhaps the most damning charge of all that affects potential user willingness to use the system is the feeling that it significantly interferes with the normal way of thinking about problems". The authors acknowledge that this was also mentioned earlier on by some authors who argued that experts used reasoning by analogy rather than discrete analytical steps and requiring them to follow an explicit procedure reduces performance quality. Hofstede (1992) postulates that managers may be hindered rather than helped by a DSS if it dismisses their intuition and

they may be of help to novices not experts. According to Barr and Sharda (1997) there is evidence that DSSs can foster dependency and subsequent decreases in the efficiency of decision making.

On a more interesting observation on why farmers are reluctant to adopt decision support systems on any other type of crops that is not new and of high value, Hayman and Easdown (2002) affirm that growers are more prepared to listen to outside experts on newer crops or high value crops. They note that this is shown by the high adoption of systematic crop checking systems and computerised aids on new crops partly because there is less that farmers learned from their fathers and their own experience.

Malcom (1994) asserts that a farm business is too complex for the deep but narrow focus provided by many DSSs. He asserts that it is better to be vaguely right than precisely wrong, to solve the whole problem roughly than part of the problem extremely well. Hayman and Easdown (2002) highlight that farm management depends more on getting most things reasonably right rather than some things exactly right.

Various issues are said to be contributing to the slow uptake, and these include earlier fear of using computers, time constraints, poor marketing, complexity, lack of local relevance, lack of end-user involvement, and mismatched objectives between developers and users (Nguyen et al., 2006).

In their paper on the state of the art and future development of DSSs in Australian agriculture, Nguyen et al. (2006) ask what issues limit the usefulness or uptake of DSSs by farmers. He found that some farmers do not like office work and see it (sitting in an office using decision support technologies) as un-productive time. The most common response however is that farmers can make good decisions without them. Nguyen et al. (2006) also found out that the other reason is that farmers are not comfortable using computers, though they acknowledge that this is changing. Farmers being not as computer literate as developers also lead to problems with the use of the products (Nguyen et al., 2006).

Nguyen et al. (2006) moreover mention that most DSSs are not focused on appropriate topic and are not well designed. This made room for their criticism and the critics suggesting they do not reflect how farmers make decisions. Another point contributing to the slow uptake by the authors is the fact that DSSs are often oriented to the researchers' perspectives an observation made by other authors such as Hochman et al. (1994), Robinson and Freebairn (2000), Pannell et al. (2000) and Keating and McCown (2001).

Another reason for the slow uptake according to Nguyen et al. (2006) is that the farmers are always busy and they simply do not have time to learn and use the DSS. They rely on help from farm advisors who aid them in strategic or tactical planning with the relevant software. Nguyen et al. (2006) put it in as follows farmers do not have time for tinkering with software which they may only need to use twice a year for planning purposes. Another suggestion from the same paper is that DSSs have not been marketed well and most farmers do not know that they exist or what they can do. The fact that most DSSs are developed by researchers in their projects and funded by institutions without a profit motive and little customer focus contributes to this (Nguyen et al., 2006). After developing the initial DSSs, researchers who are the modellers and developers move on to other projects or commitments because in most cases there is no motivation or incentives t keep it up to date and consistent with changes. Consequently the decision support system just sits on the shelf and becomes obsolete (Nguyen et al., 2006).

2.10 Theoretical Framework

2.10.1 Introduction

A number of theories have been used in the investigation of what determines the acceptance and use of information communication technologies as well as their successful adoption and use in several businesses. This chapter seeks to present the theoretical framework underpinning this study. However, to be able to come up with the a theory applicable and suitable for investigating the use and adoption of ICTs to support decision making in the wine industry in the Western Cape, some theories for ICT use and adoption are presented first. The theoretical framework underpinning the study is then presented later on in the chapter.

2.10.2 What is a theory?

Kreuter and Skinner (2001) described a theory as a logic way of following systems or situations. The authors further articulate that a theory is a set of philosophies, connotations and suggestions that forecast or explain these events or situations by demonstrating the relationship between variables. As Borgatti (2005) wrote, research theories foretell the critical concepts that need to be assessed in a particular research. In addition research

theories also test relationships between important factors of the research study. Tembo (2008) defines research theory as a set of explanations about complex phenomena, considered to be part of science. The author further states that research theory identifies variables that affect the problem of interest to the researcher and the variables explain and tell the important concepts that need to be measured in a particular research. In addition theories test the relationships between important variables in a study.

2.10.3 Theories of ICT use and adoption

In this study the use and adoption of ICTs to support wine farmers in their decision making is the focus. Therefore a number of theories on the use, acceptance and adoption of ICTs are discussed briefly.

2.10.3.1 Marcus' theoretical model of adoption

Derived by Marcus (1986) from the DOI theory and the social learning theory, the Marcus' theoretical model of adoption identifies a number of key influential factors of ICT adoption. In the theoretical model of adoption, a potential adopter observes and learns from others who possess innovative behaviour (Ankem, 2004). The model assumes that communication between a potential adopter and adopters result in modelling of the new behaviour. Even though there is no guarantee that modelling occurs when a potential adopter and adopters communicate, opportunity exists for it to occur (Marcus, 1986; Ankem, 2004). The acquisition of new behaviour is required for adoption but is not sufficient to ensure adoption, when the adopter learns the behaviour he or she evaluates behaviour in terms of associated costs and benefits to ascertain value of new behaviour. Marcus explained the value as "the potential adopter's perception of the personal and functional usefulness of innovation". An inclination to adopt is denoted by a high value and low value shows reluctance to adopt hence:

$$V = B - C$$

The *V* value attribute is the difference between perceived positive characteristics or benefits *B* and perceived negative characteristics or costs C associated with the behaviour. The costs can reflect economic constraints and can also include investments in time and effort to develop new skills and risk associated with failure such as loss of self esteem, benefits can be financial but also include increased personal satisfaction, improvements in task

performance and gains in social approval or prestige (Marcus, 1986; Ankem, 2004).

The model thus pulls together all important variables into a model of adoption and proposes that behaviour such as the adoption of innovations is a function of the resources available, the value an individual attributes to the innovation and the communication that provides the opportunity to learn about the innovation by observing others (Ankem, 2004).

This is represented as A = *f*(R, V, C)
Where *A* is adoption, *R* resources, *V* value and *C* communication with adopters thus adoption is the actual utilisation of the innovation. Ankem (2004) further articulated that "adopters are expected to attribute greater value to the innovation, communicate more often with other adopters and have more resources available than nonadopters".

2.10.3.2 Diffusion of innovations

The Diffusion of Innovations (DOI) theory by Rogers (1995) is wide used by researchers to explain the diffusion of technology in societies. Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social (relating to humans) system. The diffusion of ideas has four main elements which are the innovation, communication channels, time and the social system (Rogers, 1995; Rogers and Scott, 1997). The theory has been in use for the past five decades, studying a variety of innovations ranging from agricultural tools to organisational innovation as articulated by Vankatesh, Morris, Davis and Davis (2003:431).

An innovation is an idea, practise or object that is perceived as new by an individual or other unit of adoption (Roger & Scott, 1997). Denning (2004) defined innovation as a transformation of practise in a community. The diffusion of innovations is the process by which an innovation is communicated through certain channels over time among the members of a social system as illustrated in Figure 3.1 below (Rogers, 1995).

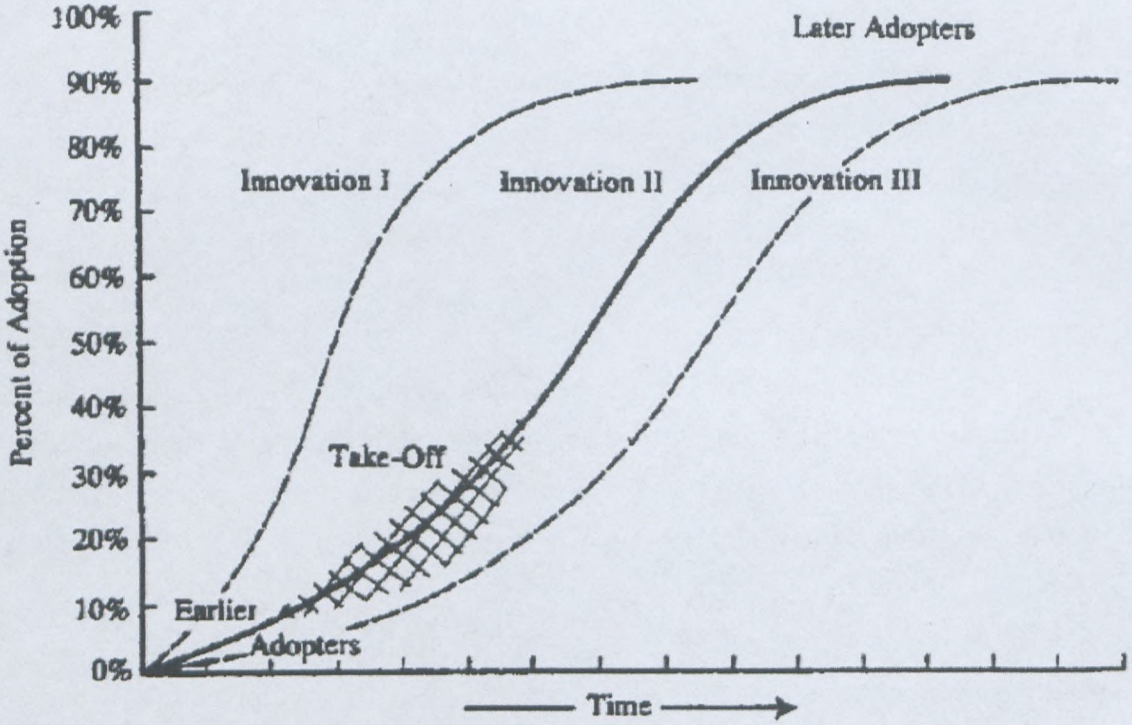

Figure 2.3: The process of Diffusion (Rogers, 1995)

Diffusion is the process by which (1) an *Innovation* is (2) *Communicated* through certain *Channels* (3) over *Time* (4) among the members of a *Social System* (Rogers 1995). The DOI theory puts emphasis on the role of individual behaviour in the technology process and time as an important factor in the rate at which diffusion tales place. Users are classified into five adopter categories which are innovators, early adopters, early majority and laggards (Rogers, 1995; Rogers & Scott, 1997). The classification is dependent on when users adopted the technology, as can be seen from Figure 3.1 where early adopters adopt the innovation early and likewise the laggards take some time before adopting the innovation. Innovators are the first 2.5 percent of the individuals in a system to adopt the innovation, early adopters are the next 13.5 percent and the next 34 percent are the early majority. Late majority consists of the next 34 percent of the individuals in a system to adopt the innovation while laggards consists the last 16 percent (Rogers 1995).

To answer the question why certain innovations spread more quickly than others, Rogers devise characteristics which determine an innovation rate of adoption and these are: relative advantage, compatibility, complexity, trialability and observability. Relative advantage is explained as the degree to which an innovation is perceived as better than the superseded idea while compatibility is the degree to which an innovation is as seen as being consistent with the existing values, past experiences and needs of potential adopters. The degree to

which h an innovation is perceived as difficult to understand and use is complexity and the degree to which an innovation may be experimented with on a limited basis is trialability. Lastly observability is described as the degree to which the results of an innovation are visible to others (Rogers, 1995; Rogers & Scott, 1997).

Given that decisions are not authoritative or collective, each member of the social system faces his/her own innovation-decision that follows the 5-step process of Rogers and Scott, (1997):

a) Knowledge – person becomes aware of an innovation and has some idea of how it functions,

b) Persuasion – person forms a favourable or unfavourable attitude toward the innovation,

c) Decision – person engages in activities that lead to a choice to adopt or reject the innovation,

d) Implementation – person puts an innovation into use,

e) Confirmation – person evaluates the results of an innovation-decision already made.

2.10.3.3 Technology Acceptance Model (TAM)

TAM is the most cited theory of ICT implementation and adoption according to Korpelainen (2011). TAM as mentioned by Davis (1989) is proposed to foresee the acceptance and use of software and information systems within institutions. Davis presented TAM aiming to predict and explain ICT usage behaviour that is what causes potential adopters to accept or reject the use of information technology (Korpelainen, 2011). Initially proposed in 1985 by Fred Davis, he postulates that system use is a response that can be explained or predicted by user motivation. This in turn is directly influenced by an external stimulus consisting of the actual system's features and capabilities as illustrated in Figure 2.4 below.

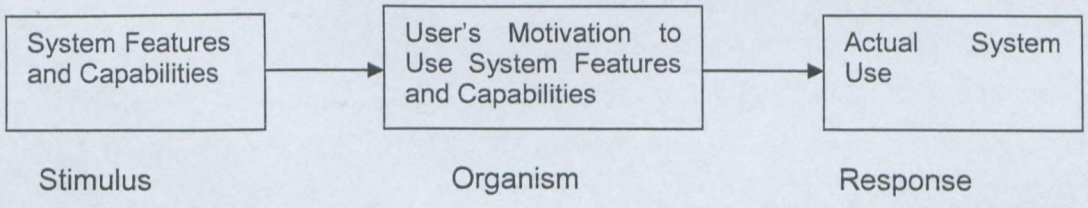

Figure 2.4: Conceptual model for technology acceptance, Davis (1985) cited in Chuttur (2009)

Davis further refines his conceptual model to propose the TAM relying on prior work by Fishbein and Ajzen (1975), who formulated the Theory of Reasoned Action (TRA). He suggests that users' motivation can be explained by three factors i.e. *perceived ease of use* which is the degree to which a person believes that using a particular system would be free of effort, *perceived usefulness* which is the degree to which a person believes that using a particular system would enhance his or her job performance and *attitude* towards using the system. Davis believed that the attitude of a user towards a system was important in determining whether the user will actually use or reject the system. The attitude in turn was considered to be influenced by two major beliefs: perceived usefulness and perceived ease of use with perceived ease of use having direct influence on perceived usefulness. These beliefs however were hypothesised to be directly influenced by the system design characteristics X_1, X_2 and X_3 as in the Figure 3.3 below (Davis, 1986; Chuttur, 2009).

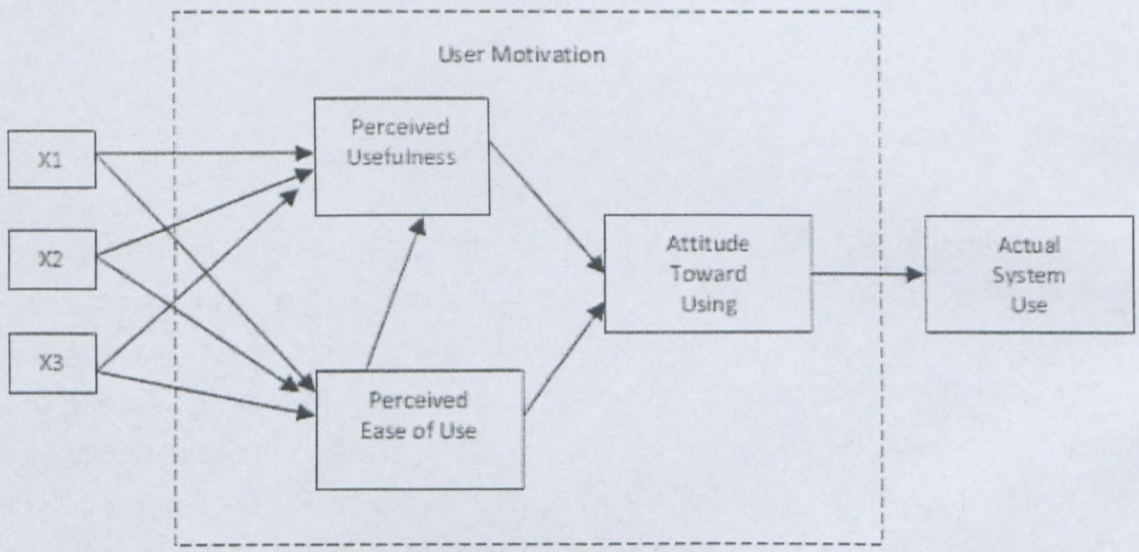

Figure 2.5: Original TAM proposed by Davis (1986:24)

In a later development, TAM included behavioural intention as a new variable that would be influenced directly by the perceived usefulness of a system. In cases when, given a system perceived to be useful, an individual might form a strong behavioural intention to use the system without any attitude. As a result a modified version of TAM (as shown on Figure 3.4) was produced (Davis, Baggozi & Warshaw, 1989).

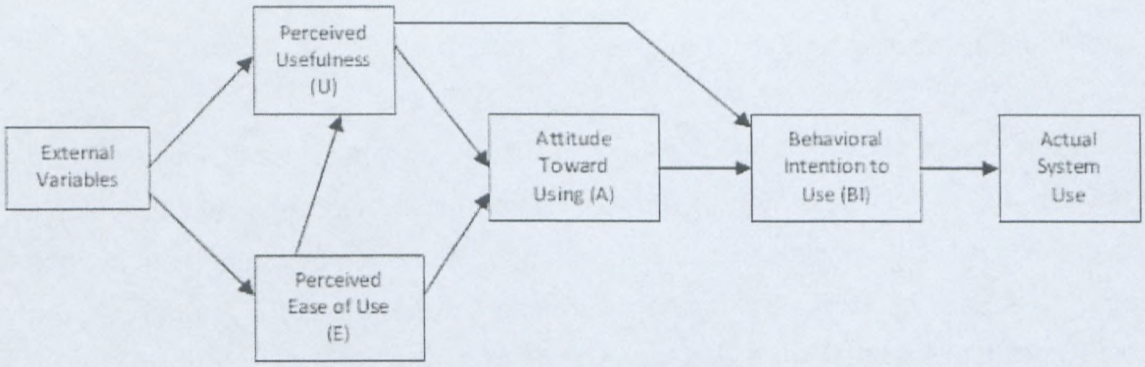

Figure 2.6: Modified version of TAM (adapted: Chuttur, 2009:985)

Davis et al. (1989) after further research found a strong correlation between reported intention and self reported system usage with perceived usefulness responsible for the greatest influence on people's intention. Perceived ease of use however was found to have a small but significant effect on behavioural intention which subsidised over time later on. However, the main findings showed both perceived usefulness and perceived ease of use have a direct influence on behavioural intention hence eliminating need for the attitude construct from the model (Chuttur, 2009).

Removing the attitude construct and introducing behavioural intention construct, results from the direct influence on of perceived usefulness on actual system use was presented (as in Figure 2.5). Removing the attitude variable at the same time eliminated any unexplained direct influence observed from the system characteristics to the attitude variable. Other factors referred to as external variables that might influence the belief of a person towards a system included system characteristics, user training, user participation in design and nature of the implementation process (Venkatesh and Davis, 1996; Chuttur, 2009). Figure 2.7 shows Venkatesh and Davis (1996)'s proposed final version of TAM.

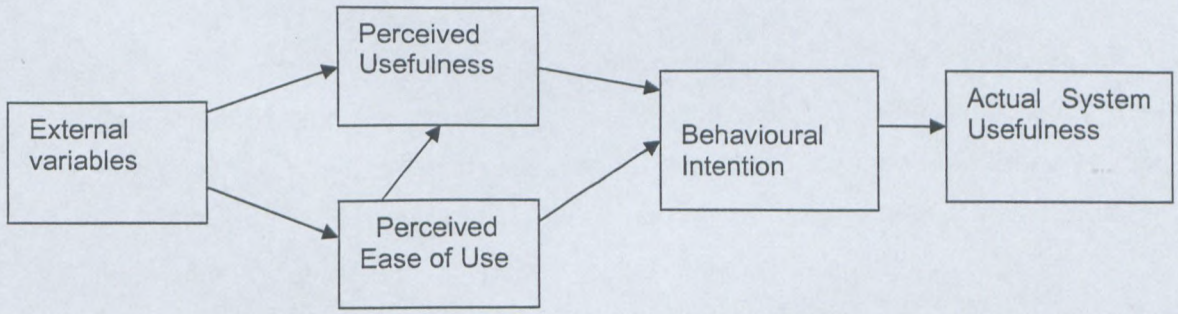

Figure 2.7: Venkatesh and Davis' (1996:453) proposed final version of TAM

2.10.4 Theoretical framework underpinning the study

This study seeks to find out how emerging farmers use or can best use ICTs to support decision making in their business. For the study the Information Innovation Adoption Model by Alvarez and Nuthall (2006) was used. It was developed and used by the authors in 2006 to investigate the use of computer based information system by dairy farmers. The information innovation model (Figure 2.8) uses Kline's (1998) modelling concepts using mediating variables to assess the relationships (Alvarez & Nuthall, 2006).

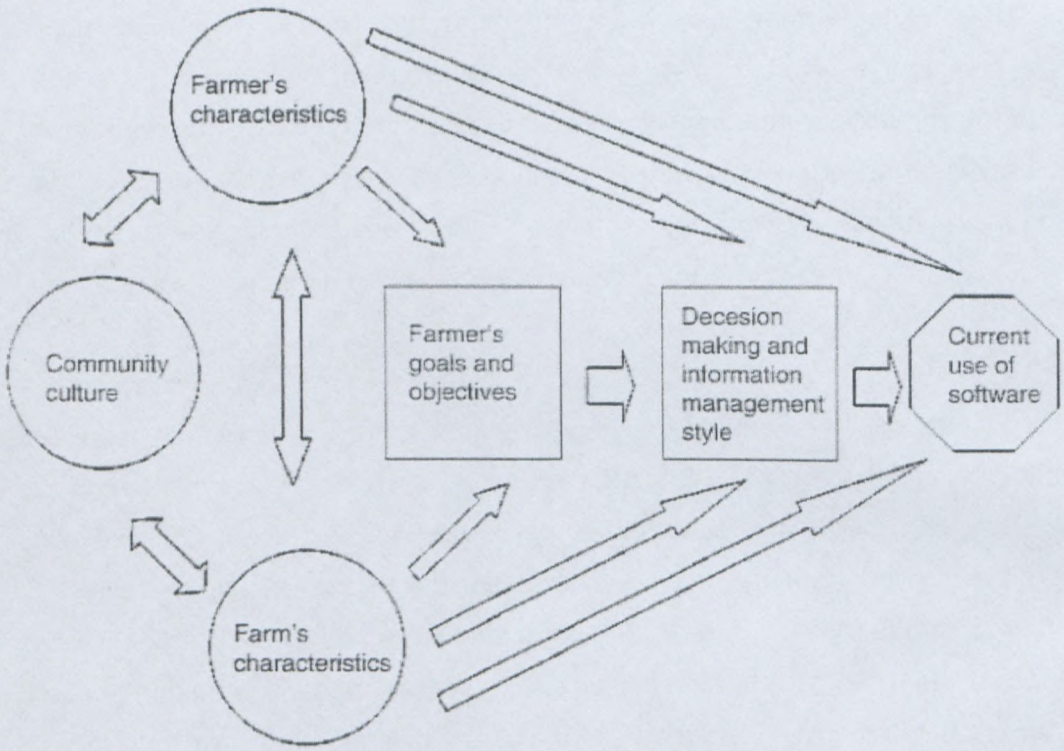

Figure 2.8: Information Innovation Model (Alvarez & Nuthall, 2006:51)

The model (Figure 2.8) relies on three types of variables and accepts that behaviour not a simple linear cause and effect relationship. The variables include antecedent variable *(circles)* such as permanent characteristics of a farmer (age, income, personality and formal education), farm characteristics such as farm size and crops grown on the farm and community culture. "An antecedent variable is an underlying cause for a situation or scenario" (Tembo, 2008). They are independent variables. The second type consists of mediating variables *(rectangles)* that is variables describing rather than when effects will occur by accounting for relationships between independent and dependent variables.

Coping styles, using of ICT in decision making, information management style, appraisals, objectives and goals pertaining to ICT form mediating variables. They are introduced to explain why an antecedent variable affects the outcome variable. Including mediating variables such as personal traits, learning styles and farmer's goals helps to provide a comprehensive explanation and better understanding of information management behaviour. Lastly are the behaviour outcome variables *(octagon)* which is the single variable reflecting the use of an on-farm computerised information system (Alvarez &Nuthall, 2006). Outcome variables are dependent variables; they depend on antecedent and mediating variables. For example the current use of is dependent on farm and farmer characteristics as well as farm culture as well as the farmer's goals and management style.

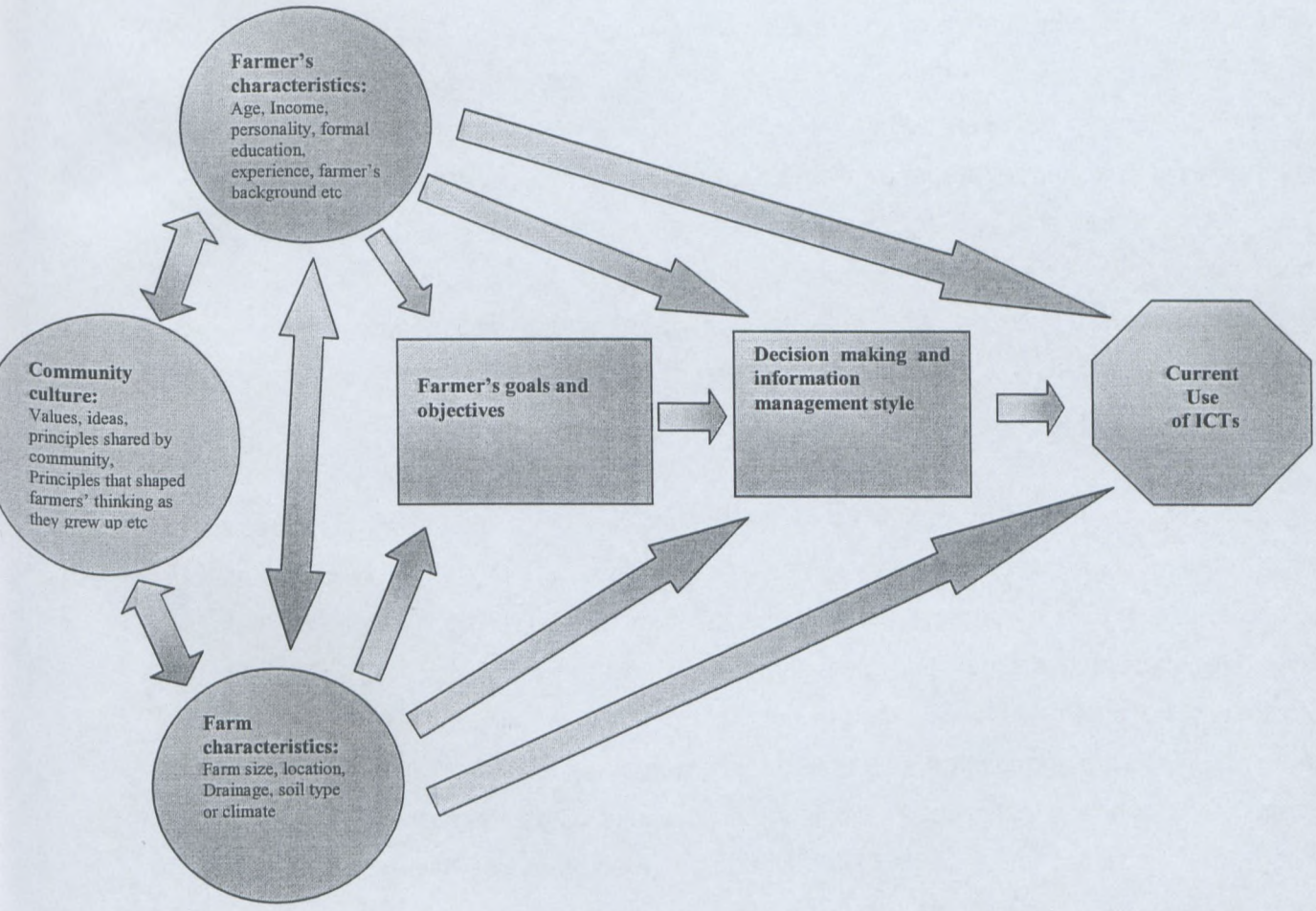

Figure 2.9: Extended information innovation adoption model (adopted from Alvarez & Nuthall, 2006:51)

Figure 2.9 shows the extended information innovation adoption model (adopted from Alvarez & Nuthall, 2006:51). It is assumed, from the model that there are direct relationships between antecedent and outcome variables (Alvarez & Nuthall, 2006). The model shows

reversible arrows on antecedent variables, which indicates a two-way relationship between the variables. Both ways, a variable may affect the other positively or negatively for example income as an independent variable maybe interacting with other some farm characteristics and/or some elements of the community culture. Relationship between antecedent and mediating variables are indicated by one-way arrows. The mediating variables explain the relationship between outcome variables and antecedent variables with each antecedent variable affecting the mediating variables either negatively or positively. For example farmer's income might affect the farmer's goals and objectives, the style of management and the ultimate use of ICT. The dependent final outcome variable is influenced by all the antecedent and mediating variables as shown in the diagram above.

This study investigates the use of ICTs by farmers in their decision hence all the three types of variables are looked at in this study. Alvarez and Nuthall (2006) looked at dairy farmers; however in this study wine farmers are investigated. The authors wanted to determine if there is a relationship between certain variables and their adoption of computer systems. The variables include farmer's age, formal education, personality, operational skills, farming culture, farm characteristics, advisory services on agricultural practices, information management skills and economic benefits perceptions. They found out significant relationships to exist between farm size, farmer's age, goals, information management practise and learning style and the farmer's adoption of computerised systems (Alvarez & Nuthall, 2006; Tembo, 2008).

Since this study seeks to investigate how the farmers use ICTs to support their decision making, relationship between variables will be explored to determine which variables affect the ultimate use of ICTs by farmers. Most of the variables mentioned by Alvarez and Nuthall (2006:51) applies to this study for example farmer's income and education level affects his/her use of ICTs as well as what kind of culture they grew or live in. Farm characteristics such as size, location and climate also affect the farmer's use of ICTs. Therefore these and more variables will be investigated in this study and results will be presented in the findings showing which antecedent and mediating variables affect the way wine farmers in the Western Cape use ICTs to support decision making in their business.

2.11 Summary

This chapter presented definitions of emerging farmers as defined by other authors as well as defining emerging farmers in the context of this study. Decisions farmers make as well as

the several ways used in decision making was also presented. It also presented types of information farmers require to support the identified categories in decision making and the technologies that are suitable to support farmers in decision making. Several ICT infrastructures farmers need to support their decision making were also explored. In this chapter the reasons for the slowness in the uptake of DSSs by emerging farmers were explored.

The theoretical framework was also presented; Marcus theoretical model of adoption, the Diffusions of innovations, the Technology Acceptance Model and the Information Innovation model were discussed. The theoretical model underpinning the study was presented at the end of the chapter.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

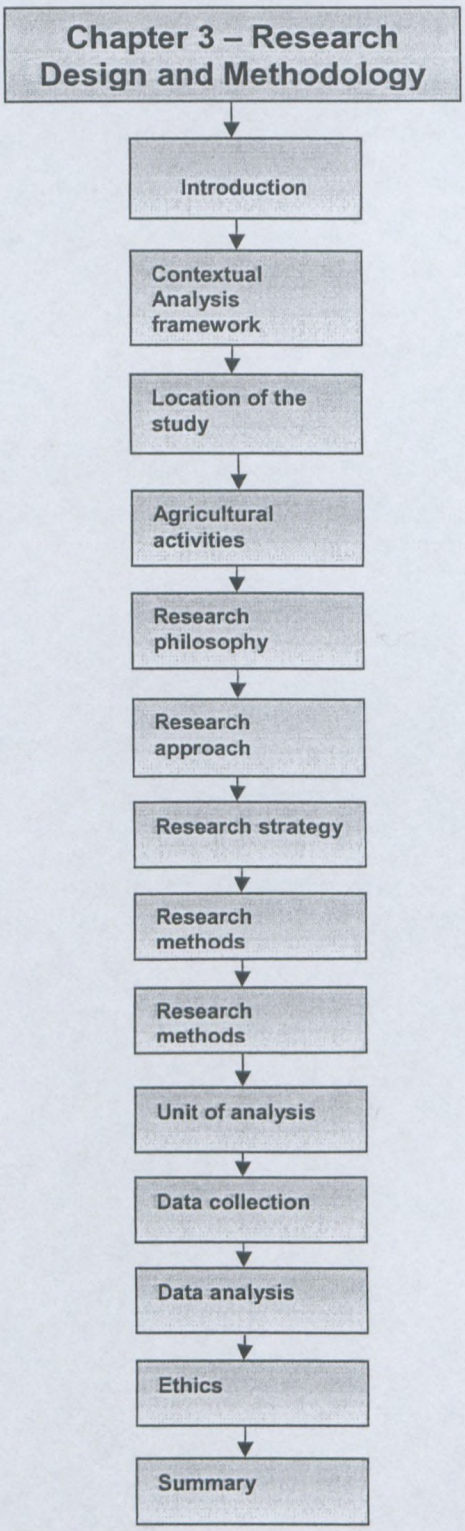

Figure 3.1: Graphical representation of Chapter 3

3.1 Introduction

The purpose of this chapter is to provide an outline of the research philosophy, approach, strategies, data collection and analysis employed in this study. The context as well as the location and the agricultural activities are covered in the chapter.

3.2 Contextual Analysis Framework

The purpose of the Contextual Analysis Framework is to provide an understanding of the research context. Walsham (2000) urges information systems (IS) researchers to truly cover all levels of analysis from the individual to the societal in their research agenda. The author further urges researchers to study particular individuals, groups, organisations or societies in detail and in context.

Korpela, Mursu and Soriyan (2001:3) propose a research contextual framework of four integrated levels of analysis: individual, group/activity, organisational and societal. Their framework, adopted from Walsham's (2000) differ in that while Walsham reviews IS research on five levels of analysis, theirs consists of four integrative levels of analysis with two viewpoints – within and between units of analysis. The authors articulate that each level requires its own methods of study, but the levels are interconnected. Korpela et al. (2001:4) further mention that not all of these levels of analysis are applicable to all studies.

For this study the main level of analysis is the organisation since this study looked at different organisations (wine farms, consultancies and vendors) within the Breede River Valley. Not only does the research involves the organisations but includes farmers and farm managers as well in their day to day decision making activities. Table 3.1 below shows contextual levels of analysis as proposed by Korpela et al. (2001) and how it is applied to the study.

Table 3.1: Contextual levels of analysis as proposed by Korpela et al. (2001) and how it is applied to the study

Context/level of analysis	Intra- viewpoint	Inter –viewpoint	Section
Societal	Breede River Valley	Between the Breede River Valley wine regions in the Western Cape, SA as well as nationally	Section 4
Organisational	Wine farms in Boesmans River Valley region	Between the wine farms(comparison of the wine farms)	Section 4
Group/Activity	Decision making	Across different farm operations e.g. sowing, planting, harvesting etc.	Section 4
Individual	Decision makers	Farmers and farm managers	Section 4

3.3 Location of the study

The study focuses on Boesmans River Valley within the Breede River Valley in the Western Cape Province of South Africa. The Western Cape is located in the south west of the country with the Northern Cape to her north and Eastern Cape to her East (Fig 3.1). Cape Town is the capital; it is the second largest city in South Africa. Wine production is one of the major economic activities in the province and it helps the country earn foreign currency from its exports, contributes to GDP, provides employment and also as a tourist attraction. Reid (2000) states that the province contributes approximately 91% of the total wine production in South Africa.

The Western Cape has the following major wine regions: Breede River valley, Coastal Region, Klein Karoo, Olifants River and Overberg. According to WOSA (2010), these encompass 18 diverse districts and some 53 smaller wards including Elim and Philadelphia.

Map of Western Cape Wine Regions

Fig 3.2: Map of Western Cape wine regions (Adopted from wine and vine search (2011) – www.wineandvinesearch.com

The Cape wine lands stretch from the rugged mountains and multi-directional slopes of the coastal region to the open plains of the Little Karoo where viticulture takes place mainly in the riverine valleys (WOSA, 2011).

Overview of the wine districts and wards

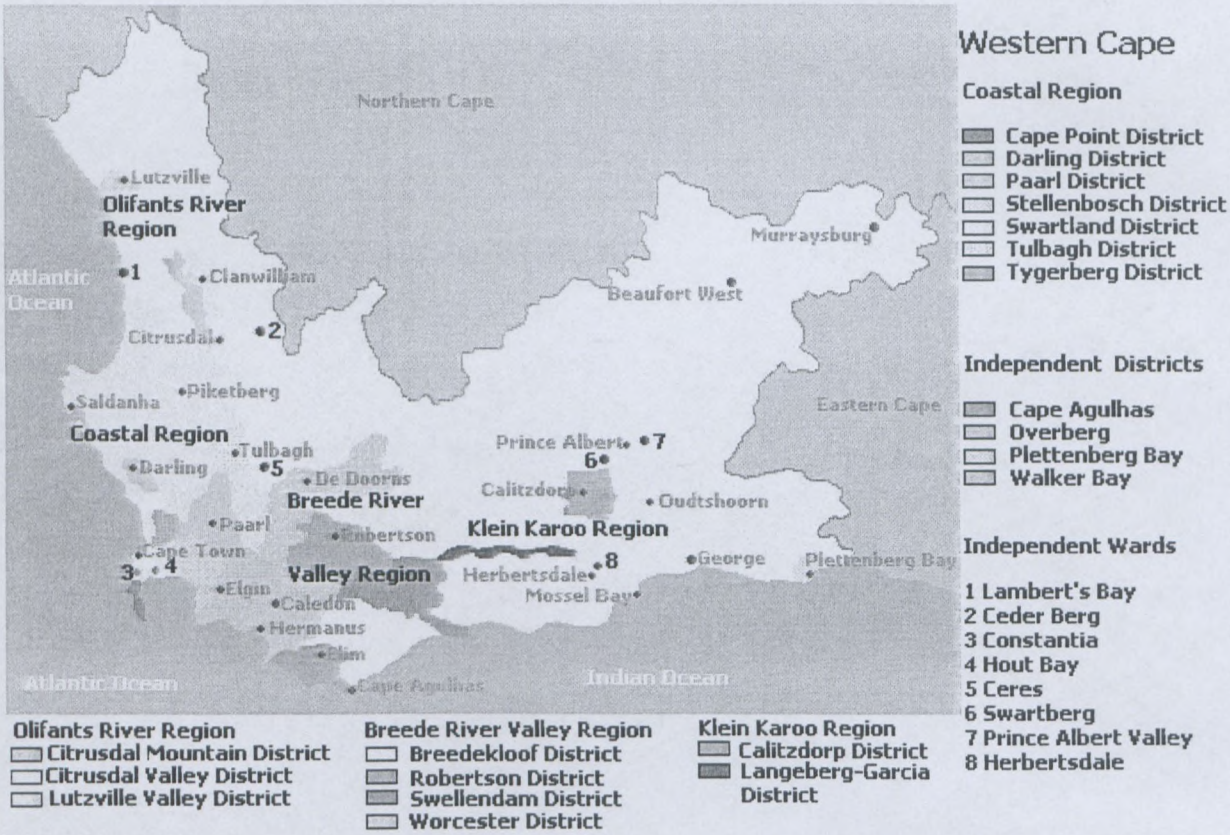

Fig 3.3: Overview of the Western Cape wine districts - (Adapted from wine and vine search (2011) – www.wineandvinesearch.com

The research was conducted in the Breede River Valley which is the largest wine producing area in South Africa. Breede River Valley derives its name from the Breede River, rising from the mountains near Ceres flowing through the valley en route to the Indian Ocean serving as the main water source for the Breede River Valley. The valley stretches from McGregor in the south and Gouda in the west, to Montagu in the east and the Karoo in the north with the N1 passing virtually through its centre in a north easterly direction. More than 50 wine estates are incorporated into various wine routes within the valley as well as a Brandy route as a result, and the relatively new and extremely popular Route 62, marketed as the longest wine route in the world, makes its way through the valley to the Klein Karoo, (sa-venues.com, 2011). It consists of Breedekloof, Worcester, Robertson 1, Robertson 2 and Swellendam.

Map of Breede River Valley

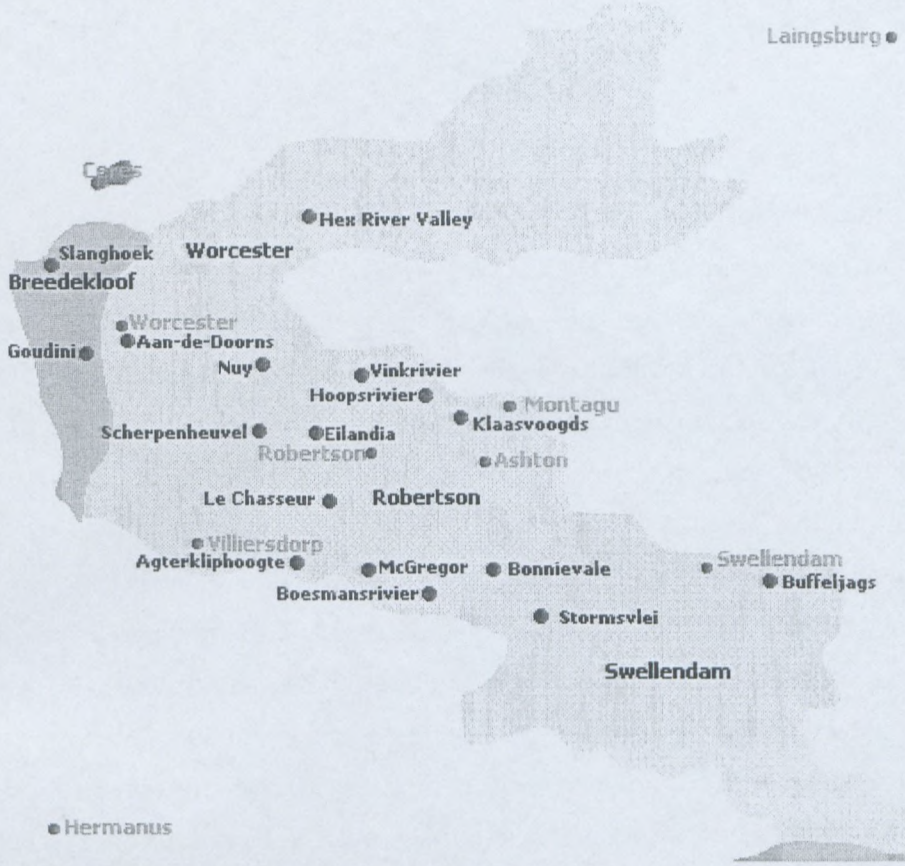

Fig 3.4: Map of Breede River Valley region (Adapted from wine and vine search (2011) – (www.wineandvinesearch.com)

3.4 Agricultural activities

Apart from racehorse breeding, the Breede River Valley is the largest fruit and wine producing valley. Tembo (2008) mentions that a number of fruits like apricots, cherries and plums are grown; vegetables like tomatoes and cabbages are also grown. With more than 50 wine estates incorporated into various wine routes within the valley, wine farming is the most dominant agricultural activity in the Breede River Valley. Several red and wine grape varieties are grown in the area with Chenin Blanc, Colombar, Cabernet Sauvignon, Pinotage, Chardonnay, Shiraz and Sauvignon Blanc among the most common ones. Breedekloof in 2010 had 12 567.78 hectares of wine grape vineyards, Robertson 14 004.28 and Worcester 8 648.84 (SAWIS, 2010). Agri-tourism has also been successful in Breede River Valley since tourists are attracted not only to the majestic view of the area but grape and wine tasting is a major attraction.

3.5 Research philosophy

3.5.1 Ontology

Ontology is concerned with nature of reality, the assumptions researchers have about the way the world operates and the commitment held to particular views. There are two main aspects of ontology namely objectivism and subjectivism (Saunders, Lewis & Thornhill, 2007:108). Saunders et al. (2007:108) mention that objectivism portrays the position that social entities exist in reality external to social actors while subjectivism states that the social phenomena are created from the perceptions and consequent actions of social actors.

This study took a subjectivist view, social constructionism which views reality as being socially constructed by the social actors who perceive different situations in varying ways as a consequence of their own view. The different interpretations affect the actions of the social actors and nature of their social interaction with others, seeking to make sense of their environment through interpretation of events and meanings they draw from these events (Saunders et al., 2007:108). The authors further state that it is the researcher's role to seek to understand the subjective reality of the customers in order to make sense of and understand their motives, actions and intentions in a meaningful way. The researcher made interactions with the actors in this study in order to make sense and understand their environment through interpretations and meanings drawn from the events.

3.5.2 Epistemology

According to Myers (1997) every research is based on some assumptions underlying it. Epistemology consists of subjectivism, positivism and critical realism (Saunders, Lewis & Thornhill, 2010). This study takes a subjectivist approach. Myers (1997) further articulates that it is crucial to know what these assumptions are in qualitative research. The most appropriate philosophical assumptions being those which relate to the underlying epistemology guiding the research. The assumptions about knowledge and how it can be obtained is referred to as epistemology (Hirschheim, 1992). Epistemology considers views about the most appropriate ways of enquiring into the nature of the world and what is and what are the sources and limits of knowledge (Easterby-Smith, Thorpe & Jackson; Eriksson & Kovalainen, 2008). Saunders et al. (2010) report that epistemology concerns what constitutes acceptable knowledge in a field of study.

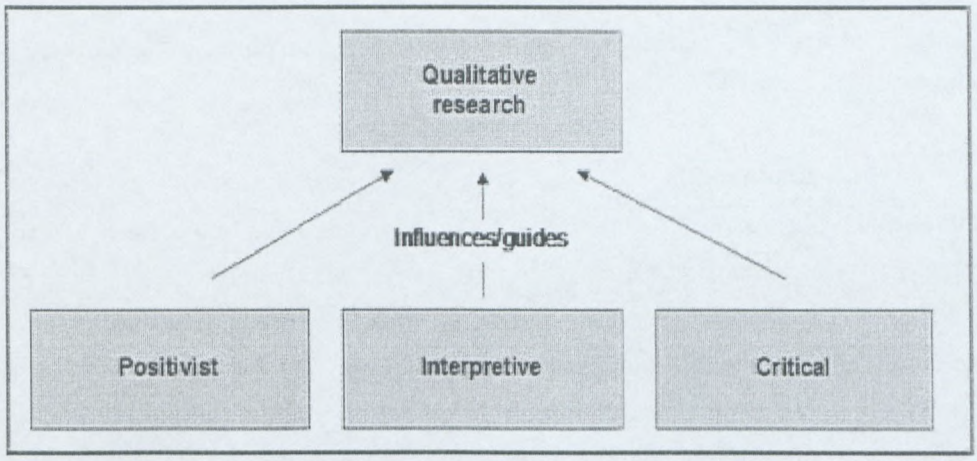

Figure 3.5: The underlying philosophical functions of qualitative research (Myers, 1997).

Qualitative research can be positivist, interpretive, or critical as see from the diagram above (Myers, 1997). As this research will follow an interpretivist stance only interpretive research will be discussed.

3.5.2.1 Interpretive research

In his description of interpretive approach, Lee (1991:347) mentions that the interpretive approach requires that the social scientist must collect facts and data describing not only the purely objective, publicly observable aspects of human behaviour, but also the subjective meaning this behaviour has for the human subjects themselves. Walsham (1993) articulates that interpretive studies attempt to understand phenomena through the meanings that people assign to them. The author further mentions that interpretive methods of research in information systems (IS) are aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context. As Kaplan and Maxwell (1994) postulated, interpretive research does not predefine dependent and independent variables, but focuses on the full complexity of human sense making as the situation emerges. The interpretive paradigm refers to the way we as humans attempt to make sense of the world around us (Saunders et al., 2007).

There are multiple constructions and interpretations of reality that are in flux and that change over time. Qualitative researchers seek to understand what those interpretations are at a particular point in time and in a particular context. The studying of how individuals experience and interact with their social world, the meaning it has for them, is considered an

interpretive qualitative approach (Merriam, 2002:4). Table 3.2 below gives a summary of the seven principles of interpretive research as proposed by Klein and Myers (1999).

Table 3.2: A summary of the seven principles of interpretive research as proposed by Klein and Myers (1999)

Principle	Explanation
1. The fundamental principle of the hermeneutic circle	The principle of hermeneutic circle propose that human understanding is achieved by considering the interdependent meaning of parts and the whole through iterating. It is fundamental to all the other principles
2. The principle of contextualization	The principle of contextualisation requires the critical reflection social and historical backgrounds of the setting of the research setting, in order for the intended audience to see how the current situation being investigation emerged
3. The principle of interaction between the researchers and the subjects	This is the principle which requires critical reflection on the social construction of the research materials data through the interaction between the researchers and respondents
4. The principle of abstraction and generalization	This principle requires the relating of the idiographic details revealed by the interpretation of data through the application of the first and second principles to theoretical and general concepts that describe the nature of human understanding and their social behaviour
5. The principle of dialogical reasoning	The sensitivity to possible contradictions between theoretical preconceptions which guide the research design and actual findings with accompanying cycles of revision is required in this principle
6. The principle of multiple interpretations	The principle of multiple interpretations requires being sensitive to possible differences which might arise in interpretations among the participants are usually expressed in multiple narratives of the same sequence of events under investigation
7. The principle of suspicion	The seventh principle requires sensitivity to biases and systematic distortions that might arise in the narratives gathered from the participants

As shown in Table 3.2 above, the principle of the hermeneutic circle which suggests that human understanding is achieved by iterating between considering interdependent meaning of parts and the whole that they form is crucial. In this study meaning is derived from considering all the parts as well as the whole. The principle of contextualisation is also important because reflection on social and historical backgrounds of respondents was crucial in this study. The social and historical background plays a role in the behaviour of

respondents and how they operate. Moreover interaction between researcher and respondents is of utmost importance in the collection of data for this study.

The principle of abstraction and generalisation is employed in this study. The theoretical framework discussed some theory in relation to this study. The principle of dialogical reasoning should not be ignored since in many studies the theoretical preconceptions do not always match the actual findings. In this study the actual findings were compared with the theoretical preconceptions as well as other literature later in the study. Differences in interpretations are possible in research; hence this study also took that into consideration. Participants might interpret the situation differently consequently giving different responds. The principle of suspicion is also crucial; there may be some biases by respondents which researchers should be sensitive to. In this study the researcher was sensitive to any bias or distortions when analysing the data collected.

3.6 Research approach

Saunders et al. (2010) articulate that researchers should use the deductive approach in which the researcher develop a theory and hypothesis and design a research strategy to test the hypothesis, or the inductive approach in which you would collect data and develop theory as a result of your data analysis.

They further suggest that inductive approach is more suited to interpretivism. This study took an inductive approach since data was gathered and analysed to come up with theory or frameworks as well as recommendations on the use of ICTs by emerging farmers to aid their decision making.

3.7 Research strategy

In his definition of a case study, Robson (2002) defines a case study as a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence. Yin (2003) agrees when he describes a case study as an empirical inquiry, which focuses on a contemporary phenomenon within its real-life context and boundaries between phenomenon and its context are not clearly evident, it is suitable for studying complex social phenomena. The author further states that case studies can be used in qualitative research, quantitative research or both; it can be exploratory, explanatory or descriptive. Earlier on, Myers (1999) mentions that case study research can be positivist, interpretive, or critical, depending upon

the underlying philosophical assumptions of the researcher. The case study can be single case or multiple case studies. A case study strategy can also incorporate multiple cases, that is, more than one case. The rationale for using multiple cases focuses upon the need to establish whether the findings of the first case occur in other cases and, as a consequence, the need to generalise from these findings (Saunders et al., 2007). For this reason Yin (2003) argues that multiple case studies may be preferable to a single case study and that, when choosing to use a single case study, a strong justification for this choice is needed.

In case studies, data are collected through methods such as participant observation, in-depth interviews, and longitudinal studies, the case study approach seeks to understand the problem being investigated (Gable, 1994; Yin, 2009). Yin (2009) adds that case studies provide the opportunity to ask penetrating questions and to capture the richness of organizational behaviour. However the conclusions drawn may be specific to the particular organisations studied as Gable (1994) observed. By concentrating upon a single phenomenon or entity, the case study seeks to describe the phenomenon in depth (Meriam, 2002). In depth interviews were used as a data gathering technique in order to gather data in the most appropriate, effective and efficient way.

Orlikowski and Baroudi (1991) and Alavi and Carlson (1992) refer to case studies as the most common qualitative method used in information systems. The multiple case study is the most appropriate strategy for this study since it enables us to gain a rich understanding of the context of the research and the processes being enacted (Morris & Wood, 1991). Therefore in this research the case study enables us to gain a rich understanding into the use of ICTs by the wine farmers and decision makers in the Breede River Valley in the Western Cape province of South Africa. The case study also enables us to establish whether the farmers are optimally using ICTs to help their decision making as well as suggest ways they might implement or use ICTs to help them in decision making or new they might adopt to help them make better decisions in their operations. Table 3.3 shows situations where the case study method can be used (Yin, 2003).

Table 3.3: When to use case studies in research (Yin, 2003)

When to use case study	Relation to the study
1. The type of research questions – typically to answer "how" and "why" questions	The study asks "how" and "why" questions as research question and sub-technologies questions
2. The extent of control over behavioural events – when investigator has little or no possibility to control the events	Researcher has no control over the behavioural events in the industry or of decision makers
3. General circumstances of the phenomenon to be studied – contemporary phenomenon in a real life context	The study focuses on a real life context

3.8 Research methods

3.8.1 Qualitative research

The aim of this research is to explore and therefore a qualitative research is more suitable (Terre Blanche, Durrheim & Painter, 2006). According to Myers (2009) qualitative research methods aids us to understand people and the social and cultural contexts within which they live. Also referred to as phenomenological inquiry, qualitative research uses different methods of collecting information which includes interviews, observations, documents and questionnaires to understand and explain social phenomena (Hoepfl, 1997; Myers, 1997; Myers, 2009). Collected data is not subjected to formulaic analysis for the purpose of generating the solution as defined by Strauss and Corbin (1990). They define qualitative research as any kind of research that produce findings not arrived by means of statistical procedures or other means of quantification.

Qualitative research is chosen in this study since, unlike quantitative research; it is able to take full account of many interaction effects that take place in social settings. Qualitative research accepts the complex and dynamic quality of the social world (Cronbach, 1975). The author further indicates that some empirical laws in quantitative research do not hold true in actual settings. Cronbach (1975) further suggested exorcism of the "null hypothesis" since it ignores effects that may be important but not statistically significant.

Since this study seeks to identify the ICT infrastructure farmers need to aid their decision making, qualitative research is the best method for this study as Strauss and Corbin (1990) articulate that qualitative methods can be used to better understand any phenomenon about which little is yet known. More so the ability of qualitative data to fully describe a situation and provide insight into participants' experiences is crucial since it helps make the findings much clearer more meaningful to the stakeholders (Stake, 1978; Lincoln & Guba, 1985).

Interviews were used to gather data. This approach was used to identify what decisions farmers make, what information and technologies do they require to support them in decision making. The approach also used to identify the requirements for an ICT infrastructure to support farmers in decision making. Interviews were used to gather information into the technological and information needs of farmers which might help them in decision making. Literature analysis will also be used in this study to gather data.

3.8.1.1 Features of qualitative research

Table 3.4: Features of qualitative research – adopted from Hoepfl (1997)

1.	It uses the natural setting as the source of data, researcher attempts to observe, describe and interpret settings as they are. Thus maintaining "empathic neutrality" (Patton 1990)
2.	In qualitative research the researcher acts as the human instrument of data collection
3.	Inductive analysis is predominantly used in data analysis
4.	Reports are descriptive, incorporating expressive language and the so called "presence of voice in the text" (Eisner, 1991)
5.	Qualitative research has an interpretive character, aimed at discovering the meaning events have for the individuals who experience them, and the interpretations of those meanings by the researcher
6.	Researchers pay attention to the idiosyncratic as well as the pervasive, seeking the uniqueness of each case
7.	It has an emergent design, and researchers focus on this emerging process as well as the outcomes or product of the research
8.	Qualitative research is judged using special criteria for trustworthiness

As Hoepfl (1997) mentions above, qualitative research uses the natural setting as source of data, the researcher is the one who goes into the field and observes and collects data, describe and interprets the set up. The researchers are the ones who collect the data which

is then analysed to draw conclusions. Hoepfl (1997) states that inductive analysis is predominantly used in data analysis for qualitative research. This study also employs the inductive approach for analysing data.

An interpretive character is employed in qualitative research in order to discover the meaning events have for the people experiencing them so that reports are descriptive. In qualitative research, researchers pay attention to uniqueness of each case therefore increasing the reliability of the research results.

3.9 Unit of analysis

The unit analysis of this study is the emerging farmers, vendors, consultants and established farmers in the wine industry in the Western Cape, province of South Africa. The main focus being farm management, farm owners and any stakeholders involved in decision making.

3.10 Data collection

Meriam (2002) reports that the data collection strategy used is determined by the question of the study and by determining which source(s) of data will yield the best information with which to answer the question. The author further postulates that the three major sources of data in qualitative research are interviews, observations and documents. However, Denzin and Lincoln (2005) add a few more when they mentioned that qualitative researchers employ several methods of data collection which includes: "interviewing, direct observation, the analysis of artefacts, documents and cultural records; and the use of personal experience". There are primary methods of data collection and secondary methods of data collection. The data collection techniques the above authors describe help gather both primary and secondary data.

3.10.1 Yin's principles of data collection

Table 3.5 below shows applicability of Yin's (2003) principles of data collection to this study.

Table 3.5: Principles of data collection (Yin, 2003)

Principle	Applicability
1. Use multiples sources of evidence	Interviews, observations and literature analysis are the sources of evidence used in this study
2. Create a case study database	Data is captured into databases, interviews recorded and literature captured into referencing tool
3. Maintain a chain of evidence	Databases and data are captured and well referenced

In this study multiple sources of evidence are also used to gather data through interviews, observations and literature analysis. A multiple case study approach is used in this study, the data is captured, interviews recorded and the literature was captured into referencing tools as Yin (2003) principles of data collection. The data collected is kept secure and is well referenced. Therefore this study employs Yin's principles of data collection.

3.10.2 Primary data

Primary sources are those data which are unpublished and which the researcher gathers from the people or organization directly (Myers, 1997). Interviews were used to gather primary data in this study.

3.10.3 Secondary data

Secondary data in this study was obtained through literature analysis also known as document analysis and from sources such as reports, publications, universities, research institutions and also from other stakeholders such as officials from Department of Agriculture (DoA) and agriculture policy makers. The secondary data was useful to augment primary data in identifying the information and technological requirements to support decision making. It also helped to clarify the views and perceptions of farmers about the use of ICT in supporting decision making.

3.10.4 Interviews

An interview is defined as a purposeful discussion between two or more people (Saunders et al., 2007). The qualitative interview is the most common and one of the most important data gathering tools in qualitative research" (Myers & Newman, 2007:3). Rubin and Rubin (2005) earlier on likened qualitative interview to night goggles which permit us to see that which is not ordinarily on view and examine that which is looked at but seldom seen.

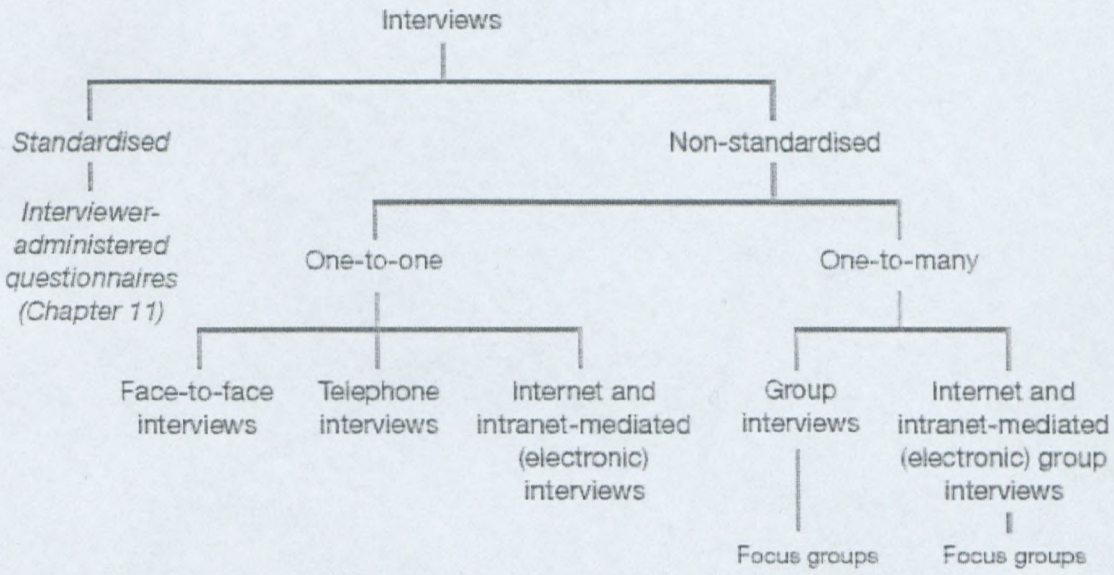

Figure 3.6: Types of interviews (Saunders et al., 2007:313)

Interviews involve mainly face-to-face structured or unstructured questioning of target respondents conducted either individually or as a group (Terre Blanche et al., 2006). Interviews range from highly structured or formalised, where standardised or specific questions and the order in which they are asked are determined ahead of time to unstructured or informal, where one has topic areas to explore but neither the questions nor the order are predetermined (Meriam, 2002; Saunders et al., 2007). Saunders et al. (2007) report that structured interviews use questionnaires based on a predetermined and standardised or identical set of questions often referred to as interviewer-administered questionnaires, the response is recorded on a standardised schedule usually with pre-coded answers. Unstructured interviews are used to explore in depth a general area in which you

are interested, therefore we refer to these as in-depth interviews, the authors added.

3.10.4.1 Guidelines for qualitative research interview

Myers and Newman (2007:16) propose seven guidelines for carrying out qualitative research as shown in Figure 3.8 below.

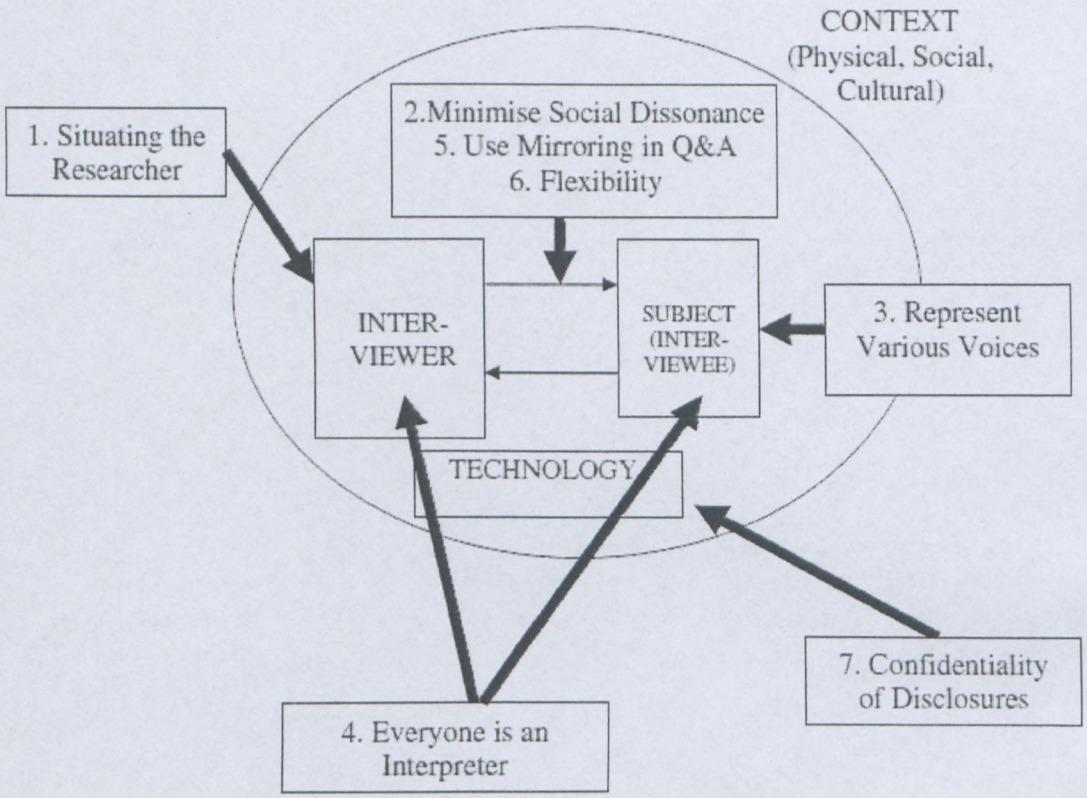

Figure 3.7: Guidelines for qualitative research interview (Myers & Newman, 2007:16)

3.10.4.2 Explanation of the guidelines

Table 3.6: Explanation of the guidelines for qualitative research (Myers & Newman, 2007)

Guideline	Explanation
1. Situating the researcher as actor	The interviewer should situate themselves as well as the interviewee. The following questions might be helpful: Who are you? What role are you playing? What is your background, experience, gender, age, and nationality? As the interviewer is not just a sponge, this information may be useful in the writing up, so that readers can assess the validity of the findings.
2. Minimise social dissonance	It is important to minimise social dissonance i.e. minimise anything that may lead to the interviewee to feel uncomfortable. This is generally thought of as a way to improve the quality of disclosure. This usually involves trying to manage first impressions, dressing appropriately and using the appropriate language/jargon. It might also mean dressing up or dressing down appropriately. Gender, age and culture may be important in some situations, depending upon the research topic
3. Represent various "voices"	In qualitative research it usually necessary to interview a variety of people within an organisation and try not to force one voice to emerge. All respondents are not the same thus it is important to try to avoid elite bias (Miles & Huberman, 1994).
4. Everyone is an interpreter	Subjects are creative interpreters of their worlds as we are of theirs. Interviewing is usually an artificial or rare event for most subjects. This means that the interview leads to creating and reading one or more texts, the initial text being the transcript of the interview.
5. Use Mirroring in questions and answers	Mirroring is taking the words and phrases the subjects use in constructing a subsequent question or comment allowing researcher to focus on the subjects' world and use their language rather than imposing yours. This allows interviewee to describe and explain their world in their own words. Open questions are encouraged to focus on common, vividly-held events and stories. The role of the interviewer involves listening, prompting, encouraging, and directing the conversation.
6. Flexibility	Semi-structured and unstructured interviewing uses an incomplete script and so requires flexibility, improvisation, and openness. The

	interviewer should be prepared to explore interesting lines of research, and look for surprises.
7. Confidentiality of disclosures	Researchers should keep transcripts or records and the technology confidential and secure. It may be advisable sometimes to provide early feedback to subjects and organisations and to check with them about factual matters if needed.

The guidelines above were employed in the study, the interviewer and interviewees were well situated and questions describing the interviewees and their roles were asked. The interviewees were asked about their role at the farm, their background as well as their experience. Moreover social dissonance was avoided or minimised during the data collection. The majority of the interviewees were interviewed at their own premises in order to improve quality of disclosure. The interviewer dressed in the best way appropriate and interviewed the respondents in the language they were comfortable with and jargon was avoided.

A variety of people were interviewed during data gathering in order to represent various voices. Farmers with different backgrounds were interviewed as well as other stakeholders who deal with farmers such as vendors and consultants. Interviewing the respondents also was also a rare event for the majority of respondents especially farmers. The interview transcripts were produced leading to the analysis of the data. During interviews was also used in answering questions as well as asking the interviews allowing the respondents to explain in their own words.

Semi-structured and unstructured questions were also used to encourage openness as well as allowing for exploration of interesting lines of research. The transcripts and the data collected are kept as confidential and secure.

3.10.4.3 Interview questionnaire

Questionnaire for interviews with the farmers

The interview questions formulated enables the researcher to get direct hand information from the people in the industry being researched. The people directly involved in decision making in the wine industry in the Western Cape were interviewed. These include the farmers and farm managers since they are the ones involved in farm decision making.

Interview questions

The interview questions formulated will enable the researcher to get direct first hand information from the people in the industry being researched. The people directly involved in decision making in the wine industry in the Western Cape will be interviewed. These include the farmers and farm managers since they are the once involved in farm decision making.

The term ICTs will be used more often during interviews, therefore it is best to define it first. Tinio (2002) defines ICT as a diverse set of technological tools and resources used to communicate, and to create, disseminate, store and manage information. She further mentioned that these technologies include computers, the internet, broadcasting technologies (radio and television) and telephony. Tembo (2008) describes ICTs as a set of activities that consists of hardware, software, networks and the media that facilitate or make it easy to collect, store, process, transit, present and communicate information (voice, data, text, images) using electronic means. This includes computers, printers, telephones, fax, internet, email, mobile phones, landline phones, e-commerce etc.

3.11 Data analysis

Data analysis is a practice in which raw data is ordered and organized so that useful information can be extracted from it. It involves breaking up the data into manageable themes, patterns, trends and relationships (Mouton, 2001). Therefore data in this study was summarised, categorised, developed into themes and then derived findings.

The following methods were used to analyse data:

3.11.1 Hermeneutics

Hermeneutics, which can be treated as both an underlying philosophy and a specific mode of analysis, was used (Myers, 2009). As Myers (2009) points out it is primarily concerned with the meaning of a text or text-analogue (an example of a text-analogue is an organization, which the researcher comes to understand through oral or written text). In hermeneutics, interpretation attempts to make clear and to make sense of an object of study which must therefore be a text or text-analogue. This is a suitable analysis tool which was used to interpret data gathered from the interviews or literature.

3.11.2 Conversation analysis

Conversation analysis is interested in the formal analysis of everyday conversations (Flick, 2006). As Grey (2009) articulates it includes the analysis of natural texts (often the result of transcribed tape recordings) and seeks to specify the formal principles and mechanisms with which participants express themselves in social interactions. Conversation analysis is less concerned with the formal analysis of language per se; it is very much focused on the issue of context. Originally limited to study of everyday conversations or family conversations it has been extended to meetings and various kinds of interviews. Therefore conversation analysis was used to analyse interviews with farmers.

3.12 Ethics

Ethical considerations were made in this study and this research did not breach any research ethics. Ethics are important in research and researchers should always observe any ethics in their area of study. Different fields have several ethics which they require any researcher to observe and consider.

In this study the researcher observed all the ethical considerations. A letter which explained to the respondents the purpose of study as well as informed consent was given to interviewees before the interviews. They were informed that their participation was voluntary and information conveyed will be strictly confidential and no references will be made to specific individuals. The consent letter also explained that the responses will be used for

academic purposes only and were encouraged to answer them to their satisfaction not under any influence or whatsoever. The letter was then signed by researcher and the research supervisor.

3.13 Summary

A subjectivist view was taken in this study to better understand and make sense of the environment the respondents operate in so that meaningful conclusions can be drawn. The epistemological stance taken in this stance is interpretivism. The study took an inductive approach as data was gathered and analysed to come up with frameworks and recommendations on the use of ICTs by emerging farmers to aid their decision making. The case study was used as a research strategy in this study since by concentrating on a single phenomenon, it seeks to describe the phenomenon in depth (Merriam, 2002). The unit of analysis is the emerging farmers, vendors, consultants and established farmers in the Western Cape province of South Africa. In depth interviews, literature analysis and observation were used to gather data in this study. Hermeneutics, conversation analysis and narrative analysis were used to analyse data so that useful information can be extracted from it.

CHAPTER FOUR

RESEARCH FINDINGS, THEMES, AND DATA ANALYSIS

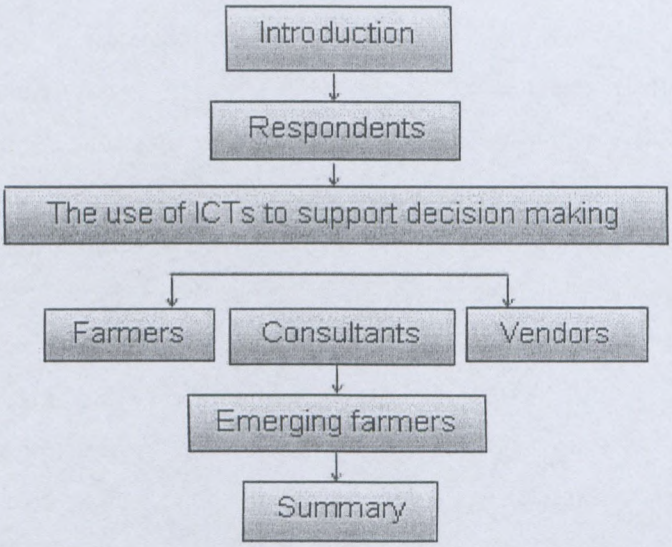

Fig 4.1: Graphical representation of chapter 4

4.1 Introduction and context

Chapter 4 presents the data analysis that was collected as well as the findings from the interviews and observations carried out in the Breede River Valley, Western Cape, South Africa (Figure 4.2). Hermeneutics and conversation analysis are used to analyse the collected data.

The wine farming industry is a capital intensive industry requiring large amounts of capital to be able to participate in. To be in the industry as a wine farmer, not only requires large amounts of capital but also training and experience. Entering the industry lacking these three factors is a high risk venture. But, although these factors are well known in the industry, investors as well as emerging farmers are still investing capital in the industry.

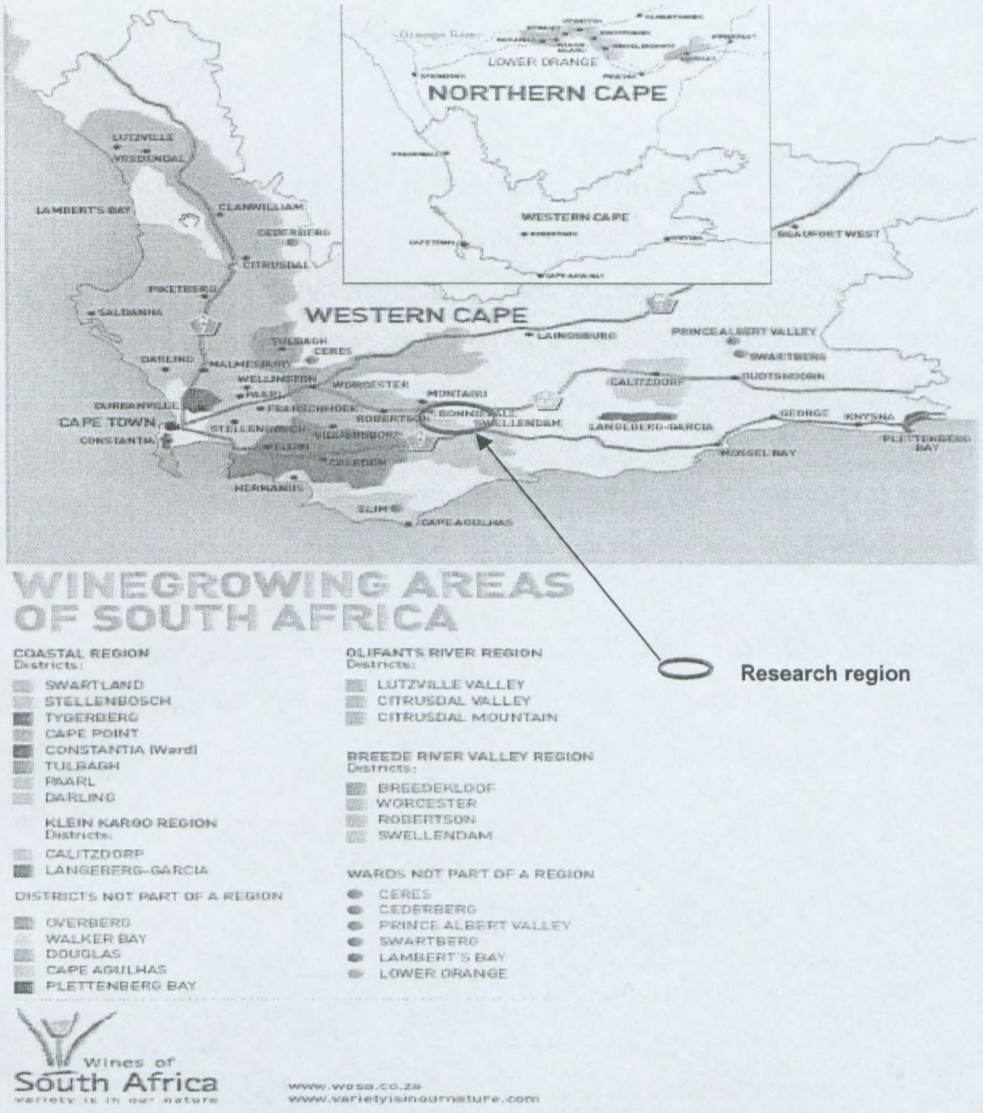

Fig 4.2 Map showing the wine regions of South Africa (WOSA, 2010)

Since the early nineties and with the change in the political dispensation, pressure to change the wine industry landscape has increase from national government to include previously disadvantage groups in the agricultural sector. Generally speaking the program up till 2012 did not succeed. There are many reasons for the failure. However, the wine industry seems to lack progress in finding ways of incorporating emerging farmers in the industry. The willingness to do so is there for all to see but the implementation seems to be very difficult.

This study focus on the importance of information and decision making of established farmers in order to propose to emerging farmers a guideline of what is important and what they need to do when entering and managing their enterprises. In an attempt to find answers for this complex problem, focus is placed on established farmers, agricultural consultants and vendors in the industry. As there are only a few emerging farmers every attempt was

made to include the emerging farmers in the study. Unfortunately only two farmers participated.

Problem statement: The environment emerging farmers operate in is complex and they are at a distinct disadvantage since they have no previous knowledge of farming hence reducing profitability and sustainability of these emerging farmers entering the industry.

The main research question is: How can emerging farmers utilise ICT in decision making in the wine industry in the Breede River Valley region in the Western Cape?

Aim: This study seeks to explore what ICT are used by established farmers to support them in decision making. A further aim is to propose a guideline for emerging farmers on the use of ICT in their farming operations.

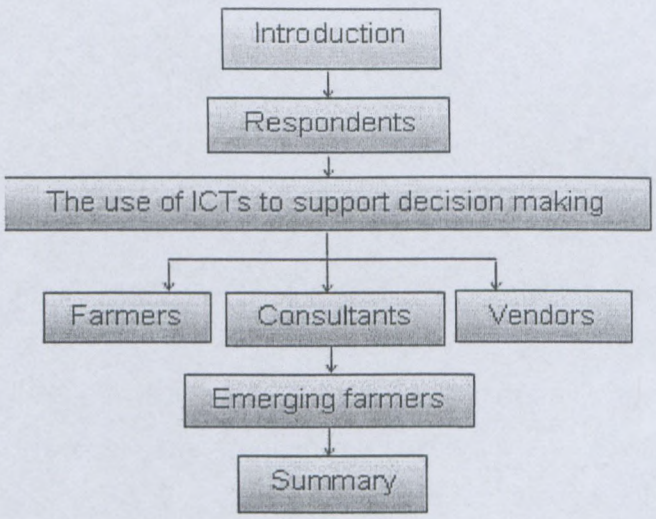

Fig 4.3 Chapter layout: Respondents

4.2 The respondents

4.2.1 Farmers

Most of the farmers interviewed in this study started off as emerging farmers (as defined in chapter 2.2) with others having bought an established farm as illustrated in Figure 4.4. Those who did not buy the farm inherited it from their fathers.

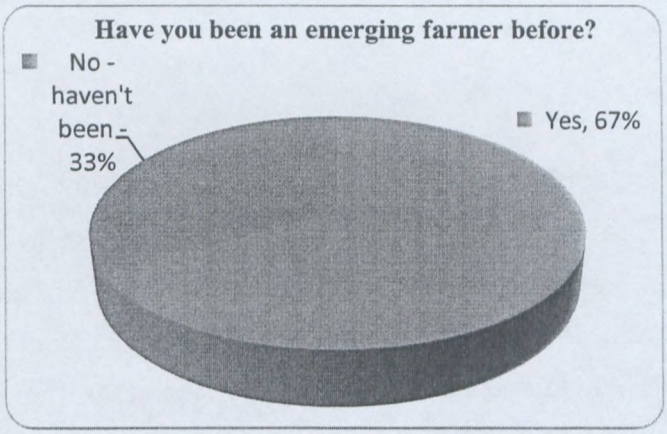

Figure 4.4: Pie chart showing whether the farmer has been an emerging farmer or not

All the respondents are farm owners. The farms range from 50 hectares to 350 hectares, and besides growing wine grapes, they also grow lucerne, apricots, plums, peaches and one farmer also do cattle farming. The farmers are also involved in exporting of their produce. The respondents experience in farming range from 6 to 37 years as shown in Figure 4.3. The farmers interviewed are all responsible for the overall farm management and its operations. Six farmers were interviewed.

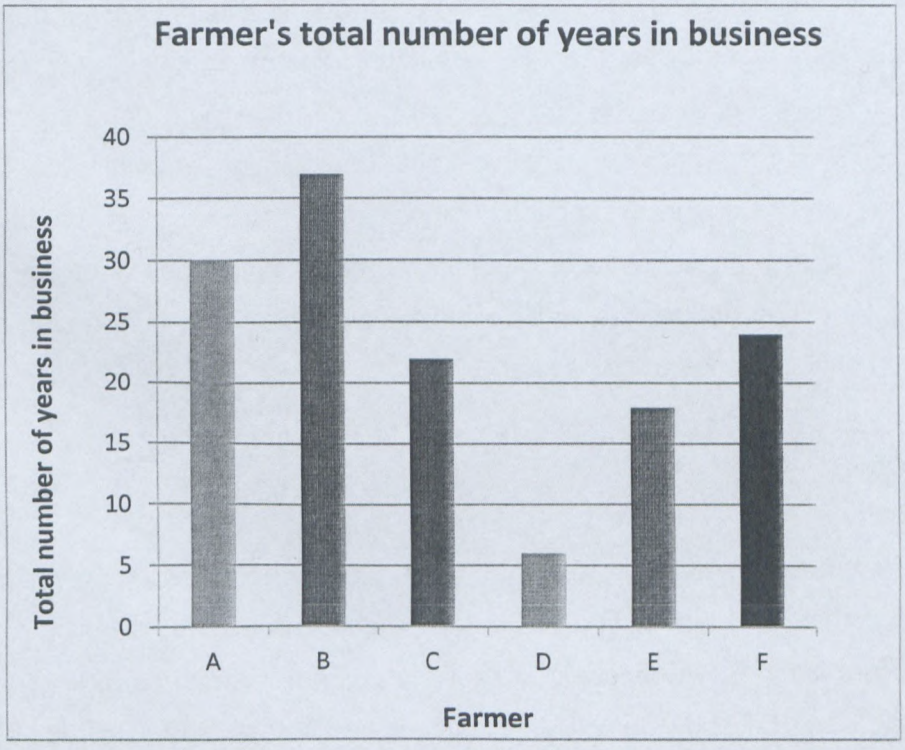

Figure 4.5: Graph showing the total number of years the farmers has been in business

4.2.2 Vendors

Vendors are companies who supply products or services to farmers, for example fertilisers, irrigation equipment, pesticides, machinery and technologies such as software and decision support systems. The vendors also provide services mainly in the form of after-sale support for their products. Vendors provided insight into the farmers' use of ICTs in decision making as they frequently interact with farmers in their operations and as the farmers require information and products. Fifty percent of the vendors provide both technological and general products such as fertilisers, pesticides and many others. Twenty five percent of the interviewees offer technological products to farmers such as software, while the other 25% give general farm products such as fertiliser, pesticides and herbicides. Four vendors were interviewed.

4.2.3 Consultants

Consultants support farmers by providing them with information to assist in their decision making. They provide knowledge and expertise and work with the farmers to improve his/her business. Most of the consultants interviewed are private consultants with only one consultant from the government's Department of Agriculture. The other consultants are from private companies such as Vinpro (www.vinpro.co.za), FarmMS (www.winems.co.za) and Farmsecure (www.farmsecure.co.za) which are reputable organisations providing consulting services to wine industry. Consulting services range from consulting on establishing vineyards that is preparing the vineyards, planting, maintaining the vineyards, and harvesting, to technology, and on local as well as international marketing information needs of the farmers. Eight consultants were interviewed.

4.2.4 Emerging farmers

As defined in the literature review (Chapter 2.2), emerging farmers are start-up farmers aiming to become a commercial farmer and are in the process of building up the necessary capacity. Emerging farmers were interviewed in order to explore if they use ICT and if the emerging farmers do use ICT, how they use the ICTs available to them in aiding their decision making. It was problematic to get emerging farmers to be interview since there are not many emerging farmers. Some of the emerging farmers are still building the necessary capacity making the scheduling of interviews with them unsuccessful. Some of them did not

see anything to gain in availing their time and consequently were not willing to be interviewed and as a result only two emerging farmers participated. Two emerging farmers were interviewed.

4.3 Analysis of data on the use of ICTs to support decision making – Farmers

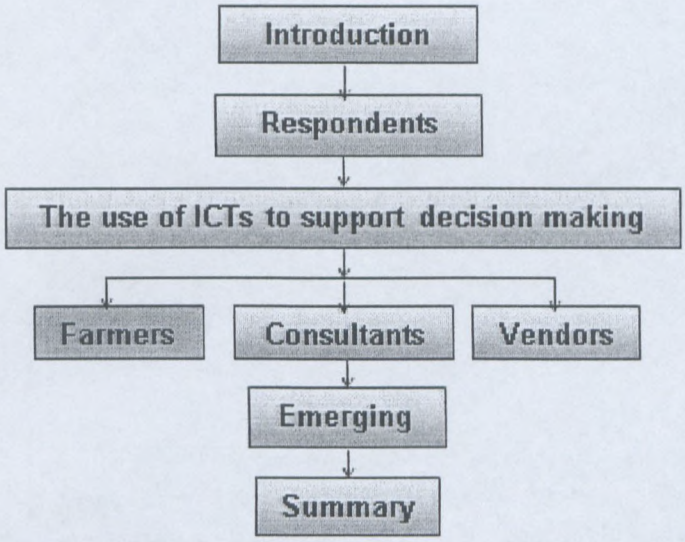

Fig 4.6 Chapter layout: Farmers

In this section the results as extracted from the interviews are given. Five main categories are discussed namely (i) The decisions farmers make followed by (ii) How Farmers make decisions, (iii) The information farmers requires in supporting their decision making, (iv) The technology suitable for farmers to make informed decisions, and (v) Farmer requirements for ICT to support the decision making of farmers. Table 4 .1 shows the summarised responses from farmers on the use of ICT linked to the sub research questions.

Table 4.1: Responses on the use of ICTs to support decision making – farmers

Sub research question	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E	Respondent F	Findings
1. What type of decisions do the farmers make?	All decisions. Labour management. Financial planning. Decisions on what to plant, when to plan	All farm decisions. Financial planning, labour management, operational decisions.	Responsible for all farm decisions. Marketing decisions, financial, recruitment – also consults his	Involved in all farm decision making. Market trends analysis, labour planning, financial planning. Operational – day t day decision	Responsible for the entire decision making. Operational, labour, financial, market	All farm decisions. Financial planning, labour, marketing etc	All the farmers are responsible for the overall decision making operational, tactical or long term decision making.

	and variety etc.		workers (co-decision making).	making.	assessment, deciding what to grow etc		
2. How do farmers make their decisions?	Consider profitability. Market trends analysis. Need to produce quality products.	Consults consultants (extension officers, cellar master, private consultants etc). Consults fellow farmers. Considers profitability. Farm terroir knowledge also plays a part in decision making.	Experience. Not systematic – gut feeling. Very flexible the way he handles decision making keeps changing. Also relies on advice from external advisors. Terroir knowledge also plays a role.	Consults others (relies on experienced neighbours). Uses his vast business experience (formerly businessman)	Uses accumulated experience. Relies on advice from colleagues. Consults buyers to get market information. Need for quality products.	Experience. Consider history. Financial and risk assessment.	Consider profitability. Market trends analysis. Consulting consultants. Need to produce quality products Accumulated experience. Financial and risk assessment. Consults fellow neighbours
3. What information is required to support the identified categories in decision making?	Information on market trends from buyers (wine makers) to determine what varieties to plant.	Needs information which helps him make decisions which have financial value in it.	Consults his workers when recruiting. Relies on external advisors for information to ascertain market requirements and financial planning.	Need technology to help in scientific assessment of soil. Useful advice from consultants. Advice from experienced fellow neighbouring farmers. Technical information from consultants – on chemical application etc. "Whole network coming together, network of expertise to gather information and resources is important".	Information on market trends and analysis.	Weather data, information on industry statistics and performance. Information on what's on demand on the market, the type of wine on demand.	Information on market trends analysis. Weather data. Industry statistics. Information which helps him make decisions with financial value in it. Consultants' advice. Information on scientific assessment of soil. Combination of information from various ICTs.
4. What technologies are suitable to support farmers in decision	Cell phones. Computers (integrated computerised system). The internet.	Cell phones, computer, internet, etc. Thinks the technology he has is adequate to support him in decision making.	It's a combination of all – cell phones, internet, computers, GPS etc. "When cell phones and internet are dead, I am out of	Desperately need cell phone coverage. Applications to help fertiliser application need to be made available.	Need for cell phone coverage. Pesticides application programs. Technologies which improves his	Cell phone, email, computer, software, computerised irrigation	

making?			my mind". It cripples his business. Stressed the important of cell phones' mobility and convenience.		interaction with marketers.		
5. What are the farmers' requirements for ICTs to support decision making?	Need to be able to provide them with quick access to the relevant information they need. Should be able to always keep them in touch with buyers, consultants, and service providers. Provide them with information on market trends.	Integrated computer system, internet, and satellite television.	The ICTs should be able to link him up with suppliers and other stakeholders whenever there is need no matter where the farmer is on the farm.	Need ICTs which promotes convenience in his business e.g. cell phones "can take pictures with cell phone and email consultant to make him better understand the problem".	Mobile – it's convenient. Technologies supporting their operation like fertiliser application programs etc.	Need to be reliable and accurate. Mobility also	Quick access t information. Integrated system. Should be able to link up with stakeholder anytime regardless of location. Mobile because of its convenience.

4.3.1 Decisions farmers make

Sub Research Question 1.1 What type of decisions do the farmers make?

All of the established farmers interviewed are responsible for the overall farming decisions. They are in charge of (i) strategic, (ii) tactical and (iii) operational decisions on the farm, from establishing new vineyards to harvesting and selling their products. Strategic decisions are decisions farmers make for long term sustainability and profitability. As vines have a lifespan of 25 years or more, and are an expensive capital investment, the choice of the variety of grapes are critical as these choices cannot be reversed at will. Tactical decisions are mid-term decisions normally a time line of a season. Operational decisions are short-term day to day decisions a farmer regularly makes or assigns to workers.

The decisions the respondents make, fall under these three categories i.e. strategic, tactical and operational. Strategic decisions are for example the specific cultivar that needs to be planted. Many aspects need to be considered such as location, market needs, terroir, climate, soil, trellising, irrigation and many more. These decisions will last for at least 25 years and making poor uniformed decisions will result in failure. Tactical decisions are seasonal bound and include decisions such as time of harvesting, labour, fertilisation, pest control and summer as well as winter pruning. The decisions effects the quality of the grapes and poor decisions will lead to poor quality resulting in poor prices for the farmer. Operational decisions are those made on a daily basis and dependence on many aspects such as infestations in the vineyard, time to harvest, when to prune, and spray and availability of labour for the specific day. These are decisions on labour management, production (including planting, soil preparation), financial planning, and marketing decision as well as day to day operational decisions as shown in Table 4.2. The interviewees are very much aware of the importance of their decisions, especially on how in impacts the farm production, labour, financial planning and sustainability. Throughout the interviews the farmers emphasised the importance of quality information to make these decisions.

Table 4.2: Table showing the type of decisions farmers make

Types of decisions farmers make	Percentage of respondents
Labour management	100
Marketing	100
Financial planning	100
Production	100
Operational	100

Finding 1: Farmers know the importance of strategic, tactical and operational decisions to be a successful farmer.

4.3.1.1 Labour management

These are decisions on management of workers such as recruiting, shift allocation, leave scheduling as well as wages. Some farmers practise co-decision making where they consult their workers when making decisions for example when recruiting, where a senior employee

will take the responsibility to manage the recruitment process of workers. Farmers also do human resource planning with their employees and supply them with homes infrastructure and take care of the children by providing schooling opportunities. All the interviewees mentioned the dependency and close relationship between the farmer and the labourers.

Finding 2: The relationship between farmer and farm workers is important.

4.3.1.2 Marketing

Although marketing is not always seen as a farming activity, wine farmers are very much aware of the importance of marketing. The high capital outlay per hectare vineyards forces the famers to consider all information especially in terms of market needs before making planting decisions. Farmers follow market trends by analysing available data as well as consulting their buyers in order to make informed decision when deciding what to do with their products. They will a take into consideration market trends when deciding which cultivars, varieties and quantities they need plant. This assists them to make better decisions especially in the complex wine industry where producing unmarketable products are costly.

Finding 3: Farmers need quality information to make marketing decisions for local as well as international markets.

4.3.1.3 Financial planning

Farmers do financial planning and analysis to ensure that they do not operate at a loss or engage in projects with no financial value in the long term. Financial analysis includes profit and loss statements, balance sheets, cash flows, debtors as well creditors control and banking requirements. Internet or mobile banking is important as it reduces the risk of cash handling on pay days.

Finding 4: Financial decisions are based on information gained from different sources including banks and accountants.

Finding 5: Internet and mobile banking is important tools for farmers.

4.3.1.4 Production

Day to day decision making is an important part of the farmers' daily existence. In many cases experience is the only "information" available to the farmer. It is the unpredictable part of the farmers' day to day decision making. Some days pest control decisions need to be made where bugs intestate a vineyard overnight harming the crop. Many farmers will react instinctively and will start a spraying program. Other farmers will first collect samples and gather information from consultants before commencing spraying. Time to make decisions can be limited and ICT can play an important role in reducing the time risk for farmers.

Finding 6: ICT reduces the time of decision making by farmers.

4.3.2 How farmers make their decisions

Sub research question: How do farmers make their decisions?

Before making decisions, farmers consider certain aspects of their business or make certain consultations. From the interviews it is evident that farmers consider profitability, market trends and analysis, history, financial and risk assessment and the need to produce quality products as priorities when making decisions. One farmer actually mentioned that "profitability, market trends, need for quality products and financial and risk assessment are crucial in decision making." They also consider advice from external consultants and fellow neighbouring farmers as well as their accumulated experience when making important decisions. Some farmers are strict in following the above mentioned criterion while a few are more flexible and not very systematic.

Figure 4.7 shows the important considerations when farmers make decisions. Profitability, market analysis and consultants advice is the most important considerations before making decisions.

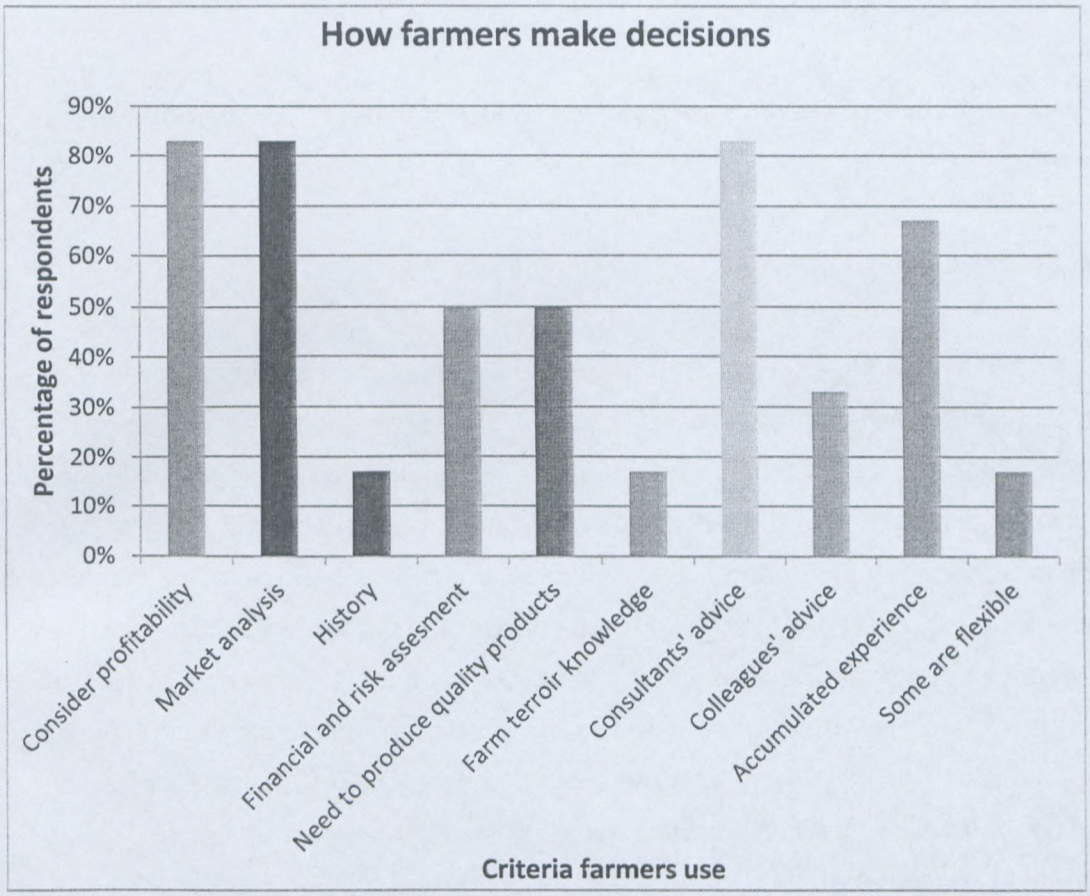

Figure 4.7: Graphical representation of how farmers make decisions in their operations

Finding 7: Farmers make use of information from a variety of sources including consultants, vendors, own experience, neighbours experience, websites, journals, magazines and many more, on many aspects of the farming enterprise.

4.3.2.1 Profitability

As discussed in section 4.3.1, farmers do financial planning to ensure their businesses yield some financial value. The majority of the farmers mentioned that they do not just farm for the sake of farming, but seriously consider profitability as shown on Fig 4.7. The farmers evaluate how much they will gain from the yields against their expenses to determine profitable. This is very crucial and necessary for the farmer's business since the farmer will be in a better position to decide which cultivar will be more profitable or how many hectares does he need to plant. Book and record keeping is therefore important so that the farmer can

consider all the data before making an informed decision. All the interviewees have some form of book and record keeping using computers and software such as Microsoft Excel or Pastel assisting in decision making process.

Finding 8: Book and record keeping is used as a tool for decision making on all aspects of farming.

4.3.2.2 Market analysis and trends

In addition to profitability, market analysis and trends are also important for decision making. More than two-thirds of the farmers interviewed (Figure 4.8) analyse the market to determine where, and when to sell in order to achieve best prices. The same information is needed for long term decisions such cultivar and variety choices. Some farmers liaise with their buyers (wine makers) to ascertain which wines are selling fast and which ones have lost the attention of wine lovers. Such information is of great value to the farmer since it can save or cost him vast amounts of money. Besides liaising with their customers, farmers also rely on industry statistics for information on market trends. Organisations such as South African Wine Industry Statistics (www.sawis.co.za) are one source of market information for the farmers. Reading and following wine industry news is another way farmers can obtain information on what is on demand on the market as well.

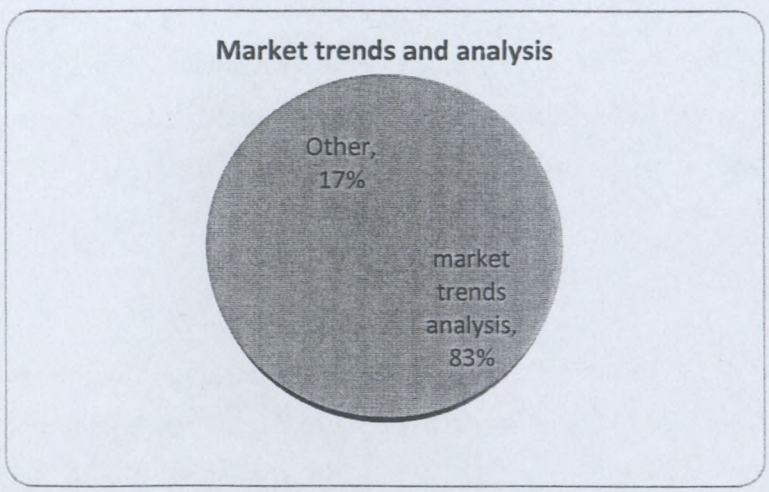

Figure 4.8: The reliance on market trends and analysis

Finding 9: Farmers use several sources of information such as industry information

on market trends to make long term decisions.

4.3.2.3 Advice from external consultants and fellow neighbours

Consulting is another source of information to assist farmers in the decision making process. There are consultants from private companies, universities and from the government's Department of Agriculture. The suppliers of agricultural products also have consultants who assist farmers on how best they can use their products and buyers who advise farmers on the quality and quantity of products they require. These people provide their knowledge and expertise to the farmers which immensely help them in their decision making for example on how best to deal with an uncommon type of pests affecting their vineyards.

The interviewees mentioned that they rely on advice from fellow neighbouring farmers with experience and knowledge of the area. The knowledge within the neighbour community especially where neighbours are well known to each other for years is shared freely. New entrants to the industry sometimes do not see this for what it is worth and tend to ignore the neighbourly advice.

Finding 10: Quality produce is important in the decision making process.

4.3.2.4 Producing quality products

The demand for quality products also affects how farmers make decisions as the respondents indicated in Table 4.1. Farmers are concerned with each and every detail to make sure quality products are produced since failure to do so will result in financial losses to the business. This striving towards high quality products also shows in the decision making process. The interviewees all expressed the importance of quality data in order for them to make quality decisions.

Finding 11: Farmers use experience of neighbours and consultants when making decisions.

4.3.2.5 Accumulated experience

The interviewees reiterated that experience also plays a part in how they handle their

decision making. Two-thirds mentioned that their accumulated experience is of value when making decisions. Inexperienced farmer will rely on advice from consultants and also use the neighbouring farmers for advice as indicated in 4.3.2.3. However, one of the most experienced farmers interviewed stated that even though he possess vast amounts of experience in the business he believes in a second opinion and believes consulting is always necessary to accompany the experience. This is worth noting since all the other respondents never mentioned that they solely rely on their own experience.

4.3.2.6 Financial and risk assessment

Assessing the risk is one of the tasks farmers are faced with in the midst of the farm decision making process. Some projects are risky and farmers need to make detailed financial and risk assessment in order to reach an informed decision on whether to engage the project or not. Some projects might have huge financial gain but are high in risks and here farmers need to do detailed risk assessment in order to reach a decision. Once again when making these high risk decisions farmers will use all the expertise they can get before deciding what to do.

Finding 12: Risk assessment is done before making decisions.

4.3.2.7 Farm terroir knowledge

Terroir knowledge is important in decision making. If a farmer is knowledgeable about his farm's terroir, it will assist the farmer when making decisions in terms of what to plant where and when. The farmer can also make better irrigation decisions, fertiliser and chemical application as well as decisions on some crops which need a good knowledge of the farm terroir. Three of the six farmers interviewed placed a high premium on terroir knowledge in the decision making process.

Finding 13: Terroir knowledge is used in the decision making process.

4.3.2.8 History

Knowledge of the past can be crucial in decision making as mentioned by one farmer. History of the farm performance and activities can be useful in aiding a farmer make farm decisions.

For example, if a field has a history of high disease susceptibility it will not be wise to plant a variety easily affected by diseases even though chemical and expertise might be available, in the same way; it will also be unwise to plant a variety that does not do well in wet areas in a field known to have a history of water logging.

Finding 14: Farmers use the history of the farming operations to assist in the decision process.

4.3.3 Information farmers require in supporting the various categories in decision making

Sub research question: What information is required to support the identified categories in decision making?

When asked what type of information they need in decision making, the respondents indicated that for them to be able to make various decisions in their business they require certain types of information. This information helps the farmer to be better equipped for the decisions he needs to make or deal with a situation requiring informed decision making. The information required (Figure 4.9) ranges from weather data, advice from consultants, information on market trends and analysis, financial information, workers' opinion, advice from experienced fellow neighbouring farmers, information on the scientific assessment of soil, information on industry statistics and performance as well as technical information from consultants. Although information on weather is expected it was surprising to note the high demand on market trends.

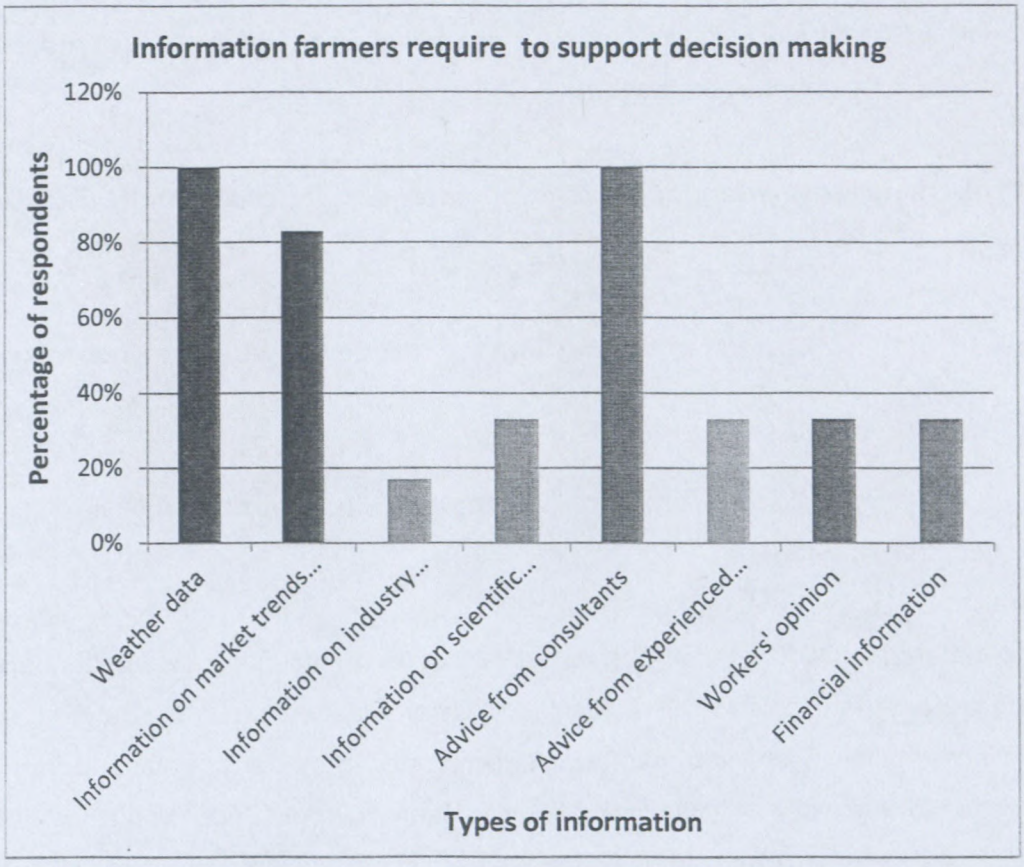

Figure 4.9: Information farmers require supporting their decision making

Finding 15: Farmers need information on weather data, advice from consultants, information on market trends and analysis, financial information, workers' opinion, advice from experienced fellow neighbouring farmers, information on the scientific assessment of soil, information on industry statistics and performance as well as technical information.

4.3.3.1 Weather data

It comes as no surprise that all the farmers interviewed indicate that they require information on weather patterns for their area in order to make better decisions in their operations. Weather data helps them plan their planting and/or harvesting operations. It also warns them to prepare for adverse weather conditions; they can make measures to avoid damage to their crops for example in case of frost or high temperatures. The majority of the farmers indicated that they use the internet to obtain weather information. They use websites such as www.yr.no, a Norwegian weather site to gather weather data for their area. A few also mentioned that they rely on television and radio for weather information. South African

Broadcasting Corporation's (SABC) channel SABC 2 was also referred to as a source for weather data by few farmers as well as DSTv's Kyknet.

The reason why www.yr.no is the most preferred source by the recipients is because it provides detailed weather information as compared to local weather sites and stations. Figures 4.10 through to 4.14 are screenshots from the website.

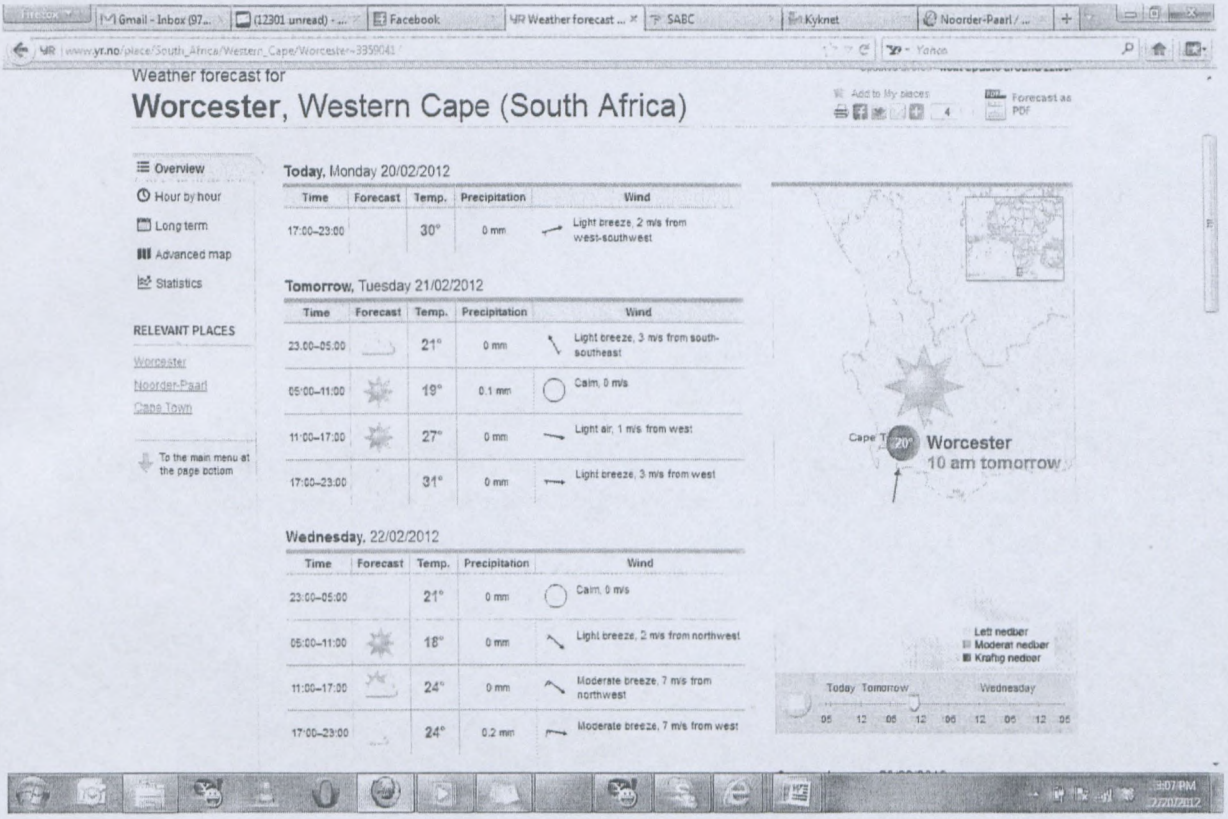

Figure 4.10: Weather forecast for Worcester

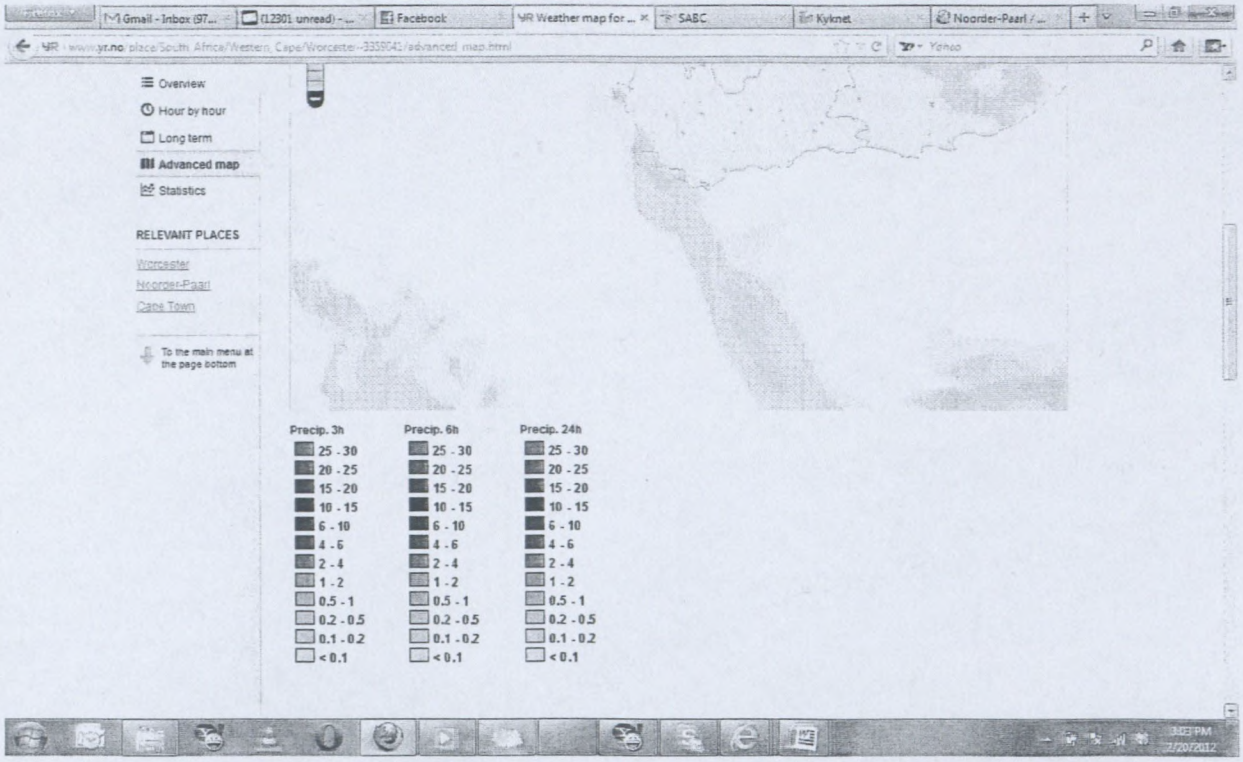

Figure 4.11: Weather map for Worcester – advanced map showing precipitation

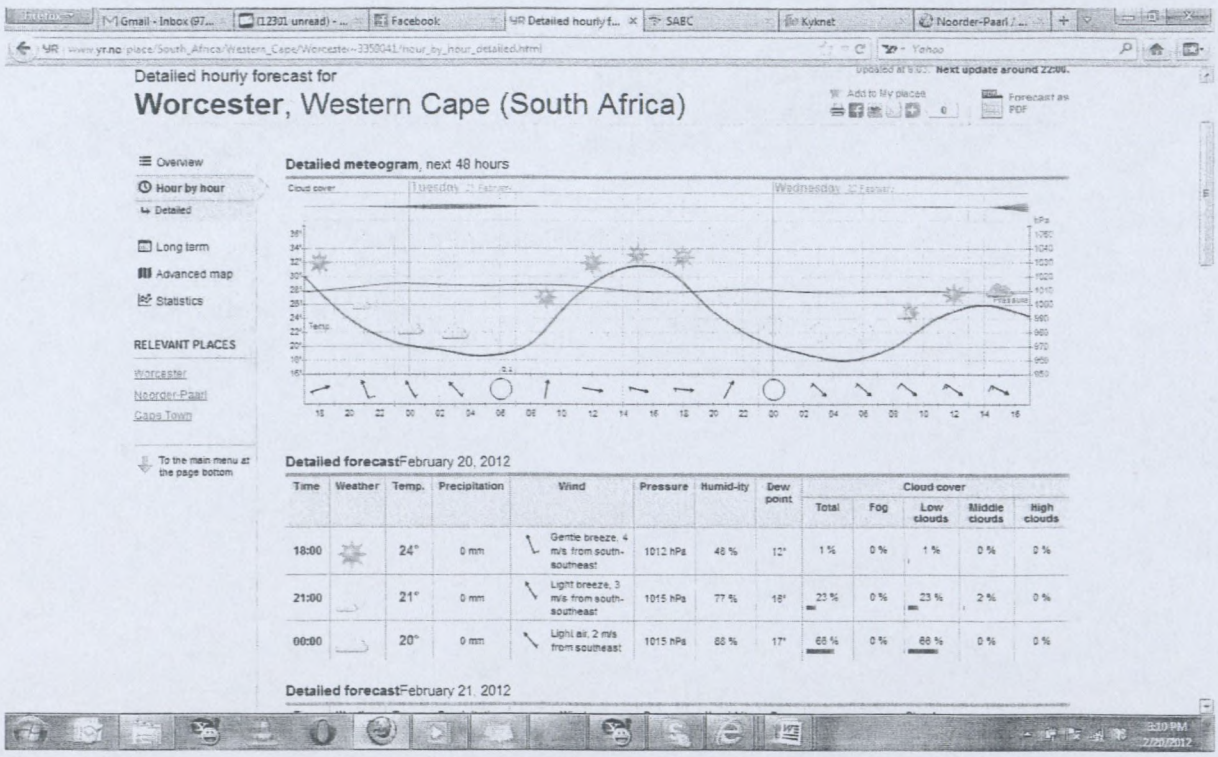

Figure 4.12: Weather forecast for Worcester – detailed hourly forecast

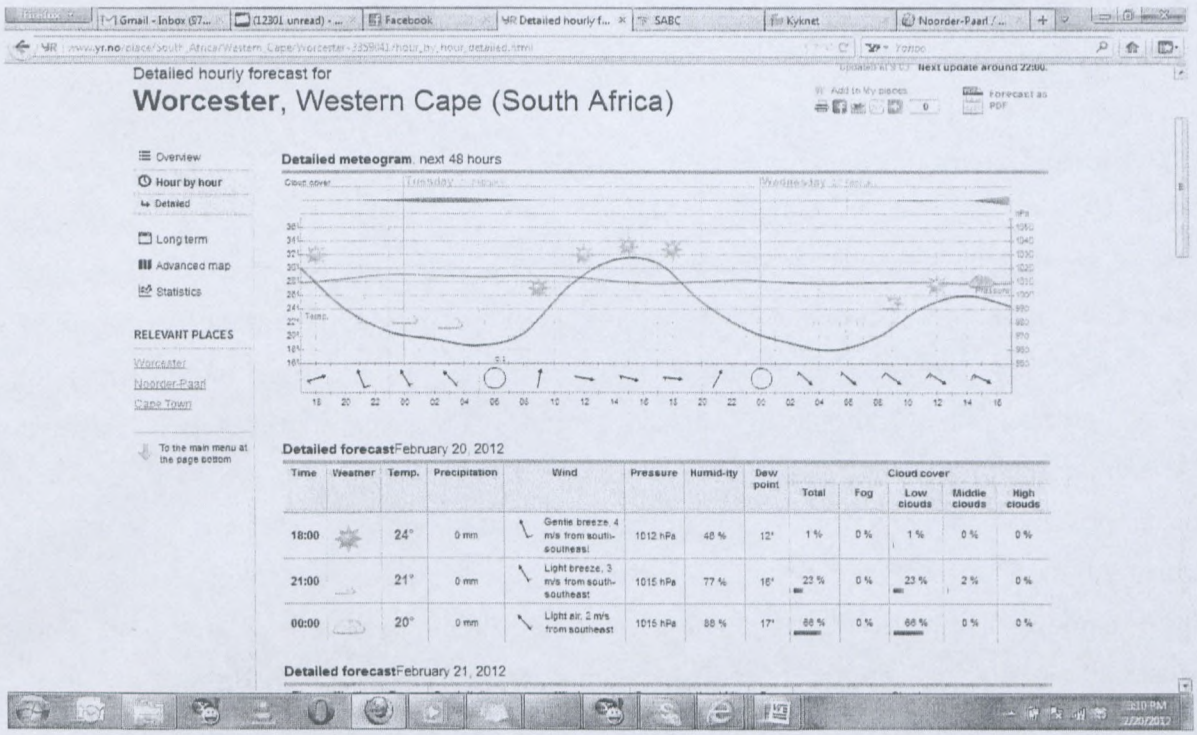

Figure 4.13: Weather forecast for Worcester – long term forecasts

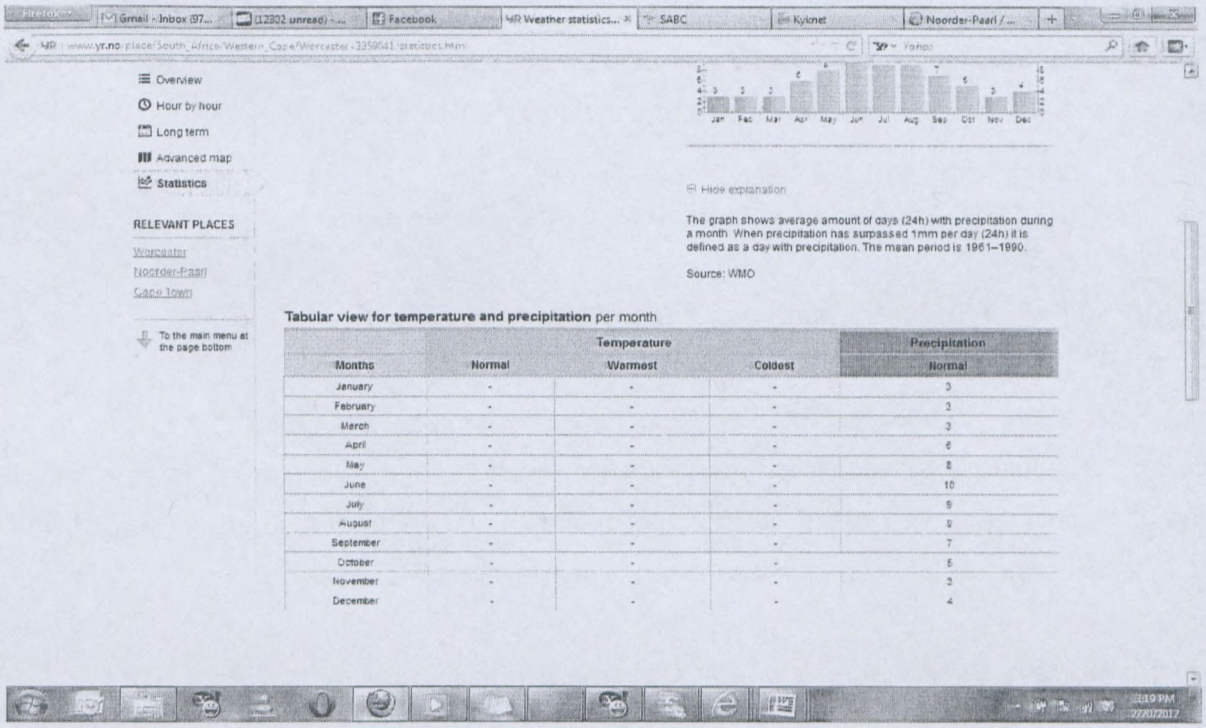

Figure 4.14: Weather forecast for Worcester – weather statistics

Finding 16: Weather information is one of the highest priorities for farmers in order to make decisions.

4.3.3.2 Information on market trends and analysis

This is of strategic importance for farmers since it gives them an idea of what the market demands are. If farmers know what their markets need are, they can make better decisions in terms of fulfilling the needs their market, hence avoiding losses caused by the supply of unwanted products or oversupplying a certain product. The farmers interviewed, indicated that it is important for them to have access to such information when needed.

They can get the information on market trends and analysis from their buyers, consultants and/or internet. The buyers or consultants study trends in the consumption of wines and analyse the data to compile information on the varieties on demand, those with low demand, varieties with increasing demand or varieties with decreasing demand. Wine makers, since they are the major wine suppliers to the wine markets play an important role in data supply to farmers. There are also private consultants from institutions specialising in the wine industry who provide farmers with such information. The South African Wine Industry Statistics (SAWIS) whose sole mandate is to provide statistics on the wine industry in South Africa is also another source. However, only one-sixth of the respondents mentioned that they rely on SAWIS. This was a surprising finding and needs more research to understand the reasons for the apathy of interviewed farmers towards the SAWIS.

Finding 17: Market trend information is used for strategic decisions.

4.3.3.3 Information on industry statistics and performance

Besides information on the market, the respondents also indicated that they rely on information on industry's statistics and performance. Statistics for example such as total hectares of a cultivar and the yield per hectare or the overall performance of the industry season by season can be of great assistance to the farmer's decision making.

Finding 18: Industry information is used for strategic and tactical decisions.

4.3.3.4 Information on the scientific assessment of soil

One of the respondents indicated that information on the scientific details of the soil on his

farm is valuable in supporting decision making. He mentioned scientific assessment of soil using advanced technologies as a better way to provide crucial information for decision making. The other interviewees also mentioned the importance of soil preparation but did not use advance technologies such as chemical or infrared analysis of the soil.

Finding 19: Scientific soil analysis are used for soil preparation, planting and fertilisation decisions.

4.3.3.5 The role of consultants in the information cycle

Finding 20: Consultants are widely used by farmers when making decisions. This came out as an important source of information for the farmers. The consultants strive to provide farmers with crucial and up to date data and information.

Information from external consultants came out as an important source of information from the respondents. As shown on Table 4.1, farmers rely on external consultants for advice in most of their operations. They get advice on planting information, spraying, fertiliser application, weeding, harvesting and many more aspects in their farming operations. In addition they also acquire advice on financial planning, marketing and overall analysis of their businesses.

The information that can be in form of financial statements, statistics on their performance or instructions on chemical application are being used by farmers in the decision making process. Suppliers also provide consultants who work with farmers and advise them on how best they can use their products. This is valuable for the farmers since lack of such information can result in losses for their business. A farmer needs to know how he is performing in order to take necessary measures to avoid losses and identify the specific areas he needs to focus on.

The consultants, as one of them mentioned, also enter into partnership with other stakeholders to try and find effective ways to assist farmers and provide them with up to date information to assist them in making informed decisions as mentioned by one consultant.

Technical information which farmers receive from consultants also emerged as another source of information to support farmers' decision making. If farmers understand the technical specifications/characteristics of their farm such as drainage, soil composition, chemical composition of their pesticides and fertilisers; it will improve their decision making. If farmers understand their farm soil's structure and chemical composition it helps them decide on which varieties to select for specific soils available to them. Information on the chemical composition of the pesticides, herbicide and fertiliser used during the season is

important to farmers as the international markets are becoming more and more "green" and the agricultural industry needs to cognisance of this phenomenon.

4.3.3.6 The role of experienced neighbouring farmers

Two of the respondents indicated that they strongly "believe in the opinion of others when making decisions" (Appendix F). One farmer stated that he does not have much experience in the industry; he bought his farm a few years ago, and therefore he consults his fellow neighbours when making decisions. This is very important and cost effective since the neighbours have been in the business for a long time and will give him better advice than a consultant without much experience in the area.

Another more experienced farmer who has been in the business for thirty seven years reiterated that he always believes in a second opinion before making a decision. In cases where he cannot reach consultants he "relies on the opinion of fellow farmers before reaching a decision in his operations" (Appendix F).

Farmers have different sources of information and their experience and knowledge varies. Consulting each other gives a platform to share that knowledge and experience with one another and this result in a support group assisting each other in decision making.

Finding 21: Experienced neighbours are often consulted and used by farmers when making decisions.

4.3.3.7 The role of the workers' opinion

Some of the respondents stated that they "regard their workers' opinion as an important source of information in certain decisions they make" (Appendix F). For example when recruiting, it is best to listen to the workers who know the qualities a suitable candidate need to meet for the job at hand The workers are also full time in the vineyards seeing possible problem areas that will then be reported to the farmer.

Finding 22: Farmers consult farm workers in their decision making process

4.3.3.8 Financial information

It is valuable for the farmer to know that he or she is operating at a profit in his business hence the need for financial information. Financial information indicates how profitable the farmer is and assists them decide as to whether they should continue operating that way of a

major or slight adjustments is needed to improve their profitability. If a certain cultivar is for example, no longer profitable a farmer can decide to reduce the hectares under that specific cultivar. Financial information on labour, equipment, harvesting, operational costs, capital investment is needed to be successful. The role of the bank in providing on demand information has also been emphasised by all the farmers (Appendix F).

Finding 23: On demand financial information is needed for farmers to make decisions

4.3.3.9 Summary of findings on ICT use by farmers

One interviewee made the comment that "whole network comes together, this network of expertise to gather information and resources is important" (Appendix F). It is not about one individual or group of expertise that is important when it comes to providing useful information to farmers but the whole support network available to the farmer.

4.3.4 The technologies suitable to support farmers in decision making

Sub research question: What technologies are suitable to support farmers in decision making?

The interviewees indicated that they use several technologies in their business to support decision making. These technologies consist (Table 4.3) of cell phones, computers, internet, integrated computerised systems, global positioning systems (GPS), email, software, computerised irrigation, pesticide application programs, televisions, land line phones, and radios.

Table 4.3: The technologies used by the interviewees

Which technologies are suitable to support your decision making?	Responses
Cell phones	100%
Computers	100%
Internet	100%
Integrated computerised systems	50%
GPS and GIS	33%
Email	100%
Software packages	67%
Computerised irrigation	67%
Pesticide application programs	67%
Television	33%
Land line phones	100%

Finding 24: ICT is widely used by the farmers – as shown on the graph several ICTs are used by farmers to support decision making. Cell phones, computers, internet, email and land line phones are the most suitable in aiding decision making.

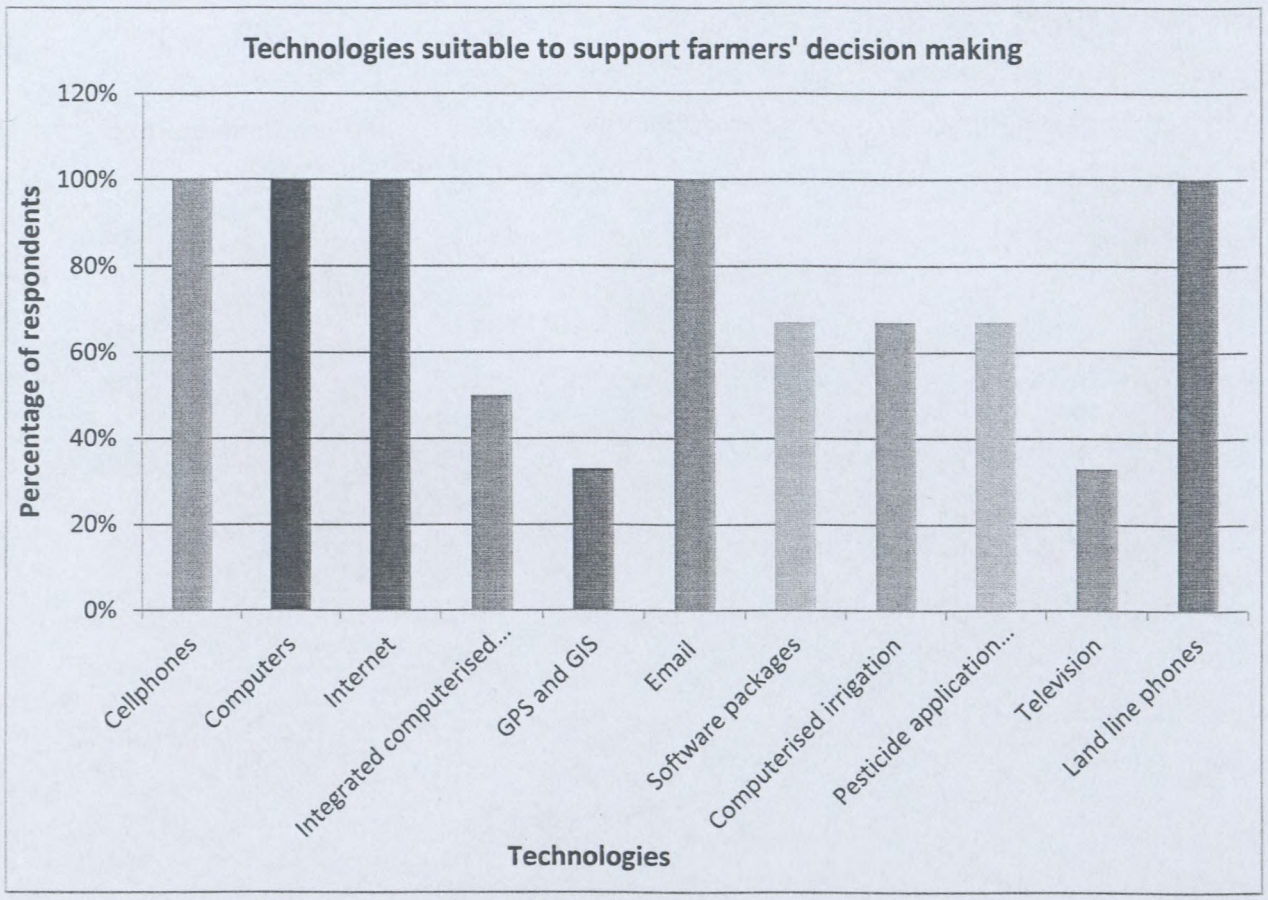

Figure 4.15 Graphical representation of the technologies suitable to support farmers in decision making

4.3.4.1 Cell phones

Cell phones because of the mobility and convenience emerged as one of the technology the interviewees regard as more suitable in support of decision making. With a cell phone the farmer is able to communicate and get in touch with anyone in the world. They can be in touch with their workers and other stakeholders anywhere. The farmers mentioned that use of cell phones helps them get prompt support from consultants and other stakeholders. For example, while in the field capture an image of whatever problem and either email or send the picture via Multimedia Messaging Service (MMS) to a consultant who can then promptly respond to the farmers' request. The farmer would have got the information he needs to make a decision quickly without wasting time go to a land line phone and attempt to describe or fax the issue at hand.

However, all the interviewees mentioned that they do not have or at least have very limited cell phone coverage on their farms and can only receive the signals as they move to pockets of reception in nearby areas. This is attributed to location of their farms which are in valley with low lying land and the infrastructure inadequate for quality access to mobile coverage. The interviewees indicated that this is a great disadvantage since they all stated that they "are desperately in need of cell phone coverage to assist them in much need connectivity to the role players and stakeholders in the industry" (Appendix F).

Finding 25: Cell phones are generally used by farmers but coverage and connectivity is a problem and causes inefficacies in the decision making process

4.3.4.2 Computers

All the farmers that have been interviewed have computers and agreed that it's one of the best technologies to assist farmers in decision making (Appendix F). Computers are desktop and laptop computers. Computers support many other technologies which the farmers also use to aid their decision making. It is the most common technology used by the interviewees as it allows for multifunctional applications such as banking, weather reports, market prices, pest control, record keeping, automated irrigation and fertilisation practices and many other applications.

Computers are also used for financial planning through applications for financial planning such as spreadsheets and Pastel. Many software products are available to assist farmers for example Microsoft Word, Microsoft Excel, Pastel, Microsoft Outlook, Boeredata, ABSI and Scan connect. Human resources applications are also used to help farmers with payroll management.

Finding 26: Computers and software such as the Microsoft suite is used by farmers

Finding 27: The farmer spouse is the main user of computer technology followed by the youngsters in the family.

Some of the technologies and applications used are discussed in the following sub sections.

4.3.4.3 Internet

Internet was mentioned by all the interviewees. It seems to be a most suitable technology for decision support. This technology has gained popularity over the past few years especially amongst farmers. Accessibility and affordability of the technology as well as the emergence of a local Internet Service Provider (ISP) are the major drivers behind the increasing use of the internet. Breede Net who is the local ISP was credited for providing reliable internet access to the specific community in the Breede River, Western Cape, South Africa.
Internet opens avenues for farmers and they can explore and have access to websites, providing them with useful information to support their decision making. The internet enables the respondents to access emails as well as weather data as seen above. The interviewees indicated that they check weather on the internet, with www.yr.no being the most common source of weather data (Appendix F). Websites such as www.fruitlook.co.za which provides farmers with detailed information about their farms ground moisture, and minerals content of the soil, is an example of how the internet as technology is used to support farmers in the decision making.
With increasing internet bandwidth and the wider distribution of internet services, internet will become the most powerful technology supporting farmers in decision making.

Finding 28: Internet services are gaining ground as a supporting tool for decision making by the farmer.

4.3.4.4 Integrated systems

This is a result of a number of technologies coming together to support certain farm operations. Computerised systems and made possible by computers and are greatly beneficial as decision support tools for farmers. An integrated irrigation system for example makes the water management decisions lower in risk and easier to do.

Finding 29: There is a lack of integrated systems in use on the farms such as Enterprise Resource Planning systems (ERP)

4.3.4.5 Global positioning systems (GPS) and Geographic Information System (GIS)

The GPS is a technology providing useful information for farmers in supporting their decision making. It provides satellite images of the farm showing geographical information which can be analysed with the help of GIS to assist farmers to make better decisions. They can analyse their soil or terrain and derive information on what varieties grow best on such terrain or soil. This is cost effective since it can save the farmer from losses due to capacity lost by growing a variety in soil that is not suitable for the specific terroir. It can also reduce concentration of chemical used when the correct cultivar is grown on the desired land.
However, the technology is expensive and the interviewees do not have the equipment and therefore relies on specialised consultants for GPS services. GPS and GIS technology is an important technology to gain a deeper understanding of the ecology of the farm and consequently resulting in better decisions. The figures 4.16 through to 4.18 show the maps produced by the GIS/GPS specialist.

Finding 30: GPS and GIS technology is under utilised by farmers in their decision making processes

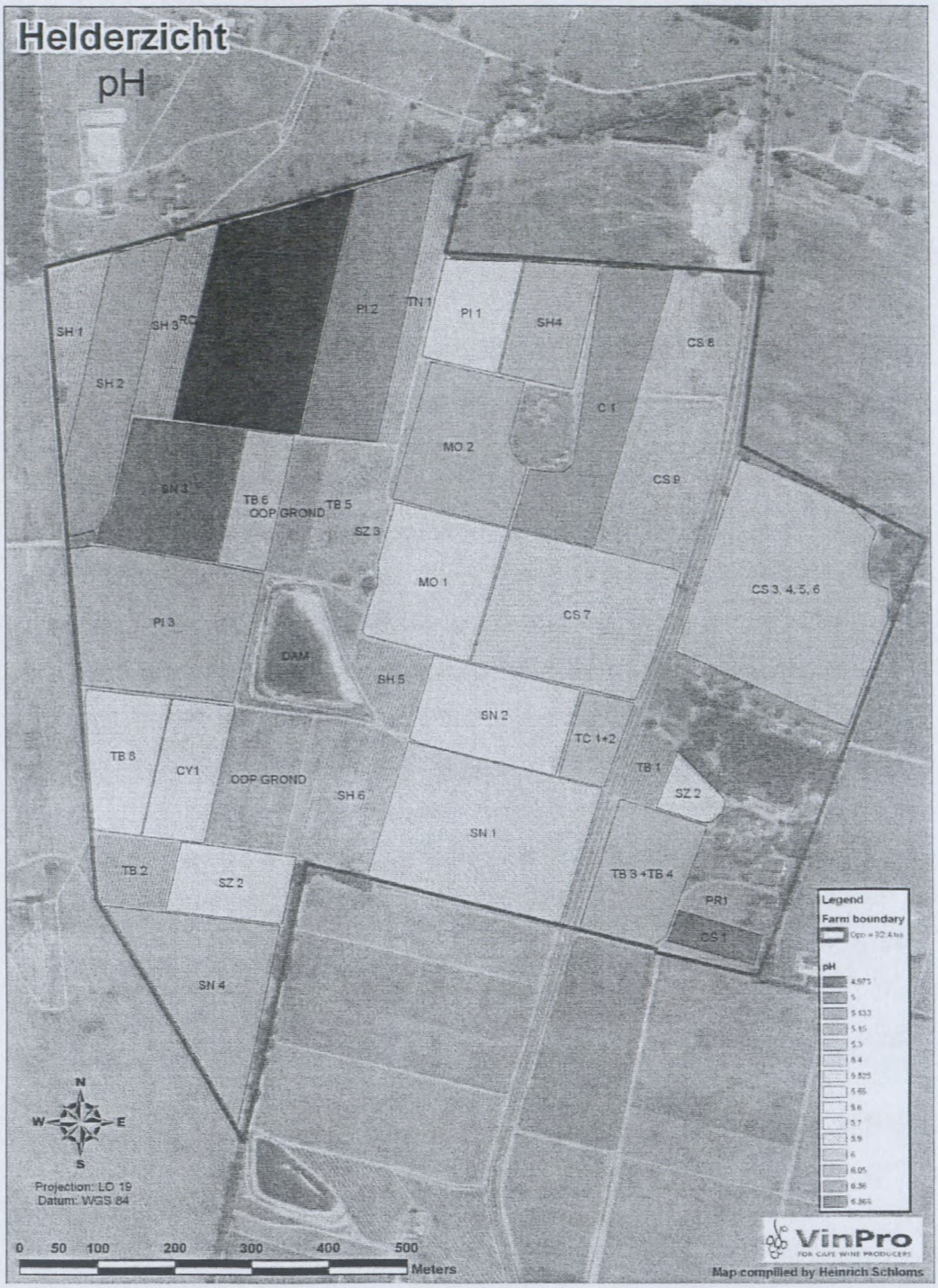

Figure 4.16: Map showing soil pH (measurement of acidity/alkanity) – (courtesy of Heinrich Schloms, Vinpro, 2011)

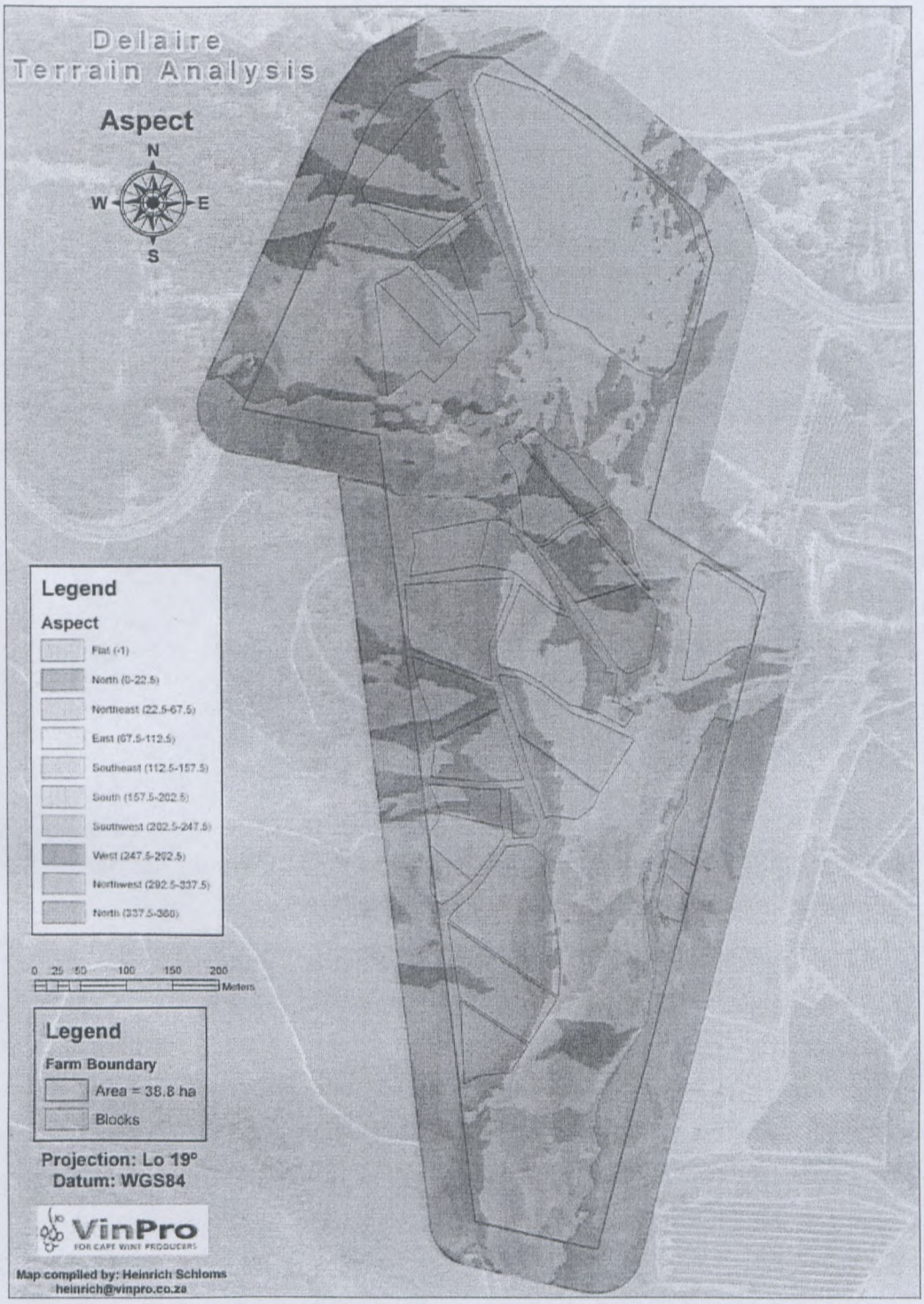

Figure 4.17: Map showing the Terrain analysis for a farming area – (courtesy of Heinrich Schloms – Vinpro, 2011)

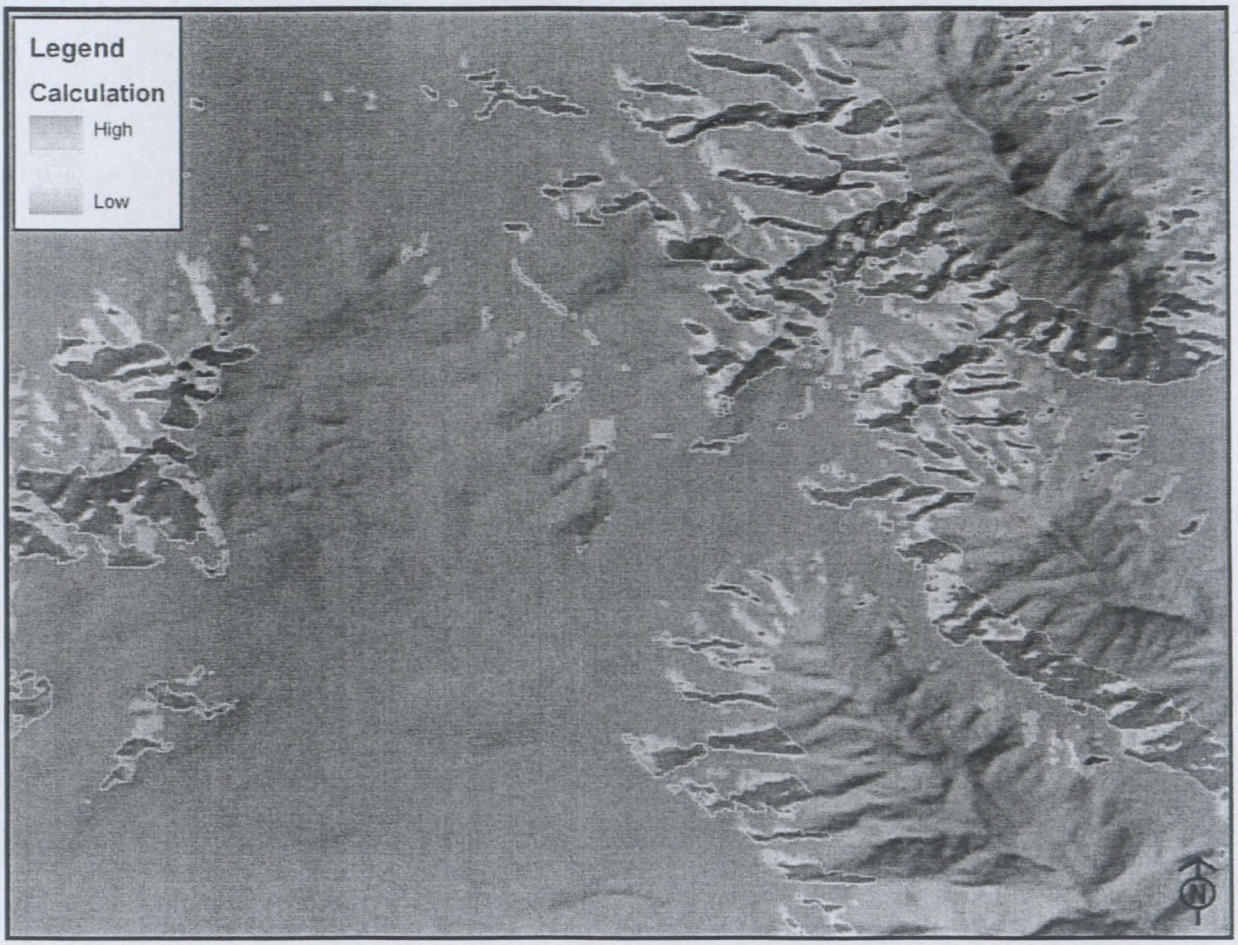

Figure 4.18: Map showing potential sites for Sauvignon blanc using multi-variable spatial modeling (courtesy of Heinrich Schloms – Vinpro, 2011)

4.3.4.6 Email

Email is a technology that the interviewed farmers use. They use emails to communicate with their customers, suppliers as well as consultants. Email is cheaper than land line phones and cell phones and also enables sending and receiving of different types of documents and files. Farmers and other stakeholders send each other documents on email which can be inputs to farmers' decision making. Instead of driving hundreds of kilometres to deliver a manual or instructions to farmers, a consultant can just email it to farmers who can download the document and use it on the farm. This speeds up their decision making and keeps them closer to other stakeholders even though they can be in Europe or any part of the world.

Finding 31: Emails are used by farmers and reduces the decision making time cycle

4.3.4.7 Software

General software packages as well as farm specific software are used by farmers and were found to be suitable decision support tools (Appendix F). General applications such as Microsoft Office's Excel and Word are some of the software used by the interviewees. They use the software for example for financial planning and presenting financial statements. The farmers use the spreadsheets and financial statements to support the process of decision making.

The respondents also indicated that they use Pastel for payroll management. Farm specific software such as ABSI, Boeredata, Cape Scan and Donherhoel Data are also being used by the interviewees. Decision support packages such as FarmMS is also suitable in aiding farmers decision making. An interesting observation was made, in that in most of the interviews the farmers made a special comment that when it comes to the use of computers they ask their spouses or children to do the work for them. They will then take the results and interpret the data for decision making (Appendix F).

Finding 32: Farmers spouses or children use the software to create information for the farmer to use in making decisions

4.3.4.8 Computerised irrigation

Not all farmers have computerised irrigation but they indicated that it is suitable in supporting their decision making. An integrated irrigation system lessons decision making since the farmer can easily control the irrigation.

Finding 33: Computerised system such as computerised irrigation creates useful information for decision making

4.3.4.9 Pesticide application programs

An application designed to help farmers in pesticides application was suggested as one of the technologies suitable of assisting the farmers in decision making. It assists farmers to manage the whole spraying process including the quantities and measures required when spraying the vineyards.

Finding 34: Application programmes such as pesticide application program are useful in the decision making processes

4.3.4.10 Televisions

Televisions used to be a great source of information. Televisions' inability to provide area specific information maybe one of the reasons why they have low preference when it comes to decision support. Weather reports on TV cover large areas of a country providing shallow data to the farmers. Television is used for program specific topics where farming issues are discussed in agriculture programmes.

Finding 35: Television weather reports are not very useful technology tool for information gathering by farmers as compared to website which are more precise and area specific

4.3.4.11 Land line phones

Landlines proved to be a common technology used for communication by the respondents. This is mainly because of lack or unsuitable cell phone connectivity. It is very difficult to communicate if the land lines are down and farmers may struggle with decision making in such a situation because they will have no access to consultants, fellow neighbours or buyers to provide them with their information needs.
However, with increasing use of cell phones, use of land line phones might not be very common in the next decade or so.

Finding 36: Landlines are old technology but still in use because of the poor net work coverage of mobile service providers

4.3.5 The farmers' requirements for ICTs to support decision making.

The interviewees mentioned some requirements ICTs need to meet to be able to effectively support their decision making.
The respondents indicate that the ICTs, in order to effectively support their decision making need to be able to provide them with quick access to relevant information. The ICTs should be able to always keep them in touch with their buyers, consultants and other service providers.

The respondents also pointed out the need for ICTs to assist them to access information and data on market trends and analysis (Appendix F). As mentioned earlier on, market information is an important input to farmers' decision making.

The need for integrated ICT system calls for ICTs capable of interacting and working together with each other. Computer technology allows a farmer to link and integrate his operations such as irrigation, pest and herbicides control and many other applications.

In addition to being able to quickly provide the information or communication a farmer needs, the respondents also requested that the ICTs should be able to link the farmer with suppliers and other stakeholders whenever there is need. This should be possible regardless of where the farmer is operating from. The ability to capture an image or video, email it to a consultant for advice, is a useful way to improve farmers' decision making and overall business (Appendix F).

The use of technologies in supporting farm operations is one of the requirements for ICTs supporting decision making. The farmers indicated that having application for operations such as fertiliser application will improve their ability to make quality decisions.

In addition to convenience, mobility and other requirements mentioned above "accuracy"; also came up as one of the requirements the ICTs should meet. It would not be helpful if an ICT is convenient and provides quick access to information which is however not accurate. The inaccurate information adversely affects the information the farmer gets and consequently affects his decision making something which can be costly for the business (Appendix F).

Finding 37: Farmers need reliable, accurate and timeous information from ICT to improve the quality of their decision making.

Finding 38: Quality Information

4.3.6 Summary – established farmers

From the interviewees themes developed. These themes are:

Agricultural domain knowledge
Family
Finance
ICT
Information resources
Labour
Marketing
Mobility
Quality information
Risk Management

- Agricultural domain knowledge: Information about agricultural domain knowledge is viewed as important as all the tactical and operational decisions are made based on the domain knowledge.
- Family: The dependency on family to assist with gathering information was mentioned by the farmers. Especially the use of ICT by the spouses and children were mentioned.
- Finance: The farmers manage their cash flow and budgets diligent. For this they depend on ICT to gain access to banks, budgets, creditors, debtors and auditors.
- ICT: The importance of ICT in strategic, tactical and operational decisions are emphasised by the responses of the interviewees. ICT plays an important role in communication, access to information and day to day to day management.
- Information resources: Multiple resources are used to find information for decision making. The internet, mobile phones, GPS and sophisticated soil humidity as well as infrared detection equipment is used. International markets as well as money trends are constantly monitored in order to make quality decisions. Experience and neighbours, vendors and consultants with local knowledge are often used as sources of information before decisions are made.
- Labour: labourers are seen as an integral part of the decision making process on the farms. They contribute towards strategic, tactical and operational decisions.
- Marketing: The farmers are very much aware of the markets they operate in and as such will make every attempt to gather information about the markets before making any decision.
- Mobility: Mobile phones are seen as away to communicate and to reduce the time to make a decision. Unfortunately the major networks have still not provided good quality coverage in the areas where the research was done.
- Quality information: farmers will go to great lengths to find quality information. They will spend time to achieve this as they realise that their decisions are depended on the quality of the information.
- Risk management: To manage risk farmers acknowledge that they are depended on quality information. They will consult widely and will take the smallest detail into consideration before making the decision.
- Strategy: As the industry is a long term industry, vineyards are utilised for 25 years with big capital investments up front, strategic decisions are important. In depth knowledge of terroir, cultivars, weather conditions, market trends and many more are

needed to be successful. Established farmers are aware of this and go to great lengths to make sure they have the correct information to make these strategic decisions.

Table 4.4 is a summary of the findings linked to the themes as discussed.

Table 4.4 Themes and findings

Theme	Findings
Agricultural domain knowledge	Terroir knowledge is used in the decision making process. Scientific soil analysis is used for soil preparation, planting and fertilisation decisions.
Family	Farmers' spouses or children use the software to create information for the farmer to use in making decisions.
Finance	Financial decisions are based on information gained from different sources including banks and accountants. Book and recordkeeping is used as a tool for decision making on all aspects of farming. On demand financial information is needed for farmers to make decisions.
ICT	ICT is widely used by the farmers. Computers and software such as the Microsoft suite is used by farmers. Internet services are gaining ground as a supporting tool for decision making by the farmer. There is a lack of integrated systems in use on the farms. GPS and GIS technology is under utilised by farmers in their decision making processes. Emails are used by farmers and reduces the decision making time cycle. Computerised system creates useful information for decision making. Application programmes are useful in the decision making processes. Landlines are old technology but still in use because of the poor net work coverage of mobile service providers.
Information resources	Farmers make use of information from a variety of sources including consultants, vendors; own experience, neighbours experience, websites, journals, magazines and many more, on many aspects of the farming enterprise. Farmers use several sources of information such as industry information on market trends to make long term decisions. To make decisions farmers make use of consultants and neighbours with experience and knowledge of the area. Farmers use experience of neighbours and consultants when making decisions Farmers use the history of the farming operation's to assist in the decision process. Farmers need information on weather data, advice from consultants, information on market trends and analysis, financial information, workers' opinion, advice from experienced fellow neighbouring farmers, information on the scientific assessment of soil, information on industry statistics and performance as well as technical information. Weather information is one of the highest priorities for farmers in order to make decisions. Industry information is used for strategic and tactical decisions. Consultants are widely used by farmers when making decisions. Experienced neighbours are often consulted and used by farmers when making decisions. Television weather reports are not very useful technology tool for information gathering by farmers as compared to website which are more precise and area

	specific. Farmers consult farm workers in their decision making process.
Labour	The involvement of farm workers when acquiring new employees are important.
Marketing	Market trend information is used for strategic decisions.
Mobility	Internet and mobile banking is important tools for farmers.
	Cell phones are generally used by farmers but coverage and connectivity is a problem and causes inefficacies in the decision making process.
Quality information	Farmers need quality information to make marketing decisions for local as well as international markets. Quality produce is important in the decision making process. Farmers need reliable, accurate and timeously information from ICT to improve the quality of their decision making.
Risk management	Risk assessment is done before making decisions.
Strategy	Farmers know the importance of strategic, tactical and operational decisions to be a successful farmer. Reduces the time of decision making by farmers.

4.4 Findings on the use of ICTs to support decision making – consultants

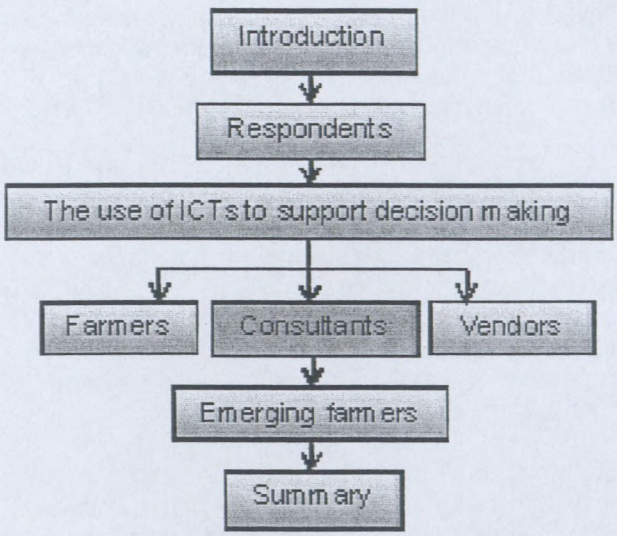

Fig 4.19 Chapter layout: Consultants

4.4.1 Technologies the farmers use to support their decision making

The consultants who work with farmers were interviewed and asked what technologies are being used by farmers to support their decision making (Table 4.5). These consists of computers, cell phones, GIS systems, DSS such as FarmMS, GPS systems, precision farming, internet, general software, industry specific software, email, scanners, weather projection systems as well as computerised irrigation systems.

Table 4.5: Findings on the use of ICTs to support decision making – consultants

Sub research question	Respondent A	Respondent B	Respondent C	Respondent D
1. What technologies are being used by the farmers to support decision making?	Computers Cell phones GIS systems Use Wine/Farm MS a production DSS GPS systems – Precision farming	Computers Cell phones Internet Donkerhoel data – financial planning. GPS for soil analysis – what to plant and where to plant. General packages like Microsoft, Pastel etc. Need to be technically competent to effectively use the software. FarmMS Moist detection systems.	Internet Cell phones Computers Email Scanners GIS GPS mapping Weather projection systems. Computerised irrigation systems.	Computers Internet Cell phones Financial packages
2. What are the farmers' requirements for ICTs to support decision making?	Technology which provides information about soil, climate, contours. - Weather station data, terroir analysis.	Computerised irrigation. Emails to communicate with external stakeholders. MS Excel for spreadsheets in financial planning. Convenience of email on mobile phones (**farmer can capture picture and immediately sent to consultant**). MS Excel for spreadsheets in financial planning.	Cell phones – for better communication. Internet – gives access to several resources – www.fruitlook.co.za	ICTs which give them access to research information on the internet. Access to updates – weekly or daily updates from consultants and vendors e.g. Winetech Scan. Websites
3. Is there slow	It's a bit slow but slowly	Not slow. They have basic	They are leading in terms of	Emerging farmers

uptake of decision support systems by emerging farmers?	they will pick up. With time they will learn and adopt more.	ICTs they need.	ICT adoption ion their operations. Older farmers are reluctant to adopt new technologies	are at a slower rate.
4. Why is there slow uptake of DSSs by emerging farmers?	Communication	More expensive for them.	**Farmers are not really keen on changing their way of operating.** There is a lot of word of mouth talk on adoption of technology. Farmers would be more willing if they see it working for colleagues who adopted the technologies.	Lack of knowledge on the benefits of adopting the DSS. Lack of training. Cost of technologies.

Finding 39: The consultants concur with the findings that result from the interviews with the farmers in terms of the technologies the farmers use

4.4.2 The farmers' requirements for ICTs to support decision making – consultants

The consultants from their experience with farmers reiterated that farmers require technologies that provide information about soil, climate and contours. Technology that enables them to do terroir analysis and gather weather data are a requirement. Being able to analyse the farm terroir equips the farmer with finer details about his farmer which can be useful when making decision. Terroir knowledge helps the farmer make informed decisions on how to plough the farm as well as deciding what varieties work best for his farm. Weather data is undoubtedly a great source of information which is required by the farmers in decision making. Weather can have adverse effects on the vineyards and grapes which can result in devastating loss to the farmer hence the need for ICTs which are able to enable the farmer access weather data.

Finding 40: Consultants reiterated that farmers require technologies that provide information about soil, climate and contours. Data about weather, market trends, labour issues and many more are important for farmers to make decisions

4.4.3 The slow uptake of decision support systems by farmers

Sub research question: Why is there slow uptake of decision support systems by emerging farmers?

Literature suggests (Anger *et al.*, 1994; Nguyen *et al.*, 2006) that there is a slow uptake of decision support systems by farmers in the wine industry. Consultants gave their assessment of uptake of DSSs by emerging farmers in the Western Cape wine industry of South Africa.

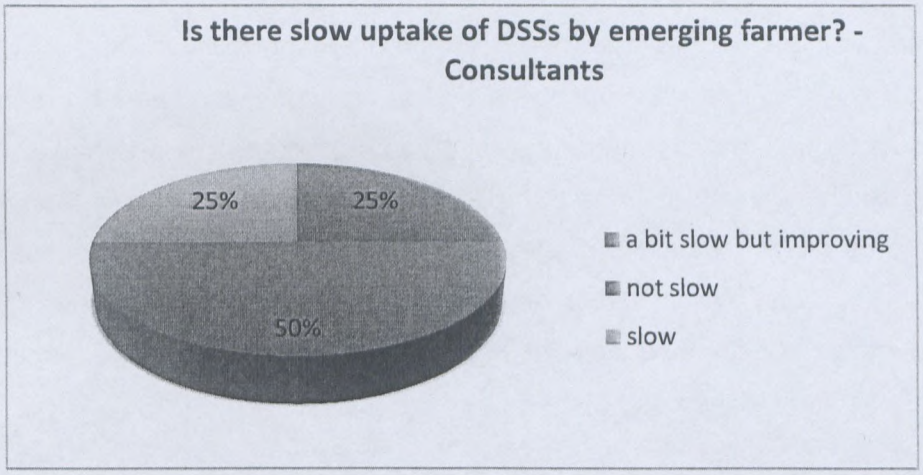

Figure 4.20: The rate of ICT uptake by farmers - consultants

A quarter of the interviewed consultants mentioned that the uptake of ICTs for decision making is slow with one consultant suggesting that even though it's a bit slow the uptake of ICT will increase and with time they will learn and adopt technologies supporting decision making.

The other 50% believe the emerging farmers' uptake of DSSs is not slow. One consultant stated that they have the basic ICTs they need to support decision making hence we cannot conclude they slowly adopt DSSs. Another consultant said the emerging farmers are leading in term of decision support tools in their operations. Older farmers however are technophobic and therefore are reluctant to adopt new technologies to support their decision making.

4.4.4 Reasons for slow uptake of decision support systems by emerging farmers – consultants

50% of the consultants believe cost is one of the reasons why emerging farmers' uptake of DSSs is slow. These consultants mentioned that the technologies are expensive and beyond the reach of emerging farmers. Unlike well established commercial farmers, emerging farmers might fail to adopt some of the DSSs as the consulted mentioned above.

However, a quarter of the consultants believe lack of communication is one of the causes. Emerging farmers might not be constantly updated with technology trends and as a result miss out on some of these technologies. This can be true but with the increasing use of technologies such as internet and emails, communication will soon disappear from the list of the causes of slow uptake.

It is also mentioned that emerging farmers are not keen on changing their ways of operating hence they will not be keen to quickly adopt the DSSs. The consultant went on to say that this can be attributed to the fact that there is a lot of word of mouth talk on uptake of these technologies. He suggested that if farmers the technology working for other farmers who adopted it they will be keen on adopting it. This means such farmers are more sceptical and want to make sure the DSSs is really useful before adopting it. In that case if the suppliers of the DSSs could do demonstrations and let the farmers use the software as trial; the scepticism might be a thing of the past

Lack of knowledge on the benefits of adopting of adopting the DSS can be linked to the point above. If farmers do not know or understand how it will be beneficial for them to adopt the technology, they will be sceptical and not willing to adopt the technology. The same consultant went on to state that lack of training is another reason for slow uptake. This also means they are not knowledgeable about the DSS therefore with some training they can appreciate the technology and adopt it.

Finding 41: High costs, lack in communication, being afraid of technology, and lack of training are the main reasons for the slow uptake of ICTs by emerging farmers

4.4.5 Summary – consultants

The interviewed consultants agreed with the responses of the established farmers responses. They added that and in fact cautioned that the high cost of ICT, the lack of training and communication with regards to ICT, and technophobia are obstacles for ICT uptake especially with emerging farmers. In the specific area of where the study was done low mobile network coverage is seen as a major obstacle for ICT growth.

4.5 Findings on the use of ICTs to support decision making – vendors

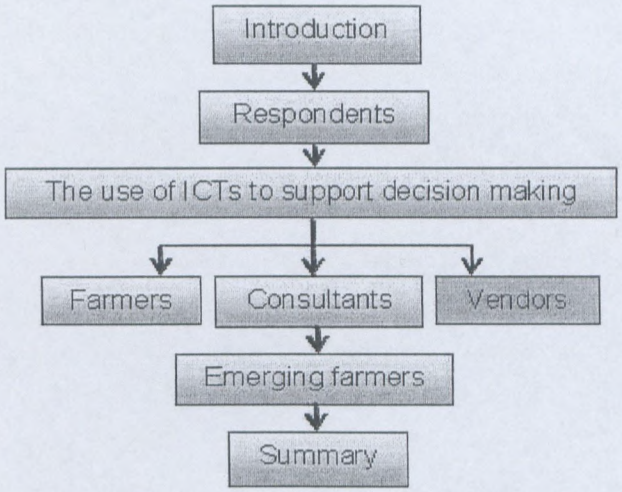

Fig 4.21: Chapter layout - Vendors

Following are the findings of the vendors perceptions interviewed. Four vendors were interviewed.

Table 4.6: Findings on the use of ICTs to support decision making – vendors

Sub research question	Respondent A	Respondent B	Respondent C	Respondent D
1. What technologies are being used by the farmers to support decision making?	Computers Mobile phones GIS GPS mapping Computerised irrigation system.	Computerised irrigation – soil moisture detection systems. Internet Pastel Partner - financial management. Microsoft packages FarmMS VIP system Donkerhoek data.	GPS mapping systems. Computers Internet Mobile phones Etc	Irrigation systems. Satellite mapping Precision farming Tractor detector devices. Computers Mobile phones Internet Etc

2. What are the farmers' requirements for ICTs to support decision making?	Emerging farmers need internet access and need to be trained to be able to effectively use it. Email for communication with vendors especially emerging farmers. Internet – marketing, access to information and resource VoIP – Skype, need to be trained on how to use.	Technology which is capable of providing farmers with access to resources information they need to support decision making. Technology used in financial planning, profitability assessment, production.	A combination of the available technologies works best not individual technologies.	Satellite mapping Computerised irrigation systems Computers Mobiles e-commerce, use of automated marketing etc.
3. Is there slow uptake of decision support systems by emerging farmers?	Yes it is slow but with training it will improve. There have been huge improvements for the past 3 years.	Slow	Not sure	Slow but improving. Farmers aren't aware of the benefits of using ICTs for decision making.
4. Why is there slow uptake of DSSs by emerging farmers?	Technophobia. Affordability and lack of knowledge on the benefits	Farmers just want to go out and work in the field, they are not interested in using ICTs, making calculations etc.	Cost	There is information overload, simplify the use of technology.

4.5.1 Technologies used by farmers to support decision making

The vendors interviewed identified the following technologies which the farmers use; computers, mobile phones, GIS, GPS mapping systems, computerised irrigation, moisture detection system, internet, financial packages such as Pastel, Microsoft Office packages, DSS such as industry specific software such as VIP system, Donkerhoek Data; satellite mapping, precision farming and tractor detector devices.

Finding 42: Vendors agree with well-established farmers and the consultants on the technologies that farmers use to support their decision making

4.5.2 The farmers' requirements for ICTs to support decision making

Availability of the internet has many advantages for the farmer and whoever he does business with. Transactions can be easily performed online rather than the farmer or the stakeholder having to travel and meet the other part to perform the transaction. E-banking is also another use of internet that can go a long way in reducing the costs the farmer incurs by visiting the bank for all his banking requirements. Beside e-business the internet is a host of many different types of information a farmer can use for decision support for example checking weather data online. However as respondent A mentioned, the need for them to be trained on how best to make optimal use of the internet should not be overlooked because navigating the internet can be a really complicated process for the not technically competent emerging farmers. Moreover, technologies such as VoIP technologies like Skype require some training on how best it can be used as well as the reduction in communication costs it is capable of achieving.

Another interviewee emphasised the "need for technologies which are capable of providing farmers with access to resources and information they need to their support decision making". The internet described above can be one of such technologies due to its capability to provide massive amount of information farmers desperately need to aid their decision making. The vendor pointed out technologies used in financial planning and profitability assessment as some of the technologies the farmers need to effectively help their decision making (Appendix F).

One vendor states that it is not about a specific individual ICT component which the farmers

require but a combination of the available technologies working together to assist the farmer with the relevant information. The ICTs the farmers require work best if they support each other rather one dominating ICT component working in isolation (Appendix F).

ICTs capable of providing satellite mapping for the farm were also mentioned as a requirement for ICTs needed to effectively support farm decision making. The ability to produce detailed satellite mapping for the farmer can assist the farmer and be supportive in decision making. As shown in figure 4.17 the detailed images can be analysed with the help of specialists to help farmers understand the geography of their farm. This will enable farmers to make informed decision in their farm operations with that knowledge. Websites such as www.fruitlook.co.za have tools which can help farmers view the satellite images for their farm.

The diagram below shows satellite image showing soil map which by use of Geographic Information Systems (GIS) can be analysed to show the soil wetness classification as the diagram shows. The information on soil wetness classification gives a great input to the farmers' decision making.

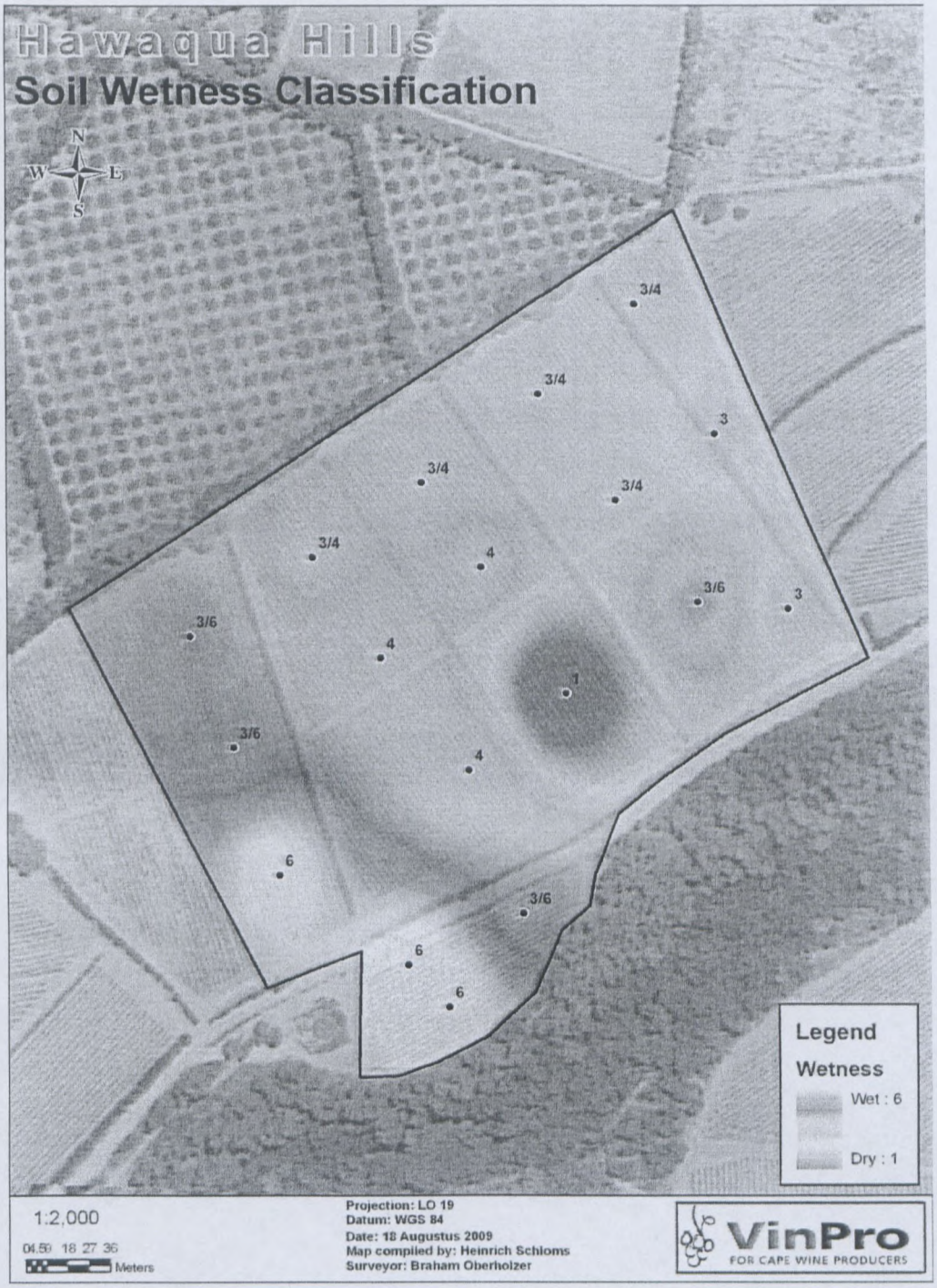

Figure 4.22: Map showing soil wetness classification for a farm (courtesy of Heinrich Shloms - Vinpro)

Finding 43: Vendors view ICT as an integral part of the farmers' decision making support tools

4.5.3 Summary - Vendors

Vendors are important role players within the agricultural sector and support farmers on a daily basis in decision making. They supply relevant information and act as critics to test farmers' decisions and option they evaluate. Vendors are in total agreement with the findings of the research as far as the study goes. They all agree that ICT will play a more important role in the future and will become an integral part of the farmers' decision making structure.

4.6 Emerging farmers

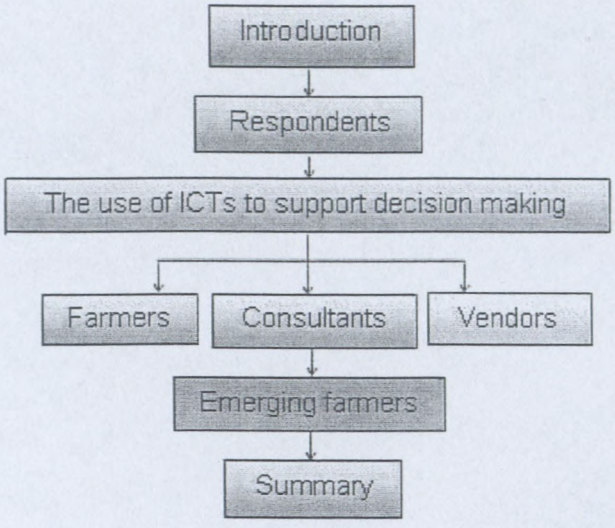

Fig 4.23 Chapter layout - emerging farmers

4.6.1 Introduction

As defined in the literature review (Chapter 2.2), emerging farmers are start-up farmers aiming to become a commercial farmer and are in the process of building up the necessary capacity. Emerging farmers were interviewed in order to explore if they use ICT and if the emerging farmers do use ICT how they use the ICTs available to them in aiding their decision making. It was problematic to get emerging farmers to be interview since there are not many emerging farmers.

4.6.2 Interviews with emerging farmers

Table 4.7: Findings on the use of ICTs to support decision making – emerging farmers

Sub research question	Respondent A	Respondent B	Summary of findings
1. What type of decisions do the farmers make?	All farm decisions , financial planning, operational etc	Operational, marketing, financial planning	All farm decisions
2. How do farmers make their decisions?	Consider profitability first Market trends and demands Quality products	Consider market trends, profitability of the business.	Consider profitability, market analysis
3. What information is required to support the identified categories in decision making?	Need a lot of training especially individually at a farm. Need to be trained so that they appreciate and be able to use ICTs to support their decision making. – need training on how to use email, internet etc.	Industry statistics, market information, need ICT skills training	Information on how they can improve their technical skills, market information
4. What technologies are suitable to support farmers in decision making?	Cell phones Computers The internet	Cell phones Computers Internet	cell phones internet computers
5. What are the farmers' requirements for ICTs to support decision making?	Cell phones Computers Internet Email	Internet Computers Cell phones	Internet Computers

As shown on Table 4.7, emerging farmers are involved in decision making on all farm operations. They make decisions on financial planning, marketing as well as operational decisions among others. They also consider profitability, market trends and analysis as well as need for quality decisions when making decisions.

Finding 44: Emerging farmers interviewed focus on financial planning, marketing and operational decisions

The emerging farmers interviewed indicated that they require intensive training so that they appreciate the importance or significance of ICTs in their decision making. They need training on how to use the internet email and other technologies. Emerging farmers require information on market trends as well as information on how they can enhance their technical skills to support decision making.

Finding 45: ICT training required to enhance the farmers' skills

The emerging farmers use technologies such as cell phones, computers, email and the internet to support their decision making. In Table 4.8 the opinions of the consultants are shown.

Table 4.8: DSS uptake by emerging farmers – consultants

Is there slow uptake of DSSs by emerging farmer? **Consultant:**	
Respondent A	Slow
Respondent B	Not slow
Respondent C	Not slow
Respondent D	Slow

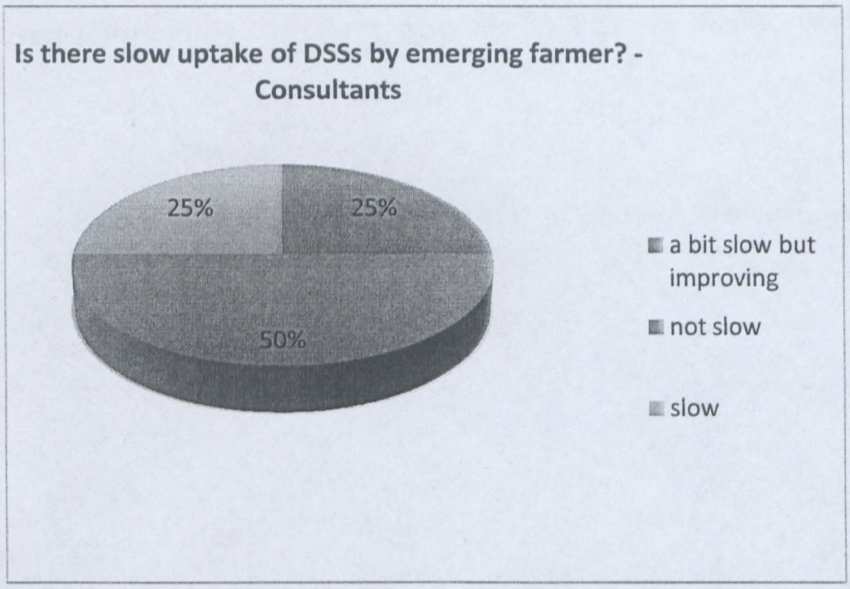

Figure 4.24: The rate of ICT uptake by emerging farmers - consultants

Some of the interviewed consultants mentioned that the uptake of ICTs for decision support is slow with one consultant suggesting that even though it's a bit slow the uptake of ICT will increase and with time they will learn and adopt technologies supporting decision making. The other 50 % however believes the emerging farmers' uptake of DSSs is not slow. One consultant stated that they have the basic ICTs they need to support decision making hence we cannot conclude they slowly adopt DSSs. Another consultant said the emerging farmers are leading in term of decision support tools in their operations.

Finding 46: The rate of the uptake of ICT is unclear within the emerging farmers in the industry.

4.6.3 Reasons for slow uptake of decision support systems by emerging farmers – consultants

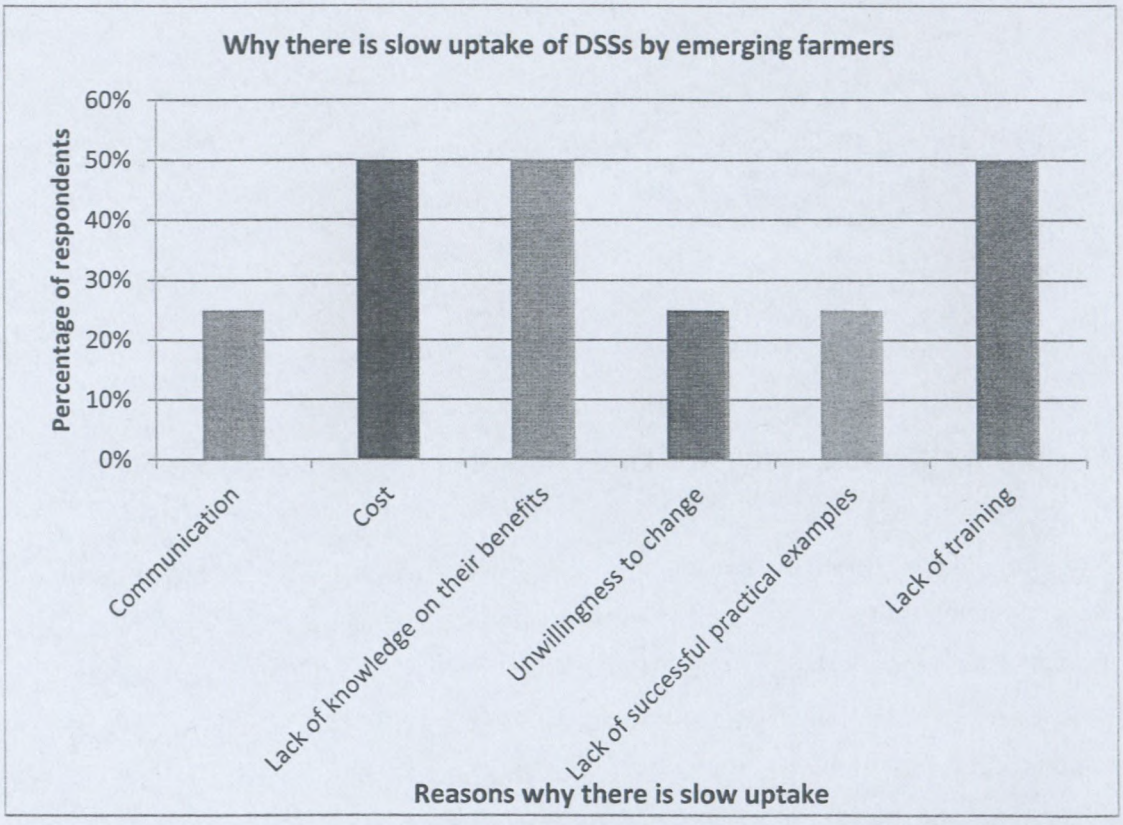

Figure 4.25: Graph showing reasons why there is slow uptake of DSSs by emerging farmers – consultants

50% of the consultants believe cost is one of the reasons why emerging farmers' uptake of DSSs is slow. These consultants mentioned that the technologies are expensive and beyond the reach of emerging farmers. Unlike well established commercial farmers, emerging farmers might fail to adopt some of the DSSs as the consulted mentioned above.

Finding 47: The perceived slow uptake of ICT by emerging farmers is as a result of the high costs associated with ICT

However 25 percent of the consultants believe lack of communication is one of the causes. Emerging farmers might not be constantly updated with technology trends and as a result miss out on some of these technologies. This can be true but with the increasing use of technologies such as internet and emails, communication will soon disappear from the list of

the causes of slow uptake.

Finding 48: The lack of communication in terms of ICT advantages is also seen as a cause for slow uptake.

It was also mentioned that emerging farmers are not keen on changing their ways of operating hence they will not be keen to quickly adopt the DSSs. However the consultant went on to say that this can attributed to the fact that there is a lot of word of mouth talk on uptake of these technologies. He suggested that if farmers the technology working for other farmers who adopted it they will be keen on adopting it. This means such farmers are more sceptical and want to make sure the DSSs is really useful before adopting it. In that case if the suppliers of the DSSs could do demonstrations and let the farmers use the software as trial; the scepticism might be a thing of the past. Lack of knowledge on the benefits of adopting of adopting the DSS can be linked to the point above. If emerging farmers do not know or understand how it will be beneficial for them to adopt the technology, they will be sceptical and not willing to adopt the technology. The same consultant went on to state that lack of training is another reason for slow uptake. This also means they are not knowledgeable about the DSS therefore with some training they can appreciate the technology and adopt it.

4.6.4 Assessment of the uptake of DSSs by emerging farmers – is there slow uptake? (vendors)

Among the vendors interviewed most indicated that the uptake of DSSs by emerging farmers in the wine industry is slow. However 50% are of the view that with training the uptake of DSSs by emerging farmers will improve. A vendor supported this view by mentioning that there have been huge improvements in the uptake of DSSs by emerging farmers in the past 3 years.

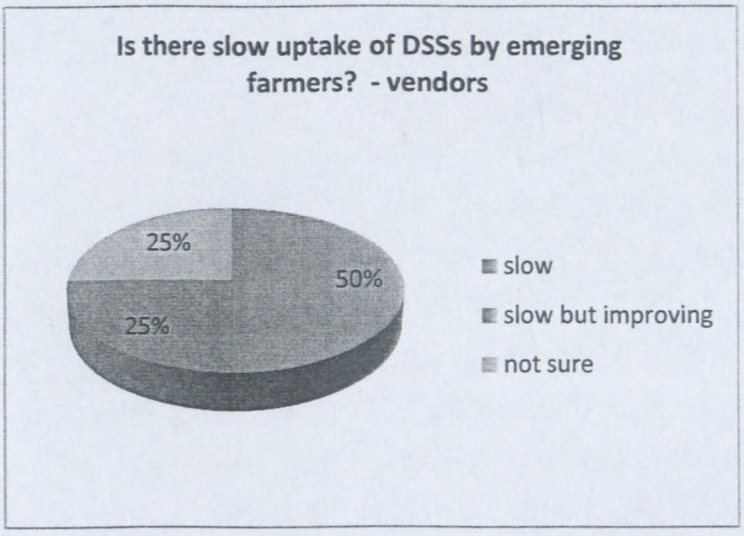

Figure 4.26: Pie chart showing whether the vendors believe there is slow uptake of DSSs by farmers or not

Among the vendors interviewed most indicated that the uptake of DSSs by emerging farmers in the wine industry is slow. However 50% are of the view that with training the uptake of DSSs by emerging farmers will improve. A vendor supported this view by mentioning that there have been huge improvements in the uptake of DSSs by emerging farmers in the past 3 years.

Besides stating that the uptake is slow, one vendor reiterated that farmers are not aware of the benefits of using ICTs for decision making hence the emphasis on training them on how to use the ICTs. The emerging farmers also need to be trained and shown how the uptake of these decision support tools can be of great benefit in the business. Most of them are not aware of the capability of these DSSs to reduce costs and ability to provide vast amount of information the farmer need to make informed decisions.

50% of the vendors interviewed specifically indicated that emerging farmers need internet access and need to be trained in order to effectively use it. The use of internet for e-commerce was emphasised but 25% of the respondents. The respondent mentioned that use of internet for online marketing (e-marketing) or buying should be encouraged among emerging farmers.

One respondent was not sure about the tempo in which the emerging farmers adopt and use the DSSs.

The reasons why there is slow uptake of DSSs by emerging farmers - vendors

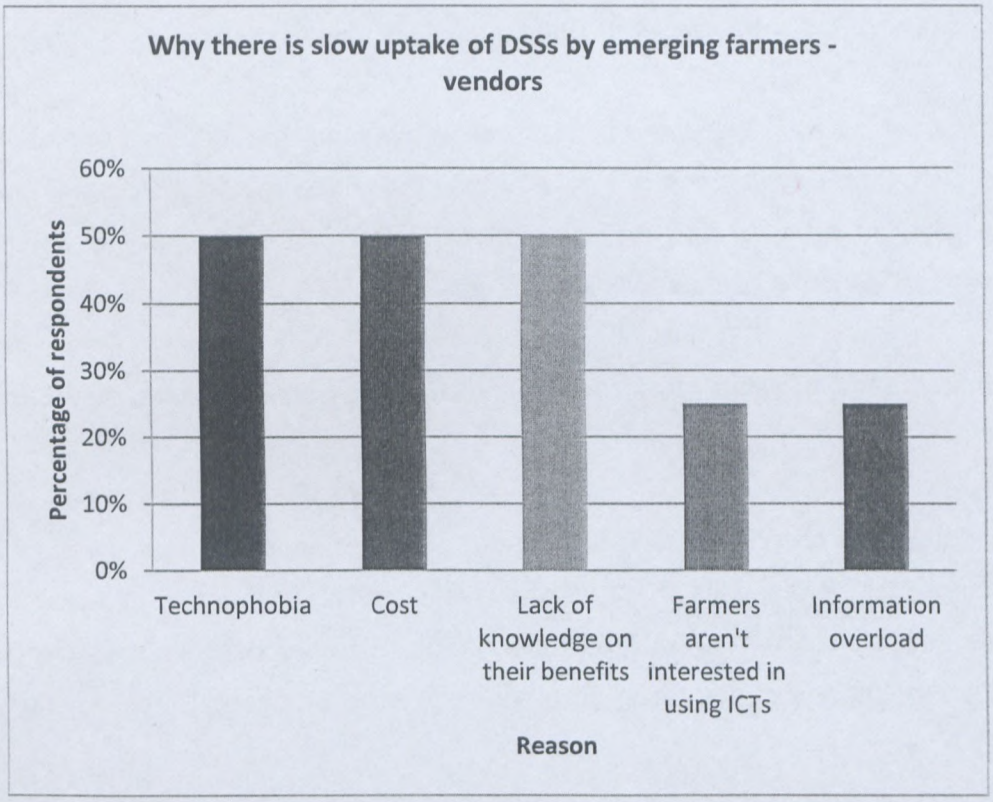

Figure 4.27: Graph showing reasons for slow uptake of DSSs by emerging farmers – vendors

Like the consultants also mentioned, technophobia also emerged among vendors as one of the causes of the slow uptake of the DSSs by emerging farmers. 50% of the vendors mentioned that farmers are not interested in using ICTs, "they do not like to make calculations etc" a vendor asserted. He stated that the farmers just want to go out and work in the fields not really sitting in the office going through the DSSs.

Finding 49: Training is needed to overcome technophobia

50% of the interviewees also suggested that affordability is one other reason why the emerging farmers' uptake is slow. The costs of the technologies and costs involved with its use are not affordable for the emerging farmers, the vendors added. This however is increasingly becoming irrelevant with the ever changing technical world technologies are becoming cheaper as one vendor who specialises in DSSs demonstrated. Moreover taking into consideration the benefits these decision support tools provide the issue of cost might not be a significant one.

Finding 50: Costs are a barrier although slowly becoming irrelevant since there is need to simplify these technologies and their use.

One vendor however believes that there is information overload from different stakeholders in the industry such that there is need to simplify these technologies and their use. This can be true since this can be confusing and disruptive for the farmers if there is continued information overload without it being sensible to them.

Finding 51: Information overload to farmers from different stakeholders may become disruptive

Some of the vendors interviewed specifically indicated that emerging farmers need internet access and need to be trained in order to effectively use it. The use of internet for e-commerce was emphasised but 25% of the respondents. The respondents mentioned that the use of internet for online marketing (e-marketing) or buying should be encouraged among emerging farmers.

Finding 52: ICT accessibility a problem for example is some areas where there is no cell phone coverage hence limiting the farmer's access to external consultants

4.6.4 Summary- emerging farmers

Only two emerging farmers were interviewed. This limited the validation of the findings. However, several issues stood out. Firstly cognisance of what was not said is important. The lack of acknowledgement of the importance of family, agricultural domain knowledge, the extensive availability of information, labour issues, quality of information, risk management and the importance of strategic and tactical thinking is evident. Focus is rather on operational issues, financial planning and marketing.

Training needs are emphasized by all interviewed. The lack of training is seen as an obstacle for emerging farmers. The perceived high cost and low returns (value) of ICT is also prohibiting the uptake of ICT by emerging farmers.

4.7 Finding on the responses from respondents

Research questions	Findings of respondents
Sub-question 1	Farmers know the importance of strategic, tactical and operational decisions to be a successful farmer
Sub-question 1	Book and recordkeeping is used as a tool for decision making on all aspects of farming
Sub-question 2	Consider profitability of the business.
Sub-question 2	Consider market trends and demands. Quality products
Sub-question 3	Financial decisions are based on information gained from different sources including banks and accountants
Sub-question 4	ICT is widely used by the farmers
Sub-question 4	Computers and software such as the Microsoft suite is used by farmers
Sub-question 4	The farmer spouse is the main user of computer technology followed by the youngsters in the family.
Sub-question 4	GPS and GIS technology is under utilised by farmers in their decision making processes
Sub-question 4	Emails are used by farmers and reduces the decision making time cycle
Sub-question 4	Farmers' spouses or children use the software to create information for the farmer to use in making decisions
Sub-question 4	Computerised system creates useful information for decision making
Sub-question 4	Application programmes are useful in the decision making processes
Sub-question 4	Television weather reports are not very useful technology tool for information gathering by farmers as compared to website which are more precise and area specific
Sub-question 4	Landlines are old technology but still in use because of the poor net work coverage of mobile service providers
Sub-question 5	Vendors view ICT as an integral part of the farmers decision making support tools
Sub-question 5	There is a lack of integrated systems in use on the farms

Sub-question 6	It is uncertain what the status on the uptake of ICT by emerging farmers are.
Sub-question 6	High costs, lack of communication, being afraid of technology, and lack of training are the main reasons for the slow uptake of ICT by emerging farmers
Sub-question 4	Scientific soil analysis are used for soil preparation, planting and fertilisation decisions
Sub-question 4	Consultants reiterated that farmers require technologies that provide information about soil, climate and contours. Data about weather, market trends; labour issues and many more are important for farmers to make decisions
Sub-question 3	Terroir knowledge is used in the decision making process
Sub-question 3	Farmers use the history of the farming operation's to assist in the decision process
Sub-question 3	The involvement of farm workers when acquiring new employees is important
Sub-question 3	Farmers consults farm workers in their decision making process
Sub-question 3	Farmers use several sources of information such as industry information on market trends to make long term decisions
Sub-question 3	Market trend information is used for strategic decisions
Sub-question 3	Farmers need quality information to make marketing decisions for local as well as international markets
Sub-question 4	Internet and mobile banking are important tools for farmers.
Sub-question 4	Cell phones are generally used by farmers but coverage and connectivity is a problem and causes inefficacies in the decision making process.
Sub-question 4	Internet services are gaining ground as a supporting tool for decision making by the farmer
Sub-question 5	Quality produce is important in the decision making process
Sub-question 3	Farmers need reliable, accurate and timeous information from ICTs to improve the quality of their decision making
Sub-question 3	Risk assessment is done before making decisions
Sub-question 3	Farmers make use of information from a variety of sources including consultants, vendors, own experience, neighbours experience, websites, journals, magazines and many more,

	on many aspects of the farming enterprise
Sub-question 3	To make decisions, farmers make use of consultants and neighbours with experience and knowledge of the area
Sub-question 3	Farmers use experience, consult neighbours as well as consultants when making decisions
Sub-question 3	Farmers need information on weather data, advice from consultants, information on market trends and analysis, financial information, workers' opinion, advice from experienced fellow neighbouring farmers, information on the scientific assessment of soil, information on industry statistics and performance as well as technical information.
Sub-question 3	Weather information is one of the highest priorities for farmers in order to make decisions
Sub-question 3	Industry information is used for strategic and tactical decisions
Sub-question 3	Consultants' advice are widely used by farmers when making decisions
Sub-question 3	Experienced neighbours are often consulted and used by farmers when making decisions
Sub-question 3	On demand financial information is needed for farmers to make decisions
Sub-question 4	The consultants concur with the findings that results from the interviews with the farmers in terms of the technologies the farmers use
Sub-question 4	Vendors agree with well-established farmers and the consultants on the technologies that farmers use to support their decision making
Sub-question 4	ICTs reduces the time of decision making by farmers

4.8 Summary

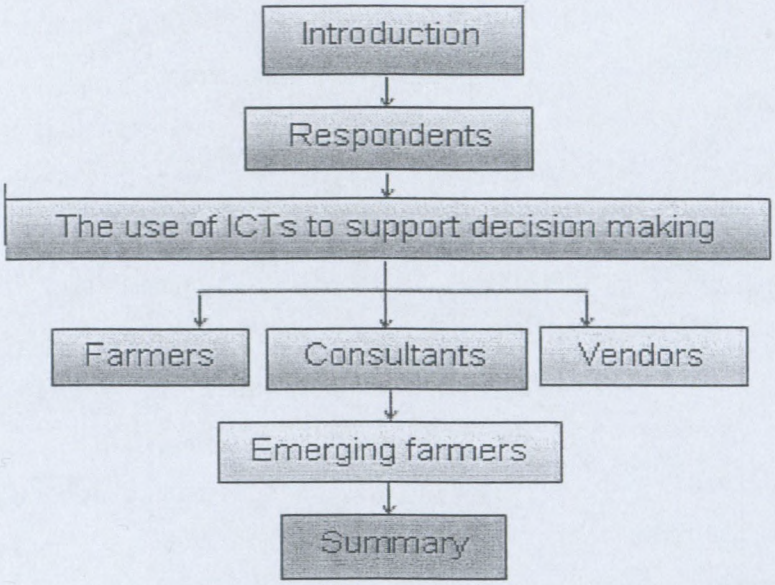

Fig 4.28: Chapter layout - Summary

Four groups of role players were interviewed. They were the established farmers, consultants, vendors and emerging farmers. Thirteen themes developed from the responses from the interviewees. They are:

Agricultural domain knowledge
Finance
Family
ICT
Information resources
Labour
Marketing
Mobility
Quality information
Risk management
Strategy

Costs

Training

Headline findings: Established farmers

Farmers view ICT as critical to their businesses. Family, neighbours, consultants, vendors and especially labourers are important contributors to information and decision making. Strategic, tactical and operational planning are the main concerns of the farmers interviewed and they admit to the need of quality information. Mobile as well as ISP network coverage are obstacles in gathering information for quality decision making. Lowered cost and more in depth training will also assist in making quality decisions.

Headline findings: Consultants

All the consultants interviewed agree with the established farmers on their information and ICT needs. They also mentioned the high costs, poor network coverage and lack of training as obstacles for more use of ICT in the industry.

Headline findings: Vendors

As in the case of the consultants the vendors also agree with the responses of the established farmers. They added to the general consensus that an integrated ICT approach is needed to optimise the flow of information within the industry.

Headline findings: Emerging farmers

Emerging farmers are still very much in the operational phase of their business. They are concerned with financial planning, some market information. Most of the emerging farmers that were approached to participate in the research declined as they could not see any value in the research for them. The two that did participate were forthcoming with information. They use ICT in decision making to a lesser extend and were unaware of most of the information resources a used by established farmers. They expressed the desire for more training especially as far as ICT goes.

Chapter 5

Discussion

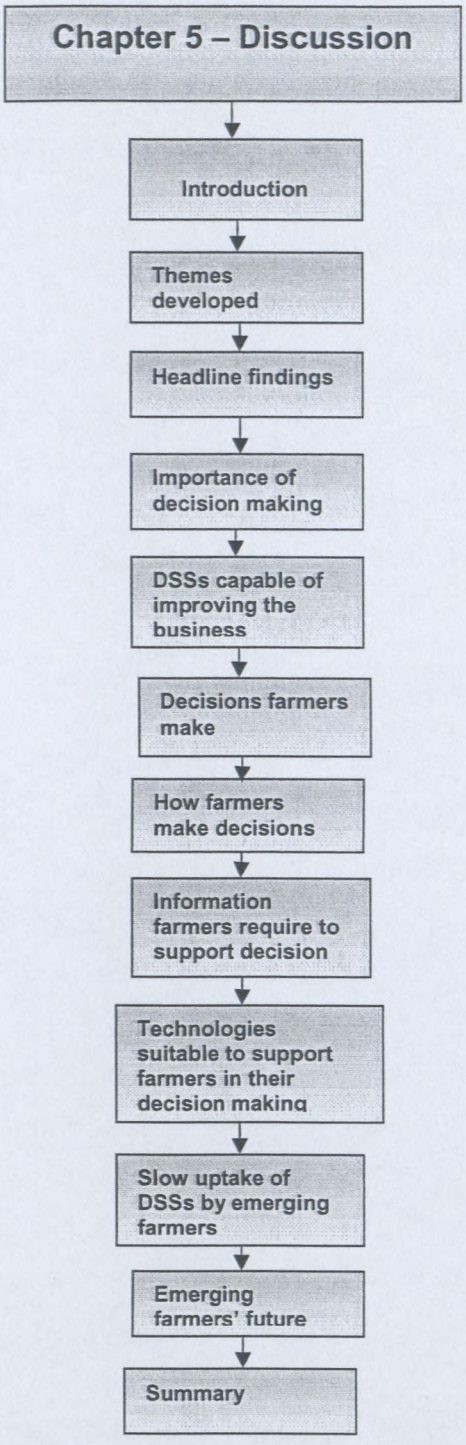

Figure 5.1: Graphical representation of Chapter 3

5.1 Introduction

This chapter presents a discussion based on the research findings and analysis of the research results. Furthermore, the findings from the study and findings from related studies are compared in this chapter. The discussion is divided into three parts namely, themes developed (section 5.2); headline findings (section 5.3) and answering the research questions (section 5.4).

The research problem

Decision making is fundamental to good management; it is one of the most important tasks in running a successful business (Dralega, 2007). Emerging farmers have to operate in a complex environment and ICT use can lead to the effective use of information to support decision making in the industry.

Experienced farmers use ICT tools to support decision making and use information to make informed decisions in their operations. Emerging farmers are at a distinct disadvantage as they have no previous knowledge of farming and have to find their way on a day to day basis.

Problem statement:
The environment emerging farmers operate in is complex and they are at a distinct disadvantage since they have no previous knowledge of farming hence reducing profitability and sustainability of these emerging farmers entering the industry.

5.2 Themes developed

Thirteen themes developed from the data analysis. Most of the themes are also reported on in the literature. These themes are:

5.2.1 Agricultural domain knowledge: Information about agricultural domain knowledge is viewed as important as all the tactical and operational decisions are made

based on the domain knowledge. Bechara et al. (1998) emphasise the importance of domain knowledge amongst the farmers since he wrote that for the farmers to make best decisions they need knowledge on criterion or mechanism on how best to do that. Rother et al. (2008) concur as they reiterate the importance of skills and experience among emerging farmers. Rao (2006) and Mackrell et al. (2009) report that farmers use accumulated knowledge when making decisions. This study also concurred with Bechara et al. (1998?), Rao (2006), Rother et al. (2008) and Mackrell et al. (2009) on farmers using domain knowledge when making decisions. It is therefore important for emerging farmers to take note of this, and to utilise the domain knowledge of the experienced farmers when making decisions.

5.2.2 Family: The dependency on family to assist with gathering information was mentioned by the farmers. Especially the use of ICT by the spouses and children were mentioned. Mackrell et al. (2009) mention that farmers not only rely on their accumulated knowledge but rely on accumulated knowledge of their partners in decision making. Family can also play the role of crop scouts as they monitor fields and collect information on insect population. The use of crop scouts plays a major role in aiding decision making as Bange et al. (2003) state. This help support the importance of family in helping farmers in decision making.

5.2.3 Finance: The farmers manage their cash flow and budgets diligently. For this they depend on ICT to gain access to banks, budgets, creditors, debtors and auditors. Bange et al. (2003), ESRI (2007) and Mackrell et al. (2009) also emphasise the importance of ICTs in aiding farmers in financial planning to ensure profitability of their businesses. For emerging farmers it is important that they make time and diligently manage their financial affairs. This is sometimes very difficult to do as they are usually occupied with the day to day operational demands of the farm.

5.2.4 Importance of ICTs: The importance of ICT in strategic, tactical and operational decisions are emphasised by the responses of the interviewees. ICT plays an important role in communication, access to information and day to day to day management. Several authors also highlighted the importance of ICTs in farmers' decision making. Hayman and Easdown (2002), Bange et al. (2003) and Richards and Bange (2003) all mention technologies farmers employ to support their decision making. Mackrell et al. (2009) added that user participation in the deployment of these ICTs plays a major role in acceptance of the technologies.

5.2.5 Information resources: Multiple resources are used to find information for decision

making. The internet, mobile phones, GPS and sophisticated soil humidity as well as infrared detection equipment is used. International markets as well as money trends are constantly monitored in order to make quality decisions. ESRI (2007) emphasise the importance of GIS, remote sensing, use of mobile devices to gather data among other technologies as an important information resource in agriculture. Strauss et al. (2008) also identify econometric modelling as a useful resource for information as well. Climate forecasting also emerged as an important information source among scholars (Chiew et al., 2000; Abawi et al., 2001; Ritchie et al., 2004).

Experienced neighbours, vendors and consultants with local knowledge are often used as sources of information before decisions are made. As mentioned earlier in 5.2.2, in addition to relying on family the farmers also extend their information resource base to neighbours who form part of their farming community.

5.2.6 Labourers: labourers are seen as an integral part of the decision making process on the farms. They contribute towards strategic, tactical and operational decisions. Many authors (Bechara et al., 1998, Rao 2006, Rother et al., 2008; Mackrell et al., 2009) focus on the farmers' knowledge and not labourers. Bange et al. (2003) reports crop scouts as crucial information gatherers for the farmers' decision making. Labourers as mentioned by interviewees play an important role in decision making and farmers should not overlook their contribution.

5.2.7 Marketing: The farmers are very much aware of the markets they operate in and as such will make every attempt to gather information about the markets before making any decision. This is also supported by Parker and Campion (1997), Fraisse et al. (2004:1) and Rao (2006).

5.2.8 Mobility: Mobile phones are seen as away to communicate and to reduce the time to make decisions. Bange et al. (2003) and the ESRI (2007) also reiterate the importance of mobile devices in supporting the farmers in decision making. Unfortunately the major networks have still not provided good quality coverage in the areas where the research was done (Fig 1.4).

5.2.9 Quality information: farmers will go to great lengths to find quality information. They will spend time to achieve this as they realise that their decisions are dependent on the quality of the information. They can find quality information by using ICTs as mentioned in

5.2.4 with the following authors concurring: Hayman & Easdown (2002), Bange et al. (2003) and Richards and Bange (2003).

5.2.10 Risk management: To manage risk farmers acknowledge that they are depended on quality information. In section 5.2.9 highlights the importance of quality information to manage risk. Farmers will consult widely and take the smallest detail into consideration before making decisions. Rao (2006) and Mackrell et al. (2009) report that farmers consult in order to get information which help them in risk aversion.

5.2.11 Strategy: As the industry is a long term industry, vineyards are utilised for twenty five years with big capital investments up front, strategic decisions are important. In depth knowledge of terroir, cultivars, weather conditions, market trends and many more are needed to be successful. Established farmers are aware of this and go to great lengths to make sure they have the correct information to make these strategic decisions. As mentioned above in section 5.2.1 and supported by published research, domain knowledge is crucial as it helps farmers in building their strategies.

5.2.12 Costs: High costs are the main reasons for the slow uptake of ICT by emerging farmers. Cox (1996) believes the high costs hamper the uptake of ICTs. He argues that the marginal benefit does not justify the cost of developing and maintaining the technologies to support farmers. However, the majority of authors believe such technologies are good investments for farmers (Mills & Clark, 2001; Hayman & Easdown, 2002; Bange et al., 2003; Rao 2006; Mackrell et al., 2008)

5.2.13 Training: The lack of training is one of the reasons for the slow uptake of ICT by emerging farmers. Kuhlman and Brodersen (2001) encourage training and education by using simpler models matching the farmers' expertise in order to improve acceptance of decision support tools by farmers.

5.3 Headline findings

5.3.1 Headline findings: Established farmers

Experienced farmers view ICT as critical to their businesses. Family, neighbours, consultants, vendors and especially labourers are important contributors to information and decision making. This is supported by authors such Bange et al. (2003), Rao (2006) as well

as Mackrell et al. (2009).

Strategic, tactical and operational planning are the main concerns of the farmers interviewed and they admit to the need of quality information. Mobile as well as ISP network coverage are obstacles in gathering information for quality decision making. Lower costs and more in depth training will also assist in making quality decisions as supported by Kuhlman and Brodersen (2001).

5.3.2 Headline findings: Consultants

All the consultants interviewed agree with the established farmers on their information and ICT needs. They also mentioned the high costs, poor network coverage and lack of training as obstacles for more use of ICT in the industry. Cox (1996) also believed high costs slow the uptake of ICTs in agriculture while Kuhlman and Brodersen (2001) agree that training is crucial in encouraging use and uptake of ICTs supporting decision making.

5.3.3 Headline findings: Vendors

As in the case of the consultants the vendors also agree with the responses of the established farmers. They add to the general consensus that an integrated ICT approach is needed to optimise the flow of information within the industry as supported by Hayman & Easdown (2002), Bange et al. (2003), Richards and Bange (2003), Mackrell et al. (2009) and Tembo et al. (2012).

5.3.4 Headline findings: Emerging farmers

Emerging farmers are still very much in the operational phase of their business. They are concerned with financial planning, and some market information. Most of the emerging farmers who were approached to participate in the research declined as they could not see any value in the research for them. This is because they do not understand the value research could bring into their business and industry at large. In order to avoid this, the emerging farmers need to be educated on the benefits of research and how best the research results can benefit their business. The two that did participate were forthcoming with information. They use ICT in decision making to a lesser extend and are unaware of

most of the information resources used by established farmers. They express the desire for more training especially as far as ICT goes as suggested by Kuhlman and Brodersen (2001).

5.4 Importance of decision making

Dralega (2008) articulate that decision making is important, and an important task of managing a successful business. This is supported by the findings of this study; all the farmers interviewed mention that decision making is important and affects and determines the success of their business. The farmers attribute this to the long term effect decision making, especially in the viticulture industry, has on the business.

5.5 DSSs capable of improving the business

In 2002, McCown wrote that DSSs fill a calculator role and make complex but well-structured calculations or inferences. The author further mention that DSSs encapsulate knowledge that is difficult to derive from experiential learning. McCartney (2007) postulates that DSS tools can also enhance gains in economic, social and environmental benefits. The farmers interviewed in this study support the above authors' affirmations as they all mentioned that DSS tools they use are beneficial to their business. All the respondents indicate that the ICTs they use in decision making to a larger extend results in better decision making for their business. One respondent mentions that "without ICTs you battle with decision making". The farmers state that they would not be able to make informed decisions and operate without the use of these tools. One farmer mentions that the lack of DSS tools "cripples business".

5.6 Decisions farmers make

RQ: What type of decisions do the farmers make?

The farmers interviewed in this study point out that they are responsible for all the on-farm and off-farm decision making in their business. They make strategic, tactical and operational decisions in their business. Some of these decisions are complex while some of them are standard. The respondents encounter situations in their business which requires them to use a limited number of variables to solve. These standards decisions are common to the farmers hence most of their operational decision making involve standards decisions for example determining the appropriate quantity when applying chemicals. These, as Pickering

et al. (1990) indicates require the use of manuals or certain rules or formulae.

Farmers also are faced with complex situations in their operations requiring novel decisions. Novel decision making which the farmers in the Breede River Valley experience requires creative solutions as indicated by Pickering et al. (1990). Farmers use their experience or help from experienced neighbours or consultants to solve complex problems. An example of a complex decision can be an emergence of a new type of pests which resists pesticides the farmers use. Such a scenario is critical and requires the farmer to be creative and seek better measures to curb the spreading of the pests while at the same time seeking professional help from consultants and pesticides vendors. Though Pickering et al. (1990) mentioned this some years ago, it is still relevant today as findings show that the situations are faced by farmers today.

The respondents, during the beginning of a season make decision on the types of varieties to grow depending on what is on demand from the market. The farmers also make decisions on how best they can use pesticides and fertilisers to improve or protect their vineyards thereby increasing chances of a better yield. This concurs with Parker and Campion (1997) who wrote that farmers make decisions on optimising the use of chemical inputs as well as selecting a variety of a given crop.

Parker and Campion (1997) report that farmers generate reports on weather patterns to predict when a crop will be ready or the earliest and latest dates when pest infestation might occur. Fraisse et al. (2004) also report that farmers make climate and weather based decisions. This also applies to the interviewed farmers. They all check weather on the internet to predict and plan against adverse weather conditions which may affect their vineyards. This concurs with Fraisse et al. (2004) when they mention that climate based decisions tend to be more strategic in nature since it assists farmers choose varieties to plant acreage allocation and purchase of inputs. Hayman and Easdown (2002) state that farmers make decisions on planting time, fertiliser application and varietal development pattern. Protecting crops from frost damage and seeking advice on chemical application are more types of decisions grain farmers make (Hayman & Easdown, 2002). Jha (2004) also report that farmers make decisions on purchase of implements and planting decisions. The interviewees regularly make decisions on purchase of inputs, planting decisions and fertiliser application as well as deciding how best to develop their vineyards. The weather monitoring also helps them protect their vineyards from adverse weather conditions such as frost or extreme temperatures. The farmers interviewed also consult experts for advice on chemical

application and pest control as Deutscher and Plummer (1998); Hayman and Easdown (2002) and Bange et al. (2004) earlier stated. Interviewed farmers make irrigation decisions in their business. Farmers making irrigation decisions are mentioned by Richards and Bange (2003) as well as Fraisse et al. (2004).

According to Ritchie (2004) farmers use ENSO to focus both rainfall and steam flow. In the study, however none of the farmers interviewed indicate the use of ENSO when making decisions or planning.

The respondents indicate that they make most of their planting decisions based on market trends and analysis. This came up as an important input for the farmers' decision making. This is in agreement with Fraisse et al. (2004) who wrote about price based decisions requiring a broad understanding of both international and domestic markets.

Jha (2004) reports that farmers make decisions on mobilising collective labour or engaging contract labour in the Balinese agriculture. The interviewed farmers also make recruitment decisions, such as how many permanent workers to recruit as well as recruiting contract labour when need arise especially when harvesting.

Rao (2006) reports that decisions are made on post harvest transactions and operations such as storage, transport, processing and marketing among others. These post harvest decisions are critical since it can define failure or success of the farmers business for the whole season. The respondents make decisions on handling of their grapes after harvesting as well as transportation to the cellars.

As can be seen above, the research findings reveal that the farmers interviewed also make their decisions in line with authors mentioned in the literature review. Only a few of the type of decisions mentioned in literature do not apply to the farmers in the Breede River Valley regions, these include ENSO decision and simulation modelling. This could be because such technologies are not used in their area.

5.7 How farmers make decisions

RQ: How do farmers make their decisions?

Pickering et al. (1990) supported by Parker and Campion (1997) report that farmers use

expert systems to support their decision making with Parker and Campion (1997) stating that rule-based ES designed to encapsulate knowledge of agricultural systems are used. However, all the farmers interviewed did not mention the use of ES in their decision making. The consultants and vendors interviewed in this study also did not indicate any use of ES in decision making by the farmers. This could be due to the fact that ES only work within design restrictions and best suited for standard decisions only.

As early as 1979 Baier reports that farmers use simulation models in crop growth. In 1997 Parker and Campion mention the use of simulation models on the reaction of pest populations to spray regimes and observing the effects of reducing levels or using fewer sprays to optimise the use of chemical inputs. However in this study the farmers interviewed did not mention the use of simulation models to support decision making in their operations. Simulation models are expensive and are mainly used to solve novel problems and require a good knowledge of the systems. This might be the reason why the interviewed farmers do not use simulation modelling but can implement them with the help of knowledgeable consultants when faced with a situation requiring novel decision making.

Singh (2005) articulates that farmers use precision agriculture or precision farming (PF) which makes use of new technologies. The technologies include GPS, sensors, satellite or aerial images and information management tools for optimum profitability, sustainability protection of land resource. In this study the above mentioned technologies are utilised by farmers and consultants to support decision making. Though most of the farmers do not have GPS and satellite imaging technologies, they engage GPS specialists when they need satellite mapping for their farm. A few of them use humidity detection sensors in irrigation. This is also reported by Batte et al. (2002). The farmers interviewed agree that the use of such technologies in decision making helps lower production costs, increasing outputs as well as profits.

The use of ENSO to support decision making on climate by farmers as reported by Podesta et al. (2002), is not practised by the respondents as none of them as well the consultants and vendors mentioned its use.

Rao (2006) reports that farmers use information from radio and television to support their decision making. 17% of the interviewees articulated that they use television to check weather hence helping him plan and make decisions. Even though the weather reports are given by experts and professional, they are distant, hence their advice might not apply to the farmer's specific area. This could be the reason why most farmers interviewed in the Breede

River Valley use the internet to check weather since the websites they use provide detailed information about the weather for the farmers' specific area.

Parker and Campion (1997) reiterate that farmers use information about current market requirements, prices and nature of the target field to assist their decision making. These emerged as some of the important inputs to farmers' decision making most of the farmers interviewed indicated that they need to know what is on demand in the market in order to plan their next season. Market information guides the farmer as to what is needed by the customer therefore giving him an idea of the varieties to plant. Parker and Campion (1997) believe that it is one of the best methods farmers should constantly practise. They further articulate that market requirements should not be ignored at all if the farmer wants to ensure his product sells; the same principle all the interviewees shared in this study.

The use of accumulated experience referred to by some authors as accumulated knowledge and intuition, has been reported by a number of authors as one of the common methods farmers engage in the process of decision making. Rao (2006), Mackrell *et al.,* (2009), and Kerr, Mackrell and von Hellens (2009), all state that farmers rely on experience when making decisions. In this study all the farmers indicated that experience is important in their business but do not solely rely on it when making decisions. They agree it is advantageous for them if they have experience but still need to consult others for best decision making. Even though 83% of them have been in business for more than 18 years, they indicate that they value the advice from experts whom they consult. A third of them mention that they also consult their fellow workers instead of solely relying on their experience with one farmer explicitly stating that he "strongly believes in second opinion hence he always consults others in decision making.

5.8 Information farmers require to support decision making.

RQ: What information is required to support the identified categories in decision making?

Pickering et al. (1990) wrote about the knowledge of pests (through previous pesticide use and scouting results) over a broad agricultural region which they get from manuals or extension bulletins being able to support farmers' decision making. Knowledge of such information is crucial when making decisions on disease control, however the farmers interviewed in this study did not mention the need to have such knowledge. This could be for

the reason that they have been farming in the same area for a long time and already have knowledge of such information and no longer see it as an area they need to invest in.

Weather data was also mentioned by Pickering et al. (1990) as an important source of information farmers require in making decision. All the respondents in this study also concur with Pickering et al. (1990) since all the farmers stated that they check weather regularly to support their decision making. Even though it is more than 20 years old Pickering et al. (1990)'s studies are still relevant to the farmers.

Information on market requirements, prices and nature of the target field was reported by Parker and Campion (1997) as other sources of information farmers require to support decision making. This is so true in the case of the wine farmers interviewed in the Breede River Valley.

Mackrell et al. (2009) suggest that instead of relying too much on certain information, farmers should use their accumulated knowledge and intuition when solving heuristic decisions. The fact that most farmers in this study indicated that despite the vast amount of experience available, they still rely on consultants or fellow neighbours, suggesting that they do not only rely on their intuition and experience when making decisions.

Information from DSS software, GIS, GPS and simulation models is mentioned by a number of authors as being crucial in supporting farmers in decision making (Bange et al., 2003; Mackrell et al., 2009). The farmers interviewed reveal that they rely on several ICTs in their business to support them in decision making. Not one specific technology was mentioned as the source of information but a wide range of ICTs as well as a combination of them. The respondents moreover mentioned several other types of information such as information on market trends and analysis, weather data, industry statistics as well as terroir knowledge among others; they rely on when making decisions in this study.

5.9 Technologies suitable to support farmers in their decision making

RQ: What technologies are suitable to support farmers in decision making?

Several authors report that farmers use DSSs to support their decision making, they are used in pest management, crop nutrition as well as irrigation management (Deutscher & Plummer, 1998; Kuhlman & Brodersen, 2001; Deutscher et al., 2001; Hayman & Easdown,

2002; Bange et al., 2003;). The farmers interviewed in this study mentioned that they use several decision support tools in several farm operations in their business. They reiterated that these technologies are important in their business and will struggle to operate effectively without them.

Bange et al. (2003) state that farmers use handheld devices to capture and transfer data when they are in the field. The farmers using such devices found them very helpful in streamlining data entry process, running models of pest development, generating field reports of pest status, accessing historical data for crops and insects as well as saving them time, the authors added. Farmers interviewed also postulated the need for mobile devices they can use when in the field. These mobile devices help improve communication with other stakeholders as well as for other reasons such as data integrity, maintaining data integrity, consistency and time saving (Bange et al., 2003). The limited use of mobile devices is as a result of the low penetration of mobile coverage in the area covered by the research. This may not be of importance in other areas where mobile coverage is sufficient. However, handheld devices such as tablet computer and connection to the wireless broadband provided by their internet service provider can be utilised when farmers are operating in the vineyards.

GIS combined with remote sensing technology was also mentioned as another type of technology farmers utilise when making decisions (ESRI, 2007). The GIS specialist interviewed articulated that he is often invited by farmers to use the GIS to analyse their farm structure and help to accurately determine and control inputs, save preventive expense and reduce the amount of harm to the soil as the ESRI (2007) reported. The farmers interviewed also indicated their need for GPS/GIS and remote sensing technologies in their business since their use assist farmers with better understanding of risk factors, better resource management and more accurate support for decision making as ESRI (2007) pointed out.

5.10 Slow uptake of DSS by emerging farmers

RQ: Why is there slow uptake of decision support systems by emerging farmers?

Anger et al. (1994) and Nguyen et al. (2006) report that DSS uptake has been slow in agriculture with Parker & Campion (1997) suggesting that the reason could be the lack of interest in such systems when they are packaged and presented for use by the consultant and farmer.

Cox (1995) identifies the following reasons for the slow uptake of DSS in agriculture: failure to support more than the exceptional circumstance, computerisation, complexity, inputs and failure to show cost benefits. The consultants interviewed in this study to a great extend agree with Cox (1995). A quarter of the consultants interviewed mentioned the lack of communication as one of the reasons, emerging farmers might not be constantly updated with technology trends hence missing out on such technologies. As Cox (1995) articulates, half of the consultants interviewed reiterated that cost is one of the reasons for the slow uptake. The consultants stated that the technologies are expensive and beyond the farmers' reach. Lack of knowledge on the benefits of adopting the DSS is also reported as one of the reasons for the slow uptake by consultants suggesting that farmers would be more willing if they see it working for colleagues who adopted it. This concurs with Cox (1995)'s assertions when he mentioned failure to show cost benefits as another reason for slow uptake. The consultants also postulated that farmers are not really keen on changing their ways of operating, something which can be linked to the reason given above. Moreover, the lack of training is also stated in the interviews with consultants as one of the reasons for the slow uptake. Farmers need to be given technical skills so that they appreciate and be more willing to implement the decision support tools.

A quarter of the vendors mentioned technophobia as one of the reasons for the slow uptake. The lack of knowledge of the benefits was reported by 75% of the vendors with a quarter linking this to information overload hence farmers end up confused and not confident with these technologies. Cost also emerged as one of the reasons why there is slow uptake of DSS by emerging farmers. 25% of the vendors interviewed however pointed out that farmers just want to go out and work in the fields and are not interested in using ICTs and making calculations etc. This concurs with Cox (1995)'s assertions when he mentions complexity as one of the reasons for the slow uptake in his study.

Although the study (Cox, 1995) is 17 years old the reasons he mentions are still relevant today. In addition the study is one of the few references the researcher could get on this topic.

5.11 Emerging farmers' future

Two-thirds of the farmers when asked about the future of the wine industry in terms of their use of ICTs in decision making said it will grow at a fast pace with one farmer mentioning

that "it is going to be turned upside down completely". One farmer suggests that the use of ICTs in supporting decision making is underestimated. However, a third of the interviewed farmers said the industry will suffer since they are struggling as a result of the lack of support. This was supported by the assertions of 83% of the farmers interviewed who indicated that government is not doing enough to help farmers. They suggest that the reasons for the success of some countries when it comes to ICT use to support decision making is largely because of the support they receive from government. The farmers are of the opinion that government should subsidise farmers for example subsiding the cost of acquiring technology. However, 17% of the farmers who indicated that they hate the idea of government subsidies and would prefer that government assists the farmers by reducing export levies.

All the vendors believe there is going to be growth in the use of ICTs supporting decision making in the industry. However, 50% mentioned the need to make the emerging farmers realise the importance of the technology, and appreciate them with 50% of the vendors suggesting that there is need for academic institutions to collaborate with private institutions to support the use of ICTs in decision making by the farmers. All vendors agree the farmers need to be equipped with technical skills through training. The academic institutions can help with the training of the farmers and equip them with the necessary skills. 25% of the vendors however are of the opinion that farmers need to learn to train themselves and equip themselves with technical skills. This assertion concurs with the idea of developing an e-learning system where farmers learn on their own on how best they can use the ICTs.

All the consultants agree there is a need to equip farmers with technical skills to improve the use of ICTs in decision making. 75% believe the government should help provide the trainers or fund the training. One consultant pointed out that government should pay the consultants enough money to provide their expertise in helping emerging farmers. Another consultant also suggested that government should engage external trainers who can help equip the farmers with the technical skills as well as carrying out a skills audit to determine the skills in need. He further stated that government should provide the technology as well as support for the technology freely to the emerging farmers. The consultant further emphasised the need to equip the community with the technical skills as well by training kids on computer skills. One consultant who acknowledges the need for the external stakeholders to assist the farmers with technical skills clearly pointed out that he is not for the idea of government subsidies at all.

75% of the consultants mentioned that there will be an increase in the use of ICTs in decision making, with 25% of them stating that without ICTs the industry will not survive, "the

more you ignore technology the more you shoot yourself in the foot". However, 25% postulate that the use of ICTs in decision making will not increase drastically, since the industry is having financial difficulties. He however, stated that farmers not using ICTs in decision making "should start adopting them now".

5.12 Summary

This chapter addressed the themes developed, headline findings as well as answering the research questions. The following themes emerged: agricultural domain knowledge, family, finance, importance of ICTs, information resources, labourers, marketing, mobility, quality information, risk management, strategy, costs and training. Farmers view ICTs as crucial in their business. The study also found out that family, neighbours, consultants, vendors, and labourers are important contributors to information and decision making. Training will assist in making quality decisions. High costs, poor network coverage and lack of training emerged as obstacles hindering more ICT use for decision making in the industry. The study also found out that integrated ICT approach is needed to optimise flow of information within the industry. All the interviewees agreed that decision making is important and determines the success of the business. The respondents also indicated that ICTs used in decision making to a greater extend results in better decision making for their business.

CHAPTER SIX

RECOMMENDATION AND CONCLUSIONS

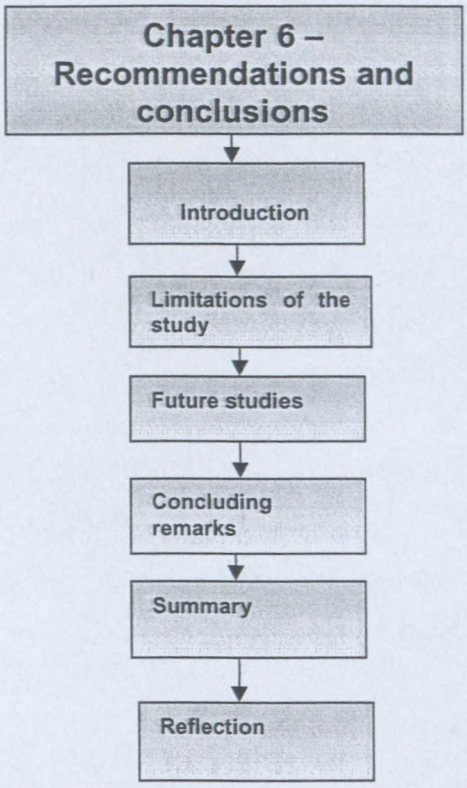

Figure 6.1: Graphical representation of Chapter 6

6.1 Introduction

The environment emerging farmers operate in is complex and they are at a distinct disadvantage as they have no previous knowledge of farming. Emerging farmers do not have the experience, knowledge and tools to make quality decisions. This has the potential of reducing profitability and sustainability of the emerging farmers who have entered the industry. This problem lead to the main research question namely how emerging farmers can utilise ICT for decision making in the wine industry in the Breede River Valley region in the Western Cape?

The research concurred with literature that agriculture as a whole and specifically long term

crops such as vines and fruit trees. The research showed that information needed by farmers (emerging as well as established) must be of high quality. This implies, relevant, useful and especially timeously information. The relevance and importance of ICT have been expressed by all involved in the research.

This chapter presents the summary of the study as well as the highlights of the main research findings, recommendations as well as conclusions from the study. The study addresses the use of ICTs by farmers in the Breede River Valley of the Western Cape to support their decision making. This study aims to present how the farmers use the information communication technologies to support their decision making. The research results and the findings summarised Table 1.1 may be used to advise ***emerging farmers*** in the wine industry and those wanting to venture into it on how they possibly can utilise ICTs to support their decision making.

Table 6.1: Summary of the research findings

Sub-question 1	Farmers know the importance of strategic, tactical and operational decisions to be a successful farmer
Sub-question 2	Consider profitability of the business. Consider market trends and demands. Quality products
Sub-question 1 and 3	Financial decisions are based on different sources such as record keeping, bank and financial statements.
Sub-question 1 and 4	ICT is widely used in decision making by the responding farmers and is critical in their decision making processes
Sub-question 5	Uncertainty about ICTs, lack of training and high costs is barriers for emerging farmers to adopt ICT and use it in the decision making processes
Sub-question 3 and 5	Information on all aspects of the wine farming industry is needed.
Sub-question 3 and 5	Experience and history, combined with research, and training is needed for successful wine farming enterprises

Sub-question 1 and 5	Labourers play an important part in decision making processes on the farm
Sub-question 1, 3 and 5	Marketing and especially information on local as well as international market trends are important
Sub-question 4 and 5	Farmers are adopting mobile technology and the internet more and more as information tools.
Sub-question 1 and 5	Quality is a non negotiable issue for the farmers to be successful and ICT plays an important role in reaching this goal.
Sub-question 1 and 5	Farmers use ICT as a risk assessment tool.
Sub-question 1, 3 and 5	For decision making farmers make use of many different sources to gather information before making decisions.
Sub-question 1 and 5	ICT is seen as a tool to shorten the decision time cycle on farms

6.2 Recommendations

To improve the use of ICTs in supporting farmers in decision making a number of issues need to be addressed especially for emerging farmers who have little or no experience in the industry. The recommendations presented below also targets the stakeholders in the wine industry such as government, wine makers, academic institutions, suppliers and service providers.

Co-decision making: This is when farmers consult their employees in certain decisions where their input is much valued. Ignoring workers' opinion in decision making might adversely affect the farmers' business. An example would be recruitment; farmers are encouraged to rely on their workers to help them select the best candidate for the vacant job. The supervisor for example who works with the labourers in the vineyards knows the attributes a good worker should possess, hence his input will be beneficial in recruiting labourers.

Market trend analysis: Market trend analysis and constant information update from buyers and wine makers is a great source of information which no farmer should ignore. The use of

ICTs to gather information on market trends helps farmers make crucial decisions as they plan and decide what to grow and in what quantities. It will be useless for a farmer to ignore the market trends and continue growing varieties which are not in demand at the market because he risks making huge losses.

Importance of experience: Even though two-thirds of the farmers interviewed rely on their accumulated experience when making decisions, none mentioned that they solely rely on it in their decision making contrary to a number of literatures. The idea of always believing in second opinion by one of the most experienced farmers (eighteen to thirty seven years) means experience alone is not adequate especially bearing in mind the complexity of the wine industry. Emerging farmers should seek advice from external advisors as well as fellow neighbouring farmers and avoid relying only on their experience.

Mobile devices: All the farmers, consultants and vendors interviewed agreed that the use of mobile devices is crucial in supporting farmers in decision making. There is therefore needed to keep encouraging farmers to effectively use their mobiles in assisting their decision making. They can use the mobile devices to capture data such as images, videos, description of a new type of pests attacking their vineyards etc. The information can then be directly send to a consultant who can then provide prompt advice who can then use the advice to immediately try and limit or avoid any adverse effects the situation can cause. However some farmers do not have cell phone coverage on their farms and from the interviews the farmers mourned of their lack of cell phone coverage as it is such a major drawback to them when it comes to effective decision making. They appealed to service providers to assist them by extending the coverage to them. Cell phone providers should heed the farmers' appeal since this will definitely bring them more business because the farmers desperately need the coverage and will surely use it when the service providers extend it to them.

Internet: There has been an increase in the use of the internet for the past few years due to increased bandwidth and affordability of internet services. Farmers also have not been an exception with all the interviewed farmers connected to the internet. Internet has a lot of benefits such as access to important information on weather, markets etc, it also provides better and effective communication with stakeholders through emails or Voice over Internet (VoIP) such as Skype or Google video chat.

Videos for training: Farmers, vendors and consultants all concur that farmers need training on how best they can use ICTs to support their decision making. Emerging farmers

especially are very much in need of training if they are to effectively use ICTs to support decision making in their business. Use of videos can be a very good way to train farmers on such technologies. Vendors and consultants in collaboration with academic institutions and private organisations can produce videos which can be shared on emails to farmers or on social network sites. Farmers will need to be trained on how best they can download videos on emails or how to play videos from social network sites such as Facebook, Youtube, Twitter etc. Once farmers learnt how to play the video, the experts can then upload the videos from their offices for farmers learn how best they can use ICTs in their business for decision support as well as for other farm processes like fertiliser application, pest control or irrigation.

Grapelook: Funded by Department of Agriculture, Western Cape supported by the Department of Agriculture, Forestry and Fisheries as well as other institutions; www.fruilook.co.za the successor of www.grapelook.co.za was launched in January 2012. It is a very useful web tool which is capable of positively transforming the farmer's decision making and his business as a whole. Farmers can sign up for free to enjoy the service. It uses satellite imaging to provide 9 parameters to monitor the farmer's vineyard. They are sorted into 3 logical groups namely growth, moisture and minerals. These parameters include: biomass production (kg/ha/week), Leaf Area Index – LAI (m2 leaf/ m2 soil), vegetation index, evaporation deficit (mm/week), actual evapotranspiration (mm//week), crop factor (-), biomass water use efficiency (kg/m2 of water), nitrogen in upper leaf layer (kg/ha) and nitrogen in leaf (kg/ha). Fruitlook.co.za provides the 9 parameters every week during the growth season from October to April. As the website also states, knowledge of the parameters helps the farmer understand where irrigation water and nutrients are required and how much to apply.

Subsidies: The majority of the farmers believe that government's support by way of subsidies can help improve their use of ICTs in their business to support decision making. They pointed out to the higher costs of technology as a hindrance to effective use of these decision support tools. Emerging farmers need support from government or other private organisations to help improve their use of these DSSs, with some consultants suggesting that the emerging farmers should be provided with computers and the infrastructure necessary as well as the expertise to support them. This is relevant and useful since the wine industry is complex and for emerging farmers to succeed they really need to be well equipped to survive and since most of them do not have enough funds government support can really make a difference. Reducing the farmers' export costs and levies can also be a big boost for emerging farmers.

6.3 Limitations of the study

The limited number of respondents in this study can be a limitation; the validity of the results could have been strengthened with more respondents. However in-depth interviews were used to get more in-depth analysis of the situation but in the future a large sampling frame with more respondents could be used. The limited number of respondents is because it was difficult to get willing farmers, emerging farmers, vendors and consultants who could give their time for the interviews due to busy schedules and commitments. Some emerging farmers actually indicated that they are not willing to give their time if they are not benefiting anything from the interviews even though the benefits were explained to them they wanted immediate tangible benefits and the researcher did not have money to pay them for the interviews. Some consultants would simply not respond to efforts made to communicate with them or not owning up to their appointments.

The unwillingness to co-operate could be because few months before the field work, a report was produced which caused an outcry since wine farmers were not happy the findings. This caused some farmers to be unwilling to take part in interviews with researchers.

This study focused on a case study therefore the research results may not be accepted at face value to be representative of the entire South African agricultural community and industry. There is need for more investigation and research in the other farming areas to reach a general conclusion.

6.4 Future studies

There are possible extensions to this study which might be explored further, these include:

E-learning model: An e-learning model, as a follow up to this study can be developed to help train farmers on how best they can utilise ICTs to support decision making. Most of the respondents, farmers, vendors, consultants as well as emerging farmers pointed out the need for training to better improve the farmers' use of decision support tools. This is crucial since farmers need to understand how important ICTs are in their decision making and be taught on how best they can use them and realise their benefits.

Expanded study: Since this study only focused on the wine industry it only gives a partial

picture of the use of ICTs in decision support in agriculture. If more studies in other agricultural fields such as grain crops, poultry, dairy etc could be investigated then a broader picture on the use of ICTs to aid decision making in agriculture could be highlighted. Exploring other regions could also give a better picture on the study.

Government policy: Government policy on support of well established farmers should also be revisited considering all well established farmers and emerging farmers interviewed expect the government to improve their support to them. Government can assist farmers who do not have enough funds to acquire the decision support tools on their own. However as one consultant suggested, strict measures should be implemented to ensure the resources are not abused and skilled expertise are provided to assist the farmers in realising the full benefits of utilising the ICTs for decision making. Government can also look into the export costs the farmers incur when exporting their products and choose to reduce or remove levies which might jeopardise the industry's success.

6.5 Concluding remarks

The research objectives for this study formulated earlier on were achieved and the use of information communication technologies to aid decision making by farmers was explored. The study discussed how farmers reach a decision in their farming operations, the broad categories of decisions they make as well as the kind of information they require to support their decision making. The technologies farmers require to support their decision making was also discussed and the ICT infrastructure they need to support their decision making. The farmers are responsible for the entire strategic, tactical and operational decision making both on farm and off farm. They rely on several types of information which they access through the use of a number of ICTs they use in their business.

Objectives

Establish how farmers reach a decision in their farming operations: Farmers consider profitability, history, market trends, financial and risk assesment and the need to produce quality products when making decisions. They also use accumulated experience; consult fellow farmers and consultants to reach a decision.

Establish what broad categories of decisions they make: The farmers make labour decisions, operational decisions, marketing and financial decisions as well as tactical and strategic decisions.

Determine what information do farmers require to support them in decision making: Farmers require information on market trends and analysis, information on soil type and classification, technical information on fertiliser and chemical application, weather data, information on industry statistics and performance to support decision making.

Determine what technologies do farmers require to support them in decision making: The following technologies are used by farmers to support decision making: cell phones, computers, internet, GPS and GIS, software packages, email, television, landline phones, computerised irrigation and pesticide application programs.

To find out the ICT infrastructure farmers need to support their decision making: Farmers need ICTs which are able to provide them with them with quick access to relevant information as well as ICTs which are able to keep them in touch with their customers, consultants and service providers. The ICTs capable of giving them access to information and data on market trends and analysis are also favoured. The need for integrated ICT system capable of interacting and working together was highly emphasied.

To investigate why there is slow uptake of decision support tools by emerging farmers: Reasons for the slow uptake of DSS tools by emerging farmers are the high costs beyond the reach of emerging farmers as well as lack of communication about the technologies. Unwillingness to change ways of operating emerged as one of the reasons why emerging farmers are not keen to adopt the DSS. Moreover lack of knowledge on the benefits of adopting the DSS is another reason why there is slow uptake of DSS by emerging farmers.

The results of the study indicate that for effective decision making farmers rely on several ICTs which provide them with important information they utilise in decision making. The farmers confessed that it will be very hard for them to operate without the use of the technologies which have become their source of information before they reach a decision. Emerging farmers in the wine industry and those contemplating of venturing into the industry should embrace these ICTs and comprehend their importance in their overall business if they are to survive and succeed in the complex industry.

6.6 Summary

Problem statement:

The environment emerging farmers operate in is complex and they are at a distinct disadvantage as they have no previous knowledge of farming. Emerging farmers do not have the experience, knowledge and tools to make quality decisions. This has the potential of reducing profitability and sustainability of the emerging farmers who have entered the industry.

Though they do not have previous knowledge, the use of ICTs to support decision making can aid emerging farmers get relevant information they need. Moreover they can make use of consultants and vendors who have experience and technical knowhow to help them. Market trends and analysis is also fundamental since it gives the farmers information about the history and status of their market.

Research question

How can emerging farmers utilise ICT for decision making in the wine industry in the Breede River Valley region in the Western Cape?

The emerging farmers can use the ICTs for market trends and analysis, to analyse farm terroir analysis using GPS and GIS analysis. Weather, financial analysis/planning, internet and mobile banking, book keeping and record keeping, soil analysis as well as communication with email, mobile devices and landline phones are ways in which emerging farmers can use ICTs in aiding decision making.

Emerging farmers should view ICTs for decision making as fundamental in the success of their business.

6.7 Reflection

The study started off with the aim of exploring the use of DSSs by wine farmers in the Breede River Valley. The intention was to explore all the ICTs the farmers use in supporting decision making. The majority of the literature focused on other wine producing areas around the world yet not much was done for South African wine industry. This also added on to the reasons why the study is relevant. Literature analysis was done on how ICTs are used in decision making in other countries as well as the reasons why the slow uptake of the DSS

has been slow.

Data was gathered to find out what decision support tools are available and how farmers are using technology to support decision making. It was encouraging to find out the majority of the farmers use technology to gather information which aids their decision making. However it was discouraging to discover that most emerging farmers were not interested in participating in the research. This ignorance could be another reason why their uptake of decision support tools is slow. Cell phone which is one of the most commonly used technology in communicating was popular among the respondents but it was surprising to discover that some areas have no or poor cell phone coverage.
As mentioned above I was suppressed by the lack of enthusiasm by emerging farmers for the research. There are most probibily many reasons for this phenomenon. Perhaps I should have spent more time on educating and explaining the purpose of the research in an endeavour to get more emerging farmers to participate.

On the other hand, it supprised me how important the established faremers, vendors and consutltants viewed the research. It is clear to me that they welcome new players In the industry and that they are willing to support the research in order to further the industry.

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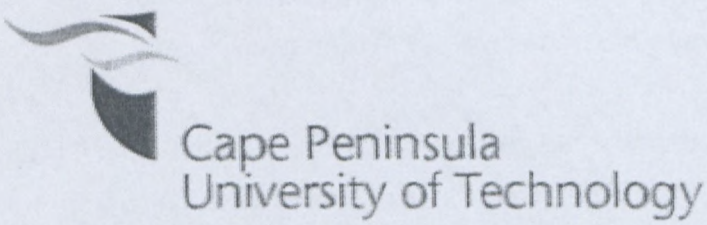
APPENDICES

APPENDIX A: INTERVIEW CONSENT FORM



Questionnaire to be used for interviews with the farmers

A research survey investigating the use of ICT in the wine industry to support decision making.

This survey's aim is to investigate and assess the use of ICT (for example, computers, global positioning systems, precision farming, tracking equipment, Internet, fax, printer, e-mail, websites, landline/mobile phones, e-commerce and other computerized agricultural systems) in agriculture. It will focus on the use of different forms of ICT in support farmers in their decision making in the Western Cape.

The results of the study will portray how ICTs are used to support decision making. This will help to assist emerging farmers on the best ICTs they can adopt to support them in decision making. With the final output from the survey, a Master's thesis will be developed and submitted at the end of the academic year 2011.

The interview is expected to take approximately 25 to 30 minutes.

Informed consent

Participation of farmers in this survey is completely voluntary. Participants are assured that all their information will be strictly confidential and anonymous. No references will be made to specific individuals. All the responses will be used for academic purposes only. All questions are answered to your satisfaction and if for any reason you feel it's inappropriate to answer certain questions, you are free to mention it to the interviewer. Your honesty and cooperation is greatly appreciated. We would be grateful for your favourable contribution towards the success of this interview.

Signed .....

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APPENDIX B: QUESTIONNAIRE FOR INTERVIEWS WITH THE FARMERS

The interview questions formulated will enable the researcher to get direct hand information from the people in the industry being researched. The people directly involved in decision making in the wine industry in the Western Cape will be interviewed. These include the farmers and farm managers since they are the once involved in farm decision making.

The term ICTs will be used more often during interviews, therefore it is best to define it first. Tembo (2008) described ICTs as a set of activities that consists of hardware, software, networks and the media that facilitate or make it easy to collect, store, process, transit, present and communicate information (voice, data, text, images) using electronic means. This includes computers, printers, telephones, fax, internet, email, mobile phones, landline phones, e-commerce etc. In her definition, similar to Tembo's, Tinio (2002) defined ICT as a diverse set of technological tools and resources used to communicate, and to create, disseminate, store and manage information. She further mentioned that these technologies include computers, the internet, broadcasting technologies (radio and television) and telephony.

To help answer the main research question which is how emerging farmers can utilise ICT in decision making in the wine industry in the Breede River Valley region in the Western Cape? The following questions will be asked.

Research questions	Interview questions	Objectives	Comments
Questions about the farm context	**Farm context** How big is your farm? – i.e. hectares in production, number of employees, annual turnover. Besides growing grapes what other farming activities or operations are you involved with? Are you the farm manager or the owner of this farm? For how long have you been in this position? What are your roles/responsibilities on this farm?	To have some context of what's happening at the farm	
Research question: How can emerging farmers utilise ICTs in decision making in the wine industry in the Breede River Valley region of the Western Cape Province of South Africa?			
Research Sub questions: a) How do farmers make their decisions	Have you been an emerging farmer before? Which functions or farming operations do you consider most important? Why do you consider these functions most important? How do you prioritise your farming tasks? How is decision making an important aspect of farming operations to you? How often do you make strategic farming decisions? Do you delegate decision making? What operational, tactical and strategic decisions do you consider crucial? Why? Why do you consider those decisions more important? How do you reach a decision in your operations? What criteria do you utilise when making decisions? (If not mentioned above) Do you use your accumulated experience and knowledge in making decisions and to what extend do you use your experience and knowledge?	Establish how farmers reach a decision in their farming operations. This helps identifies the decision making trends in the farmers' decision making. It also helps identify if there is use of ICTs in their decision making. v) To establish if they really value decision making and invest in it – do they have systems to help them or do they even think of it. vi) To establish (between farm owner and manager) which one of them is more involved in decision making. xi. To compare with findings from literature – a lot of literature points out that most farmers rely on accumulated experience and knowledge in decision making	
b) What type of decisions do the farmers make	What kind of decisions do you make?	Establish what broad categories of decisions farmers make.	

c) What information is required to support types of decisions the farmers make?	What information or resources do you need in decision making for the categories (mentioned above)? Is the information that you get adequate for your situation and decisions you make? What information do you consider lacking that could improve your decision making and your business as a whole? What do you think needs to be done to improve the availability and accessibility of such information? (If no mention of consultants from the responses) Do you sometimes rely on advice from consultants when making decisions and how often, and how useful has the advice been in your business?	Find out what kind of information do farmers require to support them in decision making iii. Farmers might be aware of sources of info which might aid them in decision making but might not have the technology or it might not be accessible to them at the moment. v. to establish if they rely on consultants in decision making	
d) What technologies are being used by farmers to support their decision making	Which ICTs do you use (need to define ICTs since they may view ICTs differently) in your farming operations? How do you connect to the world – i.e. what technologies do you use to communicate with other stakeholders (customer, suppliers etc) To what extent do you use ICTs in your business? Which general software do you use? Which farm-specific software do you use? (If not mentioned above) Do you use ICTs when making decisions? Which ICTs do you use in decision making? What kinds of decisions demand the use of ICTs? Are the ICTs able to yield the desired outcomes/ support the decision making functions? Would you be able to operate without use of ICTs in your business? To what extent do ICTs result in better decision making for your business? What technologies do you think are best suited to support your decision making? What can be done to make the technologies available or accessible?	Find out what technologies is available to support their decision making	
e) What are the farmers' requirements for ICTs to support decision making.	What kind of ICT infrastructure do you think is best to support your decision making? Is this infrastructure existent on your farm? What requirements do the ICTs need to meet to be able to effectively support your decision making? What are some of the barriers to meeting those requirements? What can be done to avoid the above	To find out the ICT infrastructure farmers need to support their decision making. i. Farmers mmight have been to other farms or learnt about some	

	barriers?	kind of infrastructure they think will work best to support their decision making. v. To give farmers platform to point out what they think will avoid the mentioned barriers.	
Conclusion	Conclusion In summary how do you compare the wine industry in the Western Cape to the other wine industries in other countries worldwide in terms of ICT use in decision making? What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use and adoption of these technologies in the region? How do you see the industry in the next few years in terms of the use of ICT in decision making?	To find out farmers' comments on the use of ICT in decision making, what they think needs to be done and how they compare their industry to others globally.	

Thanks you so much for your taking time off your busy schedule to attend the interview, much appreciated.

APPENDIX C: QUESTIONNAIRE FOR INTERVIEWS WITH EMERGING FARMERS

Research questions	Interview questions	Objectives	Comments
Questions about the farm context	**Farm context** i. How big is your farm? – i.e. hectares in production, number of employees, annual turnover. ii. Besides growing grapes what other farming activities or operations are you involved with? iii. Are you the farm manager or the owner of this farm? iv. For how long have you been in this position? v. What are your roles/responsibilities on this farm?	To have some context of what's happening at the farm	
Research question: How can emerging farmers utilise ICTs in decision making in the wine industry in the Breede River Valley region of the Western Cape Province of South Africa?			
Research Sub questions: a) How do farmers make their decisions	i. Which functions or farming operations do you consider most important? vi. Why do you consider these functions most important? vii. How do you prioritise your farming tasks? viii. How is decision making an important aspect of farming operations to you? ix. How often do you make strategic farming decisions? x. Do you delegate decision making? xi. What operational, tactical and strategic decisions do you consider crucial? Why? xii. Why do you consider those decisions more important? xiii. How do you reach a decision in your operations? xiv. What criteria do you utilise when making decisions? xv. (If not mentioned above) Do you use your accumulated experience and knowledge in making decisions and to what extend do you use your experience and knowledge?	Establish how farmers reach a decision in their farming operations. This helps identifies the decision making trends in the farmers' decision making. It also helps identify if there is use of ICTs in their decision making. v) To establish if they really value decision making and invest in it – do they have systems to help them or do they even think of it. vi) To establish (between farm owner and manager) which one of them is more involved in decision making. xi. To compare with findings from literature – a lot of literature points out that most farmers rely on accumulated experience and knowledge in decision making	
b) What type of decisions do the	What kind of decisions do you make?	Establish what broad categories	

farmers make		of decisions farmers make.	
c) What information is required to support types of decisions the farmers make?	i. What information or resources do you need in decision making for the categories (mentioned above)? ii. Is the information that you get adequate for your situation and decisions you make? iii. What information do you consider lacking that could improve your decision making and your business as a whole? iv. What do you think needs to be done to improve the availability and accessibility of such information? v. (If no mention of consultants from the responses) Do you sometimes rely on advice from consultants when making decisions and how often, and how useful has the advice been in your business?	Find out what kind of information do farmers require to support them in decision making iii. Farmers might be aware of sources of info which might aid them in decision making but might not have the technology or it might not be accessible to them at the moment. v. to establish if they rely on consultants in decision making	
d) What technologies are being used by farmers to support their decision making	i. Which ICTs do you use (need to define ICTs since they may view ICTs differently) in your farming operations? ii. How do you connect to the world – i.e. what technologies do you use to communicate with other stakeholders (customer, suppliers etc) iii. To what extent do you use ICTs in your business? iv. Which general software do you use? v. Which farm-specific software do you use? vi. (If not mentioned above) Do you use ICTs when making decisions? vii. Which ICTs do you use in decision making? viii. What kinds of decisions demand the use of ICTs? ix. Are the ICTs able to yield the desired outcomes/ support the decision making functions? x. Would you be able to operate without use of ICTs in your business? xi. To what extent do ICTs result in better decision making for your business? xii. What technologies do you think are best suited to support your decision making? xiii. What can be done to make the technologies available or accessible?	Find out what technologies is available to support their decision making	
e) What are the farmers' requirements for ICTs to support	i. What kind of ICT infrastructure do you think is best to support your decision making? ii. Is this infrastructure existent on your	To find out the ICT infrastructure farmers need to support their	

decision making.	farm? iii. What requirements do the ICTs need to meet to be able to effectively support your decision making? iv. What are some of the barriers to meeting those requirements? v. What can be done to avoid the above barriers?	decision making. i. Farmers mmight have been to other farms or learnt about some kind of infrastructure they think will work best to support their decision making. v. To give farmers platform to point out what they think will avoid the mentioned barriers.	
Conclusion	Conclusion i. In summary how do you compare the wine industry in the Western Cape to the other wine industries in other countries worldwide in terms of ICT use in decision making? ii. What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use and adoption of these technologies in the region? iii. How do you see the industry in the next few years in terms of the use of ICT in decision making?	To find out farmers' comments on the use of ICT in decision making, what they think needs to be done and how they compare their industry to others globally.	

APPENDIX D: QUESTIONNAIRE FOR INTERVIEWS WITH VENDORS

What technologies are being used by farmers to support their decision making	Which ICTs do farmers use in their farming operations? To what extent do they use ICTs in their business? (If not mentioned above) Do the farmers use ICTs when making decisions? Which ICTs do they use in decision making? What kinds of decisions require the use of ICTs? Are the ICTs able to yield the desired outcomes/ support the decision making functions? Would the farmers be able to operate without use of ICTs in their businesses? To what extend do ICTs result in better decision making for the farmers? What technologies do you think are best suited to support their decision making? If they are not available why are the farmers not using the technologies? What can be done to make the technologies available or accessible?	Find out what technologies is available to support farmers in decision making	
What are the farmers' requirements for ICTs to support decision making.	What kind of ICT infrastructure do you think is best to support farmers in decision making? Is this infrastructure existent? What requirements do the ICTs need to meet to be able to effectively support farmers' decision making? What are some of the hindrances to meeting those requirements? What can be done to avoid the above hindrances?	To find out the ICT infrastructure farmers need to support their decision making	
Why is there slow uptake of decision support systems by emerging farmers	How do you assess the uptake of DSSs by farmers in the wine industry in the Western Cape? How do you assess the uptake/adoption of DSSs by emerging farmers in the Western Cape region? What is the tempo of the uptake? – is it slow or fast What do you think is the reason for the slow uptake of DSSs by emerging farmers? (If there is slow uptake) What do you think needs to be done to speed up the uptake and use of DSSs by the emerging farmers in your region? What could have been done or could be done to avoid the slow uptake of DSSs by wine farmers in the region?	To investigate why there is slow uptake of decision support tools by emerging farmers	
Conclusion	**Conclusion** In summary how do you compare the wine industry in the Western Cape to the other wine industries in other countries worldwide in terms of ICT use in decision making? What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use	To find out vendors' comments on the use of ICT in decision making, what they think needs to be done and how they	

	and adoption of these technologies in the region? How do you see the industry in the next few years in terms of the use of ICT in decision making?	compare the Western Cape wine industry to others globally.	

APPENDIX E: QUESTIONNAIRE FOR INTERVIEWS WITH CONSULTANTS, GOVERNMENT OFFICIALS/ WESTERN CAPE AGRICULTURE AUTHORITIES

What technologies are being used by farmers to support their decision making	Which ICTs do farmers use in their farming operations? To what extent do they use ICTs in their business? (If not mentioned above) Do the farmers use ICTs when making decisions? Which ICTs do they use in decision making? What kinds of decisions require the use of ICTs? Are the ICTs able to yield the desired outcomes/ support the decision making functions? Would the farmers be able to operate without use of ICTs in their businesses? To what extend do ICTs result in better decision making for the farmers? What technologies do you think are best suited to support their decision making? What can be done to make the technologies available or accessible?	Find out what technologies is available to support farmers in decision making	
What are the farmers' requirements for ICTs to support decision making.	What kind of ICT infrastructure do you think is best to support farmers in decision making? Is this infrastructure existent? What requirements do the ICTs need to meet to be able to effectively support farmers' decision making? What are some of the barriers to meeting those requirements? What can be done to avoid the above barriers?	To find out the ICT infrastructure farmers need to support their decision making	
Conclusion	**Conclusion** In summary how do you compare the wine industry in the Breede River Valley, Western Cape to the other wine regions or other wine industries in other countries worldwide in terms of ICT use in decision making? What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use and adoption of these technologies in the region? How do you see the industry in the next few years in terms of the use of ICT in decision making?	To find out government officials' comments on the use of ICT in decision making, what they think needs to be done and how they compare their Western Cape wine industry to others globally.	

APPENDIX F: FARMERS' INTERVIEW RESPONSES

Interview questions	Farmer A	Farmer B	Farmer C	Farmer D	Farmer E	Farmer F	Summary
Farm context							
i. How big is your? i.e. number of hectares, employees etc	50 hectares	80 hectares	350 hectares	104 hectares	65 hectares	50	
ii. Besides growing grapes what other farming activities or operations are you involved with?	Peaches, apricots	Lucerne Peaches Apricots	Apricots	Peaches Apricots Lucerne	Apricots Plums Peaches	Lucerne Cattle farming	In addition to wine farming, the farmers also grow apricots, peaches, plums and lucerne.
iii. Are you the farm manager or the owner	Farm owner	Farm owner	Farm owner	Farm owner	Farm owner	Farm owner	All are farm owners
iv. For how long have you been in this position	30 years	37 years	22 years	6 years	18 years	24 years	
What are your roles and responsibilities on this farm?	Overall management of the farm and its operations	Responsible for overall farm management	Overall management of the farm Financial planning Assigning daily duties	Responsible for overall farm management. Works in conjunction with farmers in managing the farm	Responsible for overall farm management.	Involved in all farm management tasks.	Responsible for overall farm management
a. How do farmers make their decisions							

i. Have you been an emerging farmer before?	Yes	Yes	Yes	No	No	Yes – bought the farm	Most have been emerging farmers before

ii. Which functions or farming operations do you consider most important ?	- Long-term planning working hand in hand with extension officers and buyers(wine makers) to ascertain market trends - Budgeting With help of extension officers as well He needs to do that to see if his business will be profitable	Soil preparation When establishing vineyards for the first time	Financial management – management of capital, determining profitability of the business Feasibility analysis	Planning i.e. decision making	Reading the market – checking export market. Establishing good relationship with workers.	Market establishment. Disease prevention.	Financial planning, market assessment, decision making
iii. Why do you consider these functions most important ?	To determine profitability – helps him see if what he is doing is profitable	Determines type of irrigation, pesticides and fertilisers etc to apply	Help assess if the business will is feasible. Determines if he will realise profits from his operations as well. Helps him manage his finances	Helps establish if the market is available for certain crop and establish which cultivar is on demand. Helps establish which cultivar works best on the type of soil.	Determines what's on demand on the market. Good relationship with workers is good for his business.	It's crucial to establish what's on demand on the market to avoid running loss. Disease prevention ensure that we produce quality products.	Helps to determine profitability and market demands which are very crucial aspects of business.
iv. How do you prioritise your farming tasks?	Labour management Financial planning/budgeting Time of the year determines what to do	Considers the farm terroir Considers which functions will make him realise more income	"It's a feeling". Experience is important	Financial planning Goal setting Use target – targeted tonnage. Always study market trends because they change.	Focuses on producing quality products. "Quality is very crucial".	Try to meet market demands by growing right cultivars and ensuring we produce the best quality.	Financial planning, profitability and market assessment, quality first.

v. How is decision making an important aspect of farming operations to you?	Decision making is very crucial. Decisions you make today have long term effect on your business	Yes it is because without it you won't be successful	It's important aspect of farming business. ***Before ICTs used to plan with notebooks***	Very important.	Decision making is very important because decisions made today affect the business' future.	It's very crucial, it affects and determined success of your business	It is very important aspect of the farming business.
vi. How often do you make strategic farming decisions?	Monthly basis Financial Book keeping – cash flows branch analysis	Continuous Every day, every week	Continuously – continuous planning Looks at external factors as well – they influence the business.	Once a year, revisits his strategy. Does a lot of budgeting.	Continuously. April and May after harvesting is when he usually do strategic decision making.	Continuously need to plan ahead and strategise.	
vii. Do you delegate decision making?	Yes – values his workers and delegates various functions	Yes Co-decision making with employee	Yes	"Yes absolutely", farm workers are very crucial. Stressed the importance of valuing and working together with farm workers	Delegate operational decision making.	Yes	Yes they practise co-decision making with their employees (mainly on day to day decisions) not strategic.
Viii.What operational, tactical and strategic decisions do you consider crucial? Why?	Long term planning Budgeting Labour management They help determine what's on demand on the market and thus what the farmer need to do to be profitable in business	Marketing - Considers the target market before making decisions Financial and market view of specific decisions	Financial planning Continuously consult external advisors on market trends. Looking forward to diversify his business. In the long run he is	Financial planning	Financial planning Operational decisions such as deciding on spraying etc. Labour management.	Financial planning Marketing decision Operational decision – spraying etc. Risk assessment and evaluative.	Financial Labour management Market analysis Plant protection – spraying, irrigation

			looking forward to his son (who is studying Viticultur e) to take over				

ix. Why do you consider those decisions more important ?	They help determine what's on demand on the market and thus what the farmer need to do to be profitable in business	They help determine what varieties to plant and how in order for his products to be marketable	Need to assess profitability of business. Helps him determine which cultivars to grow.	Financial sustainability, ensure self sufficiency and profitability.	They help avoid losses in his business	They ensure we have an established market and we produce quality products to satisfy customers.	They help determine what's on demand on the market hence what to grow. Ensure profitability. To avoid losses in business
x. How do you reach a decision in your operations?	Consider profitability first Market trends and demands Quality products	When making decisions he looks at farm and investigate the farm terroir Looks at the financial value to be derived from the operations Depends on advice from neighbouring farmers	Need to have the terroir knowledge.	Consult others.	He does prioritise his tasks. One follows the other – more crucial to less crucial. Values quality in his operations.	Consider history and experience. Financial assessment. Risk assessment – is the risk worth?	Taking into consideration market trends. Consider profitability. Consulting
xi. What criteria do you utilise when making decisions ?	Consider profitability first Market trends and demands Quality products	Consults external consultants – extension officers, cellar masters, private consultants Consults fellow farmers in the neighbourhood	Experience – usually not systematic in decision making – gut feeling Very flexible – the way he handles decision making keeps changing	Consults his neighbours who are more experienced in the field. Also uses his vast business experience (was a business man in the city) and makes him more dependen	Uses his accumulate experience. He does prioritise his tasks. One follows the other – more crucial to less crucial. Liaises with buyers to get market		Considers market trends Consulting Profitability Accumulated experience. Very flexible on decision making.

			Advice from external advisors	t on farming knowledg e.	informatio n.		
xii. (If not mentione d above) Do you use your accumul ated experien ce and knowled ge in making decisions and to what extend do you use your experien ce and knowled ge?	Experience is important. Values expertise and experience of extension officers as well in making decisions.	Even though he's well experien ced (37 years) he strongly believes in second opinion thus he always consults others in his decision making	Yes to a great extend	Yes – from his business man expertise.	Yes but also get advice from others.	Consider history and experien ce. Financial assessm ent. Risk assessm ent – is the risk worth?	Yes. One respondent always believes in second opinion though he is well experienced in the business.
b. What type of decisions do the farmers make							
i. What kind of decisions do you make?	All decisions Labour, financial planning, operational, what to plant and when, quantities and variety etc	All decisions Financial planning, labour manage ment, operation al decisions etc	All farm decision making Financial planning Marketin g etc Recruitm ent – also consults his workers co-decision making.	Involved in all farm decision making Financial planning Operation al – day to day Labour planning. Market trends analysis etc	Responsi ble for the entire decision making. Operation al – day to day tasks. Financial planning. Market assessme nt and determini ng what to grow etc.	All farm decision – financial planning, labour, strategic, operation al, and tactical.	Responsible for the entire farm decision making.
c) What information is required to support types of decisions the farmers make?							

i. What information or resources do you need in decision making for the categories (mentioned above)?	Information on market trends from buyers (wine makers) to determine what varieties to plant etc	Needs information which helps him make decisions which have financial value in it.	Consults his workers on the criteria for recruiting the best suitable candidates. Consults external advisors to ascertain market requirement and financial planning.	Need technology to help in scientific assessment of soil. Useful advice from consultants. Advice from experienced fellow neighbouring farmers. Technical information outside consultants – on chemical application from chemical representatives. "Whole network coming together, network of expertise to gather information and resources is important".	Information on market trends.	Weather data (internet) Information on industry's statistics and performance (SAWIS) Information on what's on demand on the market – the type of wine on demand.	Information on market trends. Need information which can help him make decisions with financial value. Advice from consultant on financial planning etc. Need information on scientific soil assessment from certain advanced technologies. Advice from neighbouring farmers.
ii. Is the information that you get adequate for your situation and decisions you make?	Need to step up availability of crucial information to support decision making	Information he gets from consultants and other farmers is adequate.	Need more information	Yes it's adequate.	Stressed the importance of external information. Always need more information. Need to use different channels	The sources are not always right, can be wrong.	Two think it's adequate. Need to step availability of external sources of information

					to get information.		

iii. What information do you consider lacking that could improve your decision making and your business as a whole?	information to support decision making on a day to day basis – information on markets For example information on wine exports	He gets adequate information	Market conditions – global market Future market trends Information on the changing consumer needs Information on labour law Business farming processes	He is fine with the information he gets. Need to ensure right procedures are followed.	Information from fellow farmers – sharing information. Lack knowledge and skills on finance and book keeping. Need more information or training.	Not lacking because he works with wine makers who provide him with necessary information.	Few said it's adequate Information on market conditions. Sharing of information with fellow farmers. Technical skills to use computer, and bookkeeping etc
iv. What do you think needs to be done to improve the availability and accessibility of such information?	Need cell phone coverage in the area – cell phone keeps them updated and are very convenient. Landlines can be affected by rain and leaves them grounded. Training on technical skills – using computers to the fullest etc – farmers lack computer skills. Mentioned he is even scared to explore on his own because he is scared might damage the computer. Need for quick	n/a	Information on global market trends should be readily available from consultants "Need knowledgeable experts". As well as information on labour law, farming processes – fertiliser application, spraying irrigation etc Need help from consultants on software and planting.	n/a	Need solid relationship with external consultants who are able to his past information and records and use it for his future benefit in his operations – analysis his records to help advise him in his business.	Providers of information and statistics need to have a better and accurate system. Farmers should get information from cellars on what's on demand.	Cell phone coverage. Training on computer skills. Avail information on global market trends. Need for knowledgeable experts to assist them. Solid relationship with consultants. Need for quicker access to quality information

	access to quality information on their farming operations e.g. spraying, irrigation and fertiliser application – need for integrated computer systems to their operations. Need technology which gives them access to global economy.						
v. (If no mention of consultants from the responses) Do you sometimes rely on advice from consultants when making decisions and how often, and how useful has the advice been in your business?	Yes and their advice have been useful and very crucial. Rely on their advice on weekly basis – spraying, fertiliser application irrigation etc	Yes and found their advice very helpful.	Yes relies on advice from consultants more often.	Yes but needs a neutral Agricultural Economics specialist to assess the farm and provide a model.	Yes but needs to be close and in touch with external consultants to help them in the areas they are struggling with. "Best thing for me would be to work up in the morning and do farming and not involved in administration work."	Yes they come and support when assistance is needed.	All rely on advice from consultants more often.
d. What technologies are being used by farmers to support their decision making							

i. Which ICTs do you use (need to define ICTs since they may view ICTs differently) in your farming operations?	Computers Landline phones Fax e-filling Breedenet is their ISP.	Computers Cell phones GPS Printers Internet	Cell phone Moist meters Integrated to the software system in use. Internet to check weather – www.yr.no GPS to measure irrigation Computers Landline phones Email Internet – Google search	Cell phones – no signals Computers Water program – home made which manages irrigation on Excel. Self made annual program for fertiliser application. Own wages and financial programmes – Microsoft Office. Internet – very important – Google search. Email	Computers – *get information on exports from his computer, in season he uses his laptop to access information on exports on a 30 minute interval.* Cell phones Email Landline phones Fax Scanner	Cell phones Landline phones Computers Internet Computerised irrigation Email	Cell phones. Landline phones. Computers Fax GPS Printers Internet General software Farm specific software television
ii. How do you connect to the world – i.e. what technologies do you use to communicate with other stakeholders (customer, suppliers etc)	Emails Landline phones	Email Cell phones Landline phone Television DSTV satellite channel – to check weather	Email Landline phone Cell phone (signal problem)	Telephone Email	Cell phone Email	Email Cell phones	Email Cell phones Landline phones DSTV
iii. To what extent do you use ICTs in	To a larger extend Stressed the importance	To a larger extend	To a large extend – about 80%	To a larger extend – in most farm	To a large extend – in most farm operation	To a large extend "without them it's	To a larger extend – in most farm operations

your business ?	of emails - transmit information that might not be easily transmitted over the phone, allows you to store the information on your computer for future use.		including consultants	operations as given in d(i) above.	s	impossible to operate".	
iv. Which general software do you use?	Doesn't use any in his operations Does his book keeping, financial planning and cash flows manually		Microsoft Excel Microsoft Word Microsoft Outlook for emails Pastel Home for financial management – cash flows, salaries etc	Microsoft Excel Word	MS Word Excel Pastel Payroll software	Pastel – salary administration. Microsoft office packages.	MS Office packages, Pastel
v. Which farm-specific software do you use?	None	Use Boeredata – full package covers all farm operations wages, financial, fertiliser application, irrigation etc	***The one connected to moist meters - consultants***	n/a	ABSI – Special exporters' software. Cape Scan connect.	no	ABSI, Boeredata,
vi. (If not mentioned above) Do you use ICTs when making decisions ?	No as old people they have technophobia Reiterated again the need for training and people to support with technical needs	Yes	Yes	Yes in most decision making tasks.	Yes	Yes	Yes and one doesn't use ICTs

vii. Which ICTs do you use in decision making?	n/a	Computers Television – SABC 2, Kyknet Cell phones Land line phones Internet - weather	Computers Internet Landline phone Cell phones	Computers Software Etc	Computers Software (both farm specific and general) Cell phones Land lines	Internet Computers Software Cell phone Email Etc	Computers, television, software, internet, landline phones, cell phones,
viii. What kinds of decisions demand the use of ICTs?	Most decision making needs ICTs Weather What to plant etc	Most decisions Weather Determine what varieties to plant etc Financial planning	Most farming decisions require use of ICTs	In most decision making ICTs are needed. Irrigation Labour management Wages Fertiliser application etc	Most decisions. Marketing (most important for him) Weather Financial planning. Labour administration. etc	Strategic decisions Weather Financial planning – "without Pastel it would be a mess" Labour administration	Financial planning, weather, planting, irrigation, fertiliser application, labour administration.
ix. Are the ICTs able to yield the desired outcomes/ support the decision making functions ?	Yes – he said "ICT is the future and it yields results"	Yes "ICT use is very important to support decision making" Yes but things change over time – need to improve the farm technology as well	Yes they are	Desperately need cell phone coverage. Applications to help fertiliser application need to be made available	Need cell phone coverage at his farm	Yes	Yes but desperate need for cell phone coverage was highlighted.
x. Would you be able to operate without use of ICTs in your business ?	Lack of ICTs cripples business e.g. lack of cell phone coverage in their area is a huge drawback in terms of access to information, services and	No, it will be very hard	It's not easy to operate without ICTs	It is not easy.	No, ICTs are very crucial in his business	No, ICTs are much needed.	No, it will be very hard.

	consultants' advice.						

xi. To what extent do ICTs result in better decision making for your business ?	To a larger extend	ICTs results in better decision making to a large extend.	To a large extend	To a greater extend. "Without ICTs you battle".	To a large extend	To a large extend. With ICT it's much easier to do business	To a larger extend.
xii. What technologies do you think are best suited to support your decision making?	Cell phones Computers (integrated computerised operations) The internet	Since he has cell phone coverage , Computers, Internet etc he is he thinks the technology he has is adequate to support him in decision making	It's a combination of all Cell phones Internet Computers GPS Etc "When cell phones and internet are dead, I am out of my mind" it cripples his business. Stressed the importance brought about by cell phones – e.g. need to promptly contact technicians to fix a pump when it's not running.	Desperately need cell phone coverage. Applications to help fertiliser application need to be made available.	Need for cell phone coverage. Pesticides application programs. Technologies which improves his interaction with the marketers . Need mobile phones coverage.	Cell phone Email Computer. Software Computerised irrigation.	Cell phones, computers (integrated computerised operations). Internet. GPS, satellite mapping. Technologies which improve interaction with the marketers.
xiii. What can be done to make the technologies available or	Cell phone service providers need to provide coverage Training to equip them	n/a	Provide reliable cell phone coverage . Ensure internet	Are in desperate need of cell phone coverage.	Need for cell phone providers to provide the service to them. Training	Technology is available .	Provision of cell phone coverage. Provide consultants (extension officers) capable of

accessible?	with technical skills Provide consultants (extension officers) with technical skills to help farmers.		connectivity is always available. Need support on acquisition and use of latest convenient mobile devices they can use anywhere on the farm.		to improve technical skills		assisting farmers with technical skills
e. What are the farmers' requirements for ICTs to support decision making.							

i. What kind of ICT infrastructure do you think is best to support your decision making?	Cell phones Computers equipped to help them access various information they need in decision making. Fax Scanners	The integrated software he has in place, Computers, cell phone, television etc is suitable to support his decision making	Not so fancy about technology. Need someone who is fluent in ICTs to help His wife helps with operating the technology	Desperately need cell phone coverage. Applications to help fertiliser application need to be made available	Mobile accessibility. Pesticides application programs,	Integrated computerised operations. Mobile devices	Mobile accessibility. Application programs to help with farm operations such as fertiliser and pesticides application, irrigation etc
ii. Is this infrastructure existent on your farm?	No	Yes	Some is existent	No	No	Yes	Some is existent and some is not.
iii. What requirements do the ICTs need to meet to be able to effectively support your decision making?	Need to be able to provide them with quick access to the relevant information they need Should be able to always keep them in touch with their buyers, consultants and service providers Provide them with information on market trends	Integrated computer system, internet, satellite television	The ICTs should be able to link him up with suppliers and other stakeholders whenever there is need no matter where he is on the farm.	Need ICTs which promotes convenience in his business e.g. "cell phones enable farmers to take pictures of the problems and email them promptly hence diagnosis will be better than explaining on the phone"	Mobile – it's convenient. Technologies supporting their operations like fertiliser application programs et	Need to be reliable and accurate. Mobility	Need to be able to provide them with quick access to the relevant information they need. Mobiles – they are convenient.
iv. What are some of the barriers to meeting those requirem	Lack of cell phone coverage Lack of computer skills	Need for training to equip them with technical skills so that they can	Not technically equipped. Does not have knowledg	Lack of cell phone coverage. Financial constraints	Costs of the technologies are too high. Lack of cell phone reception.	Stealing of Telkom cables affect the landlines and consequ	Lack of cell phone coverage. Lack of technical skills. High costs of technology.

ents?		make optimal use of the technologies Need to manage time well Fast changing trends in technology Lack of applicable ICT knowledge	e to analyse IT technology changes faster and it's not easy to constantly keep up with the pace. Lack of cell phone coverage		Lack of technical knowledge/skills	ently business functions .	
v. What can be done to avoid the above barriers?	Equip the farmers with the relevant technical skills through training. Provide them with cell phone coverage	Need consultants (agriculture extension officers) who are technically competent and readily available.	Need to keep up with the changes in technology. Need technically competent people to help with technical skills Need to be trained practically on how to optimally use the technologies The need to constantly update their technical skills More mobile technology – cell phone coverage is desperat	Service providers need to provide the coverage. Financial support from government in terms of subsidies etc.	Provision of mobile coverage. Technical skills training.	Use mobile devices. Converting the landline telephone system into a mobile one.	Need training on computer skills. Cell phone coverage. Government subsidies.

			ely required.				
Conclusion							

i. In summary how do you compare the wine industry in the Western Cape to the other wine industries in other countries worldwide in terms of ICT use in decision making?	Not that much travelled but Everything is available in South Africa but not used to greater extend as it is overseas Difference in economies also makes the difference	Other countries are way ahead of South Africa in terms of their use of ICTs in decision making.	Need solid base in IT for emerging farmers entering into the field. They are quite on board but need to have young people in IT on the board	Not much knowledge about other countries.	More or less on same level but cost of technologies is a huge burden to farmers here in South Africa.	Have never been to other countries but heard some countries are more advanced in terms of their technology. Have subsidies from government which makes it much better for them.	Some don't know much about other countries. Some think other countries (the West) are way ahead. Some think we are more or less on same level but cost of technology is a huge burden to SA farmers
ii. What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use and adoption of these technologies in the region?	"I hate the idea of subsidies" i.e. government subsidising on cost of technologies. He would rather have government help reduce export levies – they pay about 22% export levies Reduction in the levies will be of great relief in their business. Need for computerised operations such as irrigation, pesticide application, applying	Government should subsidise farmers. South African government is not supporting and subsidising farmers that much as compared to the western countries. This results in farmers shrinking their pockets covering cost in their business.	Consider and address complexity of the farming environment as well as regulations and laws (labour laws) etc. Need personal contact with advisors. Need to continuously interact with them – stressed the importance of body language.	South African government need to support farmers more. It is not doing more in terms of supporting farmers. Its support helps lives of farmers and their workers as well. Farm worker is very important to the well-being of a farmer. "Government supporting farmers in ICTs would	In the west and other countries, government provide subsidies to the farmers. There is need for that also here in South Africa. Government need to subsidise on technological costs.	Need to help farmers in irrigation so that they are productive on a small piece of land	Government should support farmers (like in other countries) e.g. subsidise farmers on cost of acquiring technology, address complexity of farming environment, labour laws etc. Its support will help better lives of farmers and their employees. Government should help reduce export levies. Need personal contact with advisors/consultants.

	fertilisers etc which can be centrally controlled – importance of overnight irrigation which is more effective since there is reduced evaporation .			take a huge step towards economic freedom."			Need for computer applications to support their operations.
iii. How do you see the industry in the next few years in terms of the use of ICT in decision making?	"It's going to be turned upside down completely". Dramatic changes will be brought about through the use of technologies in decision making	It will grow because of the use of ICTs in supporting decision making. Biotech tools used to determine stress levels in plants will improve dramatically in the next five years.	He sees the increasing need of ICTs because of the speed it is changing . "It's huge"	Becoming more and more crucial to farmers. "We underestimate the use of ICTs in the industry, ICT is very crucial". Technology should not be underestimated at all.	It will suffer because of lack of funding to support farmers investing in ICTs. Desperately need government intervention through subsidies.	It's going to crumble because they are strugglin g.	It will grow because of use of ICTs in decision making. One thinks it will suffer because of lack of funding to support farmers investing in ICTs for decision making.

APPENDIX G: EMERGING FARMERS' INTERVIEW RESPONSES

Interview questions	Farmer A	Farmer B
Farm context		
i. How big is your farm? i.e. number of hectares, employees etc	5 hectares	6 hectares
ii. Besides growing grapes what other farming activities or operations are you involved with?	No	Peaches
iii. Are you the farm manager or the owner	In charge of a family venture – she is one of the 7 sisters who own it.	Owner
iv. For how long have you been in this position	Recently started wine farming but have been previously buying wine from other established wineries and marketing it.	A year ago
What are your roles and responsibilities on this farm?	Overall management of the farm and its operations	Overall management of farm and operations
a. How do farmers make their decisions		

i. Which functions or farming operations do you consider most important?	Communication/ being in touch with other stakeholders	Harvesting, marketing
ii. Why do you consider these functions most important?	Need to be connected to establish themselves in the market.	If not properly managed can result in loses
iv. How do you prioritise your farming tasks?	Financial planning/budgeting	Profitability assessment
v. How is decision making an important aspect of farming operations to you?	Decision making is very crucial. Good decision making results in success of the business.	Decision making is important, it determines success or failure in my operations
vi. How often do you make strategic farming decisions?	Continuously	In 3 years
vii. Do you delegate decision making?	Yes – to some extend	Sometimes but I do most of the decision making
Viii.What operational, tactical and strategic decisions do you consider crucial? Why?	Financial planning Market establishment - they determine the success of your business.	Market establishment – need to have an establishment market to survive in the business environment
ix. Why do you consider those decisions more important?	They determine the success of your business.	They ensure we have business.
x. How do you reach a decision in your operations?	Consider profitability first Market trends and demands Quality products	Consider market trends, profitability of the business
xi. What criteria do you utilise when making decisions?	Look at profitability. Market establishment	Financial assessment
xii. (If not mentioned above) Do you use your accumulated experience and knowledge in	Do not possess farming experience.	Doesn't have experience

making decisions and to what extend do you use your experience and knowledge?		
b. What type of decisions do the farmers make		
i. What kind of decisions do you make?	All farm decisions , financial planning, operational etc.	Operational, marketing, financial planning
	c) What information is required to support types of decisions the farmers make?	

i. What information or resources do you need in decision making for the categories (mentioned above)?	Need a lot of training especially individually at a farm. Need to be trained so that they appreciate and be able to use ICTs to support their decision making. – need training on how to use email, internet etc.	Industry statistics, market information, need ICT skills training
ii. Is the information that you get adequate for your situation and decisions you make?	No, government teach farmers as children in class. Farmers do not have opportunity to ask and share their views.	No we need government to help us with adequate support staff and subsidised inputs and equipment
iii. What information do you consider lacking that could improve your decision making and your business as a whole?	Information on market establishment as well as information on the benefits of ICTs in decision making and how best emerging farmers can adopt and use them effectively.	Information on the best farming practices, equipment and what skills are needed and how we can acquire them.
iv. What do you think needs to be done to improve the availability and accessibility of such information?	More training on the benefits of ICTs in decision making. Government (consultants) need to have a better approach and welcoming when teaching farmers	Provide more qualified consultants from the Ministry of Agriculture. Training emerging farmers and helping them cover input costs
v. (If no mention of consultants from the responses) Do you sometimes rely on advice from consultants when making decisions and how often, and how useful has the advice been in your business?	Yes but some of them do not have a better approach teaching farmers. Do not teach on market establishment which is crucial to emerging farmers.	Yes but we are not getting enough time to learn from them. They should not compare us to established farmers, we are still learning.
d. What technologies are being used by farmers to support their decision making		

i. Which ICTs do you use (need to define ICTs since they may view ICTs differently) in your farming operations?	Cell phone Laptop Computers Internet Email	Cell phone Computer Television Landline phones
ii. How do you connect to the world – i.e. what technologies do you use to communicate with other stakeholders (customer, suppliers etc)	Emails Cell phones	Cell phone Landline
iii. To what extent do you use ICTs in your business?	To a large extend, however most emerging farmers need to be taught on how to use ICTs in their business.	Mostly for communication
iv. Which general software do you use?	Pastel Quickbooks MS Office	Microsoft Office
v. Which farm-specific software do you use?	None	None
vi. (If not mentioned above) Do you use ICTs when making decisions?	Yes	Yes
vii. Which ICTs do you use in decision making?	Computer Internet Email Cell phones	Computer Cell phones
viii. What kinds of decisions demand the use of ICTs?	Marketing Accounting functions – invoicing, order notes etc.	Marketing Financial
ix. Are the ICTs able to yield the desired outcomes/ support the decision making functions?	Yes – "I will be totally lost if I don't have my laptop and cell phone". Can do business everywhere and anywhere with the above technologies.	Yes
x. Would you be able to operate without use of ICTs in your business?	No it will be very difficult.	No ICTs play a crucial role

xi. To what extent do ICTs result in better decision making for your business?	To a larger extend	To a large extend
xii. What technologies do you think are best suited to support your decision making?	Cell phones Computers The internet	Cell phones Computers Internet
xiii. What can be done to make the technologies available or accessible?	Teach the emerging farmers business and technical skills.	Subsidise costs of acquiring the technologies. Provide the technical skills to farmers
e. What are the farmers' requirements for ICTs to support decision making.		
i. What kind of ICT infrastructure do you think is best to support your decision making?	Cell phones Computers Internet Email	Internet Computers Cell phones GPS Satellite mapping
ii. Is this infrastructure existent on your farm?	Yes but most emerging farmers don't know how to use it.	Not all of it is existent
iii. What requirements do the ICTs need to meet to be able to effectively support your decision making?	Fast access of information and making communication with stakeholders easier and faster.	The ICTs should be able to facilitate easier access to market information and make communication easier
iv. What are some of the barriers to meeting those requirements?	Lack of skills or knowledge to use the technology.	Lack of adequate technology as well as skills to effectively operate the technologies
v. What can be done to avoid the above barriers?	Equip the emerging farmers with the relevant technical and business skills through training and sharing of ideas.	Need to provide the necessary skills to the emerging farmers as well as helping them acquire the relevant technologies

APPENDIX H: CONSULTANTS' INTERVIEW RESPONSES

Interview questions	Consultant A	Consultant B	Consultant C	Consultant D	Consultant E	Summary
What technologies are being used by farmers to support their decision making?						
i. Which ICTs do farmers use in their farming operations?	Computers Cell phones GIS GPS systems	Computers Cell phones Emails Internet	Internet Cell phones Computers Email Scanners GIS GPS mapping Weather projection systems. Computerised irrigation systems.	Computers Internet Cell phones Accounting packages	***Consultant E didn't have answers since he doesn't work with workers but provides research information and technical support to farmers – publishes research reports etc*** Mobile phones Internet	
ii. To what extent do they use ICTs in their business?	To a large extend	To a large extend – use of computerised irrigation (something growing)	Huge especially commercial farmers – they use it in their daily operations.	To a large extend		
iii. (If not mentioned above) Do the farmers use ICTs when making decisions?	Yes they do	Yes	Yes	Yes		

iv. Which ICTs do they use in decision making?	Use Wine MS a production DSS GPS systems – Precision farming	Donherhoel data – financial planning. GPS for soil analysis – what to plant and where to plant. General packages like Microsoft, Pastel etc. Need to be technically competent to effectively use the software. FarmMS Moist detection systems.	Internet Cell phones Computers GPS Weather projection systems Email	Computers Internet Cell phones		
v. What kinds of decisions require the use of ICTs?	Determine how much chemicals to apply per hectare (Precision farming) - production decisions - Planting decisions – disregard unsuitable areas. - soil mapping	Financial planning, budgeting and record keeping. Soil analysis – what to plant and where to plant. Moist detection for irrigation. Production planning – determining income per hectare etc	Weather Financial planning What to plant and where – mapping etc	Financial Planning and budgeting. Vineyard management. Spraying, irrigation and fertiliser application decisions. Marketing – ICT can play a major role in accessing markets.		
vi. Are the ICTs able to yield the desired outcomes/ support the decision making functions?	"Yes definitely"– helps them understand better. - "Technology has the potential to transfer information in a way which	Yes/No No if he can do it well manually. It depends – mostly yes if successful. It depends on	Yes	Yes – they rely more on consultants and extension officers. They need training.		

	can be interpreted easily by non technical people"	economies of scale.				

vii. Would the farmers be able to operate without use of ICTs in their businesses?	Technology is good but you must know how to survive both without it and with it. "Technology is making people stupid, they don't think anymore" People shouldn't be more reliant on technology – life can be easier without technology e.g. how Blackberry outage affected people.	Yes but it depends if he can do it well manually yes	It's not easy. Farmers with no access to email are difficult to communicat e with (**mostly emerging farmers**). You have to drive to them to get a document signed or deliver a form etc.	Those who do not have them (ICTs to support decision making) survive but they are struggling. "You need ICTs to market, you can produce grapes but if you don't have ICT you are dead especially export market."		
viii. To what extend do ICTs result in better decision making for the farmers?	You can't operate without it. ICTs don't do the thinking farmers should be able to interpret what they see -They make interpretation easier (Use of colours when interpreting maps etc). -GIGO, Should always ensure what is inputted is correct and accurate. However ICTs have capability to boost your data and keep it. Makes it quicker and easier to	Need to look at efficiency. If it is used efficiently yes it does. Decision making is quicker with mobile technology.	To a large extend – information gathering is a lot easier. Use of ICTs **speeds up the decision making process. Improves quality of decisions.**	To a large extend – stressed the importance of emerging farmers partnering with large commercial farmers to take advantage of economies of scale.		

	carry out tasks. Lessons financial burden to the farmer can do a 50 hours job in 20 hours or less.					

ix. What technologies do you think are best suited to support their decision making?	- Technology which provides information about soil, climate, contours. - Weather station data, terror analysis.	Computerised irrigation. Emails to communicate with external stakeholders – convenience of email on mobile phones (**farmer can capture picture and immediately sent to consultant**). MS Excel for spreadsheets in financial planning.	Cell phones – for better communication. Internet – gives access to several resources – www.fruitlook.co.za	ICTs which give them access to research information on the internet. Access to updates – weekly or daily updates from consultants and vendors e.g. Winetech Scan. Websites		
x. If they are not available why are the farmers not using the technologies?	Technology is available. There is so much technology and information out there but needs to be made available.	The technology is available.	Affordability Lack of knowledge.	Lack of knowledge. Affordability		
xi. What can be done to make the technologies available or accessible?	Technology is available.	It is available.	Farmers especially emerging farmers need assistance to enable them to access the internet as well as paying for it. Most upcoming farmers don't have computers - use of smart phones to access the	Partnering with commercial farmers. Educating them. Start small, hold their hands and get them going.		

			internet can be helpful. Help them get computers			
What are the farmers' requirements for ICTs to support decision making.						
i. What kind of ICT infrastructure do you think is best to support farmers in decision making?	- Technology which provides information about soil, climate, contours. - Weather station data, terror analysis.	Computerised irrigation. Emails to communicate with external stakeholders. MS Excel for spreadsheets in financial planning.	Cell phones – for better communication. Internet – gives access to several resources – www.fruitlook.co.za	ICTs which give them access to research information on the internet. Access to updates – weekly or daily updates from consultants and vendors e.g. Winetech Scan. Websites		
ii. Is this infrastructure existent?	Yes	Yes	Yes/No some is available some not.	Some have access to internet and few of them have their own websites. (emerging farmers)		
iii. What requirements do the ICTs need to meet to be able to effectively support farmers' decision making?	It should provide their information needs such as data on soil, weather etc. Should be easier to interpret as well as provide quality information.	Technology is available but training is needed to help farmers adopt and use the technologies.	Need to give access to better communication. Should be able to provide them with useful information to support their decision making – internet. Should be able to speeds up decision making as well as improve the	Should be able to give them access to the internet where they can get useful information and advice.		

			quality of decisions.			
iv. What are some of the hindrances to meeting those requirements?	There is need to present customised information to farmers since they are different and have different information needs.	Farmers lack technical skills. Training costs are high. **Farmers don't have time for training they just want to farm.** Travelling distances to get training is inconvenient for the farmers – **e-learning can be of great help.** Some of the technologies are too expensive. A lot of risk is involved.	Cost of the ICTs. Computer illiteracy. Lack of relevant technical skills. Consultants (from dept of Agric) don't teach people on how to use the technology – just provide information on cultivars etc. Basic literacy – most of them don't speak English.	Farmers do not usually use the ICTs or access the information on the internet. Emerging farmers do not come to study groups and meetings on industry updates etc by vendors and consultants . They lose out on what is taught as well as opportunity to interact and share ideas.		
v. What can be done to avoid the above hindrances?	Technology needs to be presented in a much simplified form – must be able communicated in a way that is not confusing to the farmers	Training for farmers in a cheaper and more convenient way for them.	Help provide technical skills. Farm worker development. Government should do skills audit to look at skills lacking. Government should provide the technology freely as well as support.	Encourage the emerging farmers to attend study groups and meeting by consultants and vendors. Promote use of internet to access useful data to support their decision making and communication. Training – academic institutions can help Develop a		

				DVD based training material for farmers especially those who can't read or write – **very crucial.** Using FAQs on advisory websites. Emailing educational video clips to farmers, uploading training videos on sharing platforms such as YouTube etc.		
Why is there slow uptake of decision support systems by emerging farmers						

i. How do you assess the uptake of DSSs by farmers in the wine industry in the Western Cape?	It's a bit slow but slowly they will pick up. With time they will learn and adopt more.	No slow uptake – most farmers have basic technologies i.e. cell phones etc. The more complex ones are more expensive.	They are leading in terms of ICT adoption ion their operations.	It's slow for upcoming farmers/ new entrant farmers.		
ii. How do you assess the uptake/adoption of DSSs by emerging farmers in the Western Cape region?	It's a bit slow but slowly they will pick up. With time they will learn and adopt more.	They have basic ICTs they need.	They are leading in terms of ICT adoption ion their operations.	Emerging farmers are at a slower rate.		
iii. What is the tempo of the uptake? – is it slow or fast	Slow	Not slow	Older farmers are reluctant to adopt new technologies	Slow		
iv. What do you think is the reason for the slow uptake of DSSs by emerging farmers? (If there is slow uptake)	**Communication**	More expensive for them.	**Farmers are not really keen on changing their way of operating.** There is a lot of word of mouth talk on adoption of technology. Farmers would be more willing if they see it working for colleagues who adopted the technologies.	Lack of knowledge on the benefits of adopting the DSS. Lack of training. Cost of technologies.		
v. What do you think needs to be done to speed up the uptake and use of DSSs by the emerging farmers in your region?	Training There should be short courses to teach farmers how to use the technologies e.g. Google	Training for farmers in a cheaper and more convenient way for them.	Agriculture merger expos etc. Promoting new might help speed up the rate of adoption and use of	Training – academic institutions can help Develop a DVD based training material for farmers		

	earth which is fast improving – "Will be like sms in the next few years"		DS technologies.	especially those who can't read or write – **very crucial.** Using FAQs on advisory websites. Emailing educational video clips to farmers, uploading training videos on sharing platforms such as YouTube etc.		
vi. What could have been done or could be done to avoid the slow uptake of DSSs by wine farmers in the region?	Address the following reasons why farmers don't like training: - farmers don't like to work with computers - They like hands on farming. - They associate computers with city boys. But they need – ICT phobia is the problem they think they can't pick up skills, I can't handle it mentality. Farmers need to keep themselves updated with technology – "If you don't keep pace with technology you can't make it"	No slow uptake.	Prove that the adoption and use of ICTs will help them support decision making and improve their business	Educate them on benefits of adopting the technologies. Training – academic institutions can help Develop a DVD based training material for farmers especially those who can't read or write – **very crucial.** Using FAQs on advisory websites. Emailing educational video clips to farmers, uploading training videos on sharing platforms such as YouTube etc.		

	There is need to prove that technology is a money and time saving device. There is need to market it well – need to get it into farmers' heads that it help them save a lot.					

i. In summary how do you compare the wine industry in the Western Cape to the other wine industries in other countries worldwide in terms of ICT use in decision making?	We are far behind. Technology available is world class but implementation lacks because they don't understand. Farmers are scared of spending money on technology.	It differs, US has advanced technology than us – one cellar has technology which crashes more than whole SA wine cellars. US has cheaper technology and expensive labour hence they use technology more than SA	Much easier in other countries because of free access to technologies such as the internet. Cost of technology is cheaper in other countries. Speed of the internet is low in SA and affects communication.	Need to make better use of ICTs. New inventions are coming; we need to be quick on it we are falling behind. Australia, America and China are more advanced.		
ii. What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use and adoption of these technologies in the region?	**Emerging farmers need to use technology.** They don't know much and need accuracy a lot. **Government should pay consultants who help emerging farmers.** They provide the expertise but do not pay enough (was the reason why he left). Since then (3 years ago) they haven't appointed someone to replace him. **Government isn't doing enough to support the farmers – (not paying enough, not**	Should help training farmers on how best they can utilise and adopt the technology. Not for the idea of government subsidies.	Help provide technical skills. Even though there is Training department responsible for farm support training in the ministry, Engage external trainers to train the farmers and their farm workers – provide courses etc. Farm worker development. Government should do skills audit to look at skills lacking. Government should provide the	There is need for much bigger focus on ICT infrastructure and facilitating support. Government should have a department searching for new markets and what's happening in the industry. Government can be much more proactive. Invest more money on research and market linkage through ICT infrastructure.		

	replacing GIS specialist, don't see the importance of soil survey etc) they don't really care. Thinks government can do better if the privatise these services (consultations).		technology freely as well as support. **Government should do more to improve training.** Subsidise farmers who encourage training for workers. Provide computers, subsidise farmers especially emerging. Emphasised the need to equip the **community, kids as well with computer skills.**			
iii. How do you see the industry in the next few years in terms of the use of ICT in decision making?	"Without ICTs we are not going to make it" – **you can't survive without it** The more you ignore technology the more you shoot yourself in the foot.	The industry is having financial difficulties and technologies may be seen as a luxury. There won't be fireworks; It's going to be steady uptake – slow to medium. **Farmers not using ICTs for decision making should start adopting it now**	There has been an increase in the last 2 years. It will improve, computerised irrigation etc.	Intensity and pace of trading will intensify.		

APPENDIX I: VENDORS' INTERVIEW RESPONSES

Interview questions	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Summary
What technologies are being used by farmers to support their decision making?						
i. Which ICTs do farmers use in their farming operations?	Computers Mobile phones GIS GPS mapping Computerised irrigation system.	Computerised irrigation – soil moisture detection systems. Internet Pastel Partner - financial management. Microsoft packages FarmMS VIP system Donkerhoek data.	GPS mapping systems. Computers Internet Mobile phones Etc	Irrigation systems. Satellite mapping Precision farming Tractor detector devices. Computers Mobile phones Internet Etc		
ii. To what extent do they use ICTs in their business?	what	To a large extend	There are 2 different types of farmers – those sceptical to adopt and use latest technologies and those willing.	Emerging farmers, not that much. Young farmers use it more especially for administration		
iii. (If not mentioned above) Do the farmers use ICTs when making decisions?	Yes – different types of farmers they deal with use different types of ICTs.	Yes	Yes	Yes		

iv. Which ICTs do they use in decision making?	Cell phones Computers GPS mapping	DFM – soil moisture management. Donkerhoek data Computers Cell phones Pastel MS packages FarmMS	GPS mapping Computers Mobiles	Satellite mapping Computerised irrigation systems. Precision farming. Computers		
v. What kinds of decisions require the use of ICTs?	Marketing Diagnostic purposes To get information and specifics on inputs they use and pesticides etc.	Financial planning Profitability assessment. Production decisions	All the operations from soil to shelf.	What to plant and where to plant. Irrigation decisions. Harvesting decisions. Financial Marketing		
vi. Are the ICTs able to yield the desired outcomes/ support the decision making functions?	Yes – grapes are more complex and require technical knowledge.	Yes	Yes – it's dynamic they are always working to improve decision making.	Yes		
vii. Would the farmers be able to operate without use of ICTs in their businesses?	Use of ICTs makes their lives much better and easier.	It wouldn't be easy.	No – the ICTs are needed	Not easy		
viii. To what extend do ICTs result in better decision making for the farmers?	ICTs provides the farmers and equips them with information they need in their operations - inputs specifics, pesticides etc.	To a large extend – the ICTs enable them to look at several factors before making a decision.	To a larger extend	To a large extent		
ix. What technologies do you think are best suited to support their decision making?	Emerging farmers need internet access and need to be trained to be able to effectively use it. Email for communication with vendors	Technology which is capable of providing farmers with access to resources information they need to support decision making. Technology	A combination of the available technologies works best not individual technologies.	Satellite mapping Computerised irrigation systems Computers Mobiles		

	especially emerging farmers.	used in financial planning, profitability assessment, production.				
x. If they are not available why are the farmers not using the technologies?	Well established farmers have it – internet and email. Emerging farmers rely on consultants when it comes to use of ICTs.	It is available to some but some do not have because a lot of farmers are under financial pressure.	They don't understand the importance of technologies. If explained well they will understand			
xi. What can be done to make the technologies available or accessible?	Farmers need to join hands and get the resources, technologies and inputs together at once including advice and consultants – it's cheaper for them.	Educating the farmers on the technologies. Marketing the useful ICTs and help farmers understand their importance.	Teach them on how best they can use them, how it is best for them.	There is need to provide farmers with the technology – computers		
What are the farmers' requirements for ICTs to support decision making.						
i. What kind of ICT infrastructure do you think is best to support farmers in decision making?	Internet – marketing, access to information and resource Email – communication. VoIP – Skype, need to be trained on how to use.	Technology that is capable of providing farmers with access to resources information they need to support decision making. Technology used in financial planning, profitability assessment, production.	A combination of the available technologies works best not individual technologies.	e-commerce, use of automated marketing etc. Satellite mapping Computerised irrigation systems Computers Mobiles		
ii. Is this infrastructure existent?	Some is available especially with well established farmers.	Yes for most well established farmers.	Yes	Yes but not all have them.		
iii. What requirements do	Easier communicatio	Should be able to	User friendly	User friendly.		

the ICTs need to meet to be able to effectively support farmers' decision making?	n – video calling, reliable internet. Access to vast amount of information and advice- internet.	provide them with necessary information to support decision making.	platforms e.g. use of icons for computer systems since farmers doesn't have a good literacy backgroun d.	E-commerce – brings together buyers and sellers electronical ly. Capable of providing integrated useful information .		
iv. What are some of the hindrances to meeting those requirements?	Technophobia – farmers are scared of using ICTs. Older farmers are more sceptic. Affordability and lack of knowledge on the benefits	Some technology is not easy to use. Farmers don't put much effort in using the technology.	Costly Lack of knowledg e.	Lack of knowledge on the benefits and technical skills		
v. What can be done to avoid the above hindrances?	Training and encouraged to adopt latest technologies. Skype enables them to interact and get help from consultants easier and quicker.	Farmers need to be more business minded. Educating the farmers on the benefits and how to use the ICTs. "The only way to involve farmers with ICTs is to show them the Rand value"	Training the farmers to use the technolog y on their own. Get users' involveme nt in design. **(they are working on an e-learning platform to help the farmers)**	Take all the worries from the farmer and let the farmer farm.		
Why is there slow uptake of decision support systems by emerging farmers						

i. How do you assess the uptake of DSSs by farmers in the wine industry in the Western Cape?	Yes it is slow but with training it will improve. There have been huge improvements for the past 3 years.	Slow	Not sure	Slow but improving.		
ii. How do you assess the uptake/adoption of DSSs by emerging farmers in the Western Cape region?	Slow	Slow	Not sure	Slow but improving.		
iii. What is the tempo of the uptake? – is it slow or fast	Slow but improving.	Slow	Not sure	Slow rate – farmers aren't aware of the benefits of using ICTs for decision making.		
iv. What do you think is the reason for the slow uptake of DSSs by emerging farmers? (If there is slow uptake)	Technophobia. Affordability and lack of knowledge on the benefits	Farmers just want to go out and work in the field, they are not interested in using ICTs, making calculations etc.	Cost	There is information overload, simplify the use of technology.		
v. What do you think needs to be done to speed up the uptake and use of DSSs by the emerging farmers in your region?	Training and encouraged to adopt latest technologies.	They should perceive ICTs as an investment not a cost.	Training the farmers to use the technology on their own. Get users' involvement in design. **(they are working on an e-learning platform to help the farmers)**	Simplify the use of technology. Make the farmers feel confident in using the technologies. Use of FAQs on advisory websites.		
vi. What could have been done or could be done to avoid the slow	Wine industry is more sophisticated, high value	They should perceive ICTs as an investment	Training the farmers to use the	Simplify the use of technology. Make the		

uptake of DSSs by wine farmers in the region?	crops hence adoption and use of ICTs to support decision should and must be of high priority.	not a cost.	technology on their own. Get users' involvement in design. **(they are working on an e-learning platform to help the farmers)**	farmers feel confident in using the technologies. Use of FAQs on advisory websites.		

i. In summary how do you compare the wine industry in the Western Cape to the other wine industries in other countries worldwide in terms of ICT use in decision making?	Doesn't have knowledge on other countries so cannot compare.	Doesn't have the knowledge	We are up on the global market. Use high level precision farming technology models.	In Western Cape management of wine farms is more sophisticated than elsewhere in Africa. Europe is better because they have better access to information and knowledge, management and logistics is better as well. Western Cape is nowhere near on efficiency compared to Europe.		
ii. What can the government, local authorities, consultants, researchers, academics and other stakeholders do to increase the use and adoption of these technologies in the region?	Farmers need to have the technologies to use. Encourage farmers to learn to train themselves	Basic computer training e.g. Excel skills especially with emerging farmers. Academic institutions can partner and offer training to farmers on basic ICT skills.	Training farmers and making them knowledgeable. Need for specific bias towards training.	We can't count on government at the moment because of different priorities. Government shove the burden to universities. Encourage private institutions to get involved. Universities of Technology are most efficient in technologies and hence need to be involved.		

iii. How do you see the industry in the next few years in terms of the use of ICT in decision making?	It will continue improving over the years. Make them appreciate the technology first. Skype is capable of making communicatio n easier and less expensive	It's going up. As a software vendor, they are getting more requests for their system now than a time ago from farmers wanting to adopt it.	Booming, it's going to grow phenomen ally.	Need to focus on the future, private institutions can liaise with banks and offer support to students who can study more and improve the use of ICTs in decision making. Reach out the less fortunate ones who will use the technology in future.		