INFORMATION AND COMMUNICATION TECHNOLOGY USAGE TRENDS AND FACTORS IN COMMERCIAL AGRICULTURE IN THE WINE INDUSTRY

by

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DECLARATION

I, Rachael Tembo, 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.

Signed **Date**

ABSTRACT

There is need to realise the potential of information and communication technologies (ICT) for farmers and agricultural role players, in order to achieve agriculture development. However in South Africa, it is not yet established which specific ICT are used and how they are used in different agricultural farm enterprises, and if used, their extent of deployment. In addition, few studies have focused on the factors that influence the use of ICT in South African agriculture. This study addresses these issues. This study investigates factors of ICT use that are helpful and necessary for the recognition of the importance and benefits of ICT in Western Cape commercial agriculture, specifically in the wine industry. The study investigates the different forms of ICT used in the wine industry, how they are being used in the industry, what they are used for, how important these technologies are as enablers of production, and the factors that affect their use. This study focuses on the use, not the adoption, of ICT in commercial agriculture.

The study involved two groups of participants and was in two phases. In phase one, a survey of commercial farmers was conducted in Robertson Wine Valley. Phase two involved their farm employees who are involved in farm activities ranging from field, winery and administrative work in Robertson Wine Valley. 15 farmers and 60 farm employees responded to the questionnaire.

The scope of the results for this study is limited to descriptive statistics, chi-square tests and correlation analysis. From the chi-square and correlation analysis, it was found that ICT training, age, race, current occupation on farm, monthly salary, education level and ICT literacy influence the use of ICT by farm employees. In terms of farmers, it was found that a number of variables do not influence the use of ICT directly but may influence their management style and decision making. The effects of age, education, off-farm income and experience of the farmer which were found in this study support the results from related studies. However, the results of this study showed that farm size and gender are not statistically significant determinants of ICT use. Another variable that was predicted to have influence on ICT use was the Black Economic Empowerment initiative. However, this study proved that BEE is not statistically related to ICT use. A statistically significant variable specifically identified in this study was the market where the farmer sells his product. The results showed that there is a positive relationship between ICT use and the market. Farmers who sell their products internationally use more ICT than those who sell locally.

The results of the study showed that computers, landline phones, tracing/tracking software and Internet are popular with the farmers when carrying out their business transactions. The

major ICT primarily used for agriculture is the computer that has proved to be a more advanced and easier way of securing production and marketing information for the farmers. Among other ICT, mobile phones and television are primarily used for social and entertainment reasons rather than for agricultural purposes.

The uses of different ICT used by the farmers and their farm workers are discussed. The benefits and problems encountered in using ICT are outlined. Some of the benefits identified include easy dissemination of information among the supply chain role players, better storage of farm data and the saving of time and labour. Identification of the factors and variables that are related to and influence the use of ICT by the farmers and their farm employees is done and determined by use of chi-square tests and correlation analysis.

Key words: Factors, Information and Communication Technologies (ICT), Use, Commercial agriculture, Wine industry

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DEDICATION

For my dear mum, R. C. Sanyamahwe, a virtuous woman who made sacrifices beyond imagination to educate me even though she was not educated. It is painful that she did not live to see and enjoy the fruits of her sweat. She will always be remembered.

RESEARCH ACHIEVEMENTS

The following papers were achieved through this study

- ✓ Rachael Tembo, Vesper Owei & Blessing Maumbe. Towards a Modelling Framework for Information and Communication Technology Use in Commercial Agriculture: Significant Factors in South Africa. *Proceedings of the IST Africa Conference,* Windhoek, Namibia. 7-9 April 2008.

- ✓ Rachael Tembo, Vesper Owei & Blessing Maumbe. Models of Information and Communication Technology Use in Agriculture: Case Studies from Developing Countries. *Proceedings of the IFIP WG 9.4 Workshop*. University of Pretoria, 23-24 September 2008.

- ✓ Rachael Tembo & Vesper Owei. Factors influencing the use of information and communication technology in the Western Cape commercial agriculture: A case study of the wine industry. Submitted to *Journal of Information Technology for Development.* Article under review.

GLOSSARY

Abbreviations and Acronyms

RWV	Robertson Wine Valley
ICT	Information and Communication Technologies
GPS	Global Positioning System
EU	European Union
DoA	Department of Agriculture
Agri-BEE	Agricultural Black Economic Empowerment
BEE	Black Economic Empowerment
GDP	Gross domestic product
SAITIS	South African Information Technology Industry Strategy
SAWIS	South African wine industry information and systems
TAM	Technology Acceptance Model
PDA	Personal Digital Assistant
CMS	Computer-Mediated Communication Services
FAO	Food and Agricultural Organization
ITU	International Telecommunication Union

Definition of terms

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

Precision farming
Using the best available technologies like GPS and specialized computer software to tailor soil and crop management to fit the specific conditions found within an agricultural field or tract.

Bar code system
A network of hardware and software, consisting primarily of mobile computers, printers, handheld scanners, infrastructure, and supporting software.

E-commerce
Conducting business transactions online where goods, information or services are sold and bought.

Computerised irrigation system
Use of a computerized central monitor and control system as a convenient means of water budgeting and scheduling to automatically allocate water to each field according to the needs of the crop in each field.

Fidelio reservation system
Range of software and hardware solutions that provide central reservations management services and connections to worldwide distribution channels.

Ezywine
Winery software that consolidates all the winery procedures into one comprehensive package that can be easily utilised.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

This research study responds to a study by Meera, Jhamtani, and Rao (2004). They concluded that there is need to realise the potential of information and communication technologies (ICT) to farmers in order to achieve agriculture development. This study investigates the factors of ICT use that are helpful and necessary for the recognition of the importance and benefits of ICT in Western Cape commercial agriculture, specifically in the wine industry. The study investigates the different forms of ICT used in the wine industry, how they are being used in the industry, what they are used for, how important these technologies are as enablers of production, and the factors that affect their use. This study focuses on the use, not the adoption, of ICT in commercial agriculture. The scope of the results for this study is limited to descriptive statistics, chi-square tests and correlation analysis. In this study, farmers are defined as those who actually own the farms or anyone acting and making decisions on their behalf (manager). Wine cooperatives are also classified as farms.

Agriculture is an important sector in most developing countries and the majority of the rural population depend on it (Stienen, Bruinsma & Neuman, 2007:2). However, the contribution of agriculture to rural development is highly dependent on the generation and delivery of new agricultural technologies and most of these new technologies can be described as information-intensive (Tripp, 2001:482). Information has become a critical factor of production in agriculture (Rao, 2006:493). The dramatic changes that have taken place in the last decade in ICT have touched almost every field of human activity, and agriculture is not an exception (Winrock, 2003:1). Like in any other fields such as mining, engineering and commerce, computers and electronic based mechanisms are now used to collect, manipulate and process information automatically to control and manage agriculture production and marketing. Agricultural development can be accelerated and livelihoods can be supported by ICT in so many ways. Some of them are discussed in detail in the following chapters of this study.

The use of ICT in agriculture is not a completely new phenomenon. During the 1970's, ICT have been widely used in e-commerce value creation in agricultural and food markets such e-auctions in the cattle industry, and electronic cotton marketing (TELCOT) in the United States

(Montealegre, Thompson & Eales, 2007). These trends have continued to evolve with modern advances in global positioning satellite (GPS) technology commonly used in precision agriculture in US commercial agriculture. Unlike in developing countries, ICT use in some developed countries started well before the advent of the Internet in the 1990s. Some of the key benefits of ICT applications in agriculture (now spreading to developing countries) include reduction of transaction costs, online input procurement, electronic data interchange (EDI), better inventory control systems, improved supply chain coordination and market access, and transparency among others (Cash & Konsynski, 1985; Montealegre, *et al*., 2007; Rao, 2006).

This chapter is divided into sections that discuss the objectives of the research, the problem statement, background information on South African agriculture, ICT penetration rates and ICT initiatives in South Africa, and the importance of agricultural information and its dissemination.

1.2 Objectives of the study

The main aim of this study is to investigate the use of ICT in South African commercial agriculture, specifically in the Western Cape Province wine industry. To achieve the relevant results of this study, the following specific objectives were addressed:

(i) Identifying the different ICT being used in agriculture by wine farmers and farm employees,
(ii) Investigating and describing the uses of different forms of ICT among wine farmers and farm employees,
(iii) Describing the socio-economic benefits associated with ICT use by the wine producers and farm employees, and
(iv) Identifying factors affecting ICT use by farmers (employers) and workers (employees) in commercial agriculture.

1.3 Problem Statement

The extent of ICT deployment in South African agriculture remains uncertain. It is not yet established which different specific ICT are used and how they are used in different agricultural farm enterprises, and if used, their extent of deployment. More studies on ICT deployment have focused on other sectors such as education, health, banking, e-government and tourism. Less research have been done on ICT deployment in South African agriculture. The few studies which were done on ICT use in agriculture focused on a limited number of ICT such as World Wide Web (Coetzee, 2000), computerised irrigation (Information for Development, 2005:23), computer (ICT Update, 2004a:8) and Internet (CTA, 2002:39). Other ICT deployed in South African

agriculture are not known. Ortmann (2000:26-35) investigated the use of information technology in South African commercial agriculture, but since then a number of new ICT have emerged, and it is likely that the farmers have adopted more technologies.

Few studies have focused on the factors that influence the use of ICT in South African agriculture. Among them is Woodburn, Ortmann and Levin (1994:183) who specifically investigated the factors that influence the use of a single ICT, computer applications, by commercial farmers. The factors that affect the use of other ICT are not known. Without a clear understanding of the factors that determine ICT use, it is difficult to develop a measure that can be used as a benchmark for relevant ICT-driven development projects in agriculture. Therefore, the purpose of this study is to identify the different ICT being used in agriculture and the factors that influence ICT use decisions in commercial wine industry. The following section presents the specific research questions for the study.

1.4 Research questions

The research questions stated on Table 1.1 were posed in order to provide direction for both the theoretical framework and empirical analysis of the research.

Table 1.1: Research questions

Research problems	Research questions
Types of ICT being used in agriculture	What are the different kinds of ICT that are being used by agricultural communities in South Africa?
Major ICT uses	What are ICT used for by the farmers and farm employees in the wine industry?
Barriers inhibiting ICT use	What are the major barriers that hinder the use of ICT in the wine supply chain and by farm employees?
Benefits of ICT use	What are the key benefits from ICT use by both commercial wine farmers and their farm employees?
Factors affecting ICT use	What factors influence the use of ICT in agriculture by farmers and farm employees?

1.5 Significance of the study

This study provides basic information for further research on ICT-driven agricultural development in South Africa. Identifying factors that influence ICT use helps stakeholders and service providers who work with farmers in commercial agriculture to put into consideration these important factors. This will help them to find possible solutions to the problems and challenges faced by both farm workers and commercial farmers and to meet their specific needs. The identified factors of ICT use will contribute to the development of a relevant model for ICT utilization for commercial agricultural purposes in a developing country. Knowledge of these use factors can also contribute towards the shaping of government policy on agricultural development. In addition, the study will contribute to the development of a model based on the factors influencing the use of ICT. This model can be used to develop a decision-making support tool for farmers and farm employees. This tool can assist farmers with the basis for how they can employ their workers, which ICT to adopt for their farms and how they can adopt certain ICT for

farm use. The farmers can use the results to recruit farm employees whose ICT use preferences and skills are better matched by available range of ICT on their farms. Farm employees can know the required qualifications for the operation of certain specialised ICT.

Furthermore, the findings in this study can be used to develop a benchmark for similar ICT use studies targeting agricultural communities. The research will also contribute to the development of a future comprehensive agricultural portal for developing countries, especially in Africa. The results of the study will enable researchers, policymakers, service providers and other interested parties better understand the ICT needs of agricultural communities in South Africa and other developing countries. Also, the agri-tourism sector may find the results of the study useful for their business and commercial information flow aspects, given the growing importance of farm tourism in South Africa. Having discussed the important issues about the study, it is important to define the technologies that this study is investigating. The following section presents the definition of ICT.

1.6 What are information and communication technologies (ICT)?

The 21st century is well known as the information society era characterised by the acquisition, development, storage, use and sharing of information and knowledge (Kavulya, 2007:300). An information society can be defined as a society in which the use of ICT plays an important role in how the people live. In the information society, people's lives interface with ICT in different ways; in the way they work, relax and sustain themselves (Bannister & Remenyi, 2003:199).

The definition of ICT seems to be subjective. Different scholars have different opinions on what to include and not to include in the definitions of ICT. This may be because information and communication technologies are expanding and advancing at a rapid rate day-by-day. As a result, what may be included in the definition today may not be the same as what will be included tomorrow. Rao (2006:492) defines ICT as a range of technologies that integrate information technology devices like personal computers with communication technologies such as telephones and telecommunication networks. Both the range of the technologies and their convergence with conventional media are expanding all the time.

For the purpose of this study, information and communication technologies are defined as a range of technologies that consists of hardware, software, networks and media that facilitate the collection, storage, processing, transmission, retrieval, presentation and communication of information (voice, data, text, images) using electronic means. This definition encompasses both

the new ICT such as e-commerce, websites and computers and the traditional ICT such as radio and television, as well as the various services and applications associated with them, such as, videoconferencing and distance learning. The following section discusses the background on South African agriculture.

1.7 Background on South African agriculture

This section discusses the background information on the overview of South African agriculture, the Western Cape fruit and wine industry and the organizations that disseminate agricultural information to South African agricultural stakeholders.

1.7.1 Overview of South African agriculture

South African agriculture is characterised by extreme dualism and inequality. The agricultural economy is highly dualistic with a well-developed commercial sector that co-exists with a predominantly large subsistence (communal) farming sector mostly in the remote and historically disadvantaged rural areas (South Africa, 2005:75). South Africa's agricultural sector is not dominated by subsistence farming like in other African countries; in fact large commercial farms dominate the sector especially in the Western Cape (Moseley, 2006:1). This is due to historical discrimination of the black majority before independence. Most blacks are involved in subsistence farming and they mainly produce for family consumption. Approximately three million black subsistence farmers are located in the communal areas of the former homelands where agriculture is not well developed as compared to fully established commercial agriculture sector. This has led to high poverty levels, especially in these communal rural areas where 70 % of the South African poor people live (Department of Agriculture (DoA), 2001:2). Faced with this challenge the DoA came up with the Agricultural Black Economic Empowerment (Agri-BEE) framework to support and empower the black South Africans to actively participate fully in agriculture as owners, managers, professionals, skilled workers and consumers (DoA, 2004:7).

South African agricultural sector provides food and fibre that are the basic human needs. According to South Africa (2005:75), the country is self-sufficient in mainly all major agricultural products and has more than enough output to export massive amounts of agricultural produce. Other Southern African countries such as Botswana, Lesotho and Namibia rely on South Africa for maize.

Generally at a national level, agriculture contributes about 2.8 % to the Gross Domestic Product (GDP) of South Africa (Cape Gateway, 2006). In 2006, the value of the commercial agricultural production was R76 billion and its contribution to the GDP was approximately R34 billion. The agricultural sector remains the major foreign currency earner and employment provider (DoA, 2007). The largest export agricultural products are wine, citrus, sugar, grapes, maize, fruit juice, wool and deciduous fruit such as apples, pears, apricots and peaches. Major export destinations for South African agricultural produce are United Kingdom (UK), Netherlands, United States of America (USA), Germany and Mozambique (South Africa, 2005:75).

Given the great potential and significance of agriculture to the economy of South Africa on one hand and the ever-increasing population with approximately 70% poor people on the other hand, there is need to effectively deploy ICT in the agricultural sector in order to increase food production, reduce poverty, improve the people's livelihoods and attain agricultural development. By fully utilizing ICT and taking into consideration people's different needs, ICT can be a powerful tool for economic and agricultural development thereby eradicating poverty (World Bank, 2003:11). The appropriate deployment of ICT can lead to the economic, social, and political empowerment of the people (Nikam, Ganesh & Tamizhchelvan, 2004:213). It cannot be overemphasized that ICT plays a crucial role in facilitating communication and access to information for agriculture and rural development (Kapange, 2006:7). This makes access to and exchange of information to be of utmost importance in a country such as South Africa with over 47 million people who need to be fed through agriculture. ICT offers new opportunities, which enhance the quality (e.g. timeliness, availability, relevance) of critical information. This has led to the emergence of global agricultural production chains that are interlinked by digital networks, and therefore has important implications for the livelihoods of farmers. ICT are driving agricultural production and marketing innovations globally and their full potential is yet to be realised in South African agriculture.

1.7.2 The Western Cape fruit industry

The Western Cape agricultural sector is substantially different from other provinces because of its climatic conditions, composition of agricultural output; export orientation, and the important implications for the needs of the emerging farmers in the sector (Moloi, 2007:2). Western Cape agriculture contributes 14.5 % of the total GDP and generates about 23% of the total gross income of the country's agricultural sector. The province accounts for more than half of South African agricultural sector's exports (Elsenburg, 2007). Commercial agriculture is the leading export sector in the province.

Western Cape agriculture is based mainly on the production of fruits (fresh, dried, processed and juices), wine, vegetables, livestock and winter grains. Fruits and nuts dominate the first position in the top 20 export products for the province and contribute 19.4% of the total agricultural produce from the province. The majority of the export potential for South African agriculture is concentrated in the wine grape producing areas of Worcester, Robertson and Stellenbosch, the deciduous fruit areas such as Caledon, Paarl and Ceres and the citrus producing areas such as Citrusdal (McDonald & Punt, 2001:1). The Western Cape is the country's largest producer of citrus fruit contributing about 90% of the country's total exports. Many fruit farms produce deciduous fruits that have been of major importance. Examples include grapes, apples, cherries, pears, peaches, and other fruits, which are being exported in great quantities mainly to European markets.

South African fruit producers benefit from fruit exports because of their growing season that is the opposite of the European season (Moseley, 2006:3). Although they compete with other Southern Hemisphere fruit producing countries, they are sustainable because they enjoy seasonal advantages over other fruit producing countries. Import duties only increase in Europe after 15 October when the European production season begins. South African fruit producers have an advantage since they produce their fruits in winter and sell them before the 15th of October when very low duties are charged. In the case of oranges, no duty is paid to European markets until the 15th of October. According to Cape Gateway (2003:7), South African citrus contributes up to 2 % of world citrus production, but accounts for more than 8.5% of total world exports. 60 % of the annual crop is exported, 25% locally consumed and 5% processed to juice.

According to Statistics South Africa (2005:47), a census of commercial agriculture that was carried out in 2002 showed the following production levels of fruits by different South African provinces (see Table 1.2).

Table 1.2: Fruits produced in South African provinces

Province	Citrus		Subtropical fruits		Deciduous fruits	
	Planted Hectares	Production Metric tons	Planted Hectares	Production Metric tons	Planted Hectares	Production Metric tons
Eastern Cape	14 263	300 069	4 570	70 695	3 876	106 588
Free State	114	1 619	240	3 890	827	13 896
Gauteng	62	936	14	91	593	7 814
Kwazulu-Natal	3 412	72 368	4 698	76 522	198	2 455
Limpopo	20 374	487 839	14 824	142 197	550	9 594
Mpumalanga	13 139	317 225	15 927	264 729	1 541	23 207
North West	1 707	27 661	173	1 974	362	4 070
Northern Cape	721	11 843	252	4 010	10 922	192 848
Western Cape	10 893	257 679	721	20 047	109 194	1 920 003
South Africa	**64 685**	**1 477 239**	**41 418**	**584 155**	**128 064**	**2 280 475**

(Adapted from Statistics South Africa, 2005:47)

As shown on Table 1.2, Western Cape Province is a major producer of deciduous fruits and grapes are among them. Its deciduous fruit production levels are far above the rest of the provinces with a production of 1 920 003 metric tons per year, followed by the Northern Cape with a production level of 192 848 metric tons per year. In citrus production, the Western Cape is the fourth highest producing province after Limpopo, Mpumalanga and Eastern Cape provinces. Its production level is 257 679 metric tons per year. Limpopo, which is the highest producer of citrus, has a production level of 487 839 metric tons per year. Due to the climatic conditions in the Western Cape Province, production of subtropical fruit is minimal. Generally, taking into consideration the proportion of the land devoted to the production of fruits and the resultant production levels, it can be deduced that the Western Cape Province is a major producer of fruits in the country.

1.7.3 The Western Cape wine industry

The South African wine industry dates back to more than three centuries ago when the first vines were grown in the cape in 1655. In 1659, wine was processed from grapes for the first time in the cape (Flockemann, 1972:481). Now South Africa is a major global player in wine

production and trading. In wine production, South Africa is ranked the 8th largest wine producer in the world (Bruwer, 2003:424). The wine industry is one of the major contributors to the South African economic growth, especially in the Western and Northern Cape (Esterhuizen & Van Rooyen, 2006:468). The industry is also a major employment provider.

The wine industry has prospered the most among all the commercial farming sectors in the Western Cape Province (Moseley, 2007:7). This is because of the favourable climatic and soil conditions in the province. Exports from this industry have increased ten fold in the past decade. The statistics shown on Table 1.3 shows that most of the wine produced in the country is exported to other countries, mostly in Europe. For the year 2006, the producers' income was R2 610 727 million and a total of 1 301 579 tons of grapes were produced. The other key statistics of the South African wine industry as per 2006 are shown on Table 1.3.

Table 1.3: Key statistics of the South African wine industry, 2006

Producers' income	R2 610. 727 million
Number of grape producers	4 175
Total grape production	1 301 579 tons
Number of wine producing cellars	576
Volume of wine production	345 165 million litres
Total exports	271 628 056 million litres
Land under vines	126 419 hectares
Number of vines	354 411 773
Number of wholesale buyers	65

(Adapted from South African wine industry information and systems, 2007)

There are a number of areas where grapes are grown in the country. According to South African wine industry information and systems (SAWIS), (2007), there are 8 wine growing areas in the Western Cape. The main areas that produce grapes on a wider scale in the province include Worcester, Paarl, Stellenbosch, Malmesbury and Robertson Wine Valley. In 2006, Worcester has the highest number of vines and large area under grape cultivation than other areas in the province. Table 1.4 shows the wine growing areas in the Western Cape Province, the number of vines in each area and the area in hectares under grape cultivation. The figures shown are for the year 2006.

Table 1.4: A summary of the wine growing areas in the Western Cape, 2006

Wine areas	Number of vines	% of total vines	Area in Hectares	% of total hectares
Worcester	66 883 478	21.80	20 200	19.78
Paarl	54 672 569	17.74	17 733	17.36
Stellenbosch	53 538 521	17.37	17 358	16.99
Malmesbury	38 662 120	12.54	15 200	14.88
Robertson	46 778 016	15.17	13 603	13.32
Olifants River	27 530 415	8.93	9 890	9.68
Orange river	10 862 242	3.52	5 160	5.05
Little Karoo	9 332 009	3.03	3 002	2.94
Total	**308 259 370**	**100.00**	**102 146**	**100.00**

(Adapted from South African wine industry information and systems, 2007)

1.7.4 Western Cape farm employees

Though little have been investigated about farm employees in the Western Cape Province, it is important to acknowledge the role of farm employees. The South African wine industry, including wine tourism employs approximately 256 908 workers (Esterhuizen & Van Rooyen, 2006:468). It is believed that the commercial farm worker population is among the poorest people in South African society. In the Western Cape Province, males form most of the permanent farm worker population while females form most of the seasonal farm worker population (Moseley, 2007:8).

A study conducted in Robertson Wine Valley on education qualifications and skills of farm workers showed that most of them have low education levels and high level of illiteracy. They highlighted the need for technical skills and training (Booysen, J.H. 2006:18). To solve this problem, an official study group was formed to train the farm employees in the wine industry and cater for their information and academic needs. The results of this initiative are yet to be realised. A number of ICT initiatives aimed at farmers and farm employees are discussed in section 1.8.

1.7.5 ICT penetration rates in South Africa

Before investigating the use of ICT, it is important and necessary to assess the penetration of ICT in South African communities. Without ICT penetration, ICT use tends to be restrained.

In South Africa, mobile technologies have the highest penetration rates than other ICT. Mobile technologies have enabled the previously marginalised millions of people to have access to personal communication (Esselaar, Gillwald & Stork, 2006). In a related study, Zama and Weir-Smith (2006) investigated ICT accessibility in all South African provinces. The results on Table 1.5 show the percentages of households who have access to different types of ICT in each Province.

Table 1.5: Percentages of households with access to ICT in South African provinces

Province	Landline at home %	Access to PC %	Access to internet %	Access to cell phone %
Western Cape	40.4	23.8	14.1	38.0
Eastern Cape	10.6	4.5	3.1	23.0
Northern Cape	17.6	9.3	3.6	18.9
Free State	18.5	10.2	4.5	26.3
Kwazulu-Natal	12.5	6.6	2.8	25.3
North West	11.1	3.7	1.9	27.9
Gauteng	17.3	15.5	11.3	43.8
Mpumalanga	14.6	6.3	3.8	25.5
Limpopo	9.5	4.7	2.7	29.1

(Adapted from Zama & Weir-Smith, 2006)

On a provincial level, the Western Cape Province has the highest penetration rates for landline phones, personal computers and Internet. Gauteng Province leads in mobile technology accessibility.

According to a comparative analysis of trends in fixed telephones line, Internet and mobile phones reported by the International Telecommunication Union (ITU), Africa still have great potential to improve its telecommunications usage. On a continental level, South Africa is among the top 15 African countries that are role players in facilitating and promoting the use of ICT (ITU, 2007). Figure 1.1 shows the 15 largest African markets in terms of total (fixed and mobile) telephone subscribers per 100 inhabitants. Among the top 15 African countries with the highest penetration rates, South Africa is ranked number 4.

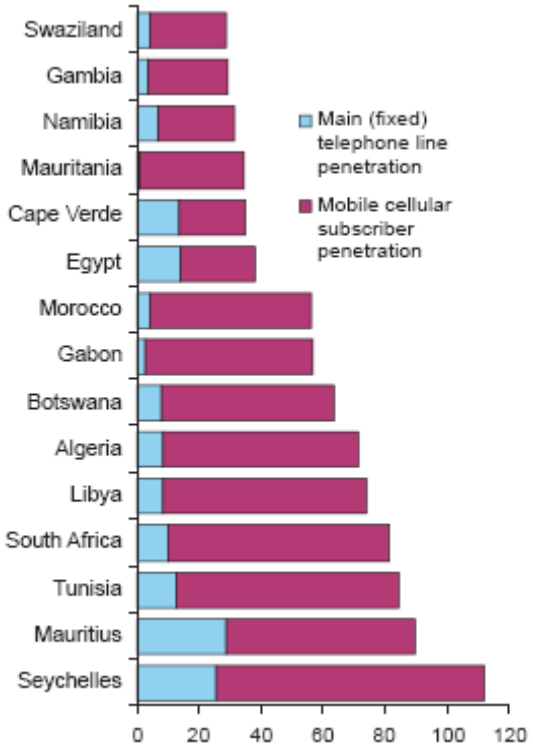

Figure 1.1: 15 African countries with highest penetration

(Adapted from International Telecommunication Union, 2007:9)

In terms of Internet penetration, South Africa is ranked number 6 among the top 15 African countries with highest penetration rates. Figure 1.2 shows the Internet users per 100 inhabitants for top 15 African countries.

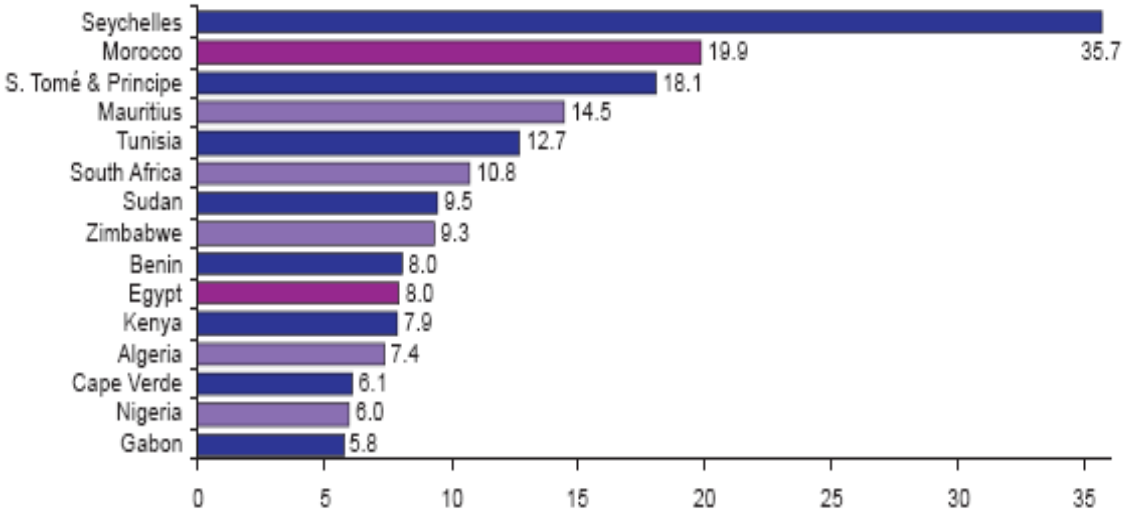

Figure 1.2: Top 15 African countries-Internet users per 100 inhabitants

(Adapted from International Telecommunication Union, 2007:12)

In comparison to other African countries, a summary of penetration rates for landline telephones, mobile phones and Internet for all African countries (see Appendix A).

The rapid penetration of ICT in South Africa offers clear opportunity to use ICT in delivering agricultural goods and services. With this increasing penetration, it is logical to investigate how ICT penetration is changing lives of communities and benefiting the agricultural role players. If information and communication technologies have managed to find their way into different agricultural communities, then it is likely that they are being used in these communities and are impacting livelihoods of the members of these communities. Given the high ICT penetration rates presented in this section, ICT use is also expected to be high in the communities. The use of ICT in the Robertson Wine Valley community will be investigated in this study.

1.8 ICT initiatives in South Africa

In this section, emerging and existing ICT initiatives that have been put in place for the benefit of communities are discussed to expose key issues for consideration in ICT deployment in commercial agriculture in South Africa. The potential of ICT use in community initiatives needs to be explored to assist current and future initiatives with ideas on how ICT can be deployed for the benefit of the communities.

Governments in most developing countries have started to appreciate the power of ICT to transform their countries and have started to apply these information and communication technologies for national development. A lot of changes in the way the government operate worldwide have been brought about by the advent of information technologies. According to Enakrire and Onyenania (2007:15), most African countries have acknowledged the information revolution, although the use of the technology differs from country to country. South Africa is not an exception; its government has put in place a number of initiatives to promote the use of ICT in different sectors of the economy. In this section, some of these initiatives that relate to South African agriculture were reviewed

The South African government has emphasized the development of an ICT sector through the formation of a national ICT strategy that addresses ICT penetration, particularly for disadvantaged communities. Besides SAITIS and Info 2025 Vision that have been assigned responsibility of building ICT infrastructure, three taskforces were put in place to address ICT deployment as a socio-economic development enabler. These are:

(i) The Presidential International Taskforce on information society, which targets mainly the global ICT markets;
(ii) The National information technology (IT) Taskforce, which deals with local national ICT initiatives and;
(iii) The IT council, responsible for local and provisional government information technology functions (Digital Opportunity Initiative, 2001:13).

A number of ICT policies were put in place. Their objectives were to transform the ICT sector, create an ICT-enabled environment that improve the socio-economic lives of people, use ICT to alleviate poverty and reduce the digital divide (Department of Communications, 2006:13). The major purpose of these policies is to provide universal access of ICT at affordable rates to all the citizens. This is supported by the telecommunications Act No.103 of 1996, 2(a) that states that the ICT policies aim to promote the universal and affordable provision of telecommunications services. The Universal Service Agency (USA) has been given a mandate to be the major vehicle in the provision of these universal ICT services. According to the Digital Opportunity Initiative (2001:2), the ICT sector is growing vibrantly.

Due to the predicament of a number of challenges such as poverty, poor ICT infrastructure, low education levels and computer skills; the South African government established the telecentre approach as a way of placing ICT and other information services within the reach of disadvantaged rural South African communities (Snyman & Snyman, 2003: 96). Telecentres are

established as information resources and communication nodes in communities to meet the needs of the people. They offer a broad range of communication services freely or on subsidies by the government or Non-Governmental Organisations (Colle & Roman, 2003:388). About 103 telecentres have been established throughout different provinces in the country and examples include Mamelodi, Gaseleka, Botlokwa, Phalala, Makuleke, Mankweng, Bakgaga-ba-Mothapo, Thakgalane and Tombo (Esselaar, Gillwald & Stork 2006:46).

In the Western Cape Province, a number of initiatives have been put in place to promote the development of the ICT sector. Cape IT Initiative (CITI) is one of the important players in the Western Cape ICT sector. Among other things, it is responsible for the marketing and developing new ICT businesses, developing ICT skills and influencing ICT policies. (Cape IT Initiative, 2002:10). Farmer and farm worker training programs have been going on for some time. The Western Cape DoA trained a number of emerging and commercial farmers on the transfer of appropriate technologies since 2003/04 period. The primary target group for the structured training programme is approximately 17500 emerging and 8500 commercial farmers in the province (Elsenburg, 2006:80).

The DoA also established a farm worker development strategy specifically for farm employees in the province. The strategy focus on training of farm employees, labour awareness, education for farm worker's children, improved service delivery and Agri-BEE. In 2005/6 period a number of funded projects trained farm employees and their children, and seasonal female farm employees. Other projects focused on bursaries for farm worker's children, provincial farm worker competition and training on safety regulations (Elsenburg, 2006:40).

In summary, there are a number of role players involved in projects that specialise in the provision of ICT to the rural isolated communities of historically disadvantaged people in South Africa. Some of the projects that focus on the disadvantaged communities are shown on Table 1.6. From the table it can be noted that the Universal Service Agency is taking the leading role in the provision of universal ICT to disadvantaged communities since it was mandated to do so by the government. Among other role players carrying out projects and aiming at providing ICT services to disadvantaged communities are Vodacom, Government Communication and Information System (GCIS), Community Based Information Services (CBIS) and the Department of Communication (DoC). The main focus of these projects is summarised on Table 1.6.

Table 1.6: Community Universal Access ICT projects in South Africa

ICT provision	Main focus
Universal Service Agency (USA) ICT centres	Provide universal ICT access centres to disadvantaged areas (such as Mamelodi telecentre)
Vodacom Phone shops	Fulfil the universal service obligation to disadvantaged communities
GCIS Multi-purpose Community Centres	Provide of government services and information to disadvantaged communities
Department of Communication Projects	Provide of ICT services through the post office, establishment of research laboratory in traditionally disadvantaged communities
Community Computing/ MPCCs	Offer ICT literary courses, training, community –based information service (CBIS) centres

(Adapted from Akinsola, Herselman & Jacobs, 2005:27)

The aim of all these community universal access ICT projects is to meet the peoples' need for information, which is essential on a day-to-day basis. People continually need to be informed on what is happening around them so that they can make informed decisions. This implies that information is very important and there is need to investigate its importance. The following section discusses the importance of agricultural information as a factor of production to the main role players in agriculture.

1.9 Importance of agriculture information as a factor of production

Equitable access to information is one of the most important necessities in the emerging global information economy, and it cannot be doubted that information is an important tool for the survival of any organisation irrespective of size, management or type of ownership (Enakrire & Onyenania, 2007:15). In agriculture, ICT facilitates access to timely information needed in each step of the agricultural process, be it production, harvesting, distribution, storage and marketing. This section discusses the importance of agricultural information to the agricultural role players. It shows the significance of agricultural information as an additional factor of production to the existing factors of production, such as land, labour and capital.

Traditionally in third world countries, access to ICT and information has not been viewed as a basic need, but nowadays it is, because of the globalized economy (Fors & Moreno, 2002:201). The rising demand for information is an emerging new paradigm for agricultural development that challenges the old ways of delivering important services to the agricultural communities in developing countries (Adebayo & Adesope, 2007:2). Information is now perceived as a factor of production like other factors such as labour, capital and land (Rao, 2006:491). Dralega (2007:3) argues that if information is combined with other factors of production, it will enhance agricultural production and marketing. It is a vital resource for development and empowerment, giving farmers the ability to make informed decisions pertaining to production, marketing and management of agricultural products and services. Kavulya (2007:299) refers to information and knowledge as the world's most critical resources and driving forces that can be used to address socio-economic challenges faced by Sub-Saharan African (SSA) countries with greater success. If ICT development projects are driven by the information needs of the poor and not the concerns for technological relevance then it can be certain that the needs of the poor will be identified and met accordingly (Moodley, 2005:13).

The main focus of ICT use in agriculture lies in meeting the farmer's needs for information (Meeira, Jhamtani & Rao, 2004:9). However, if modern information and communication technologies are not adequately built into the agricultural supply chains, there is a probability of stagnation in the dissemination, utilization and application of new scientific agricultural information for the development purposes. Kalusopa's study on Zambia (2006:416) stresses that those agricultural producers without ICT access remain at the mercy of the global market giants due to their competitive disadvantage. The same applies to the Western Cape emerging farmers whose major constraint is the lack of market information (Moloi, 2007:1). These farmers will remain dependent excessively on the middlemen, making it difficult for them to adapt to ever-changing market and environmental conditions and to get better profits from their yields. Poor information flows within and between government institutions lead to inefficient institutions, poor policies, poor service delivery and the inability to meet the needs of vulnerable and poor communities (McNamara, 2003:27). Information communicated by ICT can support livelihoods through the dissemination of information on better use of resources, markets, commodity prices, income generation projects and support services (Nikam, *et al*., 2004:215).

Empirical evidence has shown that there is a direct relationship between effective flow and transfer of information and agricultural development (Kalusopa, 2006:415). Agricultural development is severely constrained when markets perform poorly due to lack of appropriate information and communication flows. Without proper communication of useful information,

consumers may not be in a position to fully realise the advantages of technologies (Lee, Lee and Schumann, 2002:2). ICT can accelerate agricultural development by providing more accessible, complete, timely or accurate information to those making key decisions. Enhanced information flows help farmers to make more informed timely decisions. Winrock (2003:15) observes that modern ICT offer new opportunities to increase the quality (e.g. timeliness, availability, relevance) of critical information. In addition, ICT provide cost-effective methods to empower and ensure feedback from previously marginalized communities. In addition to that, ICT enable larger amounts of information to circulate and be stored at a much higher speed, diminishing the effect of distance. Among other uses, they enhance the provision of essential information on market prices, weather conditions and credit facilities. Accessibility of information on prices do not only give farmers more bargaining power but also allows them to explore alternative market opportunities beyond the farm gate (ICT Update, 2002b:3). The question that arises is how many agricultural communities are fully participating in this information age and enjoying the benefits of access to information in developing countries and specifically in South Africa?

Table 1.7 shows the typical set of information provided by ICT to agricultural communities as they make key decisions throughout the year. The information provided by ICT can be divided into categories. The four major information categories provided by ICT are on (i) agricultural technologies, (ii) natural resource base and geography, (iii) policy environment, laws and regulations and (iv) market information.

Table 1.7: Key information exchanged within the agricultural system through ICT

Agricultural technologies Best agricultural practices New technological varieties Technical assistance	**Natural resource base and geography** Climate, weather and forecasts Soil and natural resource information Rainfall and water sources
Policy environment, laws and regulations Labour laws Water access rights Environmental regulations Agricultural policies Land rights	**Market information** Prices and quality requirements Input provision Credit availability Selling options Supply and demand Distribution and logistics

(Adapted from Winrock, 2003:15)

Table 1.7 provides an insight of how important ICT are to all the role players involved in agriculture. Without ICT, it becomes difficult to disseminate all the information that is readily needed in agriculture. Since information is very important to agricultural role players, there is need for organizations, institutions and individuals to disseminate it to the respective people who need it. Enakrire and Onyenania (2007:15) and Gebremichael and Jackson (2006:268) noted that most African countries have information poverty; they do not have access to all the information categories mentioned on Table 1.7. They argued that this information poverty takes the form of poor planning because of lack of facts, unreliable information support for decision-makers, limited access to information within and among countries, lack of access to national statistics and poor access to timely information on national and international markets. The root problems of the information poverty are the poor information infrastructure of Africa, which is believed to be the least developed in the whole world (Langmia, 2006), information illiteracy, government controls and lack of resources. This problem is typical of the African continent, and the resultant effects of information poverty are the poor service delivery to the citizens, poor performance of economies and on-going poverty.

There is an ongoing debate as to what should be provided to societies in order to reduce the prevailing digital divide between those who have and those who do not have access to ICT, in order to solve information poverty. Grabill (2003:462) mentions that the problem of information

poverty can be solved by access to information that is relevant to the needs of the society. However, this should not be seen as the only solution, since information by itself is not useful unless people are taught how to use it to empower themselves and enhance their day-to-day operations. Bertot, too, argues that information access is not the only solution to the problem, but that all the different dimensions of digital divide have to be provided (2003:186). These dimensions include among other things technology, telecommunications and economic development. Taking into consideration the multidimensionality of digital divide facilitates the recognition that the solution to the digital divide problem extends beyond access to only information and technology. Other dimensions have to be taken into consideration also.

1.10 Organizations involved in agricultural information dissemination in South Africa

This section discusses some of the organizations that are involved in disseminating agricultural information to farmers and other stakeholders in a way to reduce the information poverty in the agricultural sector of South Africa. The information provided by each organization is classified under the information categories mentioned on Table 1.7.

South African farmers have access to various and numerous sources of agriculture information. These include agricultural conferences, newsletters, books, magazines, journal articles and the World Wide Web. Most of this information is available on World Wide Web. This means that only those who can access to the World Wide Web and the appropriate technologies associated with them have advantages over those without access. The majority still face challenges to access the information. Those who have access to the World Wide Web still needs to be judgemental since some of the information is not peer reviewed (Coetzee, 2000:18). Some of the organizations involved in information dissemination to farmers in South Africa are as follows:

1.10.1 The Department of Agriculture (DoA)

The national DoA (http://www.nda.agric.za) is a major agricultural information disseminator together with its subsidiary branches in each province of South Africa. Extensive information can be accessed on its websites. In addition to that, the DoA publishes a lot of documents relating to agriculture. DoA provides comprehensive information on all major issues of agriculture. The major information provided by DoA mainly falls under all the main types of information categories illustrated on Table 1.7. These are (i) agricultural technologies, (ii) natural resource base and geography, (iii) policy environment, laws and regulations and (iv) market information.

1.10.2 Aginfo Pty (Ltd)

Aginfo Pty (Ltd) is also referred to as Agrimark Trends (http://www.agrimark.co.za). It is led by a group of agricultural professionals and was established to provide market information and to carry out agriculture related research. Its vision is “To be an internationally recognized centre of excellence in agricultural research and advice and in providing objective, timely and accurate agricultural market information to the benefit and prosperity of producers, agribusinesses and policy makers”. Referring to Table 1.7, basically the type of information provided by Aginfo Pty (Ltd) falls under market information category.

1.10.3 Intertrading Limited

Intertrading Limited (http://www.agrilink.co.za) was established to support South African fruit growers who export their produce and to offer them help to access European markets. It has been a role player in the South African fruit export industry. Initially it was involved in the subtropical industry and later on got involved in the deregulated areas of deciduous and citrus fruit. The group now comprises several companies providing services in the agricultural sector, including both marketing and technical expertise to the major fruit producers in South Africa. Intertrading Limited’s area of specialisation in terms of the information types it provides falls under two categories shown on Table 1.7 that are (i) policy environment, laws and regulations and (ii) market information. Its website offers comprehensive information under these two information categories.

1.10.4 Agri South Africa (Agri SA)

Agri SA was established in 1904 as the South African Agricultural Union. At present it serves approximately 70 000 large and small-scale commercial farmer members. It developed a website called Agriinfo (http://www.agriinfo.co.za) to create a common gateway for all agriculture role players. On its website and documents Agri South Africa, provide information relating to three categories shown on Table 1.7 which are (i) agricultural technologies, (ii) policy environment, laws and regulations and (iii) market information. Its information on all these categories is detailed.

1.10.5 Land Bank

Land Bank (http://www.landbank.co.za) offers financial services to established and emerging farmers. It has recently introduced the ‘Agri info-centre’ that is a web-based library to provide

detailed agricultural information to farmers. As of now, the information that is provided by Land Bank falls under one category of market information since it specialises in providing financial assistance to farmers. In the future, it plans to provide other information that falls under agricultural technologies and policy environment, laws and regulation (see Table 1.7).

Given the mentioned and other sources of agricultural information available to South African farmers, there is a need to reduce the digital divide between the farmers with and without access to the necessary ICT. This may be done by providing all the dimensions of the digital divide as mentioned before in this chapter. This will enable all South African farmers to stand on an equal ground and equally participate in the information age in order to realise the full benefits of ICT. As of now, questions still arise as to which farmers use ICT and which do not use? This question is addressed and resolved in this study. The following section presents the summary of chapters.

1.11 Summary of chapters

This chapter served to introduce the problem to be addressed, the objective of the study, the background information on ICT and agriculture in South Africa, the importance of information as a factor of production, the research questions and the significance of the study.

Since the study deals with the use of ICT in agriculture, it would be appropriate to appreciate the importance and role of ICT in agriculture. This is undertaken in Chapter 2 where the literature is reviewed at length. Also included in this chapter is the role of ICT in poverty alleviation and integrating agribusinesses with global markets. Since the study is also interested in how ICT is used for agricultural purposes, it is important to identify barriers to ICT use by agricultural communities in developing countries, discuss success stories of ICT use by agricultural communities in developing countries, and relate ICT to gender issues.

Chapter three presents the theoretical framework underpinning this study. It discusses other models used in adoption and use of technology like Technology Acceptance Model (TAM), Marcus' theoretical model of adoption and Diffusion of Innovation (DoI) theory. The information innovation adoption model is discussed in detail and presented as the theoretical model of the study. Chapter 4 discusses the ICT models that are used in agriculture in developing countries. Econometric and non-econometric models are discussed in detail and relevant examples are given. The research method, research plan and analytical procedures are discussed in Chapter 5. Chapter 6 presents the empirical results of the study for the farm employees. Descriptive

statistics, correlation and chi-square tests results for the farm employees are presented in this chapter. Chapter seven presents the empirical results of the study for the farmers. Descriptive statistics, correlation and chi-square tests results for the farmers are presented in this chapter. The analysis of the results from the study, for both the farmers and farm employees is presented in chapter eight. Chapter nine summarizes the possible econometric model that can be derived from this study, compares the findings from this study to previous related literature and provides recommendations for the improvement of ICT use in agriculture. Lastly, chapter ten concludes the study with a brief summary, a discussion of the limitations of the study and the prospects of future studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In chapter one, the problem statement and objectives of the study were stated. The background information on South African agriculture, ICT initiatives in place and the importance of agricultural information were also discussed. This chapter presents a review of the literature pertaining to use of ICT in agriculture by agricultural communities, implications of ICT use in agriculture for poverty alleviation, role of ICT in integrating agribusinesses with global markets, constraints inhibiting the use of ICT in agriculture, successful stories of ICT use in some developing countries and gender issues surrounding the use of ICT in agriculture. Lastly, other technologies besides ICT that are used in agriculture are briefly discussed. All these issues make reference to agriculture in developing countries in general. Specific examples are given. Examples from South Africa and its agricultural industry are mentioned to provide insight to where and how ICT is used. This information is reviewed to provide answers to the cited research questions.

The discussion in this chapter highlights the importance and uses of different ICT in agriculture, as well as the various services and applications associated with them. This issue is sufficiently important to warrant a discussion before launching into more details about the study, since it is likely that the study would be appreciated if the importance and benefits of ICT in agriculture were laid bare in advance. The next section, therefore, takes up this point.

2.2 The importance of ICT use in agriculture

ICT applications are categorised into three purposes, namely (i) for decision support by public administrators, (ii) to improve services to citizens and promote transparency and (iii) to empower citizens to access information and knowledge (Bhatnagar, 2000:2). All these functions are necessary in agriculture to ensure (i) improvement in planning and monitoring agriculture development programmes, (ii) enhancement of agricultural service delivery to farmers and all role players in the supply chain and (iii) empowerment of people through training, providing access to up to date agricultural information and creating employment.

ICT can be used in almost every step in input procurement, production, distribution and marketing of agricultural produce. Information and the technologies that facilitate its use, exchange and reliability have been important aspects of agriculture and agriculture-related activities. Knowledge, communication and information exchange have influenced decisions on what to plant, when to plant it, how to cultivate and harvest and where to store and sell and at what price. As compared to traditional methods, ICT can add value when information is time sensitive, information requires significant customisation to satisfy a client's need, information needed involves standardized calculations and when there is need for significant back-and-forth interactivity over distances (Winrock, 2003). ICT are also offering more cost-effective methods for empowering and ensuring feedback from previously marginalized agricultural communities. There is an enormous potential in the use of ICT to provide information, access resources, enhance learning and research sources. It is a rapidly growing way of finding agricultural information, products and services.

According to Ortmann (2000), use of ICT is becoming popular as more and more farmers are no longer interested in the traditional ways of keeping farm data and records. This is because they are relatively simple to use and satisfy the recording and information requirements for many farmers. ICT are very useful for keeping financial and physical (crops, livestock) records for business planning purposes and for payroll preparation. They are also highly rated for providing up-to-date, more usable, easily accessible information and for saving time compared to traditional manual records. In projects, the integration of ICT can help to improve the performance of agricultural development (Woodburn *et al*., 1994).

Major benefits have emanated from using ICT in diverse areas of the food and agricultural industry including precision agriculture, product traceability and identity preservation (e-supply chains), animal husbandry, computerised irrigation systems, digital financing for farmers (i.e., Internet and mobile banking support), and computerised farm record keeping systems among others. The ICT applications and their benefits are described in more detail in the following sub-sections.

2.2.1 Precision agriculture

A growing area of ICT applications in crop production is in precision agriculture. Precision agriculture is information and technology-based agricultural management system that identifies, analyses and manages site-specific spatial and temporal soil variability within a field for optimum yield, profitability, sustainability and protection of the environment (Rilwan & Ikhuoria, 2006:

178). It uses sensors, digital application controllers, communication links, global positioning systems, computers and innovative software solutions to automatically match agricultural inputs and practices to variable local conditions. Technologies used in precision farming allow farmers to vary inputs, such as fertilizers, pesticides and seeding rates throughout fields based on management zones. Automatic guidance systems assist equipment operators in running equipment in the fields (Adrian, Norwood & Mask, 2005:257). These tools reduce redundancy and labour costs and expand hours of expansion.

It is interesting to note that even some African countries are practising precision farming. For example, the Agadi project in Sudan introduced precision farming to its commercial mechanized farming sector. Already the project had reaped some positive results. This made farming practices to be more efficient. Planting times were reduced by 60%, area under plant cover was improved by 3.5 % and the costs of spraying herbicides were cut substantially (ICT Update, 2006a:5). The benefits of precision agriculture include (i) reduction in the cost of producing the crop, (ii) reduction in the risk of environmental pollution from agrochemicals when applied at higher levels than required by the crop, (iii) provision of better information on inputs and land management, (iv) improved environmental stewardship and (v) significant improvement in agricultural yields (Covey, 1999).

2.2.2 Traceability

A number of established tracing and tracking technologies are in use in the meat industry (Mousavi & Sarhadi, 2002:10), dairy industry (Gygax, Neisen & Bollhalder, 2007:25) and food supply chain (Kelepouris, Pramatari & Doukidis, 2007:183). These include the bar codes, voice recognition systems, radio frequency tags and transponders. Computers and electronic devices are now used efficiently in computerized animal feeding, tracking systems, reproduction and disease control. Traceability can be divided into two types, depending on the direction in which information is moving in the chain. Backward traceability or tracing is the ability, at every point of the supply chain, to find the origin and characteristics of a product from one or several given criteria. Forward traceability or tracking is the ability, at every point of the supply chain to find the locality of products from one or several given criteria (Kelepouris, *et al*., 2007:186). In order to comply with the new regulatory requirements and procedures of the European Union (EU) and the concern for food safety, it is mandatory that all agricultural products entering the EU should be tracked back to the farm of origin (ICT Update, 2006b:3). This implies that all African countries exporting agriculture produce in Europe have to deploy traceability ICT. For example, in Botswana, the Livestock Identification Trace-back System (LITS) use radio frequency

Identification (RFID) to identify and monitor millions of beef cattle destined for export to Europe (ICT Update, 2004a:2).

In South Africa, the fruit farmers in the Western Cape who are selling their produce to Tesco Supermarkets in the United Kingdom (UK) are supposed to employ ethical labour standards traceability systems for their fruits to be accepted in Europe. In the South African wine industry, from the 1st of January 2005, all wine exported to EU complies with the EU regulation 178 of 28 January 2002, which states that all role players in the industry have traceability systems in place for each product to facilitate its traceability. In addition, each player in the supply chain is expected to identify any person/business dealt with one step forward and one step back along the supply chain (Matthee, 2004). In Fort Beaufort in the Eastern Cape Province, citrus farmers use computerised bar coding system to track each farmer's produce in the supply chain back to the orchard where the fruit was picked.

In India, the Agricultural and Processed Foods Product Export Development Authority have developed tracking software ''GrapeNet'' which enable European buyers to track grapes they buy from India (India Economic Times, 2007). Some of the advantages of traceability include (i) assurance of compliance with regulatory or industry requirements, (ii) enhance effective quality management, food safety and support and (iii) improved supply chain efficiency and trading partner collaboration.

2.2.3 Livestock management

One interesting development noted by Daly (2003:3) is that nowadays ICT can be embedded in agricultural machinery, contributing to efficient operations. ICT update (2004a:8) explained how ICT has become an integral part of South Africa's Agricultural Research Council Animal Improvement Institute (ARC-AII)'s activities and the national livestock sector as a whole. Many commercial farmers run a personal computer-based recording and management software that turns raw performance data into information that can be used immediately at the local farm level. In South Africa, most local livestock data is fed into the centralized Integrated Registration and Genetic Information System (INTERGIS). The system sets national livestock productivity benchmarks, keeps South Africa's livestock producers globally competitive and provides policymakers and farmers with a reliable source of reference. Above all, automatic feeding of livestock is another development that is becoming popular as a result of device embedding.

2.2.4 Computerised irrigation

The other application of ICT in crop agriculture is in computerised monitoring and controlling irrigation systems (Miranda, Yoder, Wilkerson & Odhiambo, 2005:186). This process uses a network of sensors that are buried in the irrigated fields with radio links to a central processor. The central processor can then automatically allocate water to each field according to the needs of the crop in each field. ICT use and automation has led to the enhancement of water use efficiency in irrigation by 10 -50%, increased yield per land, natural base and percentage of planted acreage harvested (Sne, 2005:9). A computerised system of irrigation in South Africa is being used in the mango and tomato-farming region of Blydepoort in Mpumalanga Province. The farmers installed a computerised private irrigation network that also uses short message system (SMS) to notify operators of water pressures that are too high or low (Information for Development, 2005:23).

2.2.5 Agricultural extension

Increasingly, ICT is now being used in agricultural extension to disseminate personalised and timely expert advice without necessarily offering face-to-face services to the farmers. An exciting example is e-Sagu, the IT-based personalized agricultural extension system that was developed and is in use in India (Sagu means cultivation). It requires a farmer to register all his/ her background and soil details for storage in the central system and be allocated an identifier. Information about crops is communicated in form of text messages and digital photographs (Ratnam, Krishna Reddy & Reddy, 2005:80). Some educated and experienced coordinators in the village send the crop information to the agricultural expert who, in turn, prepares advice based on that information. After analysing the messages and the photographs, the expert gives his advice back to the village coordinators, who in turn will give the farmer a feedback on their specific problem. The farmer will then follow the suggested advice and send a feedback to the village coordinator. The cycle goes on and on in that pattern (Ratnam, *et al*., 2005:80). A number of cotton farmers have been advised using this system. In summary the process takes place as shown in Figure 2.1

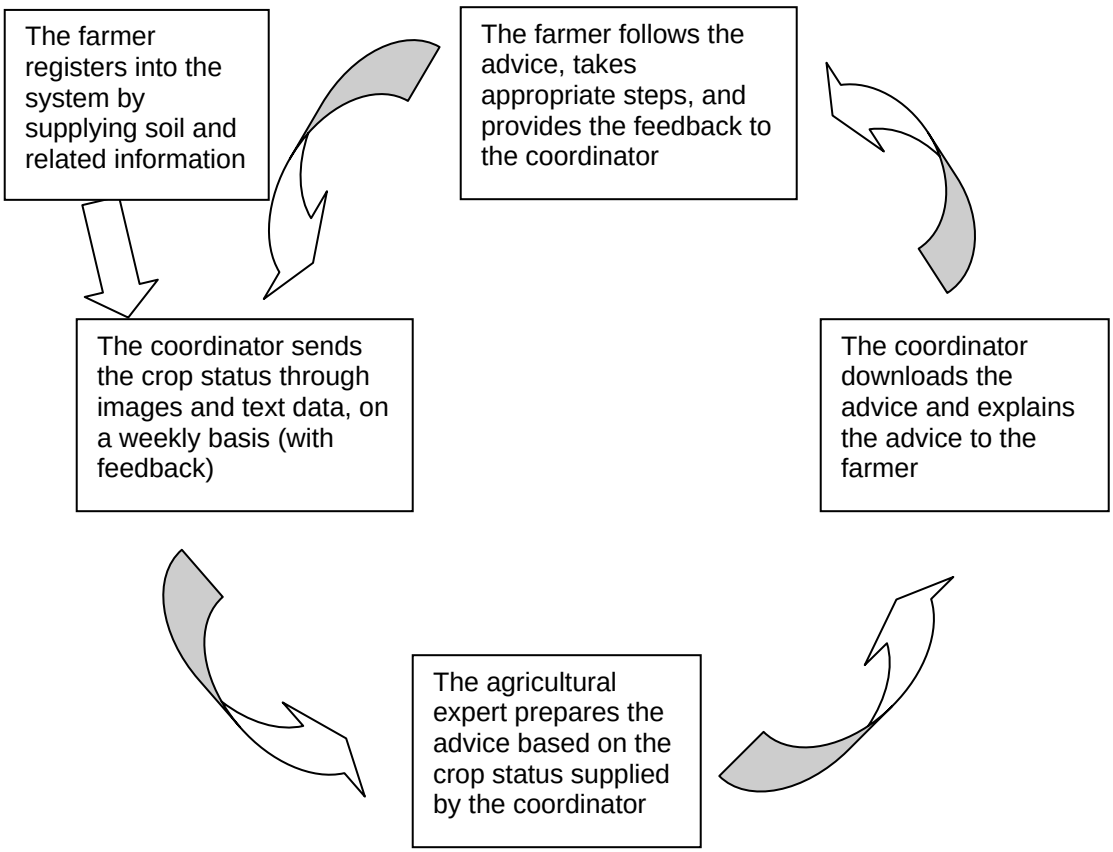

Figure 2.1: eSagu IT based personalised agriculture extension process

(Adapted from Ratnam *et al*., 2005:82)

In Africa, countries like Senegal, Uganda, Cameroon, Kenya, Tanzania, Zambia, Botswana, Gabon and Zimbabwe, have most of their populations use the Internet and eLearning for agricultural extension (Leary & Berge, 2005:57). In Kenya, extension officers even use Personal Portable Assistant (PPA) and wireless video conferencing to link farmers with distant experts, ministers and members of parliament to discuss agriculture and community-based development (ICT Update, 2004b:4).

2.2.6 Information dissemination

Computer-Mediated Communication Services (CMS) enabled by the Internet have an important role to play in the dissemination of information to agricultural role players. E-mail system enables farmer service providers and intermediary agencies working with farmers to exchange ideas, transmit data, access and disseminate information. However, e-mail technology requires efficient

power supply and a reliable and affordable telecommunications system (Munyua, 2000). The printing medium also plays a critical role for the farmers who can read, evidenced by the agricultural newspapers, posters, pamphlets and booklets that have been used successfully in the past.

2.2.7 Online banking

Online banking in South Africa is the fastest growing service that banks are offering in order to gain and retain new customers (Singh, 2004:188). It provides increased convenience and transaction cost savings to many farmers. Farmers can pay accounts, check account balances, transfer funds, create orders and carry out transactions without leaving the farm premises, thereby saving time and money. With electronic banking, consumers can carry out fast and convenient financial transactions thus enjoying the benefits of convenience and cost savings (Lee, Lee & Schumann, 2002:7). In some countries like South Africa and Philippines, banking service providers are now targeting the "unbanked" people by using mobile or m-banking. In the Philippines, the mobile operator Globe Telecom is providing banking services to over two million clients who use their phones as 'mobile wallets' to send and receive domestic and international remittances, to make payments at shops and to pay bills. In South Africa, Wizzit a mobile bank is targeting the country's estimated "unbanked" 16 million including farm workers and rural entrepreneurs (ICT Update, 2007). Wizzit's clients can use their mobile phones to make person-to-person payments, transfer money to and from a savings account, pay utility bills and buy prepaid airtime. Debit cards are also issued to pay for purchases at any shop with a point-of-sale terminal, or to withdraw cash from any automated teller machine in South Africa.

2.2.8 E-commerce

Recently, e-commerce has been used in agriculture by a number of companies in developing countries. It has been used successfully in the fishing and agricultural sectors in the Philippines where a trading portal b2bpricenow.com has been launched to provide price updates and market information for agriculturalists, consumers and manufacturers (Batchelor, Evangelista, Hearn, Peirce, Sugden, & Webb, 2003:6). Processing a purchase order include paperwork, data entry, phone calls, faxes and approval requests, and this can be quite expensive when done manually. On the other hand, performing these transactions online reduces costs substantially.

2.2.9 Computerised milk collection

In some areas such as Gujarat (India), some farmers are now using the facilities of computerized milk collection centres to ensure that farmers get better prices from the cooperatives they sell milk to. The use of computerized milk collection centres have led to transparent buying and selling of milk, faster processing, shorter queues and immediate payment to farmers (Cecchini & Scott, 2003:74; Harris, 2004:20).

2.2.10 Record keeping

Besides accessing the Internet, computers still plays an important role for farmers. Some farmers have realised that computer operations are useful for collecting, entering and interpreting data, thereby very instrumental in making decisions (Batte, 2005:2). Besides, computers can be used for crop, livestock, field and farm record keeping. Field activity records include information on field identification, tillage practices, crop progress, weather, fertilizer and lime applications, general planting information, chemical application records and general harvest information. Computers can also be used for keeping financial records, budgets, accounts and business plans.

A number of possible areas where ICT is used in agriculture have been discussed in this section. However, debate still rages on which technologies are effective for use in developing countries' agriculture. Jorge (2002:3) and Synman and Synman (2003:234) argue that traditional media such as rural radios, videos, televisions, slides, pictures and demonstrations are the widest form of communication which have been very successful and have sped up the flow of information in developing countries. Richardson (2005) also supports that simple technology like telephone is a great need and priority in most countries, and produces better results than the Internet. Adebayo and Adesope (2007) consolidate that radios and television have been the major technologies used in agriculture. It seems that traditional technologies, especially radio and telephone are most favourable than modern technologies especially in rural agriculture. This is because there are the cheapest communication technologies and they do not face significant language barriers (Kenny, 2002). The use of modern advanced technologies such as Internet and other computerised systems technologies still faces a lot of challenges in developing countries. However, as old ways of communication and technology use are being challenged there is need to accept and adopt new ways of technology use for the improvement of agriculture. Adebayo and Adesope (2007) advocate for the need to adequately incorporate modern ICT facilities into agricultural systems for the development of the agriculture sector.

The following section discusses the major issue facing most African countries – poverty. The possibility of poverty alleviation in developing countries through the use of ICT in the agriculture context is discussed.

2.3 Implications of ICT use in agriculture for poverty alleviation

The dimension of poverty and the debate on the possibility of ICT to reduce poverty are discussed in-depth in this section.

2.3.1: Dimensions of poverty

Poverty has different definitions and different dimensions. According to Obayelu and Ogunlade (2006:46) poverty is the lack of what is considered as a minimum requirement to sustain a livelihood in a given society by a household or any individual. It encompasses several dimensions such as lack of access to goods and services, income, nutrition, opportunities, political freedom and equal rights. These are the basic necessities that the largest percentage of people living in most developing countries lack. Smith (2004:245) illustrates that the following dimensions of poverty should be dealt with and made available to the poor in order to reduce poverty.

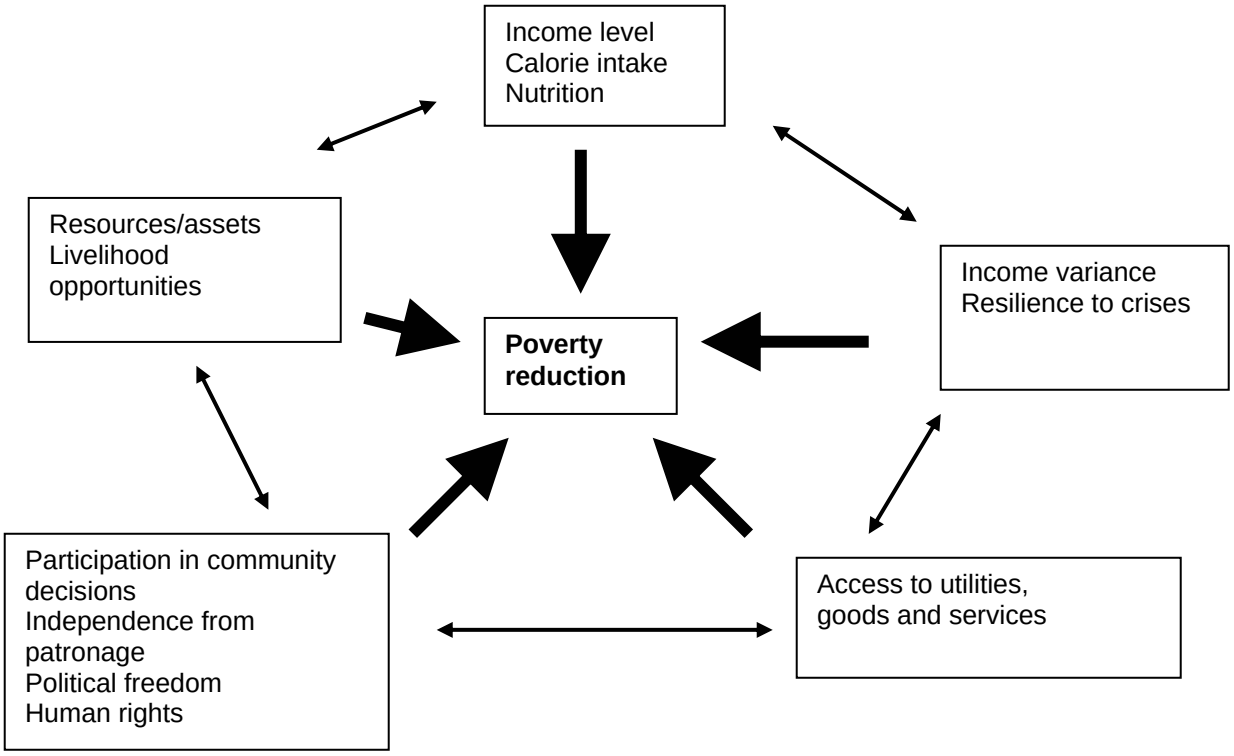

Figure 2.2: Dimensions of poverty

(Adapted from Smith, 2004:245)

As shown in Figure 2.2 poverty is not only about lack of food and income. It is multidimensional, complex and extends beyond what is mostly interpreted as poverty. Smith (2004) emphasizes that in order to deal with poverty, all the dimensions mentioned above are supposed to be readily available and people should have access to all of these dimensions. Without taking these dimensions into consideration, then poverty cannot be dealt with.

2.3.2: The role of ICT in poverty alleviation

There is evidence that ICT play an important role in eradicating poverty. If ICT are appropriately deployed to take into consideration people's different needs, they can become a powerful economic, social and political tool for the poor and those who work to eradicate poverty (World Bank, 2003:11). Some authors argue that the poor do not need ICT but that they need improved nutrition and other basic necessities that assure them of a sustainable livelihood instead. Some even argue that the poor do not eat computers and telephones; they do not need them, as they are a luxury (Daly, 2003:1). There may well be some validity to these arguments, but McNamara (2003:4) however, argues that ICT may not be the immediate solution or goal but are a tool to help achieve what the poor people actually need, combat poverty and achieve economic growth. Above all, the poor have information, communication and knowledge needs like any other

people in society and those needs deserve to be addressed (Marker, McNamara & Wallace, 2002:8).

The World Development Report 2000/01 identified three priority poverty–reducing potential of ICT which include: (i) increasing opportunities for the poor to access markets and expand their assets, (ii) enhancing empowerment through better coordination on the provision of basic needs of the poor and removal of social barriers by state institutions and agencies, and (iii) improving security of poor people through better risk management and improved access to micro-finance and global markets (Cecchini & Scott, 2003:73).

Richardson (2005:11) provides a key insight about the potential of ICT interventions in the context of developing countries:

> "Any ICT intervention that improves the livelihoods of poor rural families will likely have significant direct and indirect impacts on enhancing agricultural production, marketing and post-harvest activities – which in turn can further contribute to poverty reduction".

Richardson's observation implies that any ICT intervention will result in multiplier effects, which will lead to poverty reduction. For example, a simple rural payphone can play a significant role in enhancing the ability of poor rural families to enhance their contribution to national agricultural production and post harvest activities though better input and output market access coordination. The expected outcome of these ICT interventions is not only improved agricultural production or post harvest activities, but also poverty reduction via increased incomes and improved livelihoods. Batchelor *et al*. (2003:6), argue that the provision of transparent and timely market information to the role players (buyers and sellers) in the agricultural supply chain will enhance efficiencies in agricultural markets. Therefore, ICT intervention will promote better coordination and communication between buyers and sellers, thus leading to competitive prices in the inputs and products markets. In the short to medium term, as farmers' household incomes increase, the net result will be a reduction in poverty and an improvement in the living standards of the rural people.

ICT contribute towards sustainable poverty reduction, because it makes a country's economy more efficient and globally competitive, improve provision of services and creates new sources of income and employment for poor people (Franklin, 2006:95). It can help markets and government institutions to work more effectively for the poor through lowering transaction costs and provision of better choices. International Telecommunication Union (2006:3) regards ICT as a development

enabler and a tool for achieving development goals and objectives. Under favourable conditions it can be a powerful instrument for increasing productivity, generating economic growth, creating employment and improving quality of life. It can increase awareness of sustainable development strategies and facilitate knowledge exchange and networking among policy makers and development agencies (Marker, *et al*., 2002:15).

ICT play a role in reducing poverty by improving flows of information and communications (Marker, *et al*., 2002:11). The Food Agricultural Organization (FAO)'s ICT agenda is "fighting poverty with information" and it stresses the development of appropriate databases that facilitate agricultural information services to reduce poverty and its effects. So far, it has provided technical assistance to member states to develop and apply a variety of media in support of agriculture and food security (Winrock, 2003:40). Khaketla (2004:8) argues that ICT can revolutionize the management of the agricultural sector and improve food security by significantly improving information flows between agricultural role players, leading to higher crop yields, production that is more responsive to consumer needs and greater market access. Dissemination of information regarding crop production, cost-effective means of production and methods of preserving food is made easy by using ICT.

2.3.3: Framework for poverty alleviation using ICT

Harris (2004:48) proposed a framework that illustrates how ICT can be used for poverty alleviation by governments and institutions, which have ICT policies and are developing their ICT infrastructure. Figure 2.3 shows the framework. The ICT policy framework shown in Figure 2.3 specifically targets poverty alleviation and aims at addressing the cause of poverty. Development strategies are there to propose how poverty can be reduced. There is need for well-managed and organized local ICT access facilities. Government is a major ICT user, policy implementer and supplier of public services. Information and physical infrastructure should be provided for the dissemination of information in the society. Methods of implementation of ICT use should be demand-driven and use bottom-up approach for sustainable results (Gebremichael & Jackson, 2006:274; Moodley, 2005:13). Respective institutions are there to use ICT approaches and deliver services to the public. ICT should also be directed to specific services that will be delivered to the target population for the purpose of poverty alleviation (Harris, 2004:49).

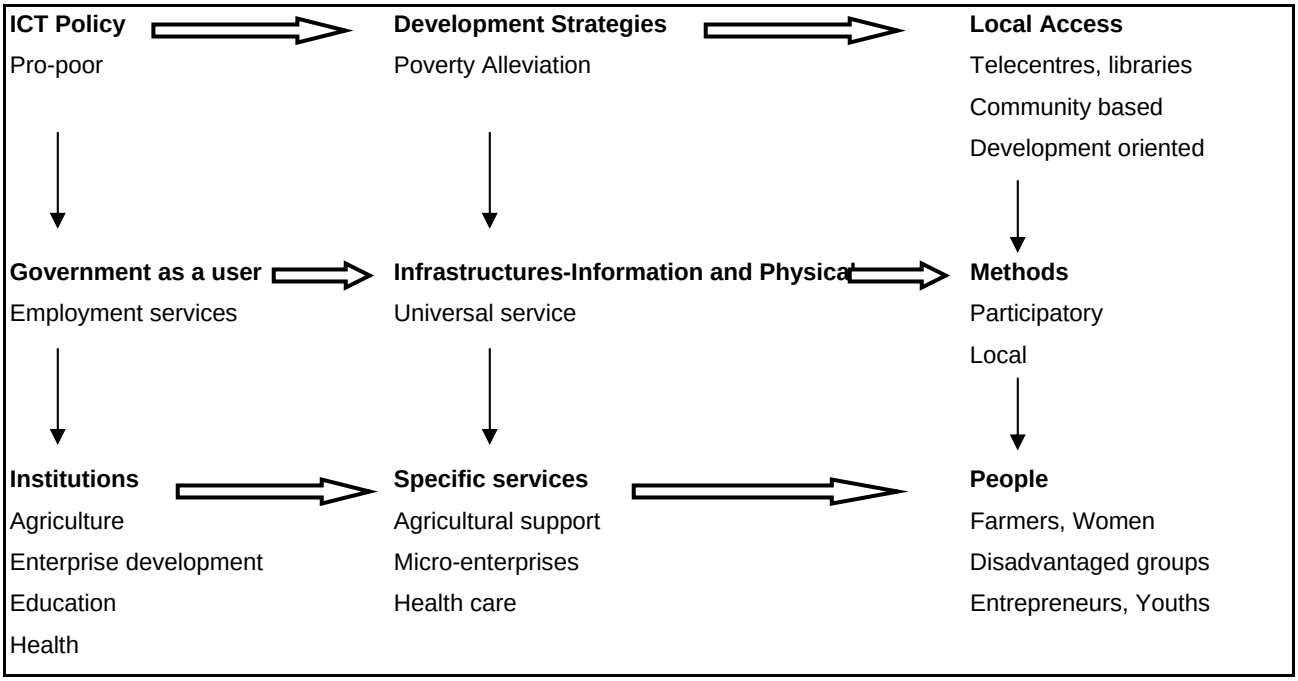

Figure 2.3: Framework for poverty alleviation using ICT

(Adapted from Harris, 2004:48)

Moodley (2005:9) however argues that in order to reduce poverty, ICT projects should be driven by development objectives and information needs not by technological concerns. The concerns should be poverty reduction not the spread of technology or reducing the digital divide. To make ICT-based system effective for poverty reduction programs, there is need for relevant data to be available to the poor; relevant skills, technology and money to access the data; motivation, knowledge and confidence to access and apply the data. Without these, ICT investments will not accomplish their purpose. As a result the poor will remain poor.

ICT are a means and not an end to all problems facing Africa. Technology itself is not a solution, in fact it requires skills to access and interpret its information. There is need for educating people and promoting ICT use for the purposes of enhancing the delivery of services and improving agriculture. The effective use of ICT can be a means to alleviate poverty, access agricultural markets and improve people's welfare. The following section presents the role of ICT in promoting agribusinesses and global markets.

2.4 Role of ICT in integrating agribusinesses with global markets

Market transactions are heavily dependent on information. In most remote areas, market related information tends to be lacking because these areas are far away from the market, therefore making it difficult for them to be fully integrated into the market system. As a result, development in these areas is greatly affected (Lio & Liu, 2006). With ICT, the economic benefits of networking are greater, as information transfer will be effective. Agribusinesses in rural developing countries benefit from improved access to global markets. Through direct marketing, remote rural-based agribusinesses are able to lower transaction costs and enhance profits by eliminating the middlemen (World Bank, 2002:7).

In India, agribusinesses have been empowered by Internet kiosks that provide farmers with information and services required to enhance agricultural yields (Paul, Katz & Gallagher, 2004:24). ICT do not only improve productivity, but also bring key agricultural stakeholders together in order to identify, modify, act on and implement relevant innovations collectively (Winrock, 2003:7). For example, farmers in the Philippines, in 2002-2003, were introduced to the InfoDev project that provided an electronic marketing site where farmers could post commodity prices, transact and even pay online, and a computer literacy training program. A website (B2Bpricenow.com) was developed to provide free market place and an electronic bulletin where farmers could get market information directly. These facilities helped the farmers to know prevailing prices, increase their negotiation power and minimise costs of intermediation in the supply chain. This enabled them to gain lower transaction costs and broader access to global market (World Bank, 2003:14). One interesting example of the use of e-commerce in South African agriculture is that of women in Pietersburg who sell chickens over the Internet to a local market and wealthy communities in the area. They are now operating as wholesale suppliers to hotels, hospitals and the nearby town (CTA, 2002:39).

ICT reduce transaction and marketing costs and combat risk before, during and after carrying out the business transaction (Lucking-Reiley & Spulber, 2001:60). Before the transaction, ICT lower the cost of searching for suppliers or buyers, making price and product comparisons relatively easier, as most of the information will be available on the Internet. During the transaction, e-commerce can reduce the cost of communication with counterparts in other companies regarding transaction details. Transactions over the computer avoid associated costs like cost of travelling, time spent on communication, physical space for meetings and processing paper documents. After the transaction, ICT allow companies to lower costs of communication, monitor contractual performance and confirm delivery. By lowering the costs of transactions, ICT also lower the costs

of production and marketing, thus improving profitability and overall performance of agribusinesses.

Another study in China confirmed that the prices the farmers were getting from the sale of their agricultural commodities were higher in villages where farmers had telephones than in villages where farmers were without telephones. Vegetables growers in the area also disclosed that access to telephones had been of help for them to make more appropriate decisions and gain more profits. As a result they have enjoyed the benefits of a more reliable supply chain for their vegetables (Harris, 2004:20). In Santa Cruz, Bolivia, vegetable growers used to depend on middlemen to sell their produce. The middlemen exploited them and paid low amount of money for their produce. Some farmers could not even cover their costs of production. The farmers were not aware of the market prices of their produce; as a result they did not have any bargaining power. After the launch of a radio program that provided relevant information to farmers in the area, the farmers could sell their produce at a favourable price and increase their profits (Global Knowledge Partnership, 2003:41).

Agricultural role players have a lot to gain from ICT in terms of exposure to market access, reduction in transaction and marketing costs and promotion of competitiveness in the global market. To remain in business in this globalized world, some of these technologies have to be utilised to maintain a competitive edge against numerous competitors. Having discussed the use of ICT in agriculture and its role in poverty reduction and integration of markets, it is necessary to investigate if agricultural communities in developing countries are using ICT, and if not, what are the barriers limiting them from doing so? A detailed discussion on barriers inhibiting farmers in developing countries from using ICT is in the next section.

2.5 Barriers inhibiting the use of ICT by agricultural communities in developing countries

A major stumbling block to the adoption and diffusion of technology in developing countries is the set of barriers inhibiting widespread use. This section presents issues that pertain to the barriers to ICT use and the factors affecting the use of ICT in developing countries. Relevant examples from agriculture communities are given.

For the past 15 or more years new technologies have been used in a way to improve agricultural production, reduce poverty and enhance food security. According to Ortmann (2000:26), commercial farmers in South Africa are now using ICT in the management of farm enterprises,

since ICT have proven to be the best way of reducing costs for farmers and enhancing demand along the agricultural food supply chain.

Despite efforts by commercial farmers to apply ICT in their farming practices, the majority poor farmers in developing countries have no or limited access to modern tools thereby highlighting the digital divide that not only exists between different continents and countries, but also provinces and even between local agricultural communities within the same country. ICT use levels of the developed countries remain higher than those achieved in developing countries as returns from the use of ICT in agriculture production by developed countries are believed to be two times higher than those of the developing countries (Lio & Liu, 2006). This may be because of some constraints that are inhibiting people in most developing countries from using ICT. Some of them are (i) poor technological infrastructure, (ii) lack of ICT access, (iii) high cost of access to ICT, (iv) lack of ICT awareness and training and, (v) language and content limitations (Rao, 2004:262; Mutula, 2005:128). Most of these constraints are common in South Africa despite its status as the economic giant of the continent. They are discussed below.

2.5.1 Poor technological infrastructure

Technological infrastructure encompasses technological tools, methods and access models that are used to facilitate the efficient management and transfer of information. Lack of adequate technological infrastructure has remained a major inhibiting obstacle to the use of ICT in most developing countries. According to Guermazi and Satola (2005:25), the infrastructure investment needed for the uptake of ICT far exceeds the resources of most developing countries and is prohibitively expensive or not commercially viable. This can be very true if one considers countries like Malawi and Mozambique. Wambui (2005:57) mention of the Sierra Leone's ICT infrastructure that is in great need of reform because of its poor shape. The country lacks communication facilities and the main efficient form of communication remains the radio. Jorge (2002:1) noted that telecommunications infrastructure is limited in most developing countries and costs are exceedingly high. The limited available infrastructure is mostly found in larger urban areas, thereby neglecting and depriving the rest of the individual farmers and firms in rural areas – those in need of a steady flow and ready access to information and wider business networks (Galloway & Mochrie, 2005:37). This situation is not favourable since the majority of the world's poorest people dwell in the rural and poor areas, where there is little or no ICT infrastructure.

Problems of connectivity and poor network coverage have been a major setback facing most developing companies in South Africa since the early 1990s (Langmia, 2006). According to Digital Opportunity Initiative (2001:1), connecting rural areas is still a challenge in South Africa since

inhabited areas are geographically dispersed, sparsely located and economically weak. Infrastructure in South Africa is poorly linked and is uneven across the country, with very low penetration of ICT services in under serviced rural and isolated historically disadvantaged remote areas. These areas are mostly those which have been considered as not commercially viable by ICT service providers due to their low population densities, low incomes and high costs of constructing ICT infrastructure (Tlabela, Roodt, Paterson & Weir-Smith, 2007:51). A number of these areas do not have electricity, which is a pre-requisite for the use of ICT infrastructure and services (Department of Communications, 2006:28). Some of them have uneven terrain and topography, especially mountainous and forest regions. This makes infrastructure construction more complex and costly than in urban areas, and sometimes infeasible (Chetty, 2005:22). Examples may be found in Mpumalanga, Limpopo, Eastern Cape and Kwazulu Natal provinces. Mobile technology is playing an important role of reducing the digital divide and improving ICT access in rural areas where only wireless systems are being used due to lack of communication infrastructure (Department of Trade and Industry, 2004:10; Cullen, 2001:313).

The identified contributing factors affecting the development of technological infrastructure in Africa include among other things, telecommunication monopoly by government and obsolete regulatory framework, inadequate coordination of physical infrastructure connections and poor availability of indigenous information via networks causing a high dependence on Western countries (Enakrire & Onyenania, 2007:17). This is evident in most African countries especially the monopoly ownership of telecommunication companies which are not allowed to be privately owned.

2.5.2 Lack of ICT access

In this era where information is considered the fundamental basis of socio-economic activities of any economy, it is unfortunate that not everyone is participating fully in the information society (Kabede, 2004:273). This result in a digital divide which hinders those without access to ICT from playing an active role and become beneficiaries of the information society. Marker, *et al*. (2002:7) noted that poor people do not have access to information, knowledge and communication. This is because access to ICT is highly dependent on telecommunications infrastructure. Therefore, without infrastructure, there is no access to ICT. Ensuring access for all to ICT is still a great challenge to most of the developing countries. Guermazi and Satola (2005:25) and Pigato (2001:8) found that most developing countries have the lowest access to ICT resources and within these countries; there is a notable digital divide between the rural and urban areas, the rich and the poor population. The inaccessibility of ICT makes it difficult to share information across traditional barriers and to give a voice to traditionally unheard people.

Rao (2004:262) noted that most developing countries lack access to modern technology like computers and Internet. Africa and Asia are still developing ICT capacity in agricultural research. Though the use of computers is improving, Internet connectivity is still extremely poor, affecting the access to information and the ability to make informed decisions by farmers (Maru & Ehrle, 2003:505). In rural areas of developing countries, the use of ICT to connect sources of agricultural innovation to end-users especially farmers is limited by lack of Internet connectivity. The majority populations depend mainly on radio, television and newspapers as the widest form of communication (Kenny, 2002:150). Raju (2004:234) acknowledged that traditional media like radios, videos, televisions, slides, pictures, exhibitions and field demonstrations have been used to speed up information flow in rural areas within developing countries.

Private ICT investors avoid investing in rural areas where the infrastructure is poor. This deprives people in South African rural areas access to ICT since ICT service providers invest mainly in areas where the infrastructure is well developed. This is evidenced by the fact that the city of Cape Town is among the cities in the country that have the highest private ICT access (Tlabela, *et al*., 2007:54). The main reason being the well developed infrastructure that attract private ICT service providers to invest in these cities. This tends to increase the gap continuously in ICT access between those in poor remote areas and those in well-developed areas.

2.5.3 High cost of ICT

According to Jorge (2002:4), even when infrastructure is available, affordable access is a concern in most developing countries. Personal computers, faxes, printers and some ICT equipment are expensive and unaffordable to the majority of developing countries inhabitants, even for middle-class families, thereby cutting down the populations who are able to use the technology (Fors & Moreno, 2002:203). The initial costs of ICT and the ongoing expenses of maintaining them are very high and a number of people cannot afford them (Galloway & Mochrie, 2005:39).

Among the main obstacles affecting ICT diffusion is the price that is charged to end- users by ICT service providers for ICT access. For example, the price of Internet provision encompasses a number of costs that are later passed on to the end-users, thereby exacerbating the charges to the Internet users (Sarrocco, 2002:22). As a result, a lot of potential users are barred from using the Internet because of the high costs.

The challenge that faces South Africa is to reduce the costs of ICT services so that they can be affordable to everyone, especially in critical areas such as health, education, agriculture and in accessing government information and services. An example is the cost of telecommunication

services in South Africa that are very high compared to other countries (Department of Communication, 2006:28).

2.5.4 Lack of ICT awareness and training

With the greatest percentage of illiterate people in developing countries, ICT face a tremendous challenge to be effectively used by the communities. Most developing countries are in the bottom rank on literacy. According to Ifinedo (2005:53) all countries in Sub-Saharan Africa with the exception of South Africa and its neighbours have a poor e-readiness score. This is evidenced by the fact that, there is a general lack of community awareness about the potential benefits and capabilities of ICT (Colle & Roman, 2003:396). Without a high level of ICT awareness, no community can fully participate in this networked world. Gelb and Parker (2005:2) noted a critical need for ICT training for end users to cater for the ever-changing information and Internet characteristics, which can be provided by extension officers, scientists and consultants. ICT training is of utmost importance for people in agricultural communities for their empowerment. Chetty (2005:27) gave an example of Tombo Telecentre in the Eastern Cape that was lying idle because no proper training was provided to the people to teach them how to use the facilities and services provided by the centre. She emphasised that training is a necessity if new technologies are introduced to enable people to use them for their benefit. Involvement of local people in deciding the key technologies for communities to use is also a critical issue, because without the necessary training and awareness, people will not be empowered. The Department of Trade and Industry (2004:15) noted that in South Africa, the high rates of illiteracy and uneducated groups have affected the skills base that continues to be in short supply.

2.5.5 Language and content limitations

In most developing countries, a major barrier in the use of ICT for economic development is the lack of local and community related content as well as content in local languages. Mutula (2005:125) noted that Sub-Saharan Africa faces a problem of inadequate locally owned, published and adapted knowledge and content to satisfy the needs of its people. Most of the content on the web is not relevant to the indigenous people of Sub-Saharan Africa. Therefore, there is need for digital information content that is relevant to the communities in Sub-Saharan Africa, to cater for the needs and requirements of different consumers and communities (Kavulya, 2007:308). ICT can only be useful and meaningful to support people-centred participatory development; particularly to the rural and poor if only relevant information and content is provided to address their local demands and needs (Dralega, 2006:6; Moodley, 2005:9). Content in local language is very important if ICT are to make a difference in people's lives. In a study conducted in the Eastern Cape Province, Chetty (2005:27) noted that the challenge is to create relevant content

that meets the needs of various user groups in their own language. The poor in most developing countries demand access to locally-contextualised information, more than existing information from an alien context (Cecchini & Scott, 2003:81).

Even to those who have ICT access, a significant barrier remains the language and content limitations. Languages spoken by millions of people are absent from the Internet. Actually, English, a language spoken by a few of the world's poorest people, remains the dominant language of the web (Kenny, 2002:150). As a result, English speakers are more likely to use ICT such as the Internet more than the non-English speakers. In order to overcome the limitations posed by language and content, there is need for translation from English to local languages. Few countries have the resources to translate most of the information into local languages. According to Langmia (2006) South Africa still face a challenge of striking a balance between technology and the need for local content development. Local problems such as the alarming technology illiteracy in South Africa cannot be effectively solved by technology coming from abroad. To solve this issue of irrelevant content, Gebremichael and Jackson (2006:278) calls for the need for a holistic approach in carrying out an in-depth analysis of the content, training and greater relevance of ICT to the needs of the local people. Among the few examples in South Africa is Zuza software foundation, which is working on translating open–source computer software into the 11 official languages of South Africa (CTA, 2002:27). If the project is successful, it may help to increase the number of people who use ICT.

2.5.6 Gender inequalities

Pigato (2001:7) mentions gender inequalities as one of the barrier of ICT use in most developing economies. Cullen (2001:312) mentioned women and girls among the specific groups of people disadvantaged in the uptake of ICT. Most women are still facing discrimination in terms of access to public services such as education and politics, thus increasing levels of illiteracy in African women. The female population remains confined to the rural areas to practice agriculture while men are participating in the modern industrial and service sector economy. A number of limitations facing women hinder them from benefiting from ICT services as compared to men. Among other things, Jorge (2002) identifies lack of gender focus in telecommunications and ICT policy as a major barrier that a lot of women in developing countries are facing. To address these gender disparities, the International Service for National Agricultural Research (ISNAR), (2002:2) proposed that (i) rural women should be enabled to use ICT to improve their livelihoods and share their views in local and national programs, and (ii) development actors are supposed to use gender sensitive approaches in their programs especially in agriculture and rural development.

2.5.7 Attitudinal barriers

In addition to all the other barriers, Cullen (2001:314) mentioned attitudinal barriers as a contributing factor inhibiting the use of ICT. Attitudinal barriers are mainly cultural and behavioural attitudes towards ICT pertaining its appropriateness, usefulness and relevance (Kabede, 2004:274). These may discourage the use of ICT even if all the other facilities for ICT use are available. An example of attitudinal barriers include beliefs in some societies such as, computers are for intelligent people or for males and the young only. Some even believe that ICT are difficult to use or they belong to the rich class or white culture. The list is endless, but these are some of the beliefs that hinder the use of technology in some societies in Africa.

Having examined some of the known constraints limiting the use of ICT in agriculture, it may be interesting to ascertain what factors affect ICT use in agriculture. It should be noted that these barriers to ICT use discussed in this section can also be referred to as "anticipated negatively related factors to the use of ICT" (Hollenstein, 2004:318). The following section addresses the factors affecting ICT use in agriculture besides the anticipated negatively related factors.

2.6 Factors affecting ICT use in agriculture

Less research has been done on the factors affecting the use of ICT in agriculture in South Africa. Most of the studies referred to in this section were undertaken in developed countries, such as Canada, United States of America and United Kingdom. In South Africa, few scholars have investigated this issue. Some examples of the few who have are Woodburn, *et al*. (1994:183) who specifically investigated the factors influencing computer use by commercial farmers. Basically, there are few reports investigating the use of other ICT in agriculture.

The technology acceptance model (TAM) suggests that there are a number of factors that influence the adoption and use of technology. These are external factors, perceived usefulness and perceived ease of use. Perceived usefulness is the degree to which using technology would improve performance and perceived ease-of-use is the degree to which using technology is expected to be effortless (Lu, Yu, Liu & Yao, 2003: 206-222). In agriculture, the use of ICT can be influenced by a number of different factors, such as type of farm enterprise, farmer's permanent characteristics, farm characteristics, goals and community culture. These factors have direct and indirect relationships and influence the use of ICT either positively or negatively. In businesses, the use of ICT also depends on the perceived value of ICT (Alvarez & Nuthall, 2006:51). Results of previous studies reported on South Africa (Woodburn, *et al*., 1994:185) and on Canada (Sabuhoro & Wunsch, 2003:6) show that certain characteristics of farmers such as

education, age and off-farm work, farm size and gender are also important variables in explaining the use of computers. Taken together, some of the factors identified in previous studies are as follows:

Age: It is anticipated that the age of the farmer is negatively related to the use of ICT, and the probability of ICT use decreases with increasing age. The younger the farmer, the more likely is the use of ICT.

Farm size: The size of the farm is expected to have a positive relationship with the ICT uptake. Larger farms tend to be earlier users of technology than smaller farms (Batte, 2005:8).

Education: Use of technology is believed to be positively associated with education (Sabuhoro & Wunsch, 2003:6). Those farmers with post-high school qualification tend to make up the majority of ICT users.

Off-farm income: Farmers with off-farm income are likely to use ICT than those in full time farming (Alvarez & Nuthalll, 2006:50). The probability of ICT use is expected to increase if the farmer has off-farm employment.

Gender: The probability of ICT use is likely to increase if the farmer is female (Sabuhoro & Wunsch, 2003:6). This depends on the geographical context. In most African countries where women are not yet as fully emancipated as their Western counterparts and are expected to stay at home. Therefore, men have more and easier access to ICT and more readily adopt technology.

Barriers to ICT use: The anticipated barriers to ICT use such as lack of ICT training, high technology costs, lack of technical know-how and lack of education affect the ICT use negatively. The higher these barriers are, the less the probability of ICT use.

Farming experience: The farmer's experience in agriculture is expected to have a positive relationship with ICT use. Those farmers with more farming experience tend to use technology than those with less experience (Hollenstein, 2004:326). This also depends on other factors such as the age of the farmers. Some experienced farmers are more likely not to be flexible and prefer their own traditional way of practising farming.

Income: Those with less annual /monthly income are often the ones with the least access to ICT. The higher the income levels, the higher the probabilities of ICT use.

Distance from centre of development: Those located close to the centres of development are expected to have greater access and use for ICT than those far away (Alampay, 2006:14).

Household size: A large household size is generally associated with a positive influence on ICT use than a smaller household size.

Attitude: Positive attitude towards ICT is likely to generate a positive effect on ICT use and a negative attitude implies otherwise (Xue-Feng, Huhua & Feng-Min, 2007:246).

Despite all the constraints and factors affecting the use of ICT in agriculture, it is interesting to note that there are other ICT users in some developing countries who have benefited from its use in agriculture and have become role models to some other ICT users and policy makers. Some of the success stories are discussed in the next section.

2.7 Successful ICT applications in developing countries

Not all efforts on ICT use have been successful and the results are mixed. This section discusses some of the successful ICT applications, which have made a great impact to the agricultural communities in developing countries. Some of the successful cases of ICT use are classified according to the countries as presented next.

2.7.1 South Africa

Wizzit, a South African mobile bank that was launched in 2004 have been successful in providing banking services to the “unbanked” South Africans in remote areas and townships. It has made a great impact to the lives of poor farm workers and low-income rural entrepreneurs (ICT Update, 2007:5). With this type of banking, distance is no longer a limitation. Wizzit do not require a minimum balance and has no monthly charges making it the most suitable for the low-income group people like farm workers. The technology that it uses is faster and cheaper than SMS. So far it has more than 70 000 clients.

The South African government has established telecentres as model of community access to information and technology services (Pigato, 2001:10). One of the telecentres successful in

content creation and dissemination of information in Africa is Mamelodi in Pretoria. It is well known for providing a database that contains useful information about the local community, including the Mamelodi directory of services, a publication updated annually and sold affordably (Colle & Roman, 2003:396). Pigato (2001:43) and NTCA (2000:43) also noted that communication services provided by Mamelodi telecentre are driven not by technology but by the real needs of communities.

2.7.2 Jamaica and Philippines

Paul, Katz and Gallagher (2004:19) acknowledge that ICT for agricultural development have been successful in Jamaica and Philippines. Muturi (2005:61) also confirms that Jamaica has set an impressive standard for other Caribbean countries, in terms of its support, implementation and applications of ICT for national development and public service delivery. In central Jamaica, the Central and Satellite Agricultural Information Centre, provides farmers with accurate and up-to-date agricultural information to enhance access to market by poor people. In Philippines, an e-marketplace (B2Bpricenow.com) was established to enables farmers, fishermen, and small and medium enterprises to access market prices and trade products. The marketplace can be accessed via web site or cell phone and it has online trading and payment options and its services are provided free of charge. It provides free market place and an electronic bulletin where farmers could get market information directly. These facilities helped the farmers to know prevailing prices, increase their negotiation power and minimise costs of intermediation in the supply chain. Lower transaction costs are gained and broader access to global market is promoted (World Bank, 2003:14).

2.7.3 Zimbabwe

In Zimbabwe, the government has used the radio and television in educating farmers, using three main languages, English, Shona and Ndebele through a program called ‘talking farming’ (English) ‘murimi wanhasi’ (Shona) and ‘Umlimi walamhla’ (Ndebele) (Zimbabwe-e-readiness survey report, 2005:65). The programme is broadcast live and offers question-and-answer sessions. It has been successful in disseminating agricultural information to agricultural role players and a lot of farmers gained relevant knowledge on agricultural practices on different farm enterprises. Besides the live television broadcast, a farming logistics programme called e-hurudza/Umtshayi wenala/Electronic farm manager was developed by a local Zimbabwean company to address farmers in three main languages. The e-Hurudza / Umtshayi Wenala / Electronic Farm Manager software enable farmers to access information on crop and livestock

cycles, rotations, the relevant input requirements and applications, tracking input prices, farm administration including financial reports, marketing and sales (Jawbone Enterprises, 2002). From this program a number of successful farmers have been able to (i) inquire and understand how to grow commercial crops, their varieties, disease control and chemical application; (ii) get advise on the most suitable crop for the region the farmer is situated, according to the soil type and rainfall pattern; (iii) receive basic and intensive instructions on how and where to grow /rear a particular crop/livestock; (iv) capture input prices which are continuously updated to enable the farmer make informed decisions when preparing a budget, and (v) budget all inputs in a categorized manner.

2.7.4 India

In India and South Asian Association for Regional Cooperation (SAARC) countries, a network of professionals called Indian Society of Agribusiness Professionals (ISAP) was formed to serve farmers, small rural entrepreneurs and agricultural graduates. (Asia-Pacific Association of Agricultural Research Institutions, APAARI, 2005:55). The professionals specialise in the provision of information through meetings, e-mails, seminars, workshops, SMS, website, telephones to provide services which pertain to irrigation, food processing, international trade, research, and agricultural extension. According to (Singh, 2006:13), this network is probably the largest agriculture and rural development professional network in the world. It has a membership of over 9000 members, 400 NGO partners, and 110,000 farmers. It has been able to provide answers to over 3000 queries and problems raised by the farming community.

2.7.5 Uganda

In Uganda, Nakaseke Multipurpose Telecentre has been among the successful telecentres. It helps farmers through creation of some educational videos on issues such as agriculture practices (Colle & Roman, 2003:397). The telecentre has made a great difference due to its commitment to gender and women. It has managed to produce a CD-ROM titled Rural Women Earning Money, in both English and the local language, with graphic and voice interfaces to facilitate use by illiterate women. The telecentre works in collaboration with Uganda's National Agricultural Research Organisation and CAB International in the development of relevant and local agriculture-related content for use by the local people (ISNAR, 2002:5).

Having discussed some of the success stories of ICT use in agriculture, there is a need to review if ICT initiatives in developing countries are also taking gender into consideration. This is discussed in the next section.

2.8 Gender and ICT

There is existence of a gender gap in the access and use of ICT in both high income and low-income countries (Muturi, 2005:68). Women are the majority of the population working in agriculture in most developing countries, but they are marginalized in terms of access to ICT for economic and social empowerment. Studies have indicated that due to the history of discrimination against women in societies and inequality in human rights, access to communication facilities may also be affected, with men having more opportunities than women (Alampay, 2006:13). Women play complex and vital roles in improving the welfare of society as a whole, but for some reasons they are often restricted from securing equal access to and benefits from ICT. Most of them in developing countries have been deprived of basic educational skills, thus further depriving them the multiplier benefits, skills and opportunities that are offered by ICT (McNamara, 2003:75). It is thus encouraging that the Millennium Development Goals of many developing countries are aiming at increasing opportunities and reducing vulnerabilities for women and girls in their societies.

According to Odame (2005:15), compared to men, women have less income, education, time, mobility, and they face religious or cultural barriers that restrict them from accessing and using technology. Some are still bounded by cultural constraints that limit their ability to access ICT in public places like telecentres and libraries regardless of availability of technology and necessary skills. CTA (2002:30) believes that even if basic infrastructure and ICT exist within rural areas of developing countries, there is a probability that ICT for agriculture and rural development may fail from a gender perspective. This can happen due to the reasons shown in Figure 2.4. The reasons mainly focus on poor access to ICT services, irrelevance of the technologies being used and the poor sustainability of ICT development projects. Examples are barriers that limit women from using ICT such as socio-cultural issues, low literacy levels, remote physical locations, high cost of ICT that is beyond the reach of many people, language and content limitations, and lack of statistics showing the progress of women in ICT. There is need to consider the role of ICT to empower women in commercial agriculture.

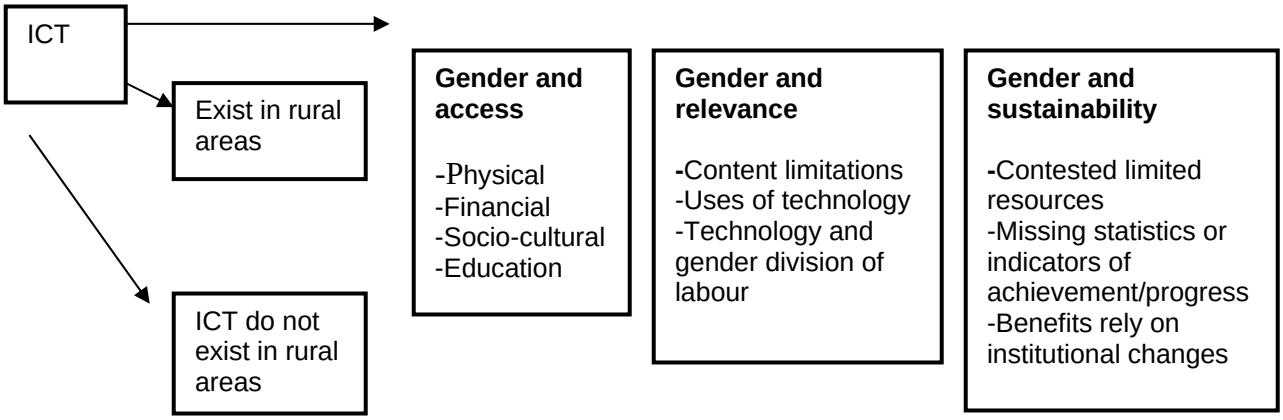

Figure 2.4: Reasons for failure of ICT for agriculture and rural development from a gender perspective

(Adapted from CTA, 2002:30)

If the identified reasons outlined in Figure 2.4 are dealt with, then from a gender perspective, ICT for agriculture and rural development is likely to be successful and make a lot of impact to the lives of women. To avoid failure, it is important to use a gender perspective to improve the efficient use of resources and empower disadvantaged rural women. This enhances the equal opportunities and participation of men and women in development activities that affect them (ICT Update, 2002a:2). ICT may impact men and women differently because of their different needs in society, therefore taking this into consideration may help to find a more balanced approach to gender issues in societies.

Some women in West Africa are being instrumental in bridging the digital divide without waiting for the policy makers to do it for them (Odame, 2005:20). Most of them are being active in bringing change and development to their own communities. Women in rural and poor societies have used ICT to produce and market their produce and some have been empowered by running ICT related businesses. Examples of women participating in ICT related development in different countries are as follows:

In Brazil, Communication, Education and Information on Gender (CEMINA) is promoting women's leadership in community development through the use of an Internet radio. Gender education is promoted using locally produced content that is disseminated to other radio stations

via Internet links. CEMINA broadcasts to over 400 women's radio stations all over Brazil and about 1500 women from all over the country have been trained in radio production. (Batchelor *et al.*, 2003:14). The evidence of the success of this project is in its wide recognition by overseas countries as an example of best practice (Global Knowledge Partnership, 2003:94).

In Ghana, radio Ada - a community radio is creating opportunities for rural women to participate in radio programming, which is participatory and based on the needs of the local people. The audience are mainly farmers, fishermen and fishmongers. Separate radio programs are directed to specific occupations, giving each occupation group an opportunity to interact and disseminate information to the other group (Mckay, 2005).

The Women Media Watch in Jamaica has covered gender-related issues and has successfully used the media and other technologies to provide ICT training, free computer courses and Internet access. Women are using ICT to produce more and market their agricultural produce competitively. JaBlum Coffee is produced in a small home in the Jamaican market but sold online to the world market (Muturi, 2005:68).

Anand (2002) applauds the explicit support for gender equity in South African telecommunications policy and regulation that has enabled the development of numerous projects which are specifically for women. One of them is a project initiated by SangoNet called Women'sNet that provides technology such as the Internet and resources to historically disadvantaged South African women. It also provides Internet training and has developed technical support centres throughout South Africa's nine provinces (CTA, 2002:38).

All the issues discussed in this section illumine the potential of ICT in changing the face of agriculture and the areas that need to be improved if agriculture is to be successful in developing countries. One of the gaps remaining is to identify the ICT being used in the different agricultural sectors and to determine the factors affecting the use of ICT in South African agriculture. The field of agriculture is a diverse sector, with many enterprises dealing in crop, fruit, dairy, poultry, beef, horticulture and agritourism, or a combination of these. Some of these sectors have been given little attention by researchers. The following section briefly discusses other technologies that are used in agriculture besides ICT. It may be important to investigate other technologies used in agriculture such as "green technologies".

2.9 Other technologies used in agriculture besides ICT

As different technologies are being used in the agricultural field, there is an increasing demand for other alternative technologies in favour of sustainable agricultural practices. According to Borch, (2007:1047) one way of ensuring sustainable agriculture is by using the emerging 'green' technologies. Green technologies refer to potential environmentally friendly technologies. There are a number of green technologies that can be used in agriculture and some examples include:

2.9.1 Integrated Pest Management (IPM)

IPM is a management approach that supports the natural control of pest by anticipating pest problems and preventing them from reaching economically damaging levels. Appropriate techniques such as enhancing natural enemies, planting pest resistant crops and adapting cultural management can be used in IPM (Hrubovcak, Vasavada & Aldy, 1999:13).

2.9.2 Enhanced nutrient management

This involves providing the nutrients that match the specific needs of the soil and to supply nutrients according to the demand of the crop. This helps farmers to use the right amount of nutrient application for optimum yields (Seth & Gupta, 2007:440).

2.9.3 Plant gene technology

Plant gene technology has always been controversial. However, according to Borch (2007:1053), it can enhance production in an environmentally friendly way and contribute to landscape and nature related values, if used carefully.

2.9.4 Conservation tillage

This involves maintaining adequate soil cover to reduce soil erosion and the use of biological and agricultural knowledge to minimise environmental effects of farming. Examples of conservation tillage practices include mulching, use of cover crops and crop rotation. Due to the concern about the environmental implications of conventional agricultural practices, FAO and the European Conservation Agriculture Federation (ECAF) are promoting the practice of conservation agriculture (Knowler & Bradshaw, 2007:26).

2.9.5 Manure technology

Manure technology is the use of animal manure as a fertiliser to deposit nitrate and phosphorus to the environment. This leads to eutrophication and increased production of important greenhouse gases.

2.9.6 Water management

In Pakistan, farmers are using laser-assisted land levelling technique that facilitates the application of less water more uniformly under flood irrigation. The technique reduces leaching and improves crop stand and yields (Seth & Gupta, 2007:440).

This chapter exposes the great opportunities offered by the use of ICT and the potential of ICT in transforming agriculture. Literature on the use of ICT in agriculture by agricultural communities, implications of ICT use in agriculture for poverty alleviation, role of ICT in integrating agribusinesses with global markets, constraints inhibiting the use of ICT in agriculture, successful stories of ICT use in some developing countries and gender issues surrounding the use of ICT in agriculture have been reviewed. All these issues made reference to agriculture in developing countries in general and specific examples from South Africa were given.

The following chapter gives an outline of the theoretical framework underpinning this study. Other models used in adoption and use of technology like TAM, Marcus' theoretical model of adoption and diffusion of innovation theory are discussed briefly. The information innovation adoption model is discussed in detail and presented as the theoretical model of the study.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1 Introduction

Several competing theoretical approaches have been used to investigate the determinants of acceptance and use of information technology (Venkatesh, Morris, Davis & Davis, 2003). However each theory has its own advantages and limitations. A research theory is a set of explanations about complex phenomena, considered to be part of science. It identifies the variables that affect the problem of interest to the researcher. Research theories explain and tell the important concepts that need to be measured in a particular research. They also test relationships between important variables in a study (Borgatti, 2005). Results from research theories in turn, form part of the body of knowledge in science.

This chapter presents the theoretical framework underpinning this study. A brief summary of relevant models used in technology adoption and use studies is given, followed by a detailed description of the theoretical framework to be adopted in this particular study.

3.2 Theories on technology use and adoption

As already stated, this study focuses on the use, not the adoption, of ICT in agriculture. Therefore the theoretical framework to be adopted in this study explains the use, not adoption of ICT. Studies on adoption and use of technology use a number of models. In this section few models are discussed in brief and one of them is chosen specifically for this study.

Most scholars use Roger's diffusion of innovation theory to explain aspects of technology diffusion (Kiplang'at & Ocholla, 2005; Migiro, 2006). Diffusion of technology can be defined as the process through which some innovation is communicated within a social system (Bates, Manuel & Oppenheim, 2007). Roger's diffusion of innovation theory has been used since the 1960s to study a variety of innovations, ranging from agricultural tools to organizational innovation (Venkatesh, *et al.*, 2003:431). The theory emphasises the role of individual behaviour in the technology diffusion process and it considers time as an important factor in the rate of diffusion. The model classifies the users into five adopter categories, namely innovators, early adopters, early majority, late majority and laggards, depending on when they adopted the

technology. Since this study is not interested in establishing how, why and at what rate new technologies spread through communities and societies, the theory of diffusion of innovation cannot be used for this study. Also in this study, time, which is considered an important factor of the rate of diffusion in the theory, is not taken into account.

Some studies use TAM to investigate the factors affecting the adoption and acceptance of technology. TAM is similar to diffusion theory, although it places more emphasis on psychological predisposition and social influences, such as beliefs, attitudes and intentions as important factors in the adoption of technology (Bates, Manuel & Oppenheim, 2007:10). TAM was proposed by Davis in 1989 to predict the acceptance and use of new information technology (software and information systems) within organizations (Davis, 1989). The theory suggests that there are a number of factors that influence the adoption and use theory of technology. These are external factors, perceived usefulness and perceived ease of use. External factors are external contextual variables that influence the acceptance of technology through perceived usefulness and perceived ease of use and may be important predictors of perceived usefulness or perceived ease of use (Musa, 2006:215). External variables affect perceived usefulness and perceived ease of use directly or indirectly, and they influence the perception about these two major factors of technology adoption. Perceived usefulness is the degree to which using technology would improve performance and perceived ease-of-use is the degree to which using technology is expected to be effortless (Lu, *et al*., 2003). Perceptions, attitudes towards ICT and ICT useability are important and suitable for this study but other aspects such as beliefs, behavioural intentions and habits are not taken into account in this study. Since this study is not investigating the acceptance and intentions on adoption of technology, this model cannot be used as a theoretical framework in this study.

Another model derived from the diffusion of innovation theory and the social learning theory is Marcus' theoretical model of adoption (Ankem, 2004). This model identifies a number of key influential factors of ICT adoption. These factors include associate innovation costs (personal and institutional), availability of necessary resources (money, equipment, training, time, prior experience and relevant skills), the value of the technology (benefit minus cost) and communication between potential adopter and other adopters. Ankem (2004) used this model to investigate the factors influencing the use of Internet resource value added processes. The model has many important relevant factors that are investigated in this study. However, the costs and benefit analysis is not part of this study and the model is mainly employed to study innovative behaviour, which is not the purpose of this study.

3.3 Theoretical framework underpinning the study

Since this study is interested in investigating the factors that determine the use of ICT, it employs the information innovation adoption model to explain farmer and farm employee ICT use behaviour. It is the best existing model that was found to explain ICT use in agriculture. The model uses behavioural modeling concepts proposed by Kline (1998) and uses mediating variables to assess the relationships. It was developed, adopted and used by Alvarez and Nuthall (2006) to investigate the use of computer based information systems by dairy farmers in Canterbury, New Zealand and Florida, Uruguay. They used this model and modified it to develop an enhanced model for computerized system adoption. The model is shown diagrammatically in Figure 3.1.

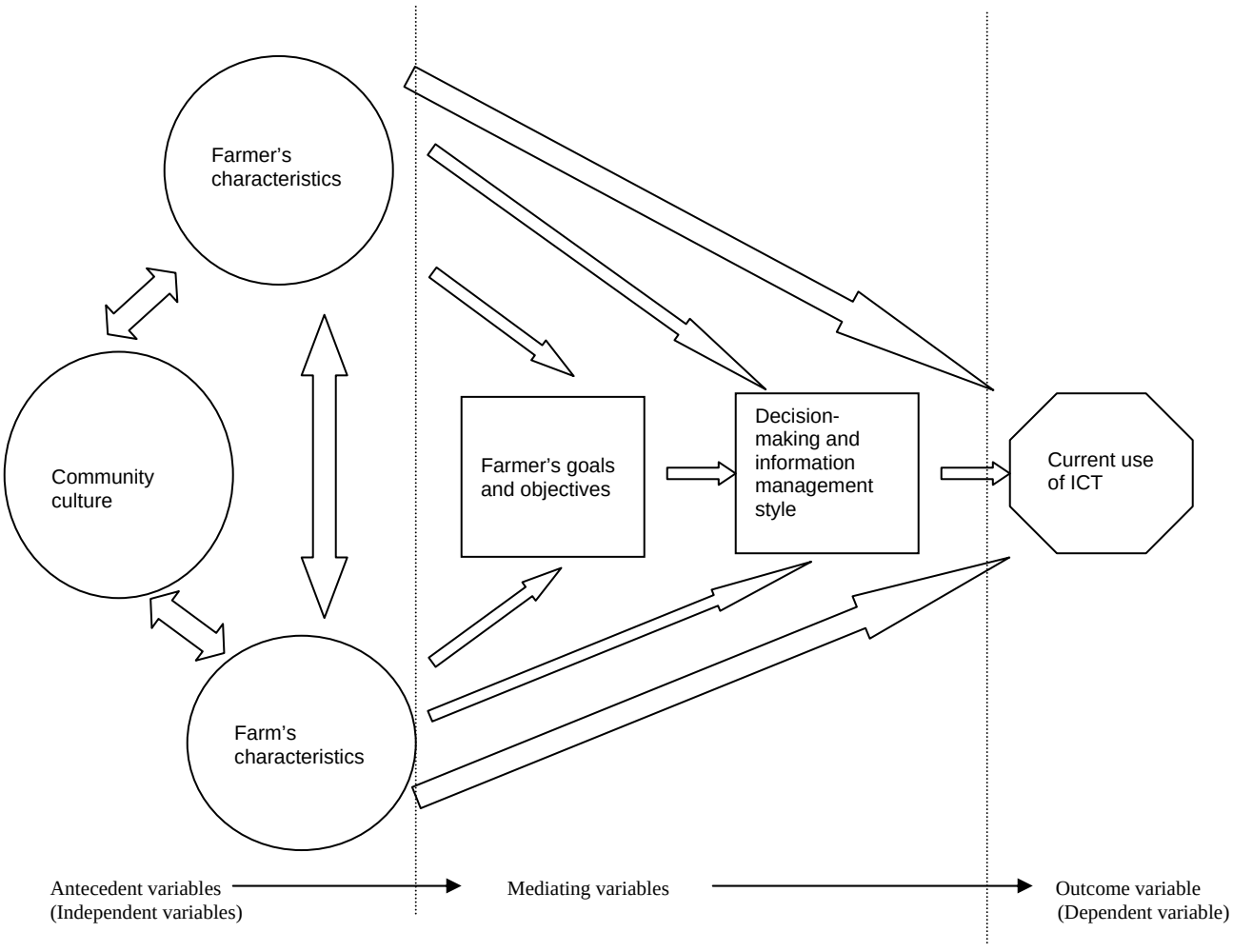

Figure 3.1: Information innovation adoption model

(Adapted from Alvarez & Nuthall, 2006)

The model shows that the use of computers by farmers relies on certain variables and that the relationship among the variables is not a simple direct one. The first group of variables is composed of antecedent variables that are indicated by circles in Figure 3.1. An antecedent variable is an underlying cause for a situation or scenario. In this model, the variables include farmer's permanent characteristics such as age, personality, formal education and income; farm characteristics such as farm size and crops grown on the farm, and community culture. Community culture is the farming culture that involves the values, ideas, and principles that were shared by the farming community when farmers were children and developed their thinking. The second group of variables includes mediating variables indicated by rectangles in Figure 3.1. Mediating variables are variables that describe how, rather than when, effects will occur by accounting for the relationship between the independent and dependent variables. Mediating variables are introduced to explain why an antecedent variable affects the outcome variable. Examples are coping styles of farmers, use of ICT in decision-making, information management style, and objectives and goals pertaining to ICT. The inclusion of mediating variables like personality traits, learning styles and farmer's goals provide a more comprehensive explanation and better understanding of information management behaviour.

According to Alvarez and Nuthall (2006:51), the model assumes that there are direct and indirect relationships between the antecedent and outcome variables. The reversible arrows on the antecedent variables indicate a two-way relationship between the variables. One variable may affect the other either positively or negatively and vice versa. For example, education, as an independent variable, may not be acting alone, but interacting with farm characteristics and/or with elements of community culture. One-way arrows indicate the relationship between the antecedent and the mediating variables, with the mediating variables explaining the relationship between the antecedent variables and the final outcome variable. Each antecedent variable may affect the mediating variable negatively or positively, for example the farmer's education may affect the farmer's objective, management style and the ultimate use of ICT.

All these variables influence the final outcome variable, which is the use of ICT represented by the octagon in Figure 3.1. Basically all these three groups of variables are being investigated in this study. In the data collection instrument there are relevant questions asked about these variables.

The respondents that were targeted by Alvarez and Nuthall (2006) were dairy farmers in two farming communities. In this study, it was considered important to include farmers and their employees as respondents. Involving the farmers and leaving their employees would give

inadequate information about their use of ICT. This is because in a farm setting, farmers make decisions about the appropriate ICT suitable for their farm configuration. On the other hand, the farm employees are there to execute what the farmer proposes. The fact that on a farm, the farm employees perform much of the routine day-to-day operations justifies the use of ICT by farm employees.

In their study, Alvarez and Nuthall (2006) investigated if certain variables have a relationship with the adoption of computerised systems. The variables included the farmer's age, formal education, personality and operational skills; farming culture, farm characteristics, advisory services on agriculture practices, information management skills and perceptions of economic benefits. In their findings, variables that were significant and have relationship with computerised system adoption include farm size, farmer's age, goals, information management practice and learning style. However, variables that may be considered as important in developed countries may not be so in developing countries. There are a number of variables that are proposed in this study that are relevant and applicable for developing countries but may not be relevant to developed countries.

Besides the variables that have been derived from previous related studies on ICT use in agriculture and from other studies on ICT adoption (Woodburn, *et al*., 1994:184; Sabuhoro & Wunsch, 2003:6) additional variables that are relevant to developing countries have been added to suit the developing country scenario. For example, in most developing countries, South Africa included, there is a strong emphasis on affirmative action in all sectors of the economy. In South African agriculture, Agri-BEE have been developed to support and empower black South Africans to actively participate fully in agriculture as owners, managers, professionals, skilled workers and consumers (Janssens, Sekofo, Van Rooyen & Bostyn, 2006:385). With this ongoing initiative, it may be necessary to investigate how farmers are empowered and how they in turn empower their employees, and how they all perceive the initiative. Another important variable that cannot be ignored in the developing country context is gender. Gender issues have recently received attention from all stakeholders in South Africa with the aim of reducing gender inequalities that have been prevailing over time. In this study, it is necessary to assess if women are being given equal opportunities in terms of agricultural resource ownership and management. Closely related to gender is income. Historically, women were paid lower salary than men, even if they were performing the same work. It may be important to assess if this is still the case on South African farms.

Another variable that is important in the post-apartheid South Africa is race. This variable measures if there is a change before and after independence in the ownership and management of resources on farms. Before independence the colonisers, mainly whites, dominated most agricultural sectors. The situation has been slowly changing since independence. Another factor that is peculiar to developing countries is that of affordability of ICT. In Africa, it is still a great challenge, especially for the black majority. It is therefore important to investigate if differences in ICT affordability have significant impacts on its use. Some variables are anticipated to make economic sense when related to ICT use. The market was also included because most of the farmers export some, if not all, of their produce to overseas markets.

In their investigation, Alvarez and Nuthall analysed the relationship between the variables they were investigating. For example, they found that farm size did not directly have an impact on the use of software, but affected the information skills and management style. This study will also investigate the relationship between different variables.

The variables proposed by the Alvarez and Nuthall model have been discussed in order to develop an extension of the information innovation adoption model to suit the developing country context. The extended model will be presented in chapter four. The extended model will be further modified, if necessary, to suit the results of this study. The modified model indicating the results of the study is presented in chapter eight. After data analysis, the variables related to ICT use will be presented in chapter six and seven. The following chapter discusses the different ICT models that are used in agriculture.

CHAPTER FOUR

MODELS OF ICT USE IN AGRICULTURE

4.1 Introduction

A model is a simplified representation of a process or system used as a way of analysing and solving problems or making predictions. A model can be econometric or non-econometric. This chapter intends to highlight the different ICT use models that are used in agriculture. Initially, non-econometric ICT models that are used in agriculture and the initiatives under them are discussed. Examples from different developing countries are given and explained briefly. With the knowledge of the importance of econometric models, a further discussion on econometric models is presented. Lastly, the variables that are investigated in this study for both farmers and farm employees are presented and explained. The following section presents the non-econometric models of ICT use in agriculture in a number of developing countries.

4.2 Non-econometric models of ICT use in agriculture

The non-econometric model is a simplified framework designed to illustrate processes, often but not always using mathematical techniques. They may be purely qualitative, for example, models involved in some aspect of social choice theory. There are several non-econometric ICT models that are used in agriculture in developing countries. Many ICT models used in agriculture are proposed to solve problems of lack of information, be it on agricultural technologies, natural resource base and geography, policy environment, laws and regulations and market information (Winrock, 2003:15). According to Mrayati (2002) ICT models have initiatives that support them in order to meet the different needs of the community. An initiative is a plan or strategy aimed at tackling a particular problem or situation.

A number of models of ICT use in agriculture have been proposed and used in different countries. Table 4.1 shows a summary of ICT models, the initiatives under them and some examples of agricultural communities in developing countries using those models.

Table 4.1: Models of ICT use in agriculture

Model	Initiatives	Examples
Rural Connectivity model	-Digital villages -E-municipality	-Village pay phones (Bangladesh) -Digital Village (South Africa)
Community-based content model	-Multipurpose information centres -Telecentres -Village information shops -Rural radios	-Mamelodi (South Africa), -Nakaseke (Uganda), -Kothmale (Sri Lanka), -Talking farming (Zimbabwe)
Virtual business incubator model	-Professional trading networks -Local business information systems and portals -Employment portals -Community financing	-ISAP (India) -B2Bpricenow.com (Philippines) -Electronic farm manager (Zimbabwe) -Vegetable trading network (Peru) e-choupal (India)
Community empowerment and participation model	-Government services to isolated communities	-Madhya Pradesh (India)
Community vocational training model	-Technical and vocational training	-Vocational training centres (Zimbabwe)

(Adapted from Mrayati, 2002)

On Table 4.1, the non-econometric models are indicated in the first column. The second column indicates the initiatives which can be undertaken under each model to fulfil the desired purpose of each model. Examples where the models have been used are listed in the third column. Most of the models given above are being used in many developing countries. The models that find most use are the community-based content model and the virtual business incubator model. For example the telecentre approach has been widely used in Africa. Telecentres are established as information resources and communication nodes in communities to meet the information needs of the people. They offer a broad range of communication services for free or on subsidies from governments or non-governmental organisations (Colle & Roman, 2003:388). In South Africa, the government established telecentres as a way of placing ICT and other information services within the reach of disadvantaged rural South African communities (Snyman & Snyman, 2003:96). About 103 telecentres have been established throughout different provinces in the country, and examples of successful telecentres include Mamelodi and Gaseleka (Esselaar, *et al*., 2006:46). Pigato (2001:43) and NTCA (2000:43) state that services provided by Mamelodi telecentre are driven not by technology but by real needs of communities. In Uganda, Nakaseke Multipurpose Telecentre has been among the successful telecentres. It helps farmers through

creation of some educational videos on issues such as agriculture practices (Colle & Roman, 2003:397). The telecentre has made a great difference due to its commitment to gender and women. It has managed to develop relevant and local agriculture-related content for use by the local people (ISNAR, 2002:5). The telecentre approach has been embraced in many countries, including Uganda, Kenya, Senegal and South Africa.

Besides telecentres, the rural radio approach is popular in disseminating agricultural information across long distances and rural remote places. One example of a successful initiative is the Kothmale community radio and Internet in Sri Lanka (Pringle & David, 2002:1). The initiative integrates community awareness, skills, capacity, public access and locally appropriate content specifically for a rural setting. It has assisted the rural people to benefit from ICT. In Zimbabwe, the government has used radio and television in educating farmers using three main languages, namely, English, Shona and Ndebele through a program called 'talking farming' (English) 'murimi wanhasi' (Shona) and 'Umlimi walamhla' (Ndebele) (Zimbabwe-e-readiness survey report, 2005:65). The programme is broadcast live and offer question and answer sessions. It has been successful in disseminating agricultural information to agricultural role players and a lot of farmers gained relevant knowledge on agricultural practices on different farm enterprises.

The virtual business incubator model has initiatives that are popular in disseminating agricultural information to farmers. Information about markets, prices, best practices, finances and weather is disseminated through electronic business portals. For example, in India and South Asian Association for Regional Cooperation (SAARC) countries, a network of professionals called Indian Society of Agribusiness Professionals (ISAP) was formed to serve farmers, small rural entrepreneurs and agricultural graduates (APAARI, 2005:55). The professionals specialise in the provision of information through meetings, e-mails, seminars, workshops, SMS, website, telephones to provide services which pertains to irrigation, food processing, international trade, research, and agricultural extension. According to Singh (2006:13), this network is probably the largest agriculture and rural development professional network in the world. It has a membership of over 9000 members, 400 NGO partners, and 110,000 farmers. It has been able to provide answers to over 3000 queries and problems raised by the farming community.

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Central and Satellite Agricultural Information Centre, provides farmers with accurate and up-to-date agricultural information to enhance access to market by poor people.

In the Philippines, an e-marketplace (B2Bpricenow.com) was established to enables farmers, fishermen, and small and medium enterprises to access market prices and trade products. The marketplace can be accessed via the web or cell phone, and it has online trading and payment options. Its services are provided free of charge. It provides a free market place and an electronic bulletin where farmers could get market information directly. These facilities help the farmers to know prevailing prices, increase their negotiation power and minimise costs of intermediation in the supply chain. Lower transaction costs are gained and broader access to global market is promoted (World Bank, 2003:14).

In Zimbabwe, a farming logistics programme called e-Hurudza/Electronic farm manager was developed by a local Zimbabwean company to address farmers in three main languages. The e-Hurudza/ Electronic Farm Manager software enables farmers to access information on crop and livestock cycles, rotations, the relevant input requirements and applications, tracking input prices, farm administration including financial reports, marketing and sales (Jawbone Enterprises, 2002). From this program a number of successful farmers have been able to (i) inquire about and understand how to grow commercial crops, their varieties, disease control and chemical application; (ii) get advise, according to the soil type and rainfall pattern, on the most suitable crop for the agro-ecological region the farmer is situated in, (iii) receive basic and intensive instructions on how and where to grow a particular crop or rear a particular livestock; (iv) capture input prices which are continuously updated to enable the farmer make informed decisions when preparing a budget, and (v) budget all inputs in a categorized manner.

It seems some countries invest more in some models than the others, depending on the needs and problems of their agricultural communities. Fewer developing countries invest in community empowerment and participation models and community vocational training models. More are interested in community-based content models, rural connectivity and virtual business incubator models. However, for ICT models to be successful there are a number of issues to be considered. One of them is the need for models to target different elements like community awareness, skills capacity, public access, empowerment and locally appropriate content. An integrated approach of these elements is very important (Pringle & David, 2002:4). Another essential issue is the identification of the problems of agricultural communities and the use of the appropriate combinations of traditional and modern ICT when implementing the initiatives to support the ICT models (International Institute for Communication and Development, 2006:19).

Advantages of non-econometric models: The models discussed above are all non-econometric. Non-econometric models are important as they show how using ICT solves identified problems and needs in agricultural communities. The advantage of non-econometric models lies in their simplicity, easy application, even when data is limited, and user-friendliness. With little training the beneficiaries can be able to comprehend what they are taught in implementing the initiatives under each model. In addition, non-econometric models are detailed and easy to understand.

Disadvantages of non-econometric models: The major disadvantage of this class of models is that facts and assumptions of a model cannot be proved statistically, thereby compromising their effectiveness. In addition, without statistical analysis one cannot get the exact value of a factor or variable. The significant influence of a variable on other variables and their relationship with other variables cannot be predicted using non-econometric models.

Given the shortcomings of non-econometric models, econometric models are often preferred. Econometric models are examined in the next section.

4.3 Econometric models of ICT use in agriculture

An econometric model is a tool used to replicate and simulate the main mechanisms of a regional, national or international economic system. It can be defined as a technique that uses more complex type of data or statistical formulas to explore relationships between and among variables. According to the European Commission (2007) there are three main purposes for constructing an econometric model. Firstly, an econometric model tests the validity of theoretical relationships between variables and the magnitude of the relationships. It is a way of testing whether a variable has influence on the other variable. Secondly, econometric models can be used for evaluating and assessing the effects of policies. Thirdly, econometric models construct alternative reality and compare the results against the usual baseline models.

Advantages of econometric models: Since without proof, facts do not speak for themselves, econometric models have the advantage of performing statistical tests with regard to various modelling assumptions, and they can assess and prove the credibility of the proposed facts. According to Abler (2006), econometric models permit the researcher to make varied and explicit assumptions. Assuming that there is real data and the study is methodically sound, econometric models produce real results. Using econometric models gives the exact value of a variable or factor and assesses if there is significant influence of that variable on other variables. Econometric models also provide an opportunity to learn from recent economic history.

Additionally, econometric models can be modified to suit changing reality. Furthermore, the fact that econometric models are informed by economic theory, which specifies the variables that are important and the causal relationship among them, proves that econometric models are viable.

Relevance of econometric models: Econometric modelling is very important because the statistical results help to explain the reasons behind a proposed assumption or hypothesis. For example for the extension of this study, this will help to identify the reasons or factors behind the use of ICT. The identified factors of ICT use will contribute to the development of a relevant ICT-driven agriculture model that can be used for agricultural development purposes. Knowledge of these use factors can also contribute towards the shaping of government policy on agricultural development. Farmers and managers can use this model to determine if the correct personnel are recruited to use the specialized technologies and to check if certain technologies are suitable for their farm operations.

Disadvantages of econometric models: Among other things, the major shortcomings of econometric models include the reliance on hypothesis that can only be supported by data. This entails the need for large data sets and a lot of data gathering. Also, econometric models need expertise to develop them. They also require forecasting of variables, and are not always the best forecasting technique. They also have problems in predicting outside of the range of currently observed time frame. Besides, results from econometric models are historical in nature and may no longer be relevant (Abler, 2006). As long as there is awareness of these disadvantages, their negative impact, or drawback, can be mitigated through conscious and purposeful effort. Thus, these disadvantages notwithstanding economic models can be powerful and effective tools for the improvement of agriculture.

Any existing econometric models on ICT use in agriculture were unknown. The closest econometric model that was found was on the use of ICT in health delivery system (Shivute, 2006). The author investigated the use of ICT in health service delivery in Namibia. In this study, ICT use in agriculture was investigated. In order to get in-depth information on ICT use by farmers and farm employees, there are a number of variables under investigation in this study. These are discussed below.

4.4 Variables under investigation in the study

This section presents the variables that are under investigation in this study. Based on the variables identified by other studies and additional variables which are considered to be applicable to developing countries (discussed in chapter three), the information innovation adoption model was extended to better explain the use of ICT in agriculture in developing countries like South Africa. Figure 4.1 shows the extended model.

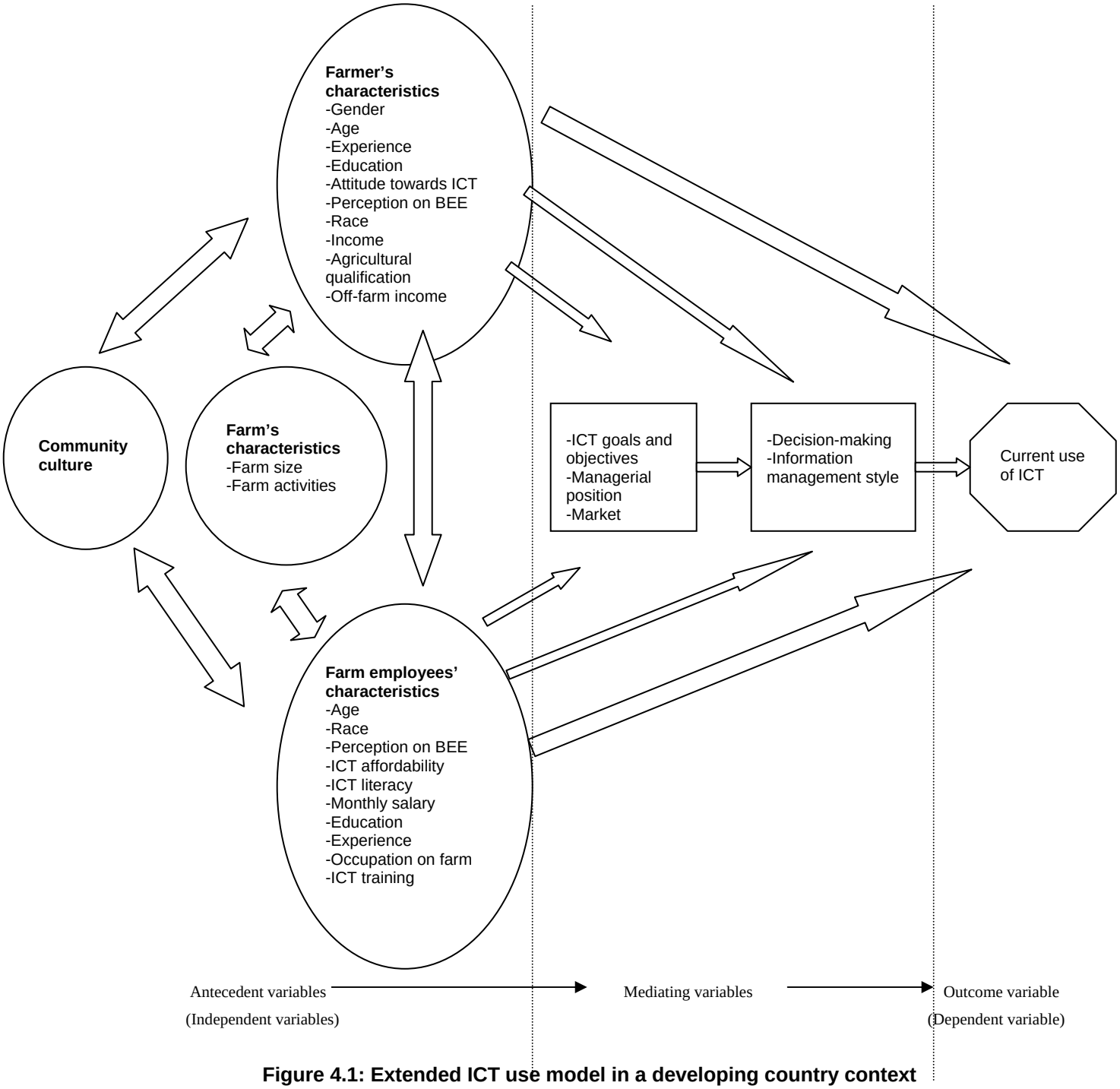

Figure 4.1: Extended ICT use model in a developing country context

Community culture which was part of the Information innovation adoption model was defined by Alvarez and Nuthal (2006) as the farming culture that involves the values, ideas, and principles that were shared by the farming community when farmers were children and developed their thinking. In a commercial farm business, decisions are made to further the business goals of the

enterprise. Cultural values and principles are not taken into consideration. Farm employees have no free choice situation where they can choose if they want to use ICT or not, regardless of their cultural background, values and principles. They do not have any say as to whether they can use ICT or not. Since employees have to implement decisions made by the farmer, they have no choice except to execute what the employer wants. They are provided with ICT tools to use on the farm and they have to use them. As a result, they do not have a choice to use or not to use ICT. Those who have cultural issues against ICT use will not apply for the job in the first instance. Only those who are prepared to use ICT apply for the job. In the case of farmers, they have to deploy ICT for farm operations regardless of the cultural values of their employees. Farmers are only interested in employing people who can work with technology. They consider employees' profiles such as education, experience, age and ICT literacy. They are not interested in cultural values of an employee. All they need is the work to be done. What is important to the farmers is to assess whether the employees' profiles enable them to use ICT productively for farm operations or not. For these reasons, these cultural variables mentioned here are outside the scope of this study.

A number of variables were derived from the model in figure 4.1 and they are presented on Table 4.2. Table 4.2 illustrates the list of variables that are hypothesised to have influence on ICT use by farmers and farm employees, and their predicted signs. These variables were identified in other studies and similar relationships have been found to exist in the use of computers and other ICT by farmers (Iddings & Apps, 1990:19-21; Sabuhoro & Wunsch, 2005:8) and in the dairy industry (Alvarez & Nuthall, 2006:48-60). Additional important variables that are related to ICT use and relevant to developing countries have also been added to the list to better account for developing countries.

Table 4.2: List of variables and their predicted signs

Variable	Description	Type of measure	Expected sign	
Dependent variables				
ICTUSE (Y)	-Whether ICT is likely to be used productively for farm operations -Whether farm employee is likely to use ICT productively for farm operations	[1]=yes, [0]=no [1]=yes, [0]=no		
Independent variables				
			Farmers	**Farm employees**
Demographics				
AGE	Age of farmer/ employee	Years	**-**	**-**
INC	Income per month/year	Rands	**+**	**+**
OFFINC	Off-farm income	[1]=yes, [0]=no	**+**	**+**
EDUC	Education level	Years	**+**	**+**
HHSIZE	Household size	Numeric	**-**	**+**
AGRIC	Agricultural qualification	[1]= yes, [0] = no	**+**	**+**
GENDER	Gender	[1]=male, [0]=female	**-**	**-**
EMPLMT	Nature of work contract	[1]=permanent, [0]=seasonal		**+**
RACE	Race	[1]=black,[2]=coloured, [3]=white	**+**	**-**
Farm & farmer characteristics				
DIST	Distance from town	Minutes	**+**	**-**
MEM	Cooperative membership	[11]=yes, [0]=no	**-**	
EXP	Farm experience	Years	**-**	**+**
FSIZE	Farm size	Hectares	**+**	
Managerial factors				
EXP	Farm experience	Years	**-**	**+**
MKT	Market	[1]=yes, [2]=no	**+**	
MGT	Managerial position	[1]=yes, [0]=no		**+**
ICT related factors				
GOAL	Farmer/employee ICT goal	[1]=yes, [0]=no	**+**	**+**
ICTLIT	Employee ICT literacy	Count	**+**	**+**
TRAIN	Employee ICT training	[1]=yes, [0]=no		**+**
Perceptions and attitude				
ATTI	Farmer/employee attitude towards ICT	[1]=positive, [0]=negative	**+**	**+**
BEE	Employee/farmer attitude towards black empowerment	[1]=positive, [0]=negative	**+**	**+**
AFFOD	Affordability of ICT	[1]=yes, [0]=no	**-**	**-**

(+) Positive association with ICT use

(-) Negative association with ICT use

Dependent variable

Use is usually defined in terms of a binary variable. In this case, ICTUSE is the dependent variable Y and is defined as a binary variable with a value of 1 and 0. For farm employees, Y has a value of 1 if a farm employee is likely to use ICT productively for farm operations and 0 if otherwise. In the case of farmers, Y has a value of 1, if ICT is likely to be used productively on the farm and 0 if otherwise.

Independent variables

The 22 potential independent variables on Table 4.2 fall under 5 categories or factors namely, farmer/farm employee demographics, farm and farmer characteristics, managerial factors, ICT related variables, and perception and attitudes. Some variables that influence use of ICT by farmers may not be necessarily the same as those that influence the use of ICT by farm employees. Even if some of the variables are the same, they may have different relationships with ICT use. Since the variables are different for farmers and farm employees, they are explained separately for each group.

4.5 Assumptions of the study

The following are the assumptions underlying the predicted relationships between the independent variables and ICT use. Each independent variable and its assumed association with ICT use is shown by either a positive or negative sign (as shown on Table 4.2). The exact relationship was validated after data collection.

- ✓ **Farmers**

Age: Younger farmers tend to use ICT more than older farmers. This is mainly because younger farmers have a chance to absorb and apply new knowledge. Older farmers had less exposure to ICT when they were at school and may not be prepared to incur costs and spend time in learning new technologies. Also, studies show that older individuals tend to exhibit fear of technology.

Income: High level of income implies the ability to invest in ICT and to bear the risks associated with the use. With less income a farmer has less to spend on new technology and may stick to old less expensive methods.

Education: Farmers with higher levels of education attainment are more likely to use more ICT than less educated ones. Higher education levels increase the probability of farmers learning and understanding easily about new technology.

Agricultural qualification: Those farmers with agricultural qualifications are more likely to use more relevant technology because due to their post-high school education, they are well equipped with the appropriate technology for different farm operations. Without relevant agricultural qualifications, the probability of acquiring the appropriate ICT decreases.

Race: Commercial white farmers are more likely to use ICT than emerging black/coloured farmers. This is mainly because more white commercial farmers have established themselves and have been in commercial agriculture for a long time than the emerging black farmers.

Distance from centre of development: Contrary to findings of Alampay (2006:14), farmers far away from town use more ICT to be more self-sufficient and reduce costs of travelling to nearby towns to access ICT than farmers close to towns. Farmers close to towns use less ICT since they know that they can travel to the nearby centre of development anytime they need ICT services at a cheaper cost. As distance from the centre of development increase, ICT use is likely to increase.

Farm size: As farms increases in size, complexity and business transactions, the use of ICT also increases. This is because as the farm size increases, it becomes difficult to manage efficiently, and use of ICT will help with record keeping, management, effective and efficiency measures.

Farming experience: Contrary to the views of Hollenstein (2004:325), experience is predicted to influence ICT use negatively. Farmers with experience in agriculture are reluctant to change; they prefer old technologies and their old ways of practising farming. Those with less experience depend on some other people or agricultural aids for more information on how to practice agriculture, so they are likely to be willing to use ICT.

Cooperative membership: Farmers who are in a cooperative are less likely to use ICT than those who are not. Cooperative members depend on the cooperative for input procurement, packaging and marketing; as a result ICT is likely to be used by the cooperative more than in their own farm operations. Farmers who are non-cooperative members are self-reliant and have to use all the necessary ICT for input procurement, production, packaging and marketing purposes.

ICT goal: A farmer who has ICT goals is likely to use ICT than the one who does not have any goals pertaining to ICT.

Off-farm income: The probability of ICT use increase if the farmer has off-farm income since he/she will have more disposable income and less financial constraints. Also, off-farm work helps in exposing the farmer to new technology outside the farm environment. A positive relationship is predicted (Xue-Feng, *et al*., 2007:246).

Market: A farmer who exports the farm produce is likely to use more ICT than the one who sells locally. Since there is need for communication with markets abroad, the farmer is compelled to use certain ICT, which may not be necessary when he sell the produce locally.

Attitude towards ICT: Positive attitude towards ICT has a positive effect on ICT use and negative attitude towards ICT has a negative effect on use.

Attitude towards black economic empowerment (BEE): BEE framework aims to support and empower the black South Africans to actively participate fully in agriculture as owners, managers, professionals, skilled employees and consumers. Farmers who have a positive attitude towards BEE are likely to use ICT to enhance their farm operations and equip their farm employees.

ICT affordability: It is negatively related to use since it is an anticipated barrier to the use of ICT. The high cost of ICT is negatively related to use. More expensive ICT are less likely to be afforded by farmers and thereby limiting their use.

- ✓ **Farm employees**

Age: Young farm employees are more likely to be interested in learning and applying new knowledge than older ones. Consequently, young employees are likely to be flexible and motivated to use ICT than older employees.

Income: Farm employees with a higher disposable income are more likely to use ICT than those with less income. Besides those ICT they use on the farm, they are able to purchase ICT for their own business and personal use.

Education: Farm employees who have attained higher levels of education are more likely to be interested in ICT use than those who have no or attained lower education level.

Household size: In most cases farm employees with a larger household size are likely to have more family members who will work at the same farm, increasing the probability of learning about technology and using ICT.

Agricultural qualifications: Farm employee with post-high school agricultural qualifications are more likely to be more knowledgeable on ICT use than fellow farm employees without qualifications. Those with agricultural qualifications are more likely to be involved in managerial duties (such as input procurement and marketing) that involve the use of ICT on a daily basis.

Race: Due to historical discrimination in South Africa, a number of farm employees are coloureds and blacks and less of them are in management positions that compel the use of ICT on a daily basis, thereby negatively influencing the use of ICT.

Distance from centre of development: Farm employees who are far away from centre of development have less access to ICT than those close by. As distance away from the nearby town increases, the probability of ICT use decreases.

Farm experience: More experienced employees are more likely to be entrusted with managerial duties which may require the more use of ICT. As farm experience of the farm employee increases, the probability of ICT use also increases.

Managerial position: Farm employees who have managerial positions are more likely to use ICT on a daily basis than the other ordinary employees. Being in a managerial position has a positive influence on ICT use.

ICT goal: It is perceived to have a positive relationship with ICT use. A farm employee who has ICT goals is likely to use ICT than the one who does not have any goals pertaining to ICT.

ICT literacy: Farm employees who are ICT literate and can operate a number of ICT are more likely to be interested in learning about new ICT and using them than those who are not ICT literate.

Gender: Contrary to the views of Sabuhoro and Wunsch (2005:8) more male farm employees are expected to use ICT than women farm employees. Since more males work on farms in South Africa, it is likely that males are more likely able to use and access ICT than women. In the South African context where more women are not yet emancipated and are expected to be at home, men have better and easier access to and more readily adopt technology.

ICT training: The trained employees are likely to use ICT than the untrained ones.

Nature of work contract: Permanent employees are more likely to be knowledgeable in ICT use due to a lot of exposure than seasonal employees. Permanent employees are more likely to have managerial positions that enable them to work with ICT throughout the year. ICT training is also likely to be given to permanent than seasonal employees.

Attitude towards ICT: Positive attitude towards ICT has a positive effect on ICT use and negative attitude towards ICT has a negative effect on use.

Attitude towards black economic empowerment: Farm employees are more likely to support black economic empowerment and be eager to empower and equip themselves with upcoming technology and to actively participate in agriculture.

ICT affordability: It is negatively related to use since it is an anticipated barrier to the use of ICT. The high cost of ICT is negatively related to use. More expensive ICT are less likely to be afforded by farm employees and thereby limiting their use.

Based on the underlying theoretical model that was adopted for this study, the variables discussed in this section were grouped in three categories according to the information innovation adoption model of Alvarez and Nuthall (2006) that was discussed in chapter three. Table 4.3 shows the classification.

Table 4.3: Classification of variables

Antecedent Variables	Mediating variables	Outcome Variable
Age	Managerial position	ICT use
Income	ICT goals and objectives	
Education	Market	
Household size		
Agricultural qualification		
Race		
Distance from nearest town		
Experience		
Gender		
ICT literacy		
Off farm income		
ICT training		
Perceptions and attitude		
Nature of work contract		
Farm size		

The next chapter presents the research method used in this study. A description of the location of study and data analysis techniques is also presented in this chapter.

CHAPTER FIVE

RESEARCH METHOD

5.1 Introduction

This chapter highlights the details of the relevant and appropriate research method adopted for this study. Explanations are provided as to how and where the research was carried out. Descriptive details of the location of study, the sampling procedures, the data collection methods and techniques of data analysis are all discussed in this chapter.

5.2 Background of the study

This section discusses the location of the study, agricultural activities and the climatic conditions of the area of study.

5.2.1 Location of the study

This study focuses on the Western Cape Province of South Africa. The province was chosen for this particular study because it is well known for its numerous and diversified commercial agriculture activities. It is also the mainstay of wine in the country. The Western Cape wine industry contributes approximately 91% of the total wine production of the whole country (Reid, 2000:3). The wine industry in this province contributes significantly to the GDP of the country and it is a major export earner.

Specifically, in the Western Cape Province, the survey was conducted in Robertson Wine Valley (RWV). The area is situated in the Breede River/Winelands local Municipality, approximately 160 kilometres east of Cape Town on Route 62. The town is known as the valley of wine and roses. The area has over the past decade gained an enormous reputation as a producer of excellent white and red wines. This is also the first region to launch a generic wine “Sinnya valley” which received an overwhelming demand from the export market (Hobson & Collins, 1997:162).

Suitability of study location: RWV was chosen for a number of reasons. Since the place is popular in winemaking and tourism, there is a possibility of a growth in the use of ICT in the day-to-day business transactions of the farmers who are involved in farming and agri-tourism. Above

that, all wine exported to the EU must comply with the EU regulation 178 of 28 January 2002, which states that all role players in the industry must have traceability systems in place for each product to facilitate its traceability. In order to comply with this regulation, it has become imperative that modern ICT in traceability be used in the wine industry. In addition, each player in the supply chain is expected to identify any person or business dealt with one step forward and one step back along the supply chain (Matthee, 2004). Without ICT, it may be difficulty to execute this requirement.

The other reason for the choice of this location is that the area offered the opportunity to investigate, insitu, ICT use in an agricultural setting. Farmers, farm employees and cooperatives responsible for grape production and wine making are in the same area and setting. This offered up for study the various other aspects germane to ICT use in commercial agriculture, namely production, packing, marketing and processing of grapes. The location is geographically close and easily accessible. The measure of convenience afforded by this is considerable, given the ever-present issues of tight constraints in time, money and other resources. Figure 5.1 shows the map of the Western Cape Province.

Figure 5.1: Western Cape Province

(Adapted from Cape Agricultural properties, 2007)

Figure 5.2 shows the map of Robertson Wine Valley. The area targeted in this study is encircled and comprises of five districts that are embraced in Robertson Wine Valley. These are McGregor, Bonnievale, Ashton, Montagu and Robertson. Each district has its own unique features and history, and this contributes to making RWV a popular tourist destination (Hobson & Collins, 1997:162).

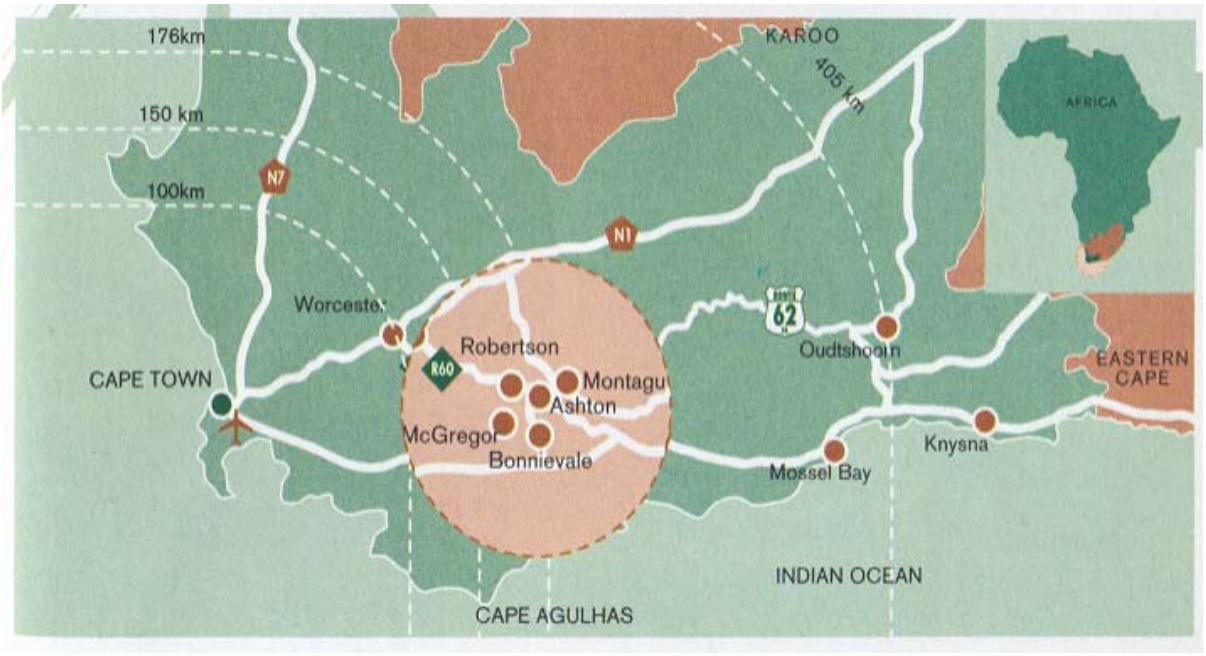

Figure 5.2: Robertson Wine Valley

(Adapted from Robertson Wine Valley, 2008)

5.2.2 Agricultural activities

Robertson area is well known for fruits and vegetable production, ostrich farming, dairy farming and wine making. The area is recognised as the 'breadbasket' of the Western Cape due to the diverse farming practiced there. Numerous fruits like apricots, cherries, peaches and plums, and vegetables like tomatoes and cabbages are grown in the area. Wine making is the dominant activity in the area and outstanding white and red wines, as well as sparkling wines are produced. Approximately 48 wineries are found in RWV, and the number of vines is 46 778 016. The total area under vines is approximately 13 603 hectares, and this constitutes 15% of South African total area under vines (Robertson Wine Valley, 2008). According to SAWIS (2007), RWV produced about 196 796 tons of grapes in 2007. The most grown red wine grape cultivars include Cabernet, Sauvignon, Shiraz and Ruby Cabernet and the most grown white wine grape cultivars include Chardonnay, Colombar and Chenin Blanc (SAWIS, 2007). Due to these agricultural activities and the great popularity of the area, a number of tourists visit the area per year, and agri-tourism has been a success.

5.2.3 Climate and soils

RWV has different soil types that can be divided into two main groups. The first group is the sandy, loamy alluvial soils as well as the red clay loam and clay Karoo. The second group is the residual soils including the Malmesbury and Bokkeveld soil families. The dominating one in RWV is the red clay loam and clay Karoo soils with a good water holding capacity and high potential of growing quality wine (Robertson Wine Valley, 2008). The alluvial soils are very fertile and if irrigated, high yields of up to ten tons per acre can be obtained (Flockemann, 1972:485).

According to Carey (2007), most vineyards in South Africa are irrigated, because of insufficient rains. RWV is one of those areas where rainfall is not adequate and full irrigation is applied to supplement the rain. RWV receives an annual average rainfall of about 250mm. In a good year, the average annual rainfall may get to 320 mm, but in a bad year the average rainfall may be 150 mm per year. The Robertson Wine Valley growers are divided into two categories according to their use of water for irrigation. The first category is of those growers who depend on the Breede River and Brandvlei Dam as their main source of irrigation water. This forms the largest percentage of the farmers. The other category consists of those farmers who depend on run-off stored winter water and boreholes for irrigation purposes (Robertson Wine Valley, 2008). Worcester is a similar wine producing area, with the same climatic and soil conditions.

In comparison, Cape Town has a Mediterranean-type climate with winter rainfall and moderate temperatures, whereas Robertson has a semi-arid climate with higher temperatures in summer and cooler temperatures in winter (Bonnardot, Carey & Strydom, 2004). The average day temperature in summer is 28.6 degrees Celsius and the average day temperature in winter is 21.1 degrees Celsius. The height above sea level is +/- 181 metres. Figure 5.3 shows the monthly temperatures and rainfall recorded at Robertson from 1961 to 1990.

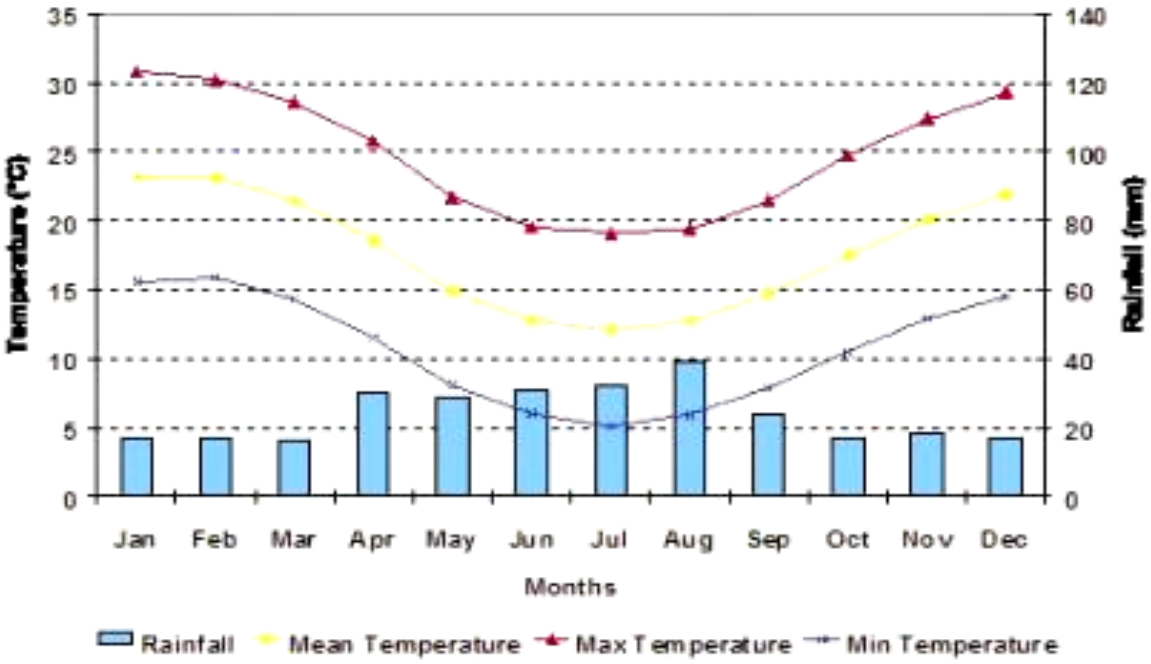

Figure 5.3: Monthly temperature and rainfall recorded at Robertson from 1961-1990

(Adapted from Bonnardot, Carey & Strydom, 2004)

From Figure 5.3 it can be deduced that the rainfall that is received in Robertson is not adequate for grape production and irrigation is important for the success of fruit production. Low average temperatures are experienced in winter especially June and July and high average temperatures are experienced in summer, especially in January and December.

5.3 Research methods and experiment

This study employed a quantitative approach. Quantitative methods were used to establish, confirm and validate relationships. Survey research by way of questionnaires was used to collect data which was helpful in establishing the existing relationships among the variables and explaining the possible reasons or causes behind those relationships. This avoided generalizations, established better results and understanding of the subject at hand, and helped to develop new concepts about the phenomenon.

In order to collect relevant data and obtain insights about the degree of ICT use, a survey research was used. The survey research enabled the collection of data from the farmers and farm employees themselves on their characteristics, opinions and attitudes towards ICT. The

data that was collected was on variables identified by the underpinning theory, in this case the information innovation adoption model. After data analysis the significant factors were used to extend the existing model, where necessary.

Survey research is defined as acquiring information about the characteristics, opinions, behaviour, attitudes, experiences and beliefs of one or more groups of people through questionnaires administered by mail, handouts, personal and telephone interviews and the Internet, and tabulating their answers (Leedy & Ormrod, 2005:183). In this study, the questionnaire was administered to the respondents through face-to-face personal interviews.

Personal interviews have a number of advantages. Some of them are:

- ✓ They allow the interviewer to clarify unclear questions and answers to and from the respondents.
- ✓ The interviewer may seek follow-up information by probing and get in-depth information.
- ✓ This is the best option to use in areas where the respondents have a high level of illiteracy. For example, in this study most of the farm employees were reported to be illiterate and needed elaboration and clarity.
- ✓ A high response rate is usually received.

However, personal interviews have their disadvantages. Some of them include high costs, high time consumption, especially if large samples are involved, and high probability of the interviewer influencing the responses (van Vuuren & Maree, 2002:281-282; Leedy & Ormrod, 2005:185).

5.4 The population

The population was composed of Robertson Wine Valley farmers and farm employees who use ICT in one way or the other along their wine supply chain. They may be involved in grape production, processing or marketing, or only in producing the grapes and then leaving the other processes on the supply chain to the cooperatives or any other middlemen.

Both the farmers and their employees were included as respondents, because leaving one of these two would give inadequate information about the use of ICT by the farms. For successful ICT use in agriculture, both the farmers and employees must be willing and able to use ICT in their day-to-day agricultural operations. Farmers make decisions on the type of employees to employ and the appropriate ICT suitable for their farm set up. On the other hand, the employees

are there to execute what the owner proposes. The fact that on a farm setting, the employees do much of the work justifies the use of ICT by employees in some of their daily operations. This study helped to determine if the correct personnel is recruited to use the specialized technologies. Also, it helped to assess if the employees are getting the benefits of the proposed ICT they use on their day-to-day operations. Additionally, with the ongoing Agri-BEE initiative, it was necessary to investigate how employees are empowered by their employers. Excluding either the farmer or the employees in the study meant that some essential information was to be omitted.

5.5 Sample size

Convenient sampling was used to select a total number of 75 respondents who were interviewed for the purpose of the study. Due to the busy farm schedules at the time of the interview, those who were readily available were interviewed for the purpose of the study. The sample consisted of 15 farmers and 60 employees. In this study, cooperatives were regarded as farms.

Participants in the survey

Two main groups of participants were included in the survey. These were the farmers and their employees.

(1) Farmers

This group was divided into two major groups, (i) individual farmers and (ii) cooperatives.

(i) Individual farmers: These produce wine grapes and process them into wine on their premises. They have wineries on their farms. They do all the processing of the grapes and sell the final product themselves.

(ii) Cooperatives: These are not owned by individuals, but by a number of shareholders. They do not produce wine grapes, so they buy from wine grape farmers. Their main area of specialisation is processing the grapes they buy from producers, into wine and then sell the final product.

(2) Farm employees

Under this group are those employees who work on wine farms owned by individuals. They work either in the vineyards, winery or in administrative work, where grapes are produced and processed on the same premises. Also included in this group are cooperative employees, who work in the vineyards, winery or administrative work in cooperatives. Each group of employees

will include those in managerial positions and those who are not. The design took into consideration the fact that some employees are in managerial and some in non-managerial positions. Employees from these two groups were included in the sample. This is important in assessing if there are any unique differences in ICT use between these two groups of employees.

5.6 Sampling procedures

The study was in two phases: phase one focused on the farmers and phase two focused on employees. In phase one, stratified random sampling was used to select the farmers since the farms falls under two main categories. Two strata have been identified. The first stratum included farmers who own individual farms and wineries on their premises. They produce wine grapes and process some of them, if not all, into wine. They find their own markets for their produce. The second stratum was composed of cooperatives that buy wine grapes from grape farmers and process them into wine. Proportional random sampling was applied to select the respondents since these two strata are not equal in size.

In phase two, since the farm employees either work for any of the categories of farms mentioned above, stratified random sampling was also used to select the employees. The basis of stratification was where the employee works; therefore the first stratum comprised of employees who work on farms that produce wine grapes and process them on their premises. They may be working in the vineyards, winery or in administration work. The second stratum comprised of employees who work in cooperatives which do not produce grapes, but buy them from other producers and process them into wine. From each stratum, respondents were randomly selected. In summary, the structure of the respondents is shown on Table 5.1.

Table 5.1: The respondents for this survey

Farmers	Individual farms	Cooperatives	Total
	11	4	15
Farm employees	Farm employees	Cooperative employees	Total
	44	16	60
Total	**55**	**20**	**75**

As noted earlier and seen on Table 5.1, the total sample size was 75, consisting of 60 employees and 15 farmers. From each farm 5 people were interviewed: one farmer and four farm employees.

5.7 Data collection

Data was collected from various sources in order to get more information about the subject at hand. Both primary and secondary sources of information were used.

5.7.1 Primary data

The first hand information to be used in this study was gathered from a survey instrument. Two separate questionnaires were developed and administered on two samples: (i) farmers and (ii) employees. The questionnaires had both open and close-ended questions. The questionnaire for employees probed types of ICT used, factors influencing ICT access, ICT literacy and training, perceptions and attitudes towards ICT and BEE. The questionnaire for farmers addressed issues of production, asset and input procurement, communication, ICT types used, challenges of ICT use and role of ICT in marketing.

Permission to carry out the survey in RWV was obtained from the RWV manager. Information about the contact details of the farm and their locations were obtained from the RWV authorities. For permission to visit the farm, each farmer was contacted. On an agreed date and time, each farm was visited to interview the farmer and the employees. Face-to-face interviews were conducted for each respondent. Each interview took approximately 20-25 minutes. Per farm, one farmer and four employees were interviewed. In this study, farmers were defined as those who actually own the farms and cooperatives or anyone acting and making decisions on their behalf (manager).

The data collection methods were aimed at investigating how ICT are being used in each stage along the wine supply chain, in order to establish the flow of information within the wine supply chain. Figure 5.4 shows an example of the different stages along the wine supply chain which need the flow of information for them to be effective and efficient. This study is limited mainly to the use of ICT by wine grape farmers in input procurement, production, harvesting, processing, packing, distribution and marketing. An example of the supply chain of wine is used in this illustration to show the need for information flow in the different stages shown. These are the stages mainly focused on in this study.

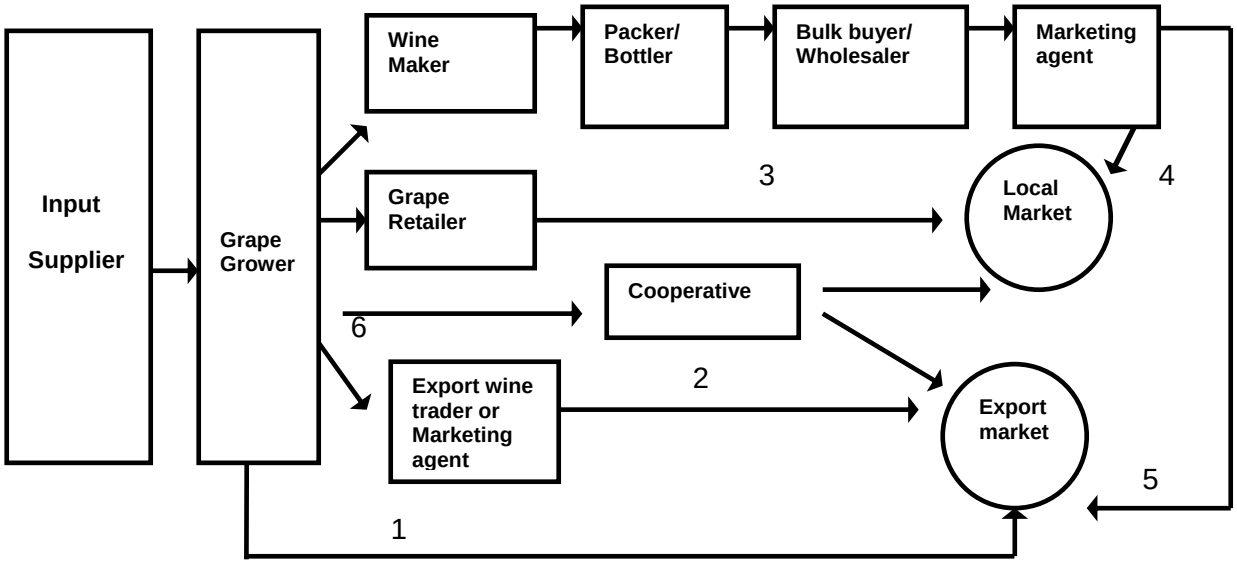

Figure 5.4: The flow of information along the wine supply chain

The flow of information may take any of the routes numbered 1 to 6 in Figure 5.4, depending on whether, in addition to production, the farmer also process, packs and distributes the product, and ships it to the market or not. In most cases, some farmers produce grapes and process them on their premises, and then sell the processed product to the marketing agent, who in turn sells the product until the product reaches the market. Number 6 in Figure 5.4 shows this supply chain. In RWV, many farmers use processes shown on route 1, 2 or 6. Those using number 1 or 2 are self sufficient in terms of doing the processing and packing on the same farm, and may only need the export agent at the last stage of the supply chain when marketing the final product to export markets. Most RWV farmers use one or more routes illustrated in Figure 5.4.

5.7.2 Secondary data

Data on ICT use in agriculture was obtained from relevant sources of information, such as publications, journals, relevant websites and books. A number of these sources have been consulted in the reviewing of literature. Different government sources were consulted for information. These included handbooks, policy statements, published statistics, national government sources, planning documents, reports, historical and other official documents.

5.8 Data analysis techniques

A number of data analysis methods that were used for this type of study are discussed briefly below. As stated in earlier chapters and shown in Figure 5.5, only descriptive statistics, chi-

square tests and correlation analysis were used in this study. The later two methods, namely, multinomial regression and logistic regression are included in Figure 5.5 to show how the results of the study can be used to develop an econometric model of ICT use. The issue of econometric modeling is discussed, in more details, in chapter 7 (section 7.2).

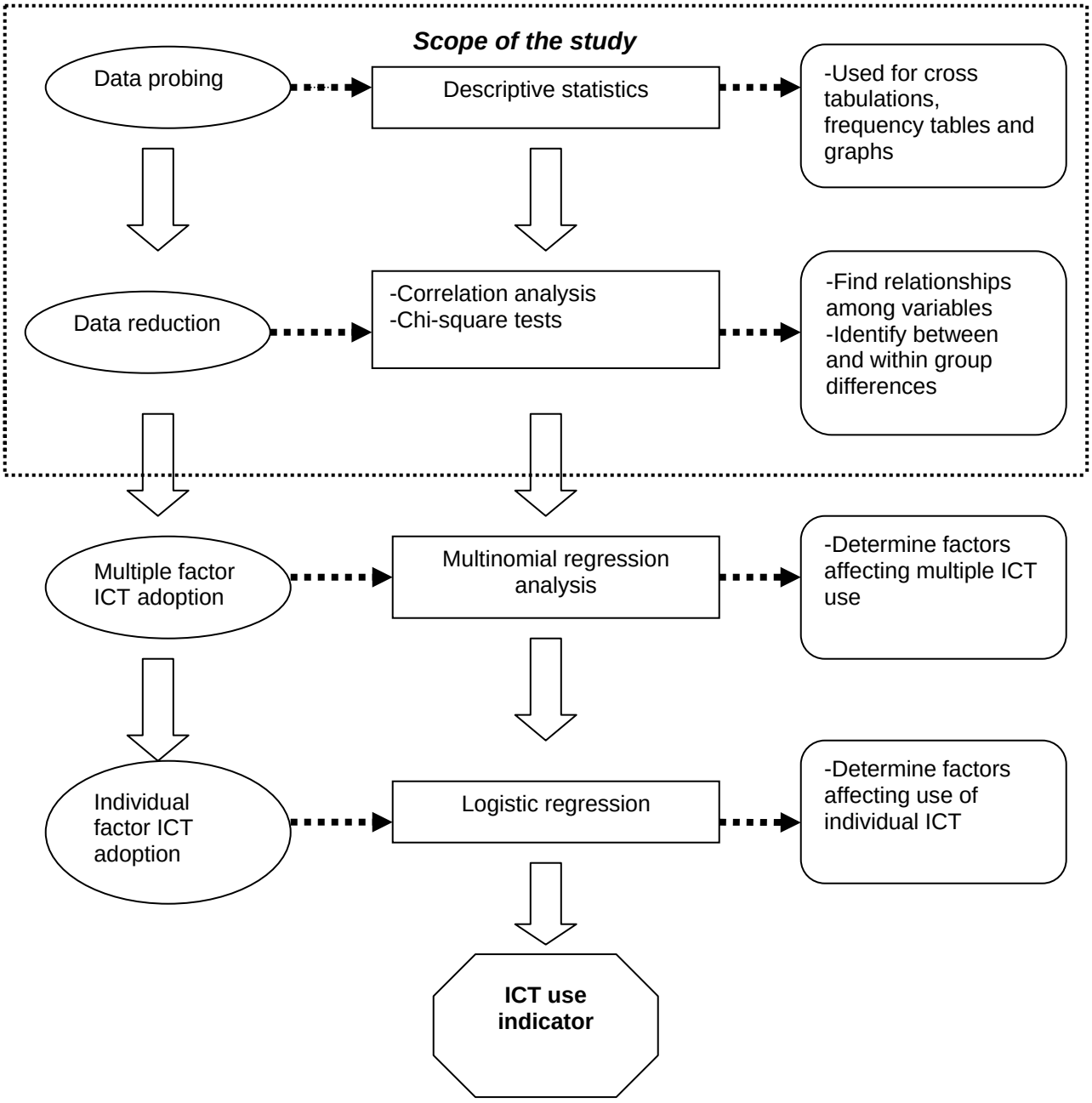

Figure 5.5: Summary of steps in data analysis procedure

5.8.1 Descriptive statistics

Descriptive statistics were used to make cross tabulations, frequency tables, pie charts, histograms, bar graphs and to calculate averages, ranges, percentages, means and correlations among key ICT use variables. To facilitate the analysis, some items on the questionnaire were measured using a Likhert scale of 1 to 5 scores.

5.8.2 Correlation and chi-square analysis

Correlation analysis and chi-square tests were conducted to identify and find the relationship between ICT use and some variables, and between the variables themselves. The cross tabulations help to identify differences between and within variable groups.

5.8.3 Multinomial regression

Multinomial regression can be used to identify significant factors affecting multiple ICT use. Alternatively, factor analysis can be used to group ICT into different collective groups based on similar characteristics, such as how ICT is used, be it individual use or technology bundling; stepwise or other formats. These different ICT groups or components can be used as dependent variables in the multinomial model to determine factors that affect multiple ICT use.

5.8.4 Logistic regression

Logistic regression can be used to analyse the relationship between one dependent variable and more than one or multiple independent variables (Booysen, C. 2006: 46; Hosmer & Lemeshow, 1989:25). It can be used to identify factors affecting the use of individual ICT. Logistic regression is more appropriate than linear regression if the dependent/outcome variable is binary.

5.9 Delineation of the study

As already stated, this research project is restricted to commercial agriculture and confined to Robertson Wine Valley in the Western Cape Province of South Africa. It mainly emphasizes the use and benefits of ICT, and the factors influencing the use of ICT by different grape producers in Robertson Wine Valley. Therefore, it is limited to the wine industry. The study does not focus on individual ICT. Rather, all types of ICT are investigated. Only descriptive statistics, chi-square tests and correlation analysis are used, since the aim is to investigate the factors of ICT use. The regression methods are stated solely to note an extension of this study that is slated for a later study. Only measurable variables influencing ICT use are considered in this study. These, however, are not the only factors to be considered in making decisions by agriculture role players. There are other unmeasured, subtle and intangible factors to be taken into account

when deciding on ICT use. They vary in nature depending on the location, geographic diversity and application, but can refer to social cohesion, population stability, gender issues, social pressures and standard of living issues. These unmeasured variables are beyond the scope of this study. The econometric model briefly discussed later and suggested for a later study can be used in conjunction with other factors as a decision support tool. The following chapter presents the empirical results of the survey that was undertaken in RWV.

CHAPTER SIX

EMPIRICAL RESULTS OF THE STUDY FOR FARM EMPLOYEES

6.1 Introduction

This chapter presents the empirical results of the main findings from the analysis of data that was collected from surveys conducted in RWV. The scope of this study is limited to descriptive statistics, chi-square tests and correlation analysis. The chi-square tests and correlation analysis were used to find relationships between factors influencing the use of ICT in South African commercial agriculture, specifically in the wine industry. SPSS was used as statistical analysis software. From the study, the following information was found about the ICT access, ICT awareness and use patterns, perception and attitudes towards ICT and demographics of the farm employees. Section 6.2 discusses the descriptive statistics and ICT aspects of farm employees. Section 6.3 and 6.4 present the chi-square tests and correlation analysis results respectively. It should be noted that most of the questions on the questionnaire had multiple responses and a respondent would choose more than one option. Therefore, some of the results were presented in terms of percentage responses not percentage respondents. However, it is stated if percentage responses or percentage respondents were used. Some questions have subsections that were only completed when the respondent qualifies for the first part of the question. The stated results are for the whole sample, unless stated otherwise.

6.2 Descriptive statistics for farm employees

This section gives an overview of the results from the sample of farm employees on their ICT access, ICT awareness and use patterns, perception and attitudes towards ICT and demographics. A sample of 60 farm employees participated in the survey.

ICT access

The respondents were presented with options to indicate where they get access to a computer. They could choose more than one option. As shown on Table 6.1, about 57 percent of responses have access to computers only at work. On the other hand, about 43 percent of responses have no access to computers at all. This is typical of the farm employees who work in the vineyards and do not have enough income to buy ICT of their own. The other reason is the

high levels of illiteracy among the farm employees that hinders them from using ICT, even when it is readily available. The few who work in the wine cellars or in administrative work are the only ones who have access to computers at work. About 23 percent of responses indicated that they have access to the computer at home. Mainly, these are administrative employees who earn high incomes or some employees who have off-farm income. They are, therefore, able to afford computers at home. About 3 percent of responses access computers at Internet cafes that are located in the nearby town.

Table 6.1: Sources of computer access for farm employees

Computer Access Frequencies			
		Responses	
		N	Percent
Do you have access to a Computer?	Q1_1 Yes, at home	14	18.4%
	Q1_2 Yes, at work	34	44.7%
	Q1_3 Yes, at Internet café	2	2.6%
	Q1_5 None	26	34.2%
	Total	76	100.0%

Source: Survey data, 2008

The computer access scenario is almost similar to Internet access for the farm employees, although the percentage responses for Internet access are higher than that of computer access. The highest number of responses for Internet access is from those who access it from work. About 52 percent of responses access Internet at work. As in the case of computer access, there are some employees who have no access to Internet at all. These form about 47 percent of responses. This implies that besides those who do not have access to computers, there are employees who have access to computers but do not have access to the Internet for some reasons. One of the reasons is the fact that a small percentage of farm employees who own computers at home are not subscribed to the Internet. Table 6.2 shows the sources of Internet access for the farm employees.

Table 6.2: Sources of Internet access for farm employees

Internet Access Frequencies			
		Responses	
		N	Percent
Do you have access to the Internet?	Q2_1 Yes, at home	12	15.8%
	Q2_2 Yes, at work	31	40.8%
	Q2_3 Yes, at Internet café	5	6.6%
	Q2_5 None	28	36.8%
	Total	76	100.0%

Source: Survey data, 2008

One interesting finding shown on Table 6.3 indicate that about 53 percent of the total farm employees use their email addresses. This is mainly because most of the employees who work in cellars or in administrative work have Internet access. About 47 percent of the employees do not use email addresses. This is mainly due to the fact that they do not have access to computers, let alone the Internet in the first place. This group of employees usually works in the vineyards and is highly illiterate.

Table 6.3: Farm employees' use of email

Q3. Do you use an email?				
		Frequency	Percent	Cumulative Percent
Valid	Yes	32	53.3	53.3
	No	28	46.7	100.0
	Total	60	100.0	

Source: Survey data, 2008

As shown on Table 6.4, approximately, 55 percent of the farm employees know how to access the Internet on their own without being assisted. About 45 percent do not know how to access the Internet on their own. This shows a level of Internet knowledge and literacy among the farm employees.

Table 6.4: Internet use ability of the farm employees

Q11. Do you know how to access Internet on your own?				
		Frequency	Percent	Cumulative Percent
Valid	Yes	33	55.0	55.0
	No	27	45.0	100.0
	Total	60	100.0	

Source: Survey data, 2003

In RWV, there are small towns like Robertson, McGregor, Ashton and Bonnievale. The farm employees were asked about the time they take to get to the nearby town and the mode of transport they use. Most of them indicated that they walk to the nearby town, some use taxis and a few of them drive their own cars. Some indicated that they use more than one option to get to town, but most of them indicated only one option. About 52 percent of farm employees use taxis, 45 percent drive their own cars and 25 percent walk to town. Those who own cars are mostly employees in managerial positions and administrative work on the farms. Majority of the employees are field workers who either walk to town or use taxis.

A question on the types of ICT the farm employees have at home was asked to get an overview of the types of ICT they use at home besides the ones they use on the farm for work purposes. 100 percent of the responses have cell phones. Approximately 88 and 83 percent of the responses have television sets and radios in their homes respectively. This may be because these two are the main basic ICT used by average South Africans for entertainment purposes. Table 6.5 shows the percentage of responses of farm employees who own ICT at their homes.

Table 6.5: ICT owned by farm employees at home

Home_ICT Frequencies			
		Responses	
		N	Percent
Which of the following ICT do you have at home	Cell phone	60	25.3%
	Television	53	22.4%
	Radio	50	21.1%
	Landline phone	20	8.4%
	Computer	18	7.6%
	Personal Digital Assistant (PDA)	1	0.4%
	E-mail	14	5.9%
	Fax machine	3	1.3%
	Printer	5	2.1%
	Internet	13	5.5%
	Total	237	100.0%

Source: Survey data, 2008

Besides the three ICT discussed above, the rest of the ICT shown on Table 6.5 have less than 50 percent of the responses who own them at home. No employees have a two-way radio at home. Only the cell phone, television and radio are popular with the farm employees, the other ICT are used by a few farm employees. The farm employees' ICT awareness and use patterns are discussed in the next section.

ICT awareness and use patterns

Depending on the type of work they do, farm employees use different ICT in their daily work on the farm. ICT that may be used by someone who works in a cellar may be different from ICT used by someone who works in administrative work, or in the field. The farm employees were asked if they use ICT to support their farm work. 67 percent indicated that they use one or more ICT and 33 percent indicated that they do not use ICT at all in their farm activities. This observation shows that besides the field workers who do not use ICT at all to perform their farm

work, a larger percentage of other employees who work elsewhere on the farm use ICT in their work, although the type of ICT differs depending on the type of work performed.

To test if the farm employees know how to use different ICT, they were asked to indicate the type of ICT they are capable of using among a wide range of ICT. Table 6.6 shows the percentage responses of farm employees who know how to use each identified ICT.

Table 6.6: Percentage responses of farm employees who know how to use ICT

KnowUse Frequencies			
		Responses	
		N	Percent
Do you know how to use the following ICT	Computers	35	10.7%
	Internet	32	9.8%
	Fax	30	9.2%
	Printers	31	9.5%
	Photocopiers	29	8.9%
	Landline telephones	37	11.3%
	Cell phone	60	17.2%
	Two-way radios	8	2.5%
	Personal digital assistant (PDA)	3	.9%
	Computerized irrigation system	4	1.2%
	Bar code system	20	6.1%
	Email	28	8.6%
	Precision agriculture system	1	.3%
	Global positioning system (GPS)	2	.6%
	Tracking /tracing software	10	3.1%
	Total	326	100.0%

Source: Survey data, 2008

The cell phone is the easiest form of ICT that all the employees know how to use. The results

showed that an enormous number of employees know how to use most of the ICT although they might not own it. Besides using cell phone, more that 50 percent of the responses indicate that the farm employees know how to use computers, Internet, printers and landline phones. Since ICT such as precision agriculture, computerised irrigation, global positioning system and personal digital assistants are not used by most of the farmers in the area, this implies that the farm employees also do not use them. This explains the low response percentages shown on Table 6.6 on these ICT.

For one to use ICT there is need for training on how to use it. Approximately 50 percent of the employees indicated that they did not receive any formal training on how to use ICT. 50 percent indicated that they received formal training. Table 6.7 shows the percentages of farm employees who received formal training on how to use ICT and those who did not.

Table 6.7: Percentage of formal trained and non-trained employees

Q10. Did you receive any formal training to use any of the ICT in Qsn 9?				
		Frequency	Percent	Cumulative Percent
Valid	Yes	30	50.0	50.0
	No	30	50.0	100.0
	Total	60	100.0	

Source: Survey data, 2008

Farm employees who received formal training on how to use ICT were further asked who trained them. 40 percent of those who received formal training indicated that experts within the farm trained them, while private consultants trained 33 percent. The results from this scenario indicate that some farmers take it upon themselves to equip their employees about the ICT used on the farm and how to use them while some do not. 27 percent received ICT training from other sources like colleges and universities. The missing variable arises from the other 50 percent employees who did not receive training and the question was a subsection of the previous question. Table 6.8 shows the different formal trainers who trained the farm employees how to use ICT.

Table 6.8: Formal trainers who trained the farm employees

Q10_1. Who trained you?				
		Frequency	Percent	Cumulative Percent
Valid	Private consultants	10	16.7	33.3
	Experts within the farm	12	20.0	73.3
	Other	8	13.4	76.7
	Total	30	50.0	183.3
Missing	System	30	50.0	
Total		60	100.0	

Source: Survey data, 2008

The farm employees use some ICT for personal use and some for business purposes. Figure 6.1 shows the percentage responses for the use of each ICT.

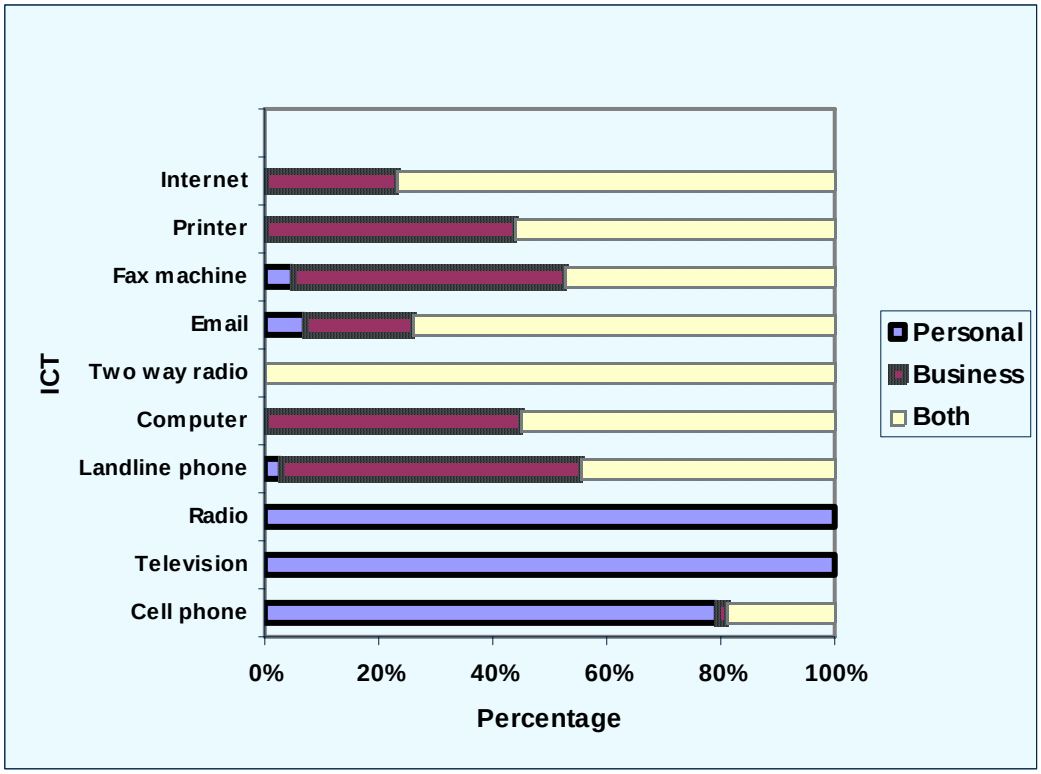

Figure 6.1: ICT purposes

Source: Survey data, 2008

The farm employees use the radio and television for personal purposes only. This is indicated by the 100 percent for the respondents under personal use for each of these two ICT. For the use of cell phone 59 employees responded to the question and 80 percent of them indicated that they use a cell phone mainly for personal purposes while 2 percent and 19 percent use it for business or both business and personal purposes respectively. This is mainly because on a farm setup, a few employees use their personal cell phones to conduct farm businesses. The two-way radio is mainly used for business by the employees, with 100 percent of those who responded to the question using it. This is mainly because it is the main mode of communication within and between farms in the region. Landline phones, computers, emails, fax, printer and Internet are basically used for both personal and business purposes on the farm. Some employees also carry out their personal transactions, as they will be doing transactions for the farm business.

There are quite a number of ICT that the farm employees have difficulty in using. Some of the employees have not been exposed to a lot of ICT and have difficulty in understanding even what the ICT looks like and how is it used. From the results, it is seen that the highest percentage of the responses indicated that they have difficulty in using the following ICT, starting with the

highest response in descending order: (1) computerized irrigation systems, (2) global positioning systems, (3) precision agriculture, (4) Internet, (5) computers, (6) printers and two-way radios and (7) fax.

The main use of ICT is to facilitate communication and dissemination of information from one person to the other. To understand the communication needs of the farm employees and the type of ICT they use when communicating at any level, they were asked to indicate the ICT they use when communicating with specific stakeholders. The aim of this investigation was to check any differences in ICT use when farm employees communicate with customers, employer, bank, friends, family and when there is an emergency. The following pie charts show the different percentage responses for each ICT used for communication by the farm employees.

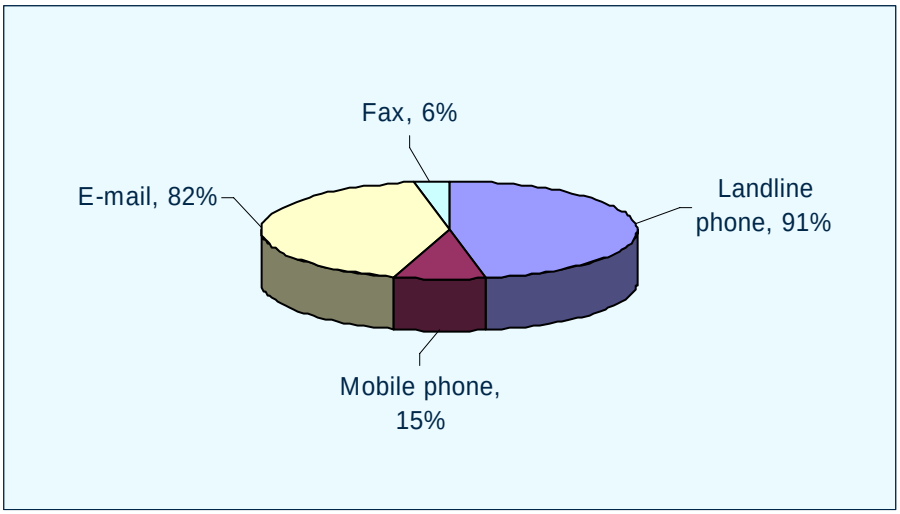

Figure 6.2: ICT use for communication with customers

Source: Survey data, 2008

From the 34 employees who indicated that they communicate with customers, 91 percent use landline, 15 percent use cell phones, 82 percent use e-mails and 6 percent use fax. The landline phone is the major ICT used when the farm employees communicate with customers. From the study, it shows that landline phones are mostly used by employees involved in administrative work and constantly communicate with customers and other stakeholders along the supply chain. Besides the landline phone, the cell phone is also mostly used to communicate with customers due to its convenience and ease of use. The fax and email are the least used ICT for communication due to the fact that not all employees have access to fax and e-mail facilities and

their uneasiness of use.

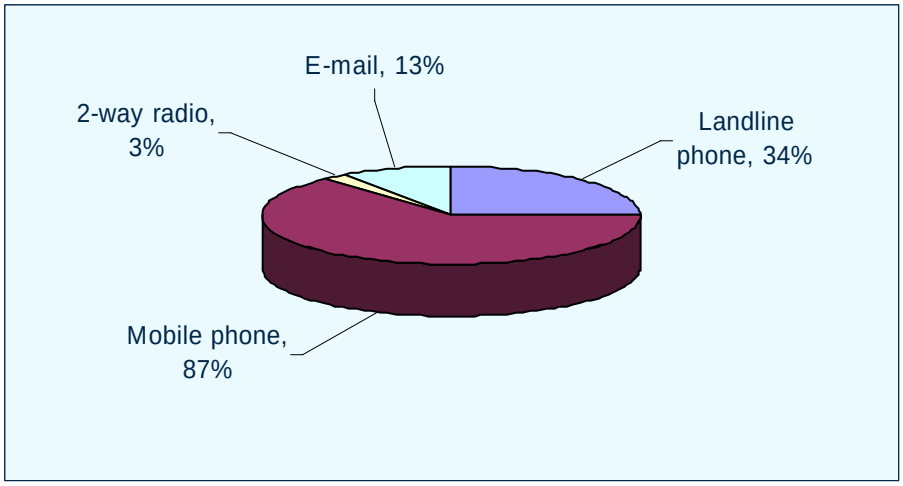

Figure 6.3: ICT used for communication with the employer

Source: Survey data, 2008

Thirty eight employees indicated that they communicate with the employer using the ICT shown on Figure 6.3. The cell phone has the highest use when the farm employees communicate with their employers. Out of the 38 respondents, 87 percent use a cell phone to communicate with their employer. This maybe due to the fact that cell phones are the easiest mode of communication used by the average South African, no matter the type of cell phone. Also, most farm employees do not have landline phones and the only alternative is a cell phone. About 34 percent use a landline to communicate with their employer. These are the employees who have access to landline phone at home or at work. E-mails and two-way radios are rarely used with only 13 percent and 3 percent respectively. Employers mainly use two-way radios and limited employees with supervisory duties. This makes their use to be limited. Some employees indicated they do not usually make calls to their employer; they simply go to his office whenever they want to communicate with him.

Some farm employees use ICT to communicate with their banks. From the total sample of employees, 32 indicated that they communicate with their banks using ICT. A highest percentage of respondents (66 percent) use online banking. Fifty nine percent of the respondents receive bank information on their cell phones and only 6 percent use landline phone. However, the rest of the employees who are not aware of e-banking do not use any ICT

to communicate with their banks; they simply go to the banks to conduct all transactions.

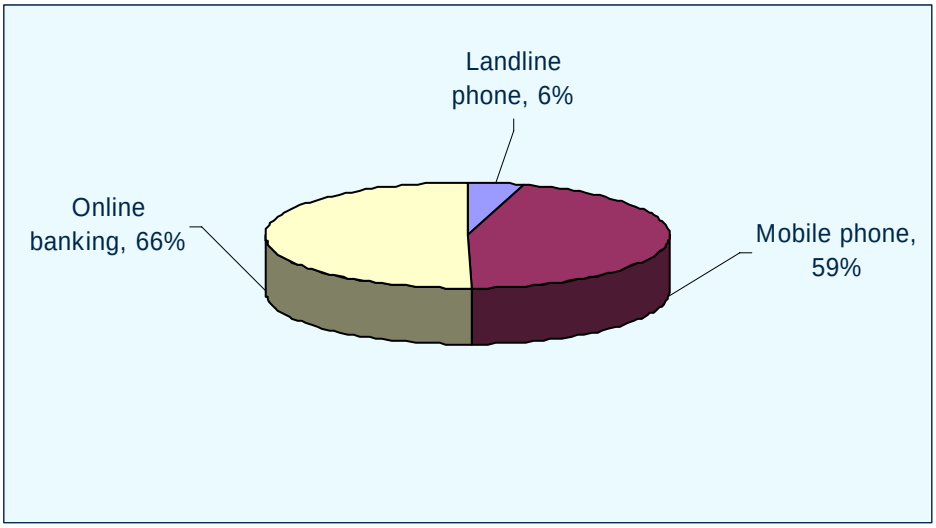

Figure 6.4: ICT used to communicate with the bank

Source: Survey data, 2008

Besides using ICT on the farms, farm employees also use ICT for their personal use. They communicate with their families, relatives, friends and when there is an emergence. Fifty nine employees indicated that they usually communicate in cases of emergence. From the results of the study, the cell phone is used mostly when there is an emergency. Out of the 59 respondents, 95 percent of them use a cell phone. However, a few people use the landline and two-way radio. A two-way radio is mainly used when there is an emergency at work. The percentages are shown in figure 6.5.

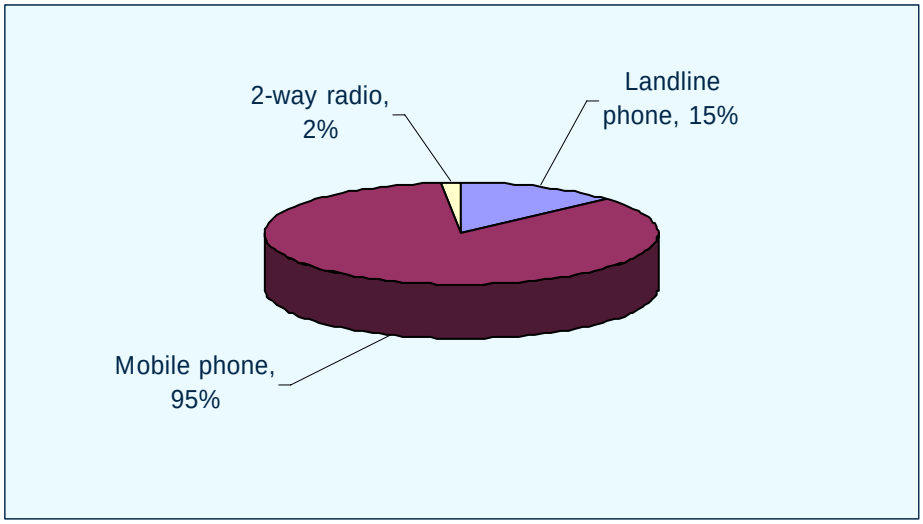

Figure 6.5: ICT used for emergency

Source: Survey data, 2008

There are similarities in the ICT used for communication with family, friends and relatives. It seems the main mode of communication with these two categories of people is the cell phone, followed by e-mail and landline phone, respectively. This is shown in Figures 6.6 and 6.7, respectively.

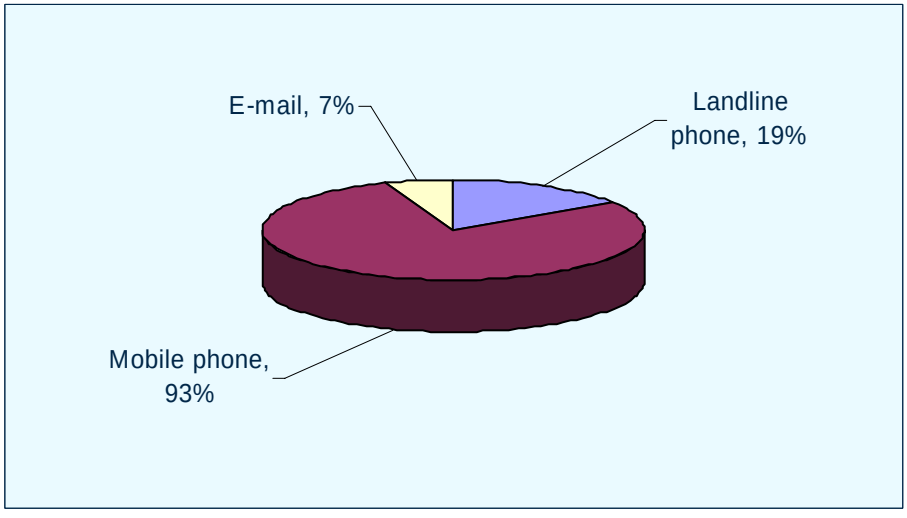

Figure 6.6: ICT used for communication with family

Source: Survey data, 2008

Fifty nine respondents indicate that they communicate with their families. Out of that sample, 94 percent use the cell phone, 19 percent use landline phone and 7 percent use e-mails to communicate with their families. Fifty eight employees responded to the question on communication with relatives and friends. From this sample, 93 percent use cell phones, 17 percent use landline and 21 percent use e-mail.

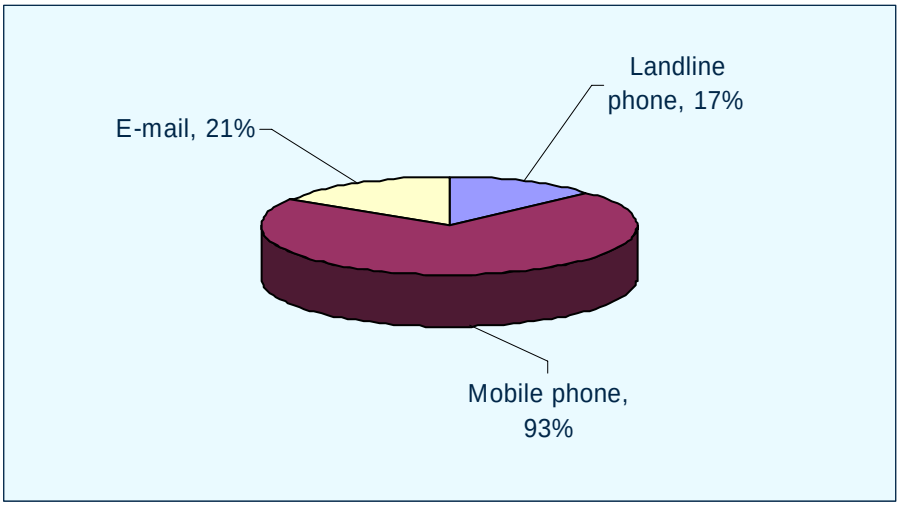

Figure 6.7: ICT used for communication with friends and relatives

Source: Survey data, 2008

Generally, the findings of the study shows the farm employees are aware of the different types of ICT used for basic communication. Most of them use the cell phone for most of their communication. This is mainly due to the limited access to ICT, especially for the field workers.

To identify the pattern and frequency of ICT use, the farm employees were asked to indicate the number of hours they spend per week using different ICT. All the respondents included in the study answered this question. Table 6.9 shows the percentage of farm employees who use different ICT and the hour's category they spend on each ICT per week.

Table 6.9: Percentage of farm employees using ICT per week

	Computer %	Printer %	Internet (worldwide web) %	E-mail %	Landline phone %	Cell phone %
0-3 hours	43	70	57	58	90	90
4-6 hours	15	15	25	23	7	3
7 + hours	42	15	18	19	3	7

Source: Survey data, 2008

Considering that the indicated hours are for the whole week not for each day, it shows that there is minimal use of ICT among the farm employees. This is indicated by the high percentages under the category 0 to 3 hours on ICT like Internet, computer and email, which implies that some do not use ICT at all within a week and some, use ICT for less than three hours. However in the case of landline and cell phones, it is to be expected that farm employees may not be able to spend more than three hours per week due to a number of reasons. For example, taking into consideration the income range for most of them, they may not be able to afford to buy airtime all the time. Some even use cell phone for receiving calls only, and may only be able to recharge airtime once or twice a month, given the high recharge costs in South Africa. Also, it is realistic to expect that the response percentage for printer use would be high, in the 0 to 3 hours range because of the limited use. Not everything typed is printed out so it is rarely used. The use of Internet and e-mail is also high in the 0 to 3 hours category because none of the employees own these facilities at their homes; they only have access at work when they carry out farm businesses. It is only the computer that has a high percentage of use on the category of 7 and above hours. This is because some employees own computer and use them not only at work but also at home.

Some ICT are convenient to use and others are not. The respondents selected the ICT that is convenient for them to use from a given list. Since some selected more than one option, the results are presented in form of percentage responses for each group of respondents who selected the same ICT. Figure 6.8 shows the percentage responses for each ICT in ascending

order staring with the most convenient.

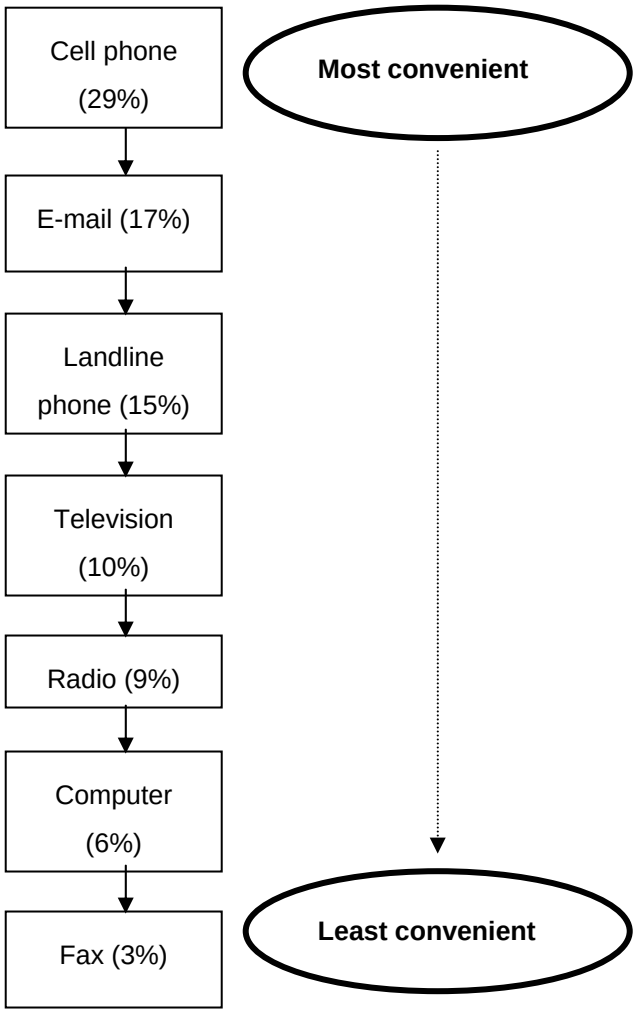

Figure 6.8: The most to the least convenient ICT

Source: Survey data, 2008

Twenty nine percent of the responses indicated that the employees find the cell phone more convenient than any other ICT. This is mainly because with a cell phone one can move around with it and can easily communicate any time and at any place as long as there is network coverage. This is unlike other ICT that cannot be taken from one place to another daily. The results also show that a computer is not convenient to most of the farm employees because access to it is limited.

In order to assess the purpose of the different types of ICT used by the farm employees on the farm, the respondents were asked the type of ICT they use along the wine supply chain from input procurement to marketing and sales stage. Five main stages along the supply chain that were investigated were input procurement, production, packing, marketing and sales. The respondents had to indicate the major ICT they used in each stage depending on where the employee works along the supply chain. Figure 6.9 shows the ICT used for input ordering.

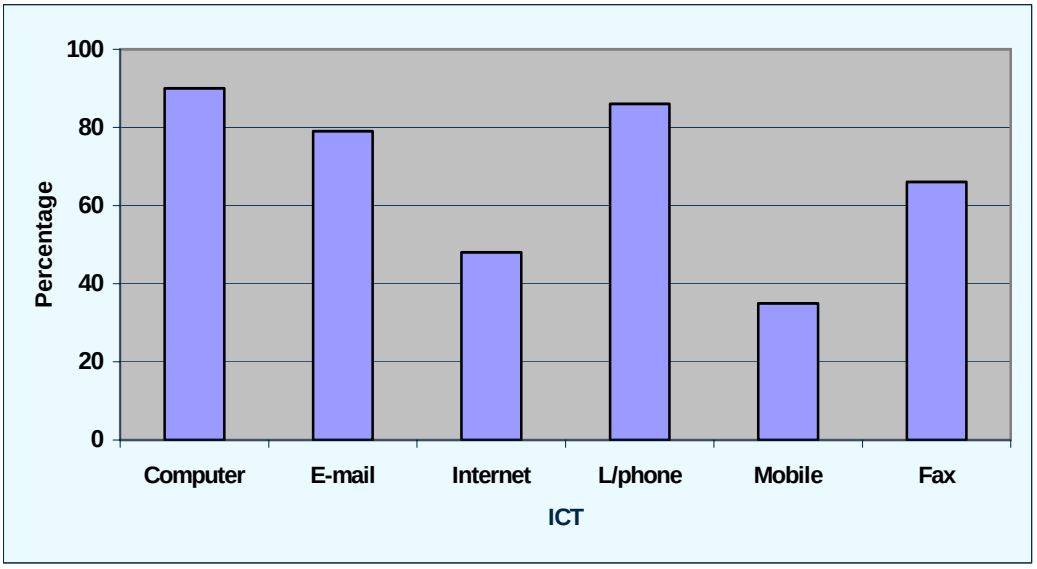

Figure 6.9: ICT used when ordering inputs

Source: Survey data, 2008

Twenty nine farm employees use ICT for input ordering. Out of these respondents, 90 percent used the computer, 86 percent used landline phone and 79 percent used e-mails to order agricultural inputs from suppliers. Computers are basically used for budgeting, data entry and calculations of the input quantities and their costs. The landline phone and e-mail are mainly used for communication with different suppliers in ordering inputs. Sixty seven percent use fax to send proof of payments, quotations and paperwork. The Internet and cell phone are used in this stage but at lower levels indicated by smaller percentages of the employees who use them. Figure 6.10 shows the types of ICT used in the production stage.

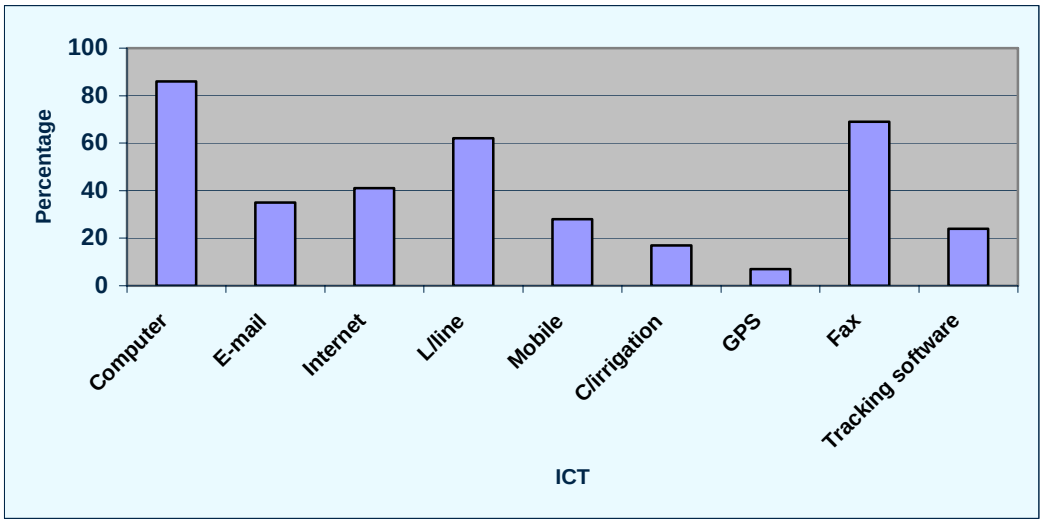

Figure 6.10: ICT used during production

Source: Survey data, 2008

The computer has the highest use in the production stage (86 percent). It is mainly because it is used for a number of uses. For example, all crop statistics, such as crop records, their heights, chemicals applied, growth curves, times and dates of planting, pruning and harvesting are recorded in the computer. In addition, some other computerised systems like computerised irrigation, tracking and tracing software work in conjunction with the computer connection, thus increasing the use of the computer. Fax and landline phone are also highly used in this stage respectively. Only 17 percent and 7 percent of the employees work using computerised irrigation and global positioning systems respectively. The issue of traceability begins at the production stage, therefore some farms use tracking software beginning in this stage. However, only 24 percent of the employees use this software in their work. Figure 6.11 shows the ICT used in the packing process, where grapes and other farm produce are packed.

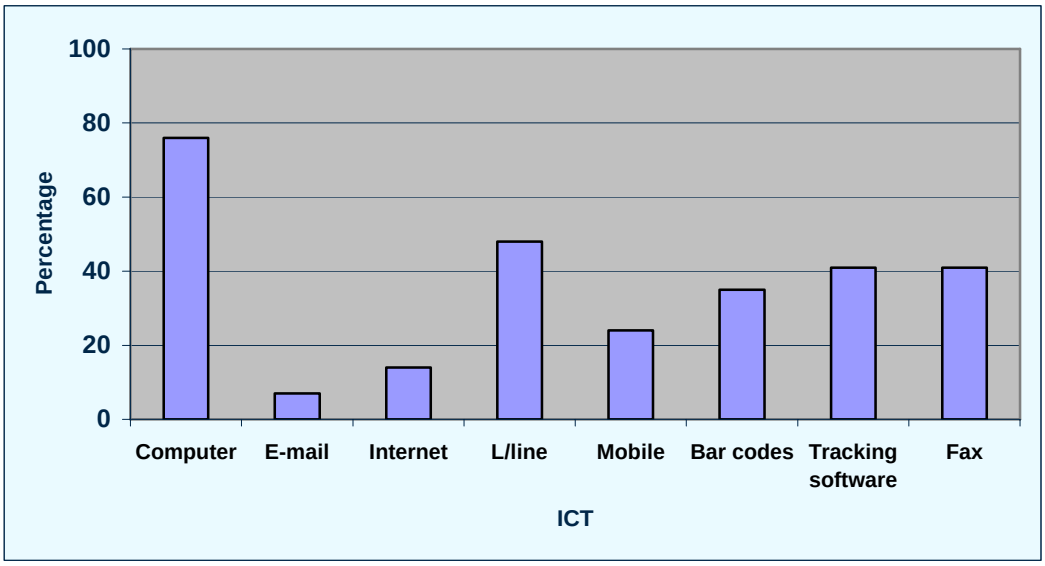

Figure 6.11: ICT used when packing

Source: Survey data, 2008

Since most of the work involved in packing is done manually, more than three quarters of the ICT are used by less than 50 percent of the respondents in their packing work. Only the computer has a percentage use of more than 50 percent. This is mainly because some bar codes and tracking software installed on the produce at this stage are linked to the computer. Also to ensure consistency in the sizes, weights and standards of the produce that will be checked, the information is linked to the computer that can detect if there is inconsistency in the sizes and weights of the packed products. At this stage, bar codes and tracking software are installed to track the product from the farm till it reaches the consumer. Figure 6.12 shows the ICT used when marketing the product, mainly grapes and wine.

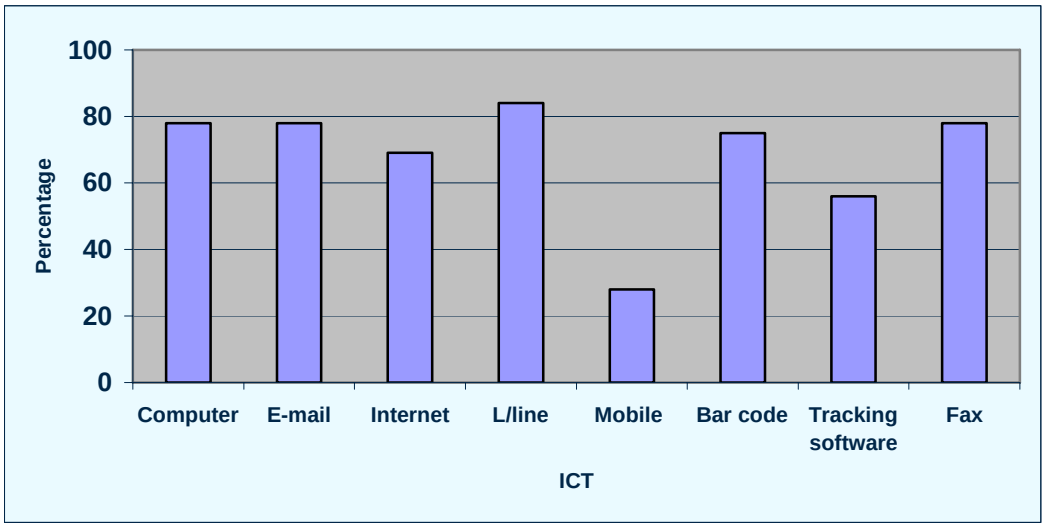

Figure 6.12: ICT used when marketing

Source: Survey data, 2008

During the marketing of the product, a number of ICT are involved. The farmers need to communicate with potential and actual customers in order to reach their markets. Most of the ICT used for communication, such as e-mail, Internet, landline phone and fax have high percentages of use because the stage needs a lot of communication between the customers and buyers of the products. Emails and faxes are usually used to communicate with international customers, as they are much cheaper, while landline phone is used to communicate with local and regional customers. Barcodes are basically used for easy identification of products. Tracking software is for traceability. The cell phone is rarely used in the marketing phase since it is expensive to use than other ICT. E-mails, websites, fax and landline phones are mostly used to get in contact with buyers and customers, since they are cheaper to use than cell phones.

Figure 6.13 shows the ICT used during product sale. Thirty two employees indicated that they use ICT in sales. In this stage the bar code system has the highest use, since every product sold has to be bar coded for the sake of tracking and identifying the product. About 72 percent of the employees use the bar code system. About 59 percent use the tracking software to show the location of the product from the time it leaves the farm gate. The cell phone is rarely used in this stage; other cheaper options for communication are used.

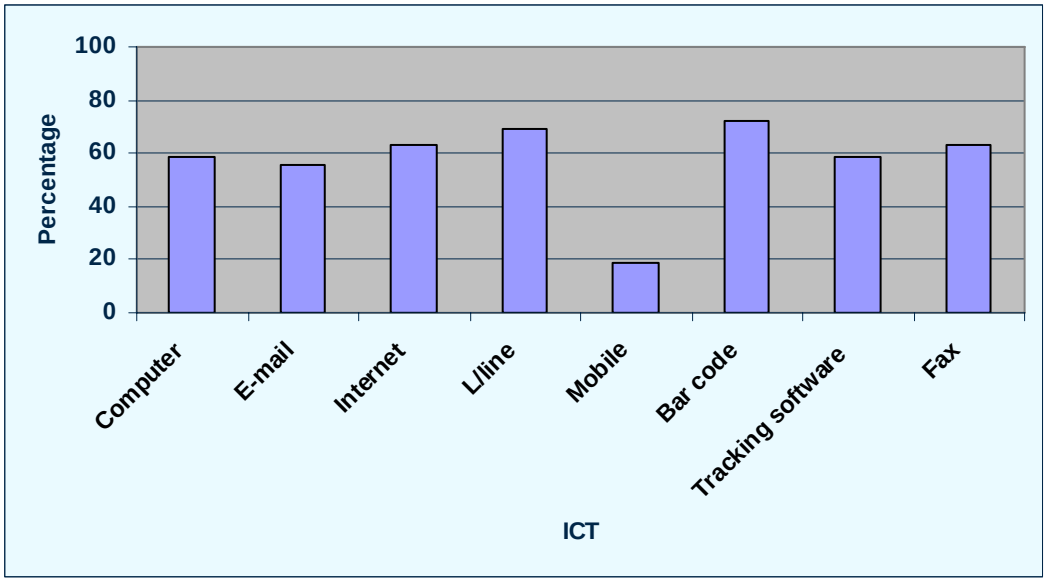

Figure 6.13: ICT used in sales

Source: Survey data, 2008

Since most of the work involved in each stage along the supply chain is linked to the computer, it was noted that the computer has the highest use in most of the stages. It is either the computer is used for keeping records, data entry and calculations or there is need for each process to be connected to the computer for better monitoring and consistency. In all the stages stated above, the cell phone is rarely used for communication. The landline phone is more popularly used in the stages along the supply chain.

The type of ICT used in each stage along the supply chain changes from one stage to the next. As compared to input procurement where less ICT is used, all the other stages along the supply chain have one or two more ICT used for another specific use. For example, computerised irrigation and global positioning system were used in the production stage whilst bar code and tracking software were added in the packing, marketing and sales stages.

There are a number of problems encountered by users of ICT. The farm employees were asked to indicate the different problems they face when using ICT. They were given an option of choosing from given alternatives. Figure 6.14 shows the response percentages of the different problems encountered when using ICT.

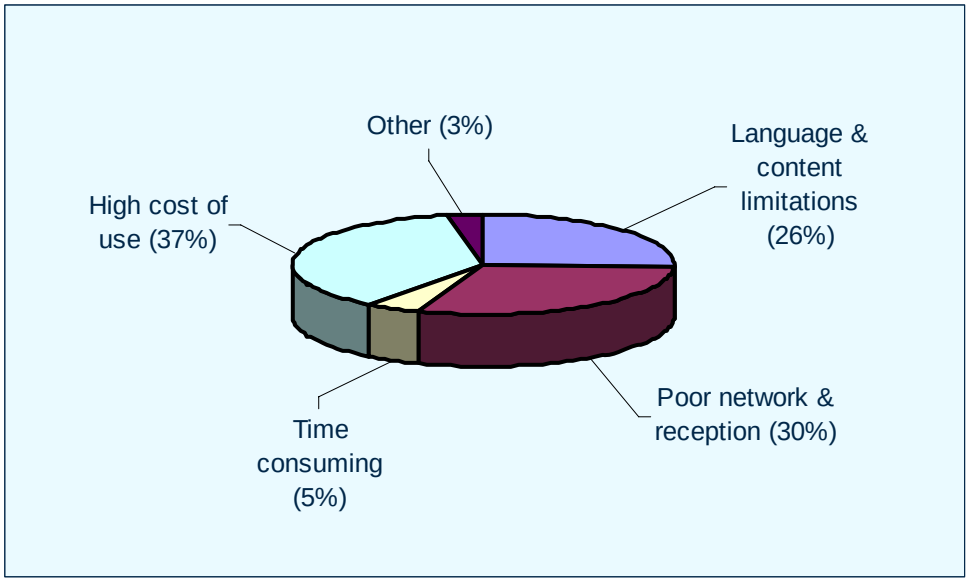

Figure 6.14: Major problems encountered when using ICT

Source: Survey data, 2008

The highest percentage of the respondents indicated that the cost of using ICT is very high, beyond the means of many farm employees. The cost of airtime and Internet cafe charges was identified as the main obstacles and cannot be afforded every time. Poor network and reception have been identified as the second major obstacle to ICT use in the region. Some farms are located in valleys and uneven landscapes where telephone and mobile reception is so poor. It causes communication problems. This situation worsened with the Eskom load shedding. Due to the fact that most of the farm employees are not highly educated, some find it difficult to use English as a medium of communication. Therefore, the language itself is a barrier to the use of ICT. Most prefer their mother languages like Afrikaans and Xhosa to English. Besides problems encountered when using ICT, there are other constraints that inhibit the acquisition and adoption of ICT by the farm employees. Some of the reasons included high cost of ICT, lack of ICT awareness and lack of ICT training. About 53 percent of the responses indicated that the major barrier is the high cost of ICT, 24 percent indicated lack of ICT awareness and 19 percent indicated lack of ICT training.

For work to be easier for the farm employees, there is need to acquire ICT that are user-friendly and effective. The farm employees indicated the ICT that they need and think is necessary for their farm work. Figure 6.15 show the response percentages of the ICT needed by farm employees in their daily work on the farm.

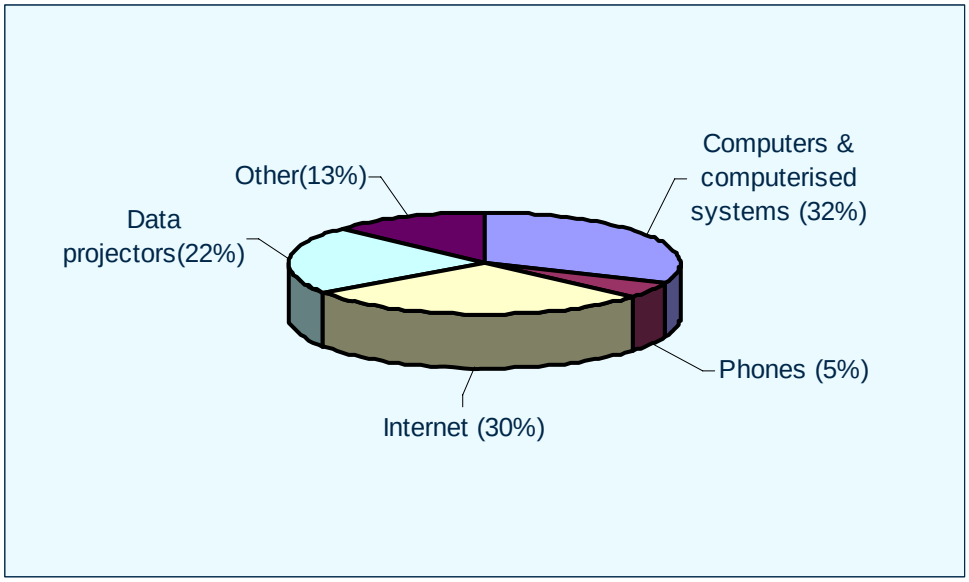

Figure 6.15: ICT mostly needed by the farm employees

Source: Survey data, 2008

The results of the study showed that most of the farm employees greatly need computers more than any other ICT. Besides the computers, the farm employees indicated that they also need access to the Internet and data projectors. Fewer are in need of phones because almost every worker has a cell phone. In the "Other (specify)" category with a 13 percent response, some indicated that they needed wine software like easy wine and wine ms, and computerised irrigation systems to make work easier.

Perceptions and Attitudes

This section presents the perception and attitudes of the farm employees about ICT in general. Most of the questions in this section were binary (yes/no). Others were on a likhert scale which indicated agree, disagree or neutral.

The BEE program was initiated to equip, support and empower black South Africans to fully participate in the country's economy as owners, stakeholders, professionals and skilled workers. In the study, farm employees were asked if they think BEE will have a positive impact on South Africa. In the context of this study, the question was mainly asked because of the ongoing Agri-BEE program. From the survey results, there is one winery that is practically taking part in the BEE initiative. It operates an educational cooperative where its employees and people of the community come to learn about computers, information technology and agriculture in general. All

classes held are taught by professionals from colleges and technikons. Quite a number of farm workers who were illiterate have been trained so far. About 88 percent of the respondents agreed that BEE will have a positive impact on South African agriculture. Since most of them were blacks, they hope that with the BEE initiative they will be able to participate in agriculture, not as workers but as landowners and professionals. Ten percent indicated that they were neutral. They neither agreed nor disagreed if BEE will have a positive impact on South African agriculture. This is mainly because some of them did not know what BEE is, and even after an explanation they did not believe it is going to change their situation in any way. Two percent totally disagreed that BEE will have a positive impact on agriculture.

The respondents acknowledge the importance of ICT for agricultural development. Eighty four percent agreed that using ICT is important for agricultural development. Seventeen percent however disagreed that ICT is important for agricultural development. Studies have found that ICT makes work easier and saves time (Woodburn *et al*, 1994). The larger proportion of the surveyed employees agreed with this view. Approximately 92 percent of the employees agreed that ICT makes work easier and about 8 percent were neutral. Approximately 97 percent of employees agreed that using ICT saves time. Some acknowledged that ICT have made their work to be easier and faster than before. However, other employees just acknowledged that ICT saves time and makes work easier, even though they do not use it. Only 3 percent were neutral. About 87 percent agreed that the use of ICT leads to agricultural productivity and about 13 percent indicated that they neither agree nor disagree.

About 90 percent of the respondents perceive that the use of ICT promotes access to banking. This may be true, considering how Wizzit bank has introduced banking to the “unbanked” South Africans including farm workers using cell phones to carry out banking transactions (ICT update, 2007). About 8 percent were neutral and 2 percent disagreed that ICT promotes access to banking.

In most developed countries personal computers, faxes, printers and some ICT equipment are expensive and unaffordable to the majority, and South Africa is not an exception. Even some middle-class families cannot afford to buy ICT (Fors and Moreno, 2002:203). Hundred percent of the respondents agreed that ICT is not affordable because of the high costs. Due to the high prices, only employees who are in managerial positions and administrative work may be able to afford most of the ICT, while the rest are constrained to using a cheaper cell phone. However, all of them were satisfied with the services they receive from the ICT they use both at home and at work.

One of the barriers identified by several researchers that inhibit the use of ICT among agricultural communities is the language and content limitations (Mutula, 2005:125; Dralega, 2006:6; Moodley, 2005:9). The farm employees were asked the type of language they prefer when using ICT like computers. Ninety five percent of them agreed that ICT would be more effective if local languages are used. However, 5 percent was neutral. Sixty two percent responded that they would prefer ICT related information to be in Afrikaans language. This is because Afrikaans speaking people dominates the area. Fifty percent indicated that they would prefer Xhosa for ICT related information. The Xhosas are the second largest group of people in the RWV. However, 33 percent indicated that they prefer English, since it is the dominant language used today on most ICT such as computers, e-mails and the worldwide web. Out of the 33 percent, not all are English speaking nationals or have English as their mother tongue, but they indicated that they are now used to using English as the medium of communication and that if it is changed to their mother languages, they may find it difficult.

Even if some of the employees lacked knowledge on most ICT, a number of them acknowledged that it was important to teach their children about ICT. Ninety seven percent agreed that it is important to teach children about ICT and only 3 percent disagreed.

Demographics

Table 6.10 presents the demographics for farm employees who were interviewed for this study.

Table 6.10: Farm employees' demographics

Demographics by:	Variable categories	Number of respondents	Percentage of respondents
Gender	Male	29	48
	Female	31	52
Age	30 and below	12	20
	31- 40	29	48
	41- 50	19	32
Marital status	Married	43	72
	Single	17	28
Race	Black	22	37
	Coloured	20	33
	White	18	30
Occupation on farm	Seasonal/vineyard	10	17
	Permanent /vineyard	17	28
	Administrative	17	28
	Winery	16	27
Experience on farm	5 and below	29	48
	5- 10	24	40
	10- 20 years	6	10
	20 and above	1	2
Average salary per month	Less than R4 000	28	47
	R4 000- R8 000	24	40
	R8 000 and above	8	13
Permanent off-farm income	Yes	9	15
	No	51	85
Education	Primary	7	12
	Matric	25	42
	College	24	40
	University	4	7
Household size	3 and below	24	40
	4- 6	26	43
	6 and above	10	17

Source: Survey data, 2008

The results from the study showed that about 52 percent of the respondents were females and about 48 percent were males. About 30 percent of the employees had ages of 30 years or below, while about 32 percent had ages ranging from 41 to 50 years. A majority of about 48

percent had ages ranging from 31 to 40 years. There were no employees aged 51 or above. About 72 percent of the farm employees are married and about 28 percent are single. The three main races represented by the employees are black, white and coloured. The blacks were about 37 percent, while the whites and coloureds were about 30 and 33 percent, respectively.

The employees were grouped under four occupations that are performed at the farm, namely (i) seasonal/vineyard workers, (ii) permanent /vineyard workers, (iii) administrative workers, and (iv) winery workers. About 17 percent were seasonal/vineyard workers, 28 percent were permanent/vineyard workers, 28 percent were administrative staff and 27 percent worked in the winery. Most of the respondents (about 48 percent) have less than 5 years experience of working on the farm. About 40 percent have 5 to 10 years experience, 10 percent have 10 to 20 years experience and only 2 percent have more that 20 years farm experience.

In terms of their monthly salary, the majority of the farm employees (about 47 percent) receive less than R4 000 per month. All the field/ vineyard workers fall under this salary bracket. This monthly salary supports the belief that farm workers are among the poorest people in South African society (Esterhuizen and Van Rooyen, 2006:468). About 40 percent have salaries ranging from R4 000 to R8 000 per month. About 13 percent have salaries above R8 000 and these are the few who are involved in administrative work. The respondents were also asked to indicate if they have off-farm income or not. The majority of about 85 percent indicated that they do not have any off-farm income and only 15 percent indicated otherwise.

From the results of the study, it was found that most of the farm employees do not have professional qualifications. Approximately 42 percent of the employees only attained matric education, while about 7 percent attained only primary education. Most, if not all of those who have attained matric work in the vineyards and have difficulties in communicating in English. They can fluently speak their native languages only. About 40 percent attained college qualifications and 7 percent have university qualifications. Those with professional qualifications perform the supervisory and managerial functions on the farms and wineries. About 40 percent of the respondents have household sizes of 3 or below, 43 percent have a household size of 4 to 6, and 17 percent have household size of 6 or above.

6.3 Chi-square tests results

The chi-square tests results for the farm employees are presented next. Both the significant and non-significant variables are presented to assist decision makers and farmers to know the variables they should consider when recruiting relevant workforce and making farm decisions. The chi-square tests were conducted to test and confirm the relationship between ICT use and different variables, and the relationship between the variables themselves.

6.3.1 Significant variables

In this section, only the variables that have a statistically significant relationship with ICT use of the farm employees are presented. The cross tabulation and chi-square tests for each significant variable are presented next and a brief summary of the relationship is given. In this case, ICT use, which is the dependent variable, was binary with a yes and no answer.

ICT training

Cross tabulation

Count		Did you receive any formal training to use any of the ICT in Question 9?		
		Yes	No	Total
Do you use ICT on your farm to support farming activities?	Yes	30	10	40
	No	0	20	20
	Total	30	30	60

Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.000	1	.000
N of Valid Cases	60		

The training offered to farm employees on how to use ICT (ICT training) is highly related to their

use of ICT, with a p-value of < 0.001. As shown on the table, all the farm employees who received ICT training confirmed that they use ICT for their farm activities. Most of the farm employees who did not receive any formal training to use ICT do not use ICT when performing their work.

Age

Cross tabulation

Count		Age			
		30 and below	31 - 40	41 - 50	Total
Do you use ICT on your farm to support farming activities?	Yes	11	20	9	40
	No	1	9	10	20
	Total	12	29	19	60

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.628	2	.036
N of Valid Cases	60		

There is a statistically significant difference in the use of ICT use between the farm employees' age groups (p-value<0.05). Comparing the ratios of employees using ICT in different age groups, younger farm employees responded positively to the use of ICT than older ones. Most workers who are 40 years and below indicated that they use ICT in their farm activities.

Race

Cross tabulation

Count		Race			
		Black	Coloured	White	Total
Do you use ICT on your farm to support farming activities?	Yes	9	13	18	40
	No	13	7	0	20
	Total	22	20	18	60

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.593	2	.000
N of Valid Cases	60		

There is a statistically significant difference in the use of ICT between the races of the farm employees (p-value<0.001). The ratio of black employees who use ICT on the farms is lower than the ratios of coloureds and whites. White employees dominate the others in terms of their ICT use and they are all ICT literate, unlike their black and coloured counterparts.

Occupation on farm

Cross tabulation

Count		Current Occupation				
		Seasonal vineyard/orchard employee	Permanent vineyard/orchard employee	Administrative employee	Winery employee	Total
Do you use ICT on your farm to support farming activities?	Yes	1	6	17	16	40
	No	9	11	0	0	20
	Total	10	17	17	16	60

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.479	3	.000
N of Valid Cases	60		

There is a statistically significant difference in the use of ICT between the four occupation groups of the farm employees (p-value<0.001). From the shown table, more administrative and winery employees responded positively to the use of ICT than the permanent and seasonal vineyard employees.

Monthly salary

Cross tabulation					
Count		Monthly Salary			
		Less than R4 000	R4 000 - R8 000	R8 000 +	Total
Do you use ICT on your farm to support farming activities?	Yes	8	25	7	40
	No	20	0	0	20
	Total	28	25	7	60

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	34.286	3	.000
N of Valid Cases	60		

There is a statistically significant difference in the use of ICT between the monthly income earning groups of the farm employees (p-value<0.001). The majority of farm employees who do not use ICT for their farm work are paid less than R4 000 per month. From the shown results, all employees who earn more than R4 000 per month responded positively to the use of ICT.

Education level

Cross tabulation

Count		Education Level				
		Primary	Matric	College	University	Total
Do you use ICT on your farm to support farming activities?	Yes	3	10	23	4	40
	No	4	15	1	0	20
	Total	7	25	24	4	60

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.973	3	.000
N of Valid Cases	60		

There is a statistically significant difference in the use of ICT between the different education levels of attained by the farm employees (p-value<0.001). Form the table, more than 50 percent of the employees who attained only primary and matric education are ICT illiterate and do not use ICT for farm work purposes. However, employees who attained college and university education responded positively to the use of ICT.

ICT literacy

Cross tabulation

Count		ICTLiteracy		
		High	Low	Total
Do you use ICT on your farm to support farming activities?	Yes	35	5	40
	No	0	20	20
	Total	35	25	60

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.000	1	.000
N of Valid Cases	60		

There is a statistically significant relationship between ICT use and the ICT literacy levels of the farm employees (p-value<0.001). Employees who were able to operate 75 percent of the listed ICT used on the farms were classified as highly ICT literate and those who were not able to operate 50 percent of the listed ICT were classified as lowly ICT literate. Employees who have high ICT literacy responded positively to the use of ICT than those who have low ICT literacy.

In summary, according to the chi-square tests, the variables which are highly related to ICT use of employees are ICT training, age, race, current occupation on farm, monthly salary, education level and ICT literacy.

Besides investigating the relationship between ICT use and variables discussed above, the relationship between the variables themselves was investigated in a way to assist in explaining the reasons behind the use of ICT by farm employees. Table 6.11 shows the significant values of the relationships between these variables, which were obtained from the chi-square test.

Table 6.11: Chi-square tests significant levels for correlated variables

	Distance	ICT training	BEE	ICT affordability	Gender	Age	Race	Current occupation	Experience	Monthly salary	Education level	HHsize	ICT attitude	ICT literacy
Distance														
ICT training							0.002	0.000		0.000	0.000			0.000
BEE														
ICT affordability										0.001				
Gender							0.016	0.021						
Age														0.022
Race								0.000		0.000	0.000			0.000
Current Occupation										0.000	0.000			0.000
Experience														
Monthly salary											0.000			0.000
Education level														0.000
Household size														
ICT attitude														
ICT literacy														

Source: Survey data, 2008

From the results on Table 6.11, it was found that the significant variables that influence ICT use were also correlated to two or more other variables. According to the chi-square tables, there is a relationship between:

- ✓ ICT training and race, current occupation on the farm, monthly salary, education level and ICT literacy
- ✓ ICT affordability and monthly salary
- ✓ Gender and race and current occupation on the farm

- ✓ Age and ICT literacy
- ✓ Race and current occupation on the farm, monthly salary, education level and ICT literacy.
- ✓ Current occupation and monthly salary, education level and ICT literacy
- ✓ Monthly salary and education level and ICT literacy
- ✓ Education level and ICT literacy

6.3.2: Non-significant variables

The variables in this section have non-significant values, indicating that they do not have a statistically significant relationship with farm employee's ICT use.

Perception on Black Economic Empowerment

Cross tabulation

Count		Do you use ICT on your farm to support farming activities?		
		Yes	No	Total
The initiative of Black Economic Empowerment (BEE) will have a positive impact on South African agriculture	Strongly agree	23	15	38
	Agree	10	5	15
	Neutral	6	0	6
	Disagree	1	0	1
	Total	40	20	60

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.145	3	.246
N of Valid Cases	60		

There is a non-significant relationship between ICT use of the farm employees and their perception on Black Economic Empowerment (p-value>0.1). In a developing country context

where most of the black majority people still need to be empowered and emancipated, it is expected that ICT use is determined by positive perception on BEE. This is not the case in this study. Most black and coloured employees have a positive perception on BEE but that does not determine their ICT use.

Perception on ICT affordability

Cross tabulation

Count		Do you use ICT on your farm to support farming activities?		
		Yes	No	Total
ICT is not affordable because of high costs	Strongly agree	38	20	58
	Agree	2	0	2
	Total	40	20	60

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.034	1	.309
N of Valid Cases	60		

There is a non-significant relationship between farm employees' ICT use and their perception on ICT affordability (p-value>0.1). Perception on ICT affordability is likely to influence the use of ICT by farm employees. If they perceive that ICT is expensive, they will not buy it and vice-versa. In this study, perception on ICT affordability does not have influence on ICT use.

Gender

Cross tabulation				
Count	Do you use ICT on your farm to support farming activities?			
		Yes	No	Total
Gender	Male	19	10	29
	Female	21	10	31
	Total	40	20	60

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.033	1	.855
N of Valid Cases	60		

Related studies like Sabuhoro and Wunsch (2003:6) have reported increase in ICT use by females. In this study, the relationship between farm employees' ICT use and gender is non-significant (p-value>0.5).

Three main variables were found not to be related to farm employees' ICT use. These are perception on Black Economic Empowerment, perception on ICT affordability and gender. The following section presents the correlation analysis results for the farm employees.

6.4 Correlation analysis results

The spearman correlation analysis was carried out to find the relationships between ICT use and different variables and, to determine the strengths of each relationship by the use of correlation coefficients. The correlation results of the correlation analysis for the farm employees are presented next.

Some of the significant variables that were significant in the chi-square test were also identified in the spearman correlation analysis, and three other additional factors were added. Categorical variables were not included in the chi-square tests, but were included in the spearman correlations therefore accounting for the additional variables. According to the spearman correlation analysis ICT use is influenced by ten variables which are ICT training, age, race, current occupation, experience, monthly salary, education level, household size, attitude towards ICT and ICT literacy. Significant levels of relationships between variables and the correlation coefficients are presented on Tables 6.12 and 6.13 respectively. The p-values are <0.05 and <0.01.

Table 6.12: Levels of significance for farm employees

	Distance	ICT use	ICT training	BEE	ICT affordability	Gender	Age	Race	Current occupation	Experience	Monthly salary	Education level	HHsize	ICT attitude	ICT literacy
Distance				.019*											
ICT use			.000**				.010**	.000**	.000**	.009**	.000**	.000**	.031*	.001**	.000**
ICT training		.000**						.000**	.000**	.022*	.000**	.000**		.001**	.000**
BEE	.019*				.044*			.048*							.041*
ICT affordability				.044*							.020*		.040*	.034*	
Gender								.009**				.025*			
Age		.010**							.042*		.016*		.004**		.010**
Race		.000**	.000**	.048*		.009**			.000**		.000**	.000**	.008**	.000**	.000**
Current Occupation		.000**	.000**				.042*	.000**		.003**	.000**	.000**		.000**	.000**
Experience		.009**	.022*						.003**						.044*
Monthly salary		.000**	.000**		.020*		.016*	.000**	.000**			.000**	.001**	.000**	.000**
Education level		.000**	.000**			.025*		.000**	.000**		.000**		.039*	.000**	.000**
Household size		.031*			.040*		.004**	.008**			.001**	.039*		.012*	.038*
ICT attitude		.001**	.001**	.034*				.000**	.000**		.000**	.000**	.012*		.000**
ICT literacy		.000**	.000**	.041*			.010*	.000**	.000**	.044*	.000**	.000**	.038*	.000**	

Source: Survey data, 2008

* Correlation is significant at P-value< 0.05

** Correlation is significant at P-value< 0.001

Table 6.13: Correlation coefficients for farm employees

	Distance	ICT use	ICT training	BEE	ICT affordability	Gender	Age	Race	Current occupation	Experience	Monthly salary	Education level	HHsize	ICT attitude	ICT literacy
Distance				.302*											
ICT use			.707**				-.332**	.505**	.744**	-.335**	.716**	.549**	-.278*	.402**	.837**
ICT training		.707**						-.452**	.655**	.-296*	-.651**	-.587**		.415**	.778**
BEE	.302*				.260*			.257*							-.265*
ICT affordability				.260*							.300*		.-265*	.275*	
Gender								.335**				.289*			
Age		-.332**							-.264*		-.309*		.362**		.331**
Race		.505**	-.452**	.257*		.335**			.566**		.572**	.666**	-.340**	-.640**	-.636**
Current Occupation		.744**	.655**				-.264*	.566**		.376**	.657**	.669**		-.532**	-.787**
Experience		-.335**	-.296*						.376**						.261*
Monthly salary		.716**	-.651**		.300*		-.309*	.572**	.657**			.629**	-.419**	.469**	.800**
Education level		.549**	-.587**			.289*		.666**	.669**		.629**		-.268*	.598**	-.702**
Household size		-.278*			-.265*		.362**	-.340**			-.419**	-.268*		.323*	.269*
ICT attitude		.402**	.415**		.275*			-.640**	-.532**		.469**	.598**	.323*		.574**
ICT literacy		.837**	.778**	-.265*			.331*	-.636**	-.787**	.261*	.800**	-.702**	.269*	.574**	

* Correlation is significant at P-value< 0.05

** Correlation is significant at P-value< 0.001

- Negative correlation

From Tables 6.12 and 6.13 there is a significant relationship between ICT use of the farm employee and

- ✓ ICT training with a significant value of 0.000 and a correlation coefficient of 0.707. The more the employees receive training on how to use ICT, the more their use of ICT.
- ✓ Age with a significant value of 0.010 and a correlation coefficient of -0.332. The younger the farm employee, the higher the use of ICT. As the farm employee's age increases, the use of ICT decreases.
- ✓ Race with a significant value of 0.000 and a correlation coefficient of 0.505. As the race of the farm employee on a likhert scale changes from black to coloured to white there is a great increase in the use of ICT, implying the high use of ICT by white employee more than their black and coloured counterparts.
- ✓ Current occupation of the employee on the farm with a significant value of 0.000 and a correlation coefficient of 0.744. ICT use of the employee increases as the farm employee's occupation changes from seasonal work to permanent to winery and to administrative work.
- ✓ Experience of the farm employee with a significant value of 0.009 and a correlation coefficient of -0.335. The more the employee is experienced, the less the use of ICT, maybe because employees who have been on the farm for a long time choose to stick to their traditional ways of doing things and are not willing to use ICT.
- ✓ Monthly salary of the employee with a significant value of 0.000 and a correlation coefficient of 0.716. As the monthly salary of an employee increases, his/her ICT use also increases due to more disposable income to spend on purchasing ICT.
- ✓ Education level of an employee with a significant value of 0.000 and a correlation coefficient of 0.549. The higher the level of education attained by an employee, the higher his/ her use of ICT.
- ✓ Household size of an employee with a significant value of 0.031 and a correlation coefficient of -0.278. The larger the household sizes, the less the use of ICT. Employees with larger household sizes need to support their families, and may not have enough disposable income to purchase ICT.
- ✓ Attitude towards ICT with a significant value of 0.001 and a correlation coefficient of 0.402. A positive attitude entails the use of ICT and a negative attitude entails otherwise.
- ✓ ICT literacy of an employee with a significant value 0.000 and a correlation coefficient of 0.837. The higher the ICT literacy of the employee, the higher his/her use of ICT.

The results from the study for the farm employees were discussed in this chapter. The following chapter presents the empirical results of the study for the farmers in RWV.

CHAPTER SEVEN

EMPIRICAL RESULTS OF THE STUDY FOR FARMERS

7.1 Introduction

This chapter presents the empirical results of the main findings from the analysis of data that was collected from the farmers in RWV. The scope of this study is limited to descriptive statistics, chi-square tests and correlation analysis. The chi-square tests and correlation analysis were used to find relationships between factors influencing the use of ICT in South African commercial agriculture, specifically in the wine industry. SPSS was used as statistical analysis software. From the study, the following information was found about the ICT access, ICT awareness and use patterns, perception and attitudes towards ICT and demographics of the farmers. Section 7.2 presents the descriptive statistics and ICT aspects of farmers. Section 7.3 and 7.4 present the chi-square tests and correlation analysis results respectively.

7.2 Descriptive statistics for farmers

This section gives an overview of the results from the sample of farmers on their farm activities, ICT use patterns, ICT costs and constraints, employees and ICT, perceptions and attitudes and demographics. The data has a sample of 15 farmers who participated in the survey. The first 4 questions in the questionnaire only applied to the farmers and not cooperatives (see appendices section for the questionnaires).

Farm Activities

Among the farms included for this study, 11 of them were owned by private farmers and 4 by cooperatives. As already mentioned earlier in the study, cooperatives are also referred to as farms. Since RWV is mainly a fruit producing area, all the 11 farmers who were interviewed practiced fruit production, although the fruits produced may be different. Hundred percent of these 11 farmers produced grapes mainly for wine production. Grape production is the major activity of the farmers in the area. Besides grapes, some farmers produced other fruits such as peaches, plums, butternuts and apricots. About 36 percent of the farmers produced peaches, about 9 percent produced plums. On the “Other specify” section, about 36 percent indicated that they produced other fruits, such as apricots, butternut, lucerne and herbs. The four cooperatives

are not included as fruit producers, since they do not produce fruits. They only specialize in wine production. They buy wine grapes from grape farmers and then process them into wine. Among the farmers, one farmer also has a livestock enterprise besides the main fruit enterprise.

The farms in this region vary in sizes, from 20 to 67 hectares. The average farm size is about 44 hectares. Only about 73 percent of the farmers answered the question on farm sizes and hectares allocated to each crop because the other 27 percent are cooperatives that do not have land allocated specifically for production. Each crop on the farm has certain hectares of land allocated to it. Figure 7.1 shows the total land allocated to different crops by the farmers who were interviewed.

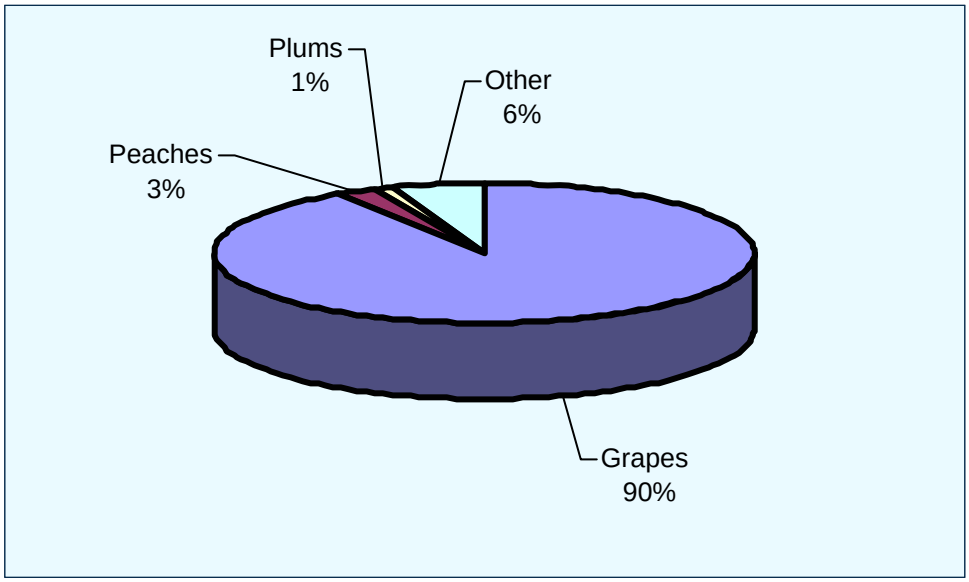

Figure 7.1: Percentage of land allocated to fruits by farmers

Source: Survey, 2008

From the results, about 90 percent of the total land is allocated to grape production, showing that the major farm activity in the area is grape production. About 6 percent is allocated to other fruits and crops like apricots, butternut, lucerne and herbs

The farmers have a number of various assets that are basically for production, processing, packing and storage purposes. About 85 percent of the farmers have tractors, precooling and cold storage facilities. Combine harvesters are owned by about 46 percent of the farmers. Other

assets, including cellar pressing and storing equipment, production stores and workshops, are owned by about 23 percent of the farmers.

All the farms are located within a 45 minutes drive radius from the nearby town. The least time taken to drive from the farm nearest to this town is 5 minutes. Some farmers take about 45 minutes.

ICT use patterns

During the survey, the farmers were requested to indicate the different types of ICT they use on their farms and the year they bought these ICT. Table 7.1 shows some of the ICT used by the farmers, the percentage of farmers using it, percentage of farmers who indicated the year they initially used the ICT and the range of the years during which these ICT were initially used.

Table 7.1: Percentage of farmers using ICT and the years of purchase

ICT	% of farmers using ICT	% of farmers who indicated year of initial use	Year of purchase (ranges)
Computer	100	63	1948-2007
Internet, fax, printer	100	40	1988-2007
Photocopier	87	31	1988-2004
Landline Phone	93	36	1988-2006
Cell phone	100	67	1990-2005
Two-way radio	33	7	2000
PDA	7	7	2004
Computerized irrigation	27	14	1987-2006
Bar code system	87	28	1994-2006
Email	100	53	1994-2007

Source: Survey data, 2008

From the results of the study, some farmers did not indicate the year they purchased or started using the ICT. Some had forgotten about the dates. Out of the total percentage of farmers who

use the respective ICT, only the percentage of those who indicated the year of purchase was included on Table 7.1. Since the year of purchase differs from one farmer to the other, only the ranges were shown on Table 7.1. It seems that the computer is the oldest ICT that has been used by some farmers since 1948. Some farmers also showed that they use other software and winery management systems that are specifically for wine, such as Mswine and Ezywine.

It is interesting to note that 100 percent of the farms that were visited for the purpose of this study have their own website for the purposes of advertising and carrying out online transactions. Table 7.2 shows the percentage of farmers who have their own websites.

Table 7.2: Farmers who have their own websites

Do you have your own website?				
		Frequency	Percent	Cumulative Percent
Valid	Yes	15	100.0	100.0

Source: Survey data, 2008

Most of the websites for farms in the area are mainly informative. They show the location of the farm, the major agricultural and non-agricultural activities carried out at the farm and contact details of the farmer or manager. A few of them have facilities to do transactions online, where ordering and payment for the produce is done online. For example, one cooperative indicated that it has two websites, one for its production facility and the other for sales and e-commerce. Since the area is a major tourist attraction, having a website would be advantageous for the purposes of information dissemination and communication with prospective and current customers. Farmers also interact using Computer-Mediated Communication Services (CMS). CMS are servives provided by communication that occurs within a computer mediated system and they are playing an important role as valuable sources of information for agricultural producers in South Africa (Ortmann, 2000). Farmers in RWV are not an exception; they are also using CMS to interact over time as well as over geographical location. These are shown on Table 7.3 with the respective percentages of the farmers who use them.

Table 7.3: Percentage of farmers using computer-mediated communication services

		N	%
Which Computer-Mediated Communication services do you use	Internet	15	100.0%
	Email with customers and suppliers	15	100.0%
	Online banking	14	93.3%
	E-commerce (transactions online)	3	20.0%
	Total	15	100.0%

Source: Survey, 2008

Hundred percent of the farmers included in this study use CMS such as the Internet and email. About 93 percent of the farmers use e-banking facilities and about 20 percent practice e-commerce (doing transactions online). Various forms of wine trading are available to facilitate e-commerce through institutions like Global Wines and Spirits, International Beverages Network, Tarhells Wine Traders and Buy South African Wine. Some farmers use the paypal method of paying for transactions conducted online and over geographical locations. Once the customer pays for the wine online, it is delivered to him by the farmer within a few days.

The farmers were also asked whether they have any business goals with regard to ICT. As shown on Table 7.4, 40 percent of them indicated that they have business goals that pertains to ICT and 60 percent indicated otherwise.

Table 7.4: Farmers' business goal with regard to ICT

Do you have any business goals with regard to ICT?				
		Frequency	Percent	Cumulative Percent
Valid	Yes	6	40.0	40.0
	No	9	60.0	100.0
	Total	15	100.0	

Source: Survey data, 2008

Some indicated more than one business goals with regard to ICT. Some of the goals indicated by the 40 percent include the optimization of electronic networking, to be ahead in the wine industry in terms of information related to the industry, to equip all junior and senior workers, to install wireless network, to sell wine over the Internet, to acquire computerized irrigation system and modern printers, to keep all stakeholders and public informed, and to use e-commerce.

In purchasing ICT for farm use, about 93 percent of the responses from the farmers indicated that they make personal decision without necessarily consulting any other sources about the type of ICT to purchase and their suitability for the farm. Only about 27 percent of the responses showed that some farmers purchase ICT based on expert advice on how the ICT works and the suitability to the farm operations. There are a number of ICT that can be used on the farm for different purposes. Figure 7.2 shows the different ICT used by farmers and indicates if they are used for personal, business or both purposes. It should be noted that the percentages shown are expressed in terms of the number of responses not respondents.

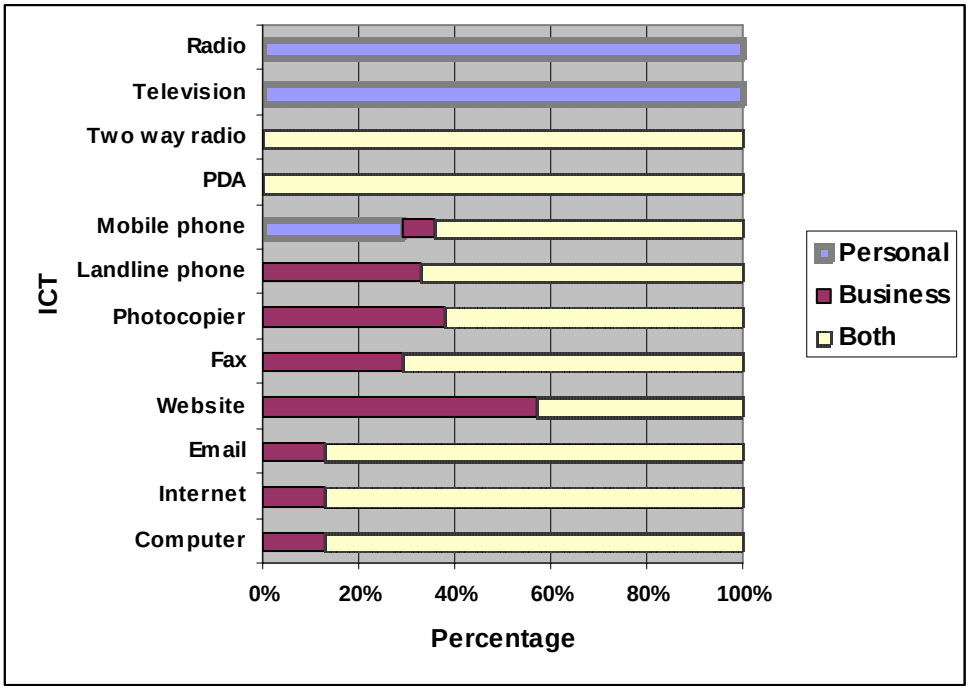

Figure 7.2: ICT purposes

Source: Survey data, 2008

From the farmers who indicated that they use computers, Internet and emails, approximately 87 percent of them use these three ICT for both personal and business purposes, while about 13 percent use these three ICT for business purposes only. About 57 percent of the responses indicated that they use their websites for business purposes and about 43 percent show that they use websites for both business and personal purposes. More than 50 percent of the responses show that they use fax, photocopiers, landline phone and cell phone for both business and personal purposes. Unlike the case of most farm employees who clearly used ICT either for personal or for business purposes, the farmers seems to use most of the ICT for both purposes, without a clear distinction of which is for personal use and which is for business purposes. The two exceptions, which were also found among the farm employees, are on the 100 percent responses on either business or personal purposes. On one hand the ICT that are used solely for business purposes are two-way radios and personal digital assistants (PDA). On the other hand, the ICT that are used solely for personal purposes are radio and television. The same results were found for the farm employees.

To assess if there are differences on ICT use between the employees and farm, the farmers were asked to indicate the number of hours they spend using different ICT per each week. Table

7.5 shows the percentage of farmers who use different ICT and the hour's category they spend on each ICT per week.

Table 7.5: Percentage of farmers using ICT per week

	Computer %	Printer %	Internet (worldwide web) %	E-mail %	Landline phone %	Cell phone %
0-3 hours	7	53	13	27	46	53
4-6 hours	0	20	13	27	27	20
7 + hours	93	27	74	46	27	27

Source: Survey data, 2008

Unlike the farm employees whose hours fall mainly in the 0-3 hour's category, the farmers spend more time using ICT. For example, about 93 percent of the farmers use the computer for 7 or more hours per week. This is mainly because the computer is used for multi-purposes and some facilitates are only used when connected to the computer. Besides the computer, the Internet is seen to evidence a high percentage usage, with approximately 74 percent of the farmers using it for 7 or more hours per week. The cell phone and printer have about 53 percent of the farmers using them for 0-3 hours per week. This is mainly because a printer is used for the single purpose of printing, and only necessary documents are printed. On the other hand, since most farmers use alternative means of communications such as PDA, two-way radios and landline phones, they may only use a cell phone for convenience for a short period of time in a week.

The most popular mobile operator among the farmers is Vodacom, MTN and Cell C, respectively. Some farmers use more than one mobile operator, so some farmers indicated more than one response. About 62 percent of the responses from the farmers showed that they use Vodacom, about 46 percent use MTN and about 31 percent use Cell C. About 69 percent of the responses showed that most of the farmers mainly use prepaid sim cards, while about 31 percent use contract sim cards.

Due to European Union regulations pertaining to wine exported to the EU, wine farmers are obliged to use tracking systems. To get more information about systems used by some farmers in RWV, they were asked to indicate the ICT they use for tracing wine from their farm gate until it reaches the final consumer. About 47 percent of the farmers indicated that they have adopted the method of traceability. The most popular ICT used for traceability are bar codes and tracking software. Using these ICT, the farmers can trace the fruits from the orchard to the final consumer. For security purposes and emergency management, about 80 percent of the farmers use the alarm systems on their premises and wineries. In addition to the alarm system, about 14 percent of the farmers also use video cameras. For pre-cooling, storage and safety of fruits, about 40 percent of the farmers use cooling rooms and refrigerators with regulated temperatures.

A number of ICT are used in stages along the products supply chain. Some ICT are used in only one stage while others are used in more than one stage along the supply chain. Table 7.6 shows the percentages of farmers using the different ICT and the stages along the supply chain where they use the ICT. ICT with closely related results are grouped together and discussed next.

Table 7.6: Percentages of farmers who use ICT along the supply chain

	Input procurement %	Production %	Packing %	Marketing %	Sales %
Global positioning system (GPS)	0	8	0	0	0
Precision farming	0	15	0	0	0
Bar code system	0	8	71	87	87
Computer	100	85	86	93	93
Cell phone	55	46	21	47	53
Internet	82	46	29	93	73
E-commerce	0	0	0	20	13
Fax	72	39	43	73	60
Email	91	15	21	93	67
Printer	73	46	43	73	53
Landline phone	82	69	36	80	67
Computerized irrigation system	0	15	0	0	0

Source: Survey data, 2008

Global positioning system, precision farming and computerized irrigation system: From the results, very few farmers in the area only use these three ICT in the production stage. They are not yet popular in the area and some farmers mentioned the high cost as a constraint in using them. About 8 percent of the farmers use GPS, 15 percent use precision farming and computerized irrigation systems.

Bar code system: The bar code system is used in almost every stage along the supply chain except in input procurement. It is the major ICT used for traceability purposes by most farmers. Although most farmers use it mainly in marketing and sales, some start using it in production stage to allow traceability from the orchard until the product reaches the final consumer. About 87 percent of the farmers use it in marketing and sales, 71 percent in packing and only 8 percent in production stage.

Computer: From the results, 100 percent of the farmers use the computer in the input procurement stage. Some of the popular uses of the computer may be for determining input costs and product quantities and for budgeting purposes. The fact that a computer also facilitates the use of computer-mediated communication services, software and programs makes it very popular throughout all the stages along the supply chain. It has the highest number of farmers using it in all the stages from input procurement, production, packing, marketing and sales.

Cell phone: The percentage of farmers using cell phone is below 50 percent. This is because it does not have a specific role to play in any stage; it can be used here and there for communication purposes when the need arises.

Internet and emails: These two ICT are mainly used in the marketing stage where a lot of communication is done over the Internet and the products are advertised on the World Wide Web. About 93 percent of the farmers use Internet and emails for marketing purposes. In addition to marketing purposes, the two ICT are also mainly used for input procurement. The Internet is used for searching and identifying possible input suppliers and emails are mainly used for communication with potential and actual suppliers of different inputs needed on the farms. About 82 and 91 percent of the farmers use Internet and email, respectively, in input procurement.

E-commerce: E-commerce has facilitated the easy carrying out of transaction online and offer payment options to customers beyond the reach of the seller. In some developing countries, it is still a new phenomenon. However, a few farmers have adopted e-commerce for easy marketing of their products to customers over long geographical areas. From the results of this study, about 20 and 13 percent of the farmers use e-commerce for marketing and sales purposes, respectively.

Fax and printer: These two ICT are used in all stages along the supply chain, mainly because they are used for keeping hard copies for transactions carried out, from input procurement through to marketing and sales. They can be used for documenting orders, farm stocks and proof of purchases. About 72 and 73 percent farmers use them, respectively.

Landline phone: The results of the study show that most farmers prefer using the landline phone over cell phone because it is cheaper. The need for communication is high throughout the

supply chain and most farmers communicate on a daily basis. Landline phone is highly used by 82 percent of farmers in input procurement and by 80 percent of the farmers in marketing.

Using ICT in the stages along the supply chain has advantages and disadvantages for farmers. RWV farmers suggested some of the advantages and disadvantages for ICT use in each stage. These are listed on Table 7.7.

Table 7.7: Advantages and disadvantages of using ICT in stages along the supply chain

Stage	**Advantages of using ICT**	**Disadvantages of using ICT**
Input procurement	-Assist in decision making on how much quantities of inputs to buy -Orders arrive on time -Timing efficiency -Fast and saves time	-If supplier does not have same communication technology, it is difficult - Affected by poor networks
Production	**-**Assist in decision making on how much inputs to apply -Using machinery reduces labour costs by more than R30 000 -Reduce production costs -Fast and saves time	-High costs of use -Expensive to purchase -Affected by power load shedding
Packing	-Makes packing faster and saves time -Ensures standards consistence -Enables traceability efficiency control	-Affected by power load shedding
Marketing	**-**Cheap and easy to use -Facilitates easy and fast communication with International customers and agents **-**Enables information update and dissemination -Reduces paperwork and transactions costs -Saves lots of paper	**-**E-commerce is still poor in South Africa -Affected by power problems -High costs of use -No face to face contact with customers and marketing agents

Sales	-Facilitates traceability of products -Timing efficiency -Makes things fast and cheap	
All stages	-All work is made easier and faster -Communication is made easier	-Power problems may affect ICT use

Source: Survey data, 2008

About 87 % of the farmers reported using their computer for accounting but more activities were reported for non-accounting usage. These findings suggest that farmers first use their computers to reduce the monotonous routine work of keeping financial and business records and then adopt other computer applications to assist in information management, such as farm record keeping (93%), preparing farm budgets (73%), irrigation scheduling and water budgeting (27%), facilitating traceability systems (27) and other uses (for example, Ezywine programs, powerpoint presentations, GIS system) (13%). Table 7.8 shows the percentage of farmers using computers for different purposes.

Table 7.8: Farmers' computer usage

		N	%
What purposes do you use the computer for	Preparing farm budgets	11	73.3%
	Accounting	13	86.7%
	Keeping farm and payroll records	14	93.3%
	Tracking system	4	26.7%
	Irrigation scheduling and water budgeting	4	26.7%
	Other (specify)	2	13.3%
	Total	15	100.0%

Source: Survey data, 2008

All the farmers who were interviewed for this study have their computers connected to Internet. The Internet is used for several purposes. 30 percent of the farmers use the Internet for accessing agricultural information; about 43 percent use it for communication purposes. Only 27 percent of the farmers use Internet for e-commerce. As shown on Table 7.9, 100 percent of the farmers advertise their farms, wineries and products using different ICT.

Table 7.9: Percentage of farmers who advertise their farm produce

Do you advertise your products				
		Frequency	Percent	Cumulative Percent
Valid	Yes	15	100.0	100.0

Source: Survey data, 2008

Figure 7.3 shows the ICT mainly used for advertising by the farmers. It was found that the farmers do not use television at all in advertising. The most popular medium used for advertising are websites, newspapers and posters, and radio broadcasts. From the results shown in Figure 7.3, 100 percent of the farmers use websites for advertising their farms, wineries and products. The farmers use mainly their own websites, business partner websites, farmer organizations, tourism boards and Wine of South Africa (WOZA) website. About 80 percent of the farmers use magazines and newsletters that are mainly published by the farmers themselves, the Robertson Wine valley association and other tourism boards. These newsletters are made available or distributed to visitors on the farms. Radios are only used by about 7 percent. Other medium of advertising used by about 20 percent farmers includes wine magazines, wine shows, posters and emails. Beside ICT, some even use sales representatives and direct marketing to advertise.

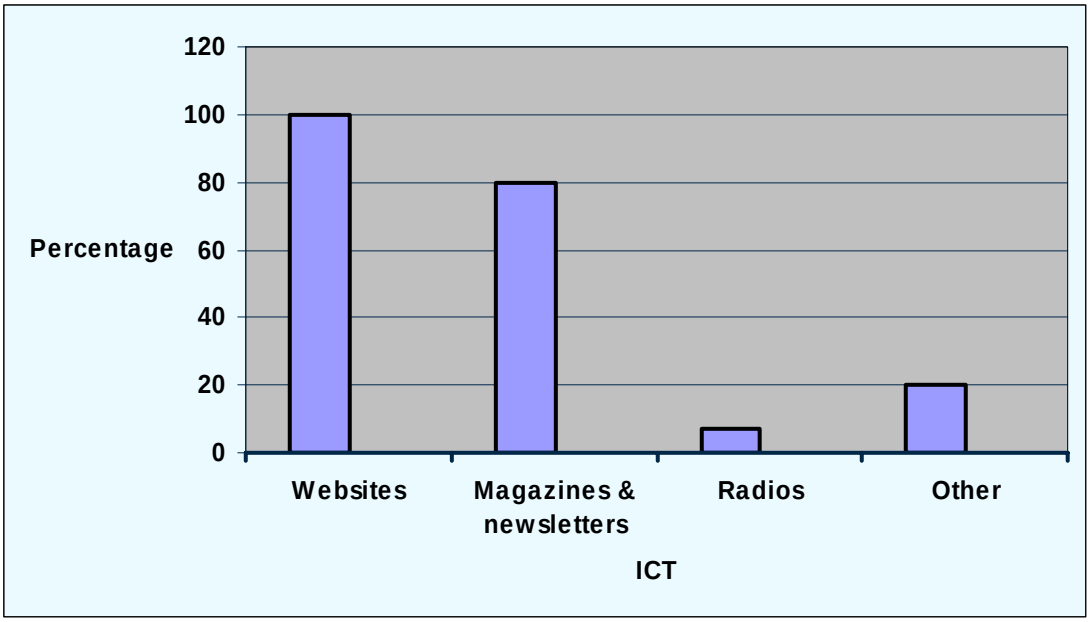

Figure 7.3: ICT used for advertising by farmers

Source: Survey data, 2008

There are a number of stakeholders that the farmers communicate with, and in so doing use a number of ICT. For example they may communicate with their customers, suppliers, marketing agents, banks, other farmers and family members. Figure 7.4 shows the percentage of farmers who use ICT for communication with the indicated stakeholders. A number of ICT are used, but only the two main ICT used by the farmers were chosen from the results.

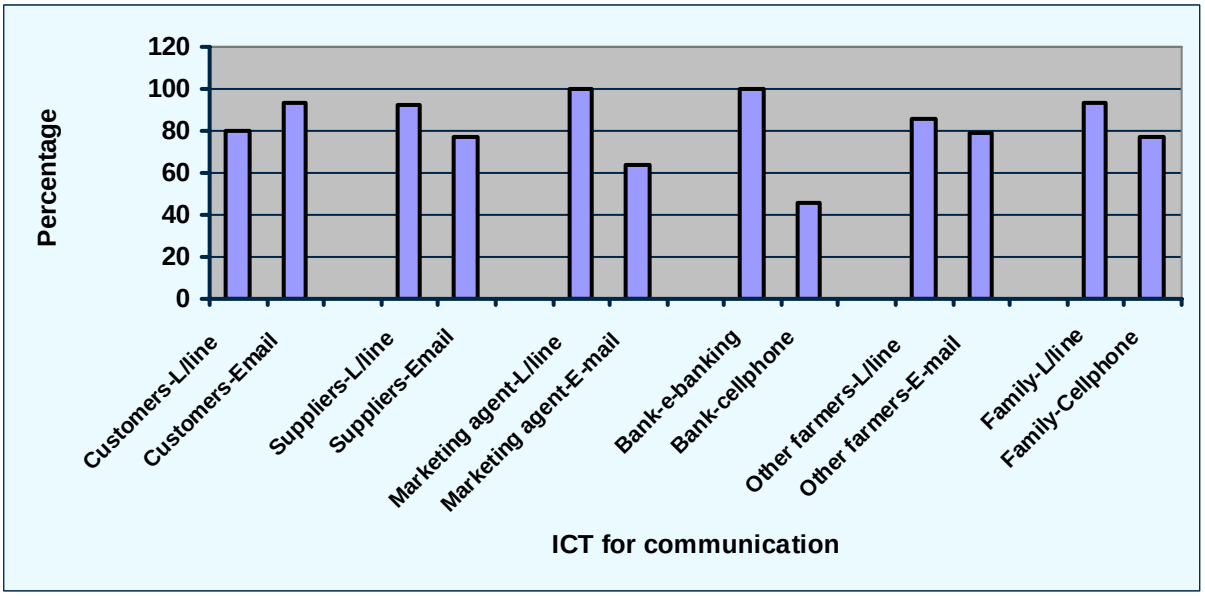

Figure 7.4: ICT used for communication with different stakeholders

Source: Survey data, 2008

For communication with customers, the two main ICT used are e-mails and landline phone, with the highest number of farmers using email. To communicate with suppliers, marketing agents, other farmers and family members, the two main ICT used are landline and e-mail, with most farmers using the landline phone. However when communicating with their banks 100 percent of the farmers use electronic-banking, only a few use cell phones.

Some of the farmers also use ICT for decision-making purposes. About 60 percent reported that they use ICT for making decision pertaining to their farm business. However, 40 percent showed that they do not use ICT in their decision-making processes. Some of the decisions where they use ICT include how to perform budget planning and management, how to market the business, which inputs to use and in what quantities, how to conduct research and development and gather relevant information.

Some ICT are more convenient to use than others. It is interesting to note that there is a difference in ranking on ICT convenience between the farmers and farm employees. The most convenient ICT for farm employees is a cell phone, while email is perceived to be the most convenient by the farmers. The least convenient ICT for farm employees is the fax, while radio and television are the least convenient for the farmers. Figure 7.5 shows the most to the least convenient ICT for the farmers and the percentage of respondents who indicated it.

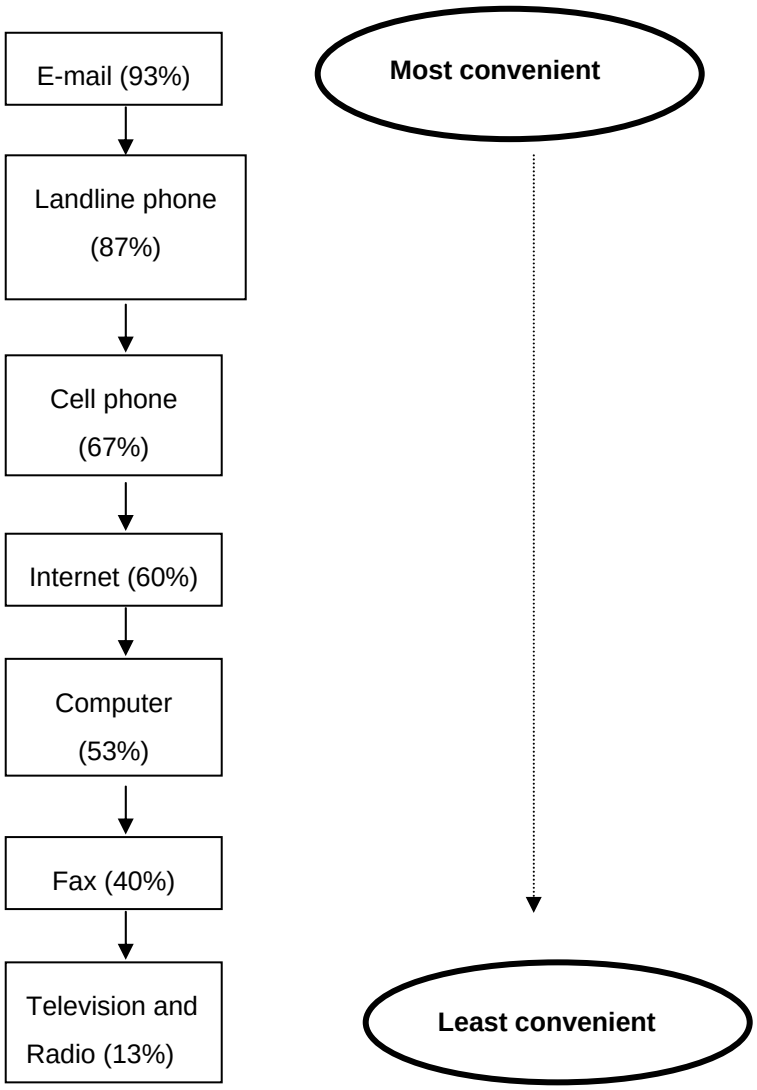

Figure 7.5: The most to the least convenient ICT

Source: Survey data, 2008

The state of the weather is very important to farmers. Therefore they should have a reliable source for weather updates and forecasts. For weather report updates and forecasts, most of the farmers use the Internet, television and cell phones. In addition to weather update information, the farmers need ICT related information on relevant ICT to use, the different types available on the market and the cost of the ICT. For this information, about 73 percent of the farmers depend on ICT suppliers and vendors who specialize in selling different ICT. The Internet is the other source of information that is used by about 67 percent of the farmers. Among the sources that are least used are newspapers, magazines, journals and government

departments.

The market where the farmers sell their produce was chosen as an important variable in ICT use decisions, mainly because most of the farmers sell most of their produce to international markets, and for transactions to be done there is need for ICT use. Most farmers indicated that produce such as bulk wine, bottled wine, table grapes and other fruits are exported to countries such as United Kingdom, Mauritius and China. Small amounts are sold in the local markets. Some farmers do not sell directly to these countries, they use marketing agents who buy from them and in turn sell the products to international markets. Approximately 53 percent of the farmers are in contract with marketing agents. Some have been in the contract for more than 8 years. Examples of marketing agents involved in the marketing process include Sea Trans shipping agents, CIATTI, Bibendum, Distinctive Choice, Liquor logistics and Meridian Marketing. To facilitate the process of marketing a number of ICT are used.

ICT costs and constraints

Farmers pay for services provided by ICT to different service providers. Table 7.10 shows the percentage of farmers who incur costs on different ICT per month.

Table 7.10: Percentage of farmers who incur ICT costs per month

ICT	Less than R3 000 (%)	R3 000 – R6 000 (%)	R6 000+ (%)
Landline phone/Internet	60	33	7
Fax	93	7	0
Printer	93	7	0
Cell phone	87	13	0

Source: Survey data, 2008

Most of the costs that are incurred by the farmers for ICT use are less than R3 000. About 60 percent of the farmers incur less than R3 000 per month on landline phone/ Internet. About 33 percent incur R3 000 to R6 000 and 7 percent incur R6 000 or more per month. These two were grouped together since Internet and landline phone charges are billed together. About 93 percent of the farmers incur less than R3 000 per month on fax and printer. About 87 percent

incur less than R3 000 per month on cell phone charges.

The major problem that the farmers encounter is poor network and reception. About 64 percent of the farmers reported this problem as a major hindrance to ICT use. Internet and cell phones are greatly affected by this problem. Some mentioned power problems and network overloads. The latter causes the networks to be slow.

Employees and ICT

From the results of the survey, about 87 percent of the farmers communicate with their employees using ICT, while 13 percent do not use ICT when communicating with their employees.

The farmers were asked to indicate if they provide formal training to their employees on how to use ICT at work. As shown on Table 7.11, 80 percent of provide some form of formal training for their employees on how to use ICT at work. However, 20 percent strongly indicated that they do not provide formal training to their employees on the use of ICT at work. One of the reasons they stated for not training employees was that it was not their duty to train an employee. They expressed the view that an employee is supposed to know his work. In their view, if an employee cannot do the job, then there is no reason to recruit him. Some stated that they do not have training facilities.

Table 7.11: Provision of ICT training to farm employees

Do you provide formal training to your employees on how to use ICT at work?				
		Frequency	Percent	Cumulative Percent
Valid	Yes	12	80.0	80.0
	No	3	20.0	100.0
	Total	15	100.0	

Source: Survey data, 2008

From the 80 percent who provide formal training to their employees, some provide training to

administrative staff, winery employees, permanent or seasonal employees. Figure 7.6 shows the percentage of farmers who provide training to the different classes of employees.

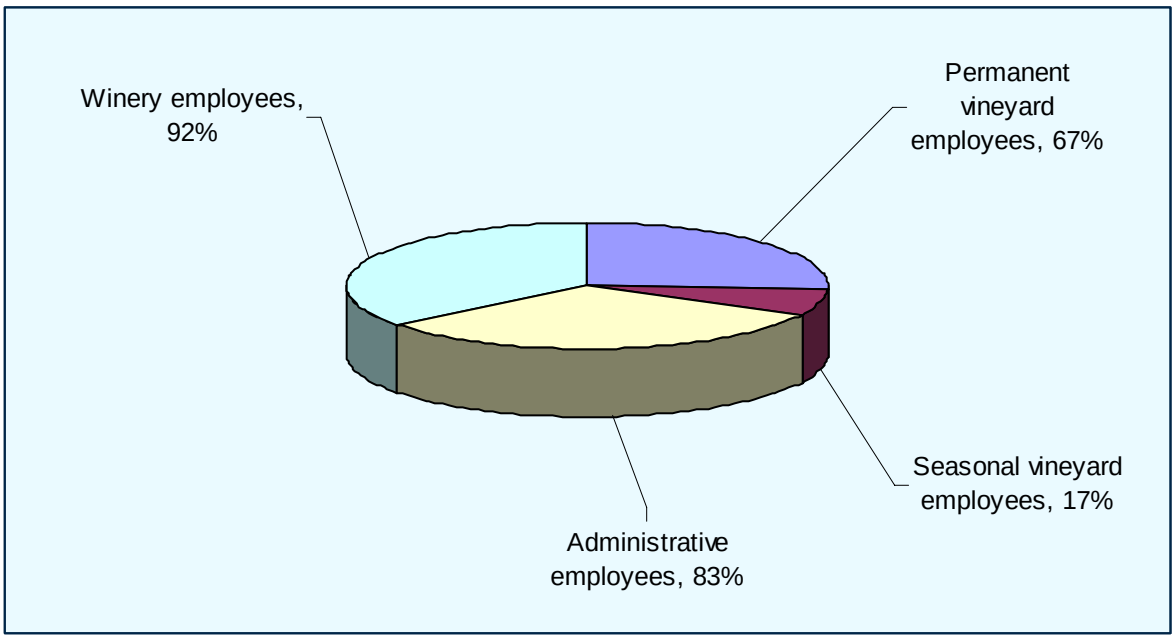

Figure 7.6: Percentage of farmers who provide formal training to their employees

Source: Survey data, 2008

On the farm, the results indicate that a large proportion of winery and administrative employees receive ICT training. A smaller proportion of vineyard employees are trained in ICT. This is mainly because winery and administrative employees work with ICT on a day-to-day basis more than the vineyard workers. About 92 percent of the farmers provide formal training to winery employees, 83 percent provide training to administrative employees, 67 percent provide training to permanent vineyard employees and 17 percent provide training to seasonal vineyard employees. Fewer farmers provide training for vineyard employees, especially the seasonal ones, because their work on the farm does not involve the use of ICT. To train the employees, the farmers mainly use experts within the farm or private consultants.

Perceptions and Attitudes

The farmers seem to have many ICT needs that they intend to fulfill in the future. Among other things, the farmers intend to buy fidelio reservation system, global positioning system,

computerized irrigation system, ezywine software, satellite radios, updated software and upgraded computers in the future in order to support and improve their agricultural activities. Some did not specify the ICT they needed, but they emphasized that they needed any ICT that can reduce their costs and improve the quality of their wine.

Like the farm employees, the farmers also share the same sentiments that BEE will have a positive impact on South African Agriculture. About 80 percent of the farmers agree with the statement, 13 percent were neutral and only 7 percent disagree. Hundred percent of the farmers agree that the benefits of ICT are greater than the costs and that ICT improves agricultural development. This shows how ICT use is appreciated over non-ICT use. The farmers also agree that ICT facilitates the easy flow of and access to information.

Besides being fast and time-saving, ICT use also saves money through lowering of costs, thereby increasing the profits of farm businesses. About 87 percent of the farmers agree that the use of ICT have enhanced the profitability of their farms. This is mainly because ICT use has led to the reduction of major transaction and labour costs, thereby increasing the profits for farmers. Only 13 percent of the farmers disagree that they have not experienced any increase in their profits due to ICT use.

There is information that is considered relevant and essential for farmers in their day-to-day farm operations. Some of the important information needed by the farmers is shown on Table 7.12.

Table 7.12: Important relevant information needed by farmers

Agriculture information Frequencies			
		Responses	
		N	Percent
What agricultural information do you consider relevant to your needs?	Market information	13	33.3%
	Input and output prices	4	10.3%
	Weather forecasts	8	20.5%
	General agricultural news	2	5.1%
	Latest agriculture practices and technologies	6	15.4%
	Warning systems about diseases and pests	3	7.7%
	Radio question and answer service	1	2.6%
	Farm business and management	2	5.1%
	Total	39	100.0%

Source: Survey data, 2008

Among the major information needed by farmers in RWV is market information of wine and other produce. About 87 percent of the responses from the farmers show that they need market information relating to input and output prices. Some even emphasized that there is need for a world stock exchange system specifically for bulk wine, where daily trading activities are made available to the whole world. About 53 percent responses show that the farmers need information on weather updates and forecasts. Only 40 percent responses show that the farmers are in need of information pertaining to the latest agricultural practices and technologies. These are the major three information needs for the farmers in Robertson Wine valley.

Demographics

Table 7.13 presents the demographic aspects of the RWV farmers.

Table 7.13: Farmer demographics

Demographics by:	Variable categories	Number of respondents	Percentage of respondents
Gender	Male	8	53
	Female	7	47
Age	21- 40	1	7
	41- 60	12	80
	61 and above	2	13
Marital status	Married	12	80
	Single	3	20
Race	Black	0	0
	Coloured	0	0
	White	15	100
Experience on farm	5 and below	2	13
	5- 10	3	20
	10- 20 years	8	53
	20 and above	2	14
Average farm income per month	Less than R200 000	7	47
	R200 000- R500 000	4	27
	R500 000 and above	4	27
Average personal salary per month	Less than R20 000	11	73
	R20 000- R50 000	4	27
	R50 000 and above	0	0
Permanent off-farm income	Yes	5	33
	No	10	67
Education	Primary	0	0
	Matric	3	20
	College	8	53
	University	4	27
Agricultural qualification	Yes	10	67
	No	5	33
Type of agricultural qualification	Diploma	6	40
	Degree	4	27
Household size	3 and below	7	47
	4- 6	8	53

Source: Survey data, 2008

The majority (about 53%) of the farmers are males. Although the male-female proportions are

not the same, it is interesting that at least about 47 percent of the farmers are women. About 80 percent farmers are from 41 to 60 years of age and are married. It seems not much progress has been made in land ownership transfer to Blacks since independence, since all the farmers who were included in this study are white. It may not be a true representation of the bigger picture in the area, but it seems to indicate that land is still in the hands of the minority. About 87 percent farmers have more than 5 years of farming experience, which shows that most of them have been in the wine business for a long time.

The average farm income gained by most farmers from farming is less than R200 000 per month. Only about 27 percent farmers receive R200 000 or more per month. However, the average personal salaries (from farming) of most of the farmers are R20 000 or below per month. The majority of the farmers (about 73%) fall in this salary category. The other 27 percent of the farmers have monthly salaries that range from R20 000 to R50 000. No farmer earns above R50 000 per month.

Besides their farm income, about 33 percent farmers have off-farm income from other businesses. Some receive off-farm income from operating Bed and Breakfast (BandB) facilities for tourists, remittances from children who are abroad and other investments. The majority farmers (67%) concentrate on farming only as a source of income.

Unlike the case of farm employees where the majority attained primary and matric education, the farmers are more educated. About 53 percent farmers have attained college education and 27 percent even attained degrees from Universities. Most farmers are not only educated but they have relevant agriculture qualifications. From the total sample of farmers, approximately 67 percent have agricultural qualifications. Among those with agricultural qualifications, 40 percent have diplomas and 27 percent have degrees. Among those with degrees, some are Doctors in agriculture economics and have obtained qualifications from Universities in developed countries. This seems to suggest a belief that education is important for the running of a successful competitive farming business. The remaining 33 percent do not have agricultural qualifications. On a different note, all the farmers have household sizes of six and below.

Descriptive statistics for the farmers were discussed in this section. The following section presents the chi-square tests results for the farmers.

7.3 Chi-square tests results

The chi-square tests results for the farmers are presented next. Both the significant and non-significant variables are presented to assist decision makers and farmers to know the variables they should consider when making farm decisions. The chi-square tests were conducted to test and confirm the relationship between ICT use and different variables, and the relationship between the variables themselves.

In this study, it was found that all the farmers use ICT, therefore no further tests were carried to find differences in their ICT use. The chi-square tests were carried out to find relationship between variables which do not affect ICT use directly, but may affect management style and decision-making of the farmers. These relationships are reported next.

7.3.1: Significant variables

In this section, only the variables which have statistically significant relationships are presented.

Perception on Black Economic Empowerment (BEE) and ICT goals

Cross tabulation

Count		The initiative of Black Economic Empowerment (BEE) will have a positive impact on South African agriculture				
		strongly agree	agree	neutral	Disagree	Total
Do you have any business goals with regard to ICT?	Yes	3	1	2	0	6
	No	2	6	0	1	9
	Total	5	7	2	1	15

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.429	3	.043
N of Valid Cases	15		

There is a significant relationship between the farmers' perception on BEE and their ICT goals (p-value<0.05). The majority of the farmers who have a positive perception on the impact of the BEE initiative have no specific business goals with regard to ICT use.

Education level and market

Cross tabulation

Count		Please indicate your highest level of education				
		primary	matric	college	university	Total
Market	Export	0	1	3	1	5
	Local	1	1	0	1	3
	Both	0	0	5	2	7
	Total	1	2	8	4	15

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.214	6	.023
N of Valid Cases	15		

There is a statistically significant relationship between the education level of the farmers and the market where they sell their produce (p-value<0.05). Farmers who have attained college and university education sell their produce either exclusively to overseas markets or both overseas and local markets. Those who are less educated, who attained only primary or matric education sell their produce locally because they cannot cope with the complexities of exporting products.

Market and the average farm income per month

Cross tabulation					
Count		What is your average farm income per month?			
		less than R200 000	R200 000 - R500 000	R500 000+	Total
Market	Export	0	2	4	6
	Local	0	2	0	2
	Both	5	1	1	7
	Total	5	5	5	15

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.543	4	.021
N of Valid Cases	14		

There is a statistically significant relationship between the market where the farmers sell their produce and their average farm income (p-value<0.05). Farmers who export their produce have more average farm income per month than those who sell their produce locally.

Market and salary per month

Cross tabulation

Count		What is your average personal salary per month?		
		Less than R20 000	R20 000 - R50 000	Total
Market	Export	2	3	5
	Local	3	0	3
	Both	6	1	7
	Total	11	4	15

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.455	2	.045
N of Valid Cases	15		

The market and the farmer's monthly salary are highly related (p-value<0.05). The market has influence on the profits of the farmer as well as the salary the farmer will receive per each month. Most farmers who sell their produce locally have monthly salaries of less than R20 000. Those who export their produce have generally more salaries per month than those who sell locally.

Education level and Perception on BEE

Cross tabulation

Count		Please indicate your highest level of education				
		primary	matric	college	university	Total
The initiative of Black Economic Empowerment (BEE) will have a positive impact on South African agriculture	strongly agree	0	1	3	1	5
	agree	0	1	5	1	7
	neutral	0	0	0	2	2
	disagree	1	0	0	0	1
	Total	1	2	8	4	15

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.429	9	.011
N of Valid Cases	15		

Education level of the farmers and their perception on BEE have a statistically significant relationship (p-value<0.05). Farmers who attained at least matric education have a positive perception on the impact of BEE. Those who attained only primary education have a negative perception on BEE.

Experience and off-farm income

Cross tabulation

Count		Do you have any permanent off-farm income		
		Yes	No	Total
How many years of experience do you have in fruit production on your farm	4	2	0	2
	10	0	3	3
	11	0	1	1
	12	0	1	1
	15	0	2	2
	17	1	0	1
	18	0	1	1
	19	2	0	2
	25	1	0	1
	30	1	0	1
	Total	7	8	15

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.000	9	.001
N of Valid Cases	15		

There is a statistically significant relationship between the farmer's experience and his off-farm income (p-value=0.001). Farmers who are highly experienced in wine production have other sources of income besides agriculture.

Education level and formal agriculture qualification

Cross tabulation

Count		If yes, indicate its category:			
		No formal Agricultural qualification	diploma	degree	Total
Please indicate your highest level of education	primary	0	0	0	0
	matric	1	2	0	3
	college	2	6	0	8
	university	2	0	2	4
	Total	5	8	2	15

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.714	6	.049
N of Valid Cases	15		

Education levels and agricultural qualification of the farmers have a statistically significant relationship (p-value<0.05). Generally, most of the farmers who attained at least matric education have agriculture qualifications. Those who attained only matric education do not have agricultural qualification.

Farm income per month and salary per month

Cross tabulation					
Count	What is your average farm income per month?				
		less than R200 000	R200 000 - R500 000	R500 000+	Total
What is your average personal salary per month?	less than R20 000	7	4	1	12
	R20 000 - R50 000	0	0	3	3
	Total	7	4	4	15

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.545	2	.008
N of Valid Cases	15		

The relationship between the farm income and the monthly salary of the farmer is statistically significant (p-value<0.01). The farmers with average farm income of R500 000 and above has more salaries than those with less farm income per month.

7.3.2: Non-significant variables

In this section, some relationships that are not statistically significant in this study are presented.

Market and ICT goals

Cross tabulation				
Count	Do you have any business goals with regard to ICT?			
		Yes	No	Total
Market	Export	2	3	5
	Local	1	2	3
	Both	3	4	7
	Total	6	9	15

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.079	2	.961
N of Valid Cases	15		

The market is expected to play a major role in assisting the farmer to come up with ICT goals that aligns with the demand of the market. A farmer who exports his produce is expected to have more ICT goals since more ICT is used when exporting produce than when selling locally. However, in this study the relationship between these two variables is highly insignificant (p-value>0.1).

Race and ICT goals

Cross tabulation				
Count	Do you have any business goals with regard to ICT?			
		Yes	No	Total
Indicate your race	white	6	9	15
	Total	6	9	15

Chi-Square Tests	
	Value
Pearson Chi-Square	.
N of Valid Cases	15

The relationship between race and ICT goals is statistically insignificant. The p-value could not be computed because the race of the farmers is constant, all are whites.

Age and perception on BEE

		Cross tabulation				
Count		The initiative of Black Economic Empowerment (BEE) will have a positive impact on South African agriculture				
		strongly agree	agree	neutral	disagree	Total
State your age	21 - 40	0	1	0	0	1
	41- 60	3	6	2	1	12
	61and above	2	0	0	0	2
	Total	5	7	2	1	15

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.571	6	.473
N of Valid Cases	15		

The relationship between age and perception on BEE is highly insignificant (p-value>0.1). Although most farmers have a positive perception on BEE despite their ages, these two variables have an insignificant relationship.

ICT affordability and salary per month

Cross tabulation					
Count		Affordability			
		Not expensive	Somewhat Costly	Costly	Total
What is your average personal salary per month?	less than R20 000	6	3	2	11
	R20 000 - R50 000	1	3	0	4
	Total	7	6	2	15

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.946	2	.229
N of Valid Cases	15		

It is usually expected that those who earn more salaries afford to adopt and use ICT than those who earn less. In this study, the salary of the farmer is not related to his ability to afford to adopt and use ICT. The relationship between perception on ICT affordability and the salary of the farmer per month is highly insignificant (p-value>0.1). This section presented the chi-square tests results for the farmers. The correlation analysis results for the farmers are discussed next.

7.4 Correlation analysis results

The spearman correlation analysis was carried out to find the relationships between ICT use and different variables and, to determine the strengths of each relationship by the use of correlation coefficients. The correlation results of the correlation analysis for the farmers are presented next.

Spearman's correlation analysis was used to investigate the relationships among the different variables of the farmers. No ICT use variable was investigated because all the farmers use ICT. Although these variables do not directly affect ICT use, they affect the management style and decision-making of the farmers. The results of the Spearman correlation analysis of the farmers

are shown in Table 7.14. Both significant figures and correlation coefficients are indicated. Correlation coefficients are indicated by the asterisks.

Table 7.14: Correlation analysis results for the farmers

	Distance	Farm size	ICTgoals	Market	BEE	Affordability	Age	Experience	Farm income	Monthly salary	Off-farm income	Education level
Distance												
Farm size												
ICT goals												
Market								0.049 .517*		0.017 .603*		
BEE												
Affordability												
Age												
Experience				0.049 .517*								0.006 .669**
Farm income										0.005 .704**		
Monthly salary				0.017 .603*					0.005 .704**			0.05 .533*
Off-farm income												
Education level								0.006 .669**		0.05 .533*		

Source: Survey data, 2008

* Correlation is significant at P-value< 0.05

** Correlation is significant at P-value< 0.001

From the results shown on Table 6.27 there is a relation between the farmer's

- ✓ Experience and market at 0.049 significant level with a correlation coefficient of 0.517. As

wine production experience of farmer increases, where the product is sold tend to change from local to export markets.

- ✓ Monthly salary and market at 0.017 significant level with a correlation coefficient of 0.603. As the farmer shift from local to international market, his monthly salary tends to increase. This is because of a possibility of profit increase due to foreign currency earnings.
- ✓ Education level and experience at 0. 006 significant level with a correlation coefficient of 0.669. The farmer's education tends to enhance his experience.
- ✓ Monthly salary and farm income at 0.005 significant level with a correlation coefficient of 0.704. These two relate to one another and affect each other positively mainly because the farm income is mostly the main source of the monthly salary. As the farm income increases, the monthly salary also increases.
- ✓ Education level and monthly salary at 0.05 significant level with a correlation coefficient of 0.533. The higher the education levels of the farmer, the higher his monthly salary.

The dominating variables influencing the farmer's activities are monthly salary and education level.

This chapter indicated the main findings that were found from the study on farmers in RWV. The following chapter presents the analysis of results for both the farmers and farm employees.

CHAPTER EIGHT

ANALYSIS OF FINDINGS

8.1 Introduction

This chapter presents the analysis of the results that were found in this study for both the farmers and the farm employees. The contribution of this study towards the theoretical model is presented in section 8.3.

8.2 Analysis of findings

This study set out to ascertain and probe the factors that influence the use of ICT in commercial agriculture in the wine industry in the context of a developing country. The investigation was centred on a number of research questions that were posed in chapter 1 to guide the study. In this section, an analysis of the research findings is done to answer the research questions. Although some of the research questions were answered through the literature review that was presented in chapter two, they are briefly restated here under the appropriate and pertinent research questions. Added to those findings from the literature review is the analysis of the findings from the experiment.

8.2.1. Different kinds of ICT that are being used by agricultural communities

ICT are used in diverse areas of the food and agricultural industry. These include precision agriculture, product traceability and identity preservation (e-supply chains), animal husbandry, computerized irrigation systems, digital financing for farmers (i.e., Internet and mobile banking support) and computerized farm record keeping systems, among others. From the literature, it was seen that a lot of ICT are used in different agricultural communities depending on the type of enterprise. For example, in animal production ICT like PC-based recording and management software, Integrated Registration and Genetic Information System, Livestock Identification Trace-back System, transponders, bar codes and radio frequency Identification are used (ICT Update, 2004a:2). In crop production, ICT like precision farming (Rilwan & Ikhuoria, 2006:178), computerized irrigation (Miranda, Yoder, Wilkerson & Odhiambo, 2005:186), tracking and tracing technologies (Kelepouris, Pramatari & Doukidis, 2007:186) and other software are used.

From the results of this study, the cell phone was found to have the highest number of users among the farm employees. All the farm employees use it. This is acceptable in this information age where almost everyone has a cell phone, even the cheapest mode, for the purposes of communication. Besides cell phones, most of farm employees indicated that they use computers, Internet, e-mails, two-way radios, printers, tracking and tracing software and landline phones. This is because these ICT are mainly used on a day-to-day basis on the farms and an employee can use one or two of these ICT in his/her work. Other ICT such as precision agriculture, computerised irrigation, GPS and PDA are not familiar with most farm employees since less farmers use them. The fact that most of the farmers do not use these ICT implies that the farm employees also do not use them. The farm employees indicated that a cell phone is the most convenient ICT, mainly because one can move with it and can communicate easily any time. Besides the issue of convenience, the employees find a cell phone to be the easiest and most flexible ICT to use since they have personal freedom to use it than other ICT available at work because of company restrictions, policies and restrictions. The least convenient ICT is the computer and fax since their access is limited to most farm employees.

Emails are mainly used by winery and administrative employees as they have access to the Internet and they can use emails frequently in conducting business as well as personal transactions. The vineyard workers do not use emails due to the fact that they do not have access to the internet and most of them have high levels of illiteracy so they cannot work with technology.

The farmers themselves are major users of ICT on the farms. They use ICT that range from computer, Internet, fax, printer, photocopier, landline phone, cell phone, two-way phone, PDA, computerised irrigation, bar code system, email, tracking and software and their own websites. However, very few farmers use GPS, precision farming and computerised irrigation because of the high costs involved in using them. Unlike farm employees, the farmers spend a lot of time using ICT per week because they do not have any company regulations and policies forbidding them to use any ICT since they are the owners of the business.

8.2.2. What ICT are used for by the farmers and farm employees in the wine industry

As reported in related literature, computerized irrigation is used to monitor and control the allocation of water to each field according to the needs of the crop (Sne, 2005:9). Tracing and tracking technologies are used for backward and forward traceability (Kelepouris, Pramatari &

Doukidis, 2007:186). Precision farming is used to vary inputs, such as fertilizers, pesticides and seeding rates throughout fields based on management zones (Adrian, Norwood and Mask, 2005:257). Computer-Mediated Communication Services enabled by the Internet are used for the dissemination of information to agricultural role players (Munyua, 2000).

The results of this study showed that ICT such as e-mails, landline phones, cell phones and two-way radios are mainly used by farm employees for communication with the customers, employer, other employees, family members, friends and relatives, and when there is an emergency.

A number of ICT are used along the stages of the wine supply chain. The computer is the dominant ICT used in input ordering, production, packing, marketing and sales. This is because a computer can serve multiple purposes in every stage along the supply chain. It can be used for budgeting, data entry and spreadsheet calculation in input ordering, record keeping in the production stage, tracking software and bar code installation in the packing stage, and accessing the Internet and emails for communication and marketing in the marketing and sales stages. In addition, some other ICT work in conjunction with a computer, thus enhancing the functionality of the computer. Examples include computerized irrigation, tracking and tracing software, bar codes and CMS such as emails, online banking and Internet.

During data collection, not all farm employees indicated the type of ICT they use on the farm, and for which purposes along the supply chain. This is mainly because not all farm employees use ICT in their farm work. For example, field workers do not use ICT at all, some use only one or two, while their winery and administrative counterparts use a number of ICT. Their use of ICT depends mainly on the type of work they perform on the farm.

The farmers use websites mainly for advertising their farms and products and for carrying out online transactions. This has proven to be the easiest way of making themselves known locally and abroad thereby attracting potential and current customers. Besides, a number of them conduct business transactions online for orders and payments.

The bar code system is used mainly in sales and marketing, although some farmers use it from the production stage to the end of the supply chain. This is done to facilitate the traceability of the product from the orchard until it reaches the final consumer. The farmers also use the computer, fax and printer in all stages of the supply chain. These three ICT facilitate the

documentation and storage of proof of business transactions. Internet and emails are mainly used in input ordering and marketing stages. The internet is used to search and identify possible input suppliers and customers, and email is used for communication with suppliers and customers. The other ICT used by farmers is e-commerce which is used for carrying out transactions online and offer payment option to customers beyond the reach of the farmers. Unlike the farm employees, the farmers use a landline phone more than a cell phone, because it is cheaper to communicate with.

8.2.3. Major barriers that hinder the use of ICT in the wine supply chain and by farm employees

Although little investigation has been conducted on the wine supply chain and the farm employees in the South African wine industry, Moseley (2007:8) reported that the commercial farm worker population is among the poorest people in the South African society. The high level of poverty within this group may account for the limited use of ICT by farm employees. According to the study that was conducted in the Robertson Wine Valley on education qualifications and skills of farm workers, it was found that there is need for technical skills and training, since most of the farm workers are illiterate and have low education levels (Booysen, 2006:18).

The results of this study showed that the major barrier inhibiting the use of ICT by the farm employees is the high cost of purchasing and accessing ICT. Given the low incomes of most farm employees, it is difficult, if not impossible, to buy ICT of their own. Some indicated that internet cafe charges and airtime are not affordable all the time.

A number of employees highly recommended training on the use of ICT. Since most of the farm labour force is recruited from poor and illiterate coloured and black communities, the main challenge is lack of training and awareness of ICT. Illiteracy and lack of training on the use of ICT hinder most of the farm employees from using ICT productively on the farms. This is coupled with language and content limitations placed by most ICT that use English as their interaction language. Unless training is provided, ICT use will be difficult for some farm employees who are illiterate and are familiar only with Afrikaans and Xhosa languages.

Some farmers indicated that e-commerce usage in South Africa is still in its infancy. As a result, this places a limitation on a number of agricultural role players who actually use it. This is further

exacerbated if the other participants in the supply chain do not have the same ICT. Even where the farmers use e-commerce, if other players along the supply chain do not use it, transactions can not be carried out. What this suggests is that, for an ICT to be successfully used, all participants along the supply chain must be using it. This will greatly improve the use of e-commerce in the wine industry and enable the farmers to benefit from using it.

The other major concern of using ICT in conducting business transactions is the issue regarding security of information transmitted over the Internet. Customers' willingness to buy wine online and provide their personal financial information is still a challenge; most customers are not willing to share their personal financial information online, due to fear of fraud and other security concerns. This draws all the people involved in business transactions back to the traditional way of face-to-face buying and selling, making the farmers to lose prospective customers in international markets. There is still need for awareness on the reliability and security of financial transactions, as this is important to users.

Low quality networks and poor communication reception are also concerns in RWV, due to the low-lying terrain of the area. Both the farmers and farm employees indicated that this is a major communication barrier. In addition to that, electricity problems caused by Eskom (Electricity Supply Commission of South Africa) are worsening the situation.

8.2.4. Benefits from ICT use by both commercial wine farmers and their farm employees

Major benefits from ICT use include the facilitation of communication and information exchange. This has influenced decisions on what to plant, when to plant it, how to cultivate and harvest and where to store and sell, and at what price (Winrock, 2003). ICT are also highly rated for providing up-to-date, more usable, easily accessible information and for saving time, compared to traditional manual records (Woodburn *et al*, 1994).

RWV farm employees who use ICT acknowledge that ICT makes their work easy and fast to do. A number of farmers appreciated the benefits of using ICT in the day-to-day activities and along the stages of the supply chain. Some of the advantages are listed on Table 6.3.7 (section 6.3). Generally, some of the main advantages of using ICT they mentioned include saving of time and money and the fact that they are cheap and easy to use. In addition, ICT facilitate the traceability of products and provide assistance in decision making. Most farmers appreciated online banking

mainly because they can do all their bank transactions without leaving the farm gate, thus saving time and money.

8.2.5. Factors that influence the use of ICT in agriculture by farmers and farm employees

Results of previous studies reported by Woodburn, Ortmann and Levin (1994:194) and Sabuhoro and Wunsch (2003:6) showed that certain characteristics of farmers such as education, income, age and gender are important variables in explaining the use of ICT like computers. Other ICT which were identified as ICT use determinants include farm size (Batte, 2005:8), off–farm income (Alvarez & Nuthall, 2006:50), gender (Sabuhoro & Wunsch, 2003:6), farming experience (Hollenstein, 2004:326) and distance from centre of development (Alampay, 2006:14). No previous studies were found to have identified factors influencing ICT use by farm employees.

This study identified different factors of ICT use for both the farmers and farm employees. Some possible reasons for the relationships found from the results of this study are stated below for both farmers and farm employees.

- ✓ **Farm employees**

The trained employees use ICT than the untrained ones. This is mainly because training is essential for the effective use of ICT by the employees, especially the ICT that need a user to be computer literate. Without ICT training it is difficult for farm employees to be able to use the ICT productively for farm purposes.

Most workers who are 40 years old and below indicated that they use ICT in their farm activities. This is mainly because, most young people are willing to learn and are flexible than older ones. Older people tend to have technophobia.

Administrative and winery farm employees tend to us more ICT than the permanent and seasonal vineyard employees. The work of administrative and most winery employees involve the use of ICT in communication and other farm activities more than both permanent and seasonal vineyard employees. Also, farmers prefer to use the handpicking method for harvesting grapes than machinery harvest to ensure better quality produce. That is why most employees

who work in the vineyard do not use ICT in their work since hand picking is highly recommended than mechanical harvesting methods.

Farm employees with incomes of R4 000 or less do not use ICT as compared to middle and high income earners. This is because since they have less disposable income, it is unlikely that they can afford to buy ICT for their personal use. Employees who have middle and high incomes use ICT more than low income earners. This is mainly because they may have extra money to buy ICT even for their own personal use in their homes, giving them advantage over the less paid employees since they will not need much training since they will be ICT literate.

Unlike in other related studies, in this study gender has no influence on ICT use because there is no large difference in the number of female and male employees. Males were 29 and females were 31. This little margin could not make any significant different in their ICT use.

- ✓ **Farmers**

The results of the study show that unlike in the case of farm employees, there is high use of ICT by the farmers, as all farmers indicated that they use ICT. It is interesting to note that three of the important variables under investigation in the study had the same response from the farmers. This indicates that the farmers who were interviewed have a lot in common. This may be due to the fact that they are located in the same geographical area and they are in the same industry which entails the use of certain specific ICT. All the farmers use ICT, use their own websites and are white. This implies that the variables; race and ICT use could not be investigated further since there are no differences which have to be investigated. As a result, these variables could not be included in the chi-square test or correlation analysis. In this case, the dependent variable, ICT use is always 1, implying that all farmers use ICT.

Farmers who have a positive perception on the impact of BEE have no specific goals with regard to ICT. This could be due to the fact that the farmers have already achieved their ICT goals and are now focusing on empowering themselves and their employees by implementing the BEE initiative.

Education of the farmer and the market he sells his produce are highly related since education is an important variable in helping the farmers to choose the appropriate market for the produce.

This will also determine the profits to be obtained from the sales. Educated farmers sell their produce to international markets and vice versa.

Farmers who sell their products to international markets have high farm incomes. The export market influences the farm income positively. Exported products bring in more profits thereby increasing the farm income than locally sold produce. For example, the farmers who are selling their products now are earning high profits due to the weaker rand.

Farmers who attained only primary education have a negative perception on BEE mainly because of ignorance and lack of knowledge about BEE.

Farmers with more farming experience have off-farm activities. Some have invested in tourism, accommodation and other business ventures for diversification, with the knowledge that the agricultural field has a number of uncertainties and risks. The other probable reason is that they have accumulated profits over the years, which enabled them to invest in other businesses.

Farm income and monthly salaries are highly related. This is mainly because the farm income obtained by the farmer is the main determinant of the monthly salary that the farmer receives. Farmers who earn high farm incomes have also high monthly salaries. The following section shows the contribution of the study towards the theoretical model which was adopted for this study.

8.3 Contribution of the study to the theoretical model

In chapter three (section 3.2), we argued for the need to modify or extend the information innovation adoption model (Alvarez & Nuthall, 2006) for developing country contexts. Accordingly, a generalized extended model was proposed in chapter 4 (section 4.4). The generalized model can be rendered specific for each developing country by validation through statistical experimentation, as done in this study for the Western Cape Province. Based on the variables which were found significant from the statistical analysis carried out in this study, an extension of the information innovation adoption model was developed to explain the results of this study. Figure 8.1 shows the ICT use model showing the results of this study.

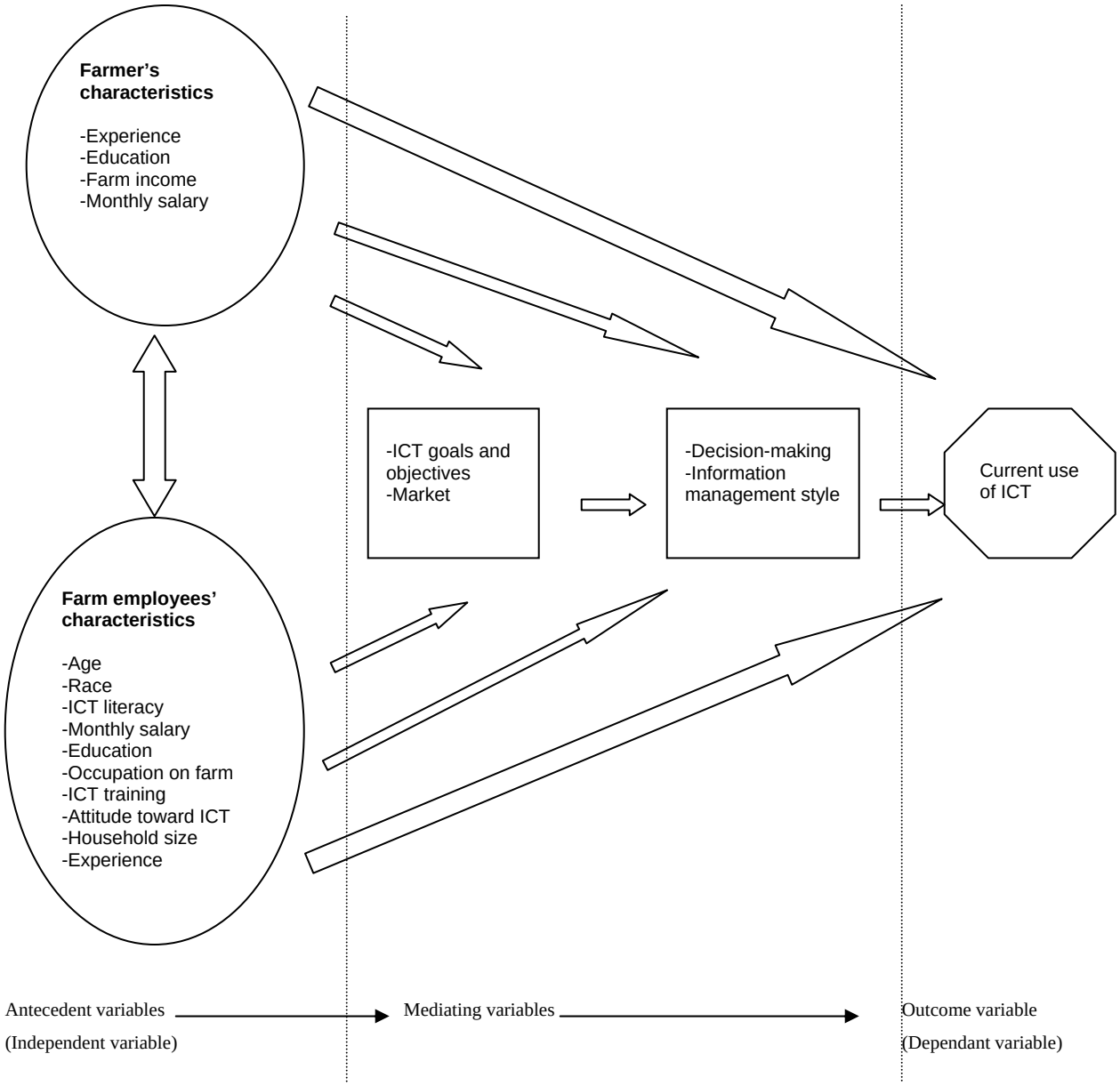

Figure 8.1: Extended ICT use model for commercial agriculture in developing country context

The variables shown in Figure 8.1 were found to be relevant and applicable in this study. The extension of the information innovation adoption model indicates some of the most important determinants of ICT use in agriculture in developing countries. It shows that ICT use in agriculture is influenced by a number of factors such as farmer's characteristics, farm employee's characteristics, farmer's goals and objectives and the market. No similar tests were

carried out on the mediating variables, particularly the decision-making and information management style as this is beyond the scope of this study.

Generally from the results presented in this chapter, it is interesting that all the farmers and a larger number of farm employees use ICT in their day-to-day activities. However, different variables affect different groups of people. The results of this study show that monthly salary and experience are the common variables that affect the use of ICT by both the farmers and farm employees. The other variables that affect ICT use of farmers are not the same as those that affect the farm employees. The following chapter summarizes the possible econometric model that can be derived from this study, compares the findings from this study to previous related literature and provides recommendations for the improvement of ICT use in agriculture.

CHAPTER NINE

DISCUSSION

9.1 Introduction

Firstly, this chapter discusses possible econometric models that can be derived from the further analysis of the results found in this study. Secondly, the findings from this study are compared to findings reported in related studies in the literature to assess their similarities and differences. Lastly, the study provides general recommendations on how ICT use can be greatly improved in agriculture.

9.2 Econometric model

As stated earlier, the study focused on descriptive statistics, correlation analysis and chi-square tests of ICT use by commercial farmers and farm employees. Taking into consideration that the major requirements of econometric modelling of ICT use in agriculture have been stated in this study, an extension of this study on the econometric model of ICT use in agriculture would be of great importance. Given the disadvantages of non-econometric models stated in this study, econometric models are often preferred to test the validity of theoretical relationships between ICT use and the identified variables, and the magnitude of the relationships. It is a way of testing whether some variables have influence on ICT use in agriculture. The outcome of an econometric model will draw us closer to reality and will help in benchmarking the results against the usual baseline models. On that note, an econometric modelling framework and a general format of the econometric model is proposed for a later study. This is presented next.

9.2.1 Econometric Modelling Framework

As already discussed, a number of factors influence ICT use in agriculture. In the proposed model, the independent variables are grouped under five categories that have been found by Woodburn, *et al*. (1994), Sabuhoro and Wunsch (2003) and Alvarez and Nuthall (2006) to influence the use of ICT in agriculture. This is shown diagrammatically in Figure 9.1. As seen in the figure, statistical modelling techniques (discussed in chapter 5) are applied to the independent variables to determine a suitable indicator for ICT use in agriculture. The proposed model in this study is derived from agricultural practice in South Africa, mainly because its demographics, the ICT profile of its farmers and other ICT related variables more closely resemble those of other developing countries.

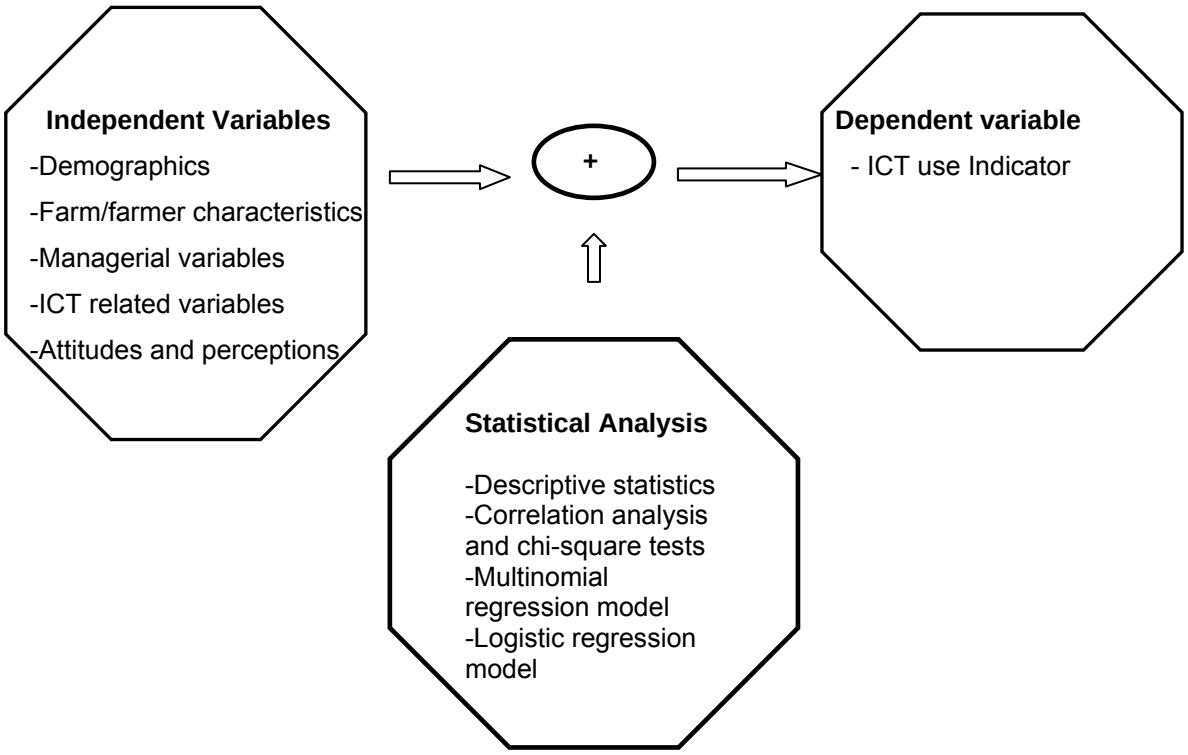

Figure 9.1: Framework for statistical modelling of ICT use in agriculture

9.2.2. General format of econometric models

A set of equations that depict real economic sense can be used to express the relationships among the variables and predict the effects of each variable on the dependent variable. The proposed general form of the equations is the same for both farmers and farm employees, but the independent variables are different. The generalised equations are applicable to ICT use in agriculture in developing countries, particularly South Africa. Similar relationships have been found to exist in the use of computers and other ICT by farmers (Iddings & Apps, 1990:19-21; Sabuhoro & Wunsch, 2005:8), in the dairy industry (Alvarez & Nuthall, 2006:48-60) and in the health industry (Shivute, 2007). Therefore, the proposed general format of the econometric models is as follows:

Econometric model 1: farmers

$$Y = B_0 + B_1 AGE + B_2 INC + B_3 EDUC + B_4 AGRIC + B_5 RACE + B_6 DIST + B_7 FSIZE + B_8 EXP + B_9 GOAL + B_{10} OFFINC + B_{11} MKT + B_{12} ATTI + B_{13} BEE + B_{14} AFFOD + \varepsilon_0$$

Where:

Y = ICT suitability for farm operations (A binary value of 1 if ICT is likely to be used productively on a farm, 0 if otherwise)

B_0 = Constant

B_1- B_{14} = Coefficients
ε_0 = Error term

Econometric model 2: farm employees

$$Y = \alpha_0 + \alpha_1 AGE + \alpha_2 INC + \alpha_3 EDUC + \alpha_4 HHSIZE + \alpha_5 RACE + \alpha_6 DIST + \alpha_7 EXP + \alpha_8 MGT + \alpha_9 ICTLIT + \alpha_{10} GENDER + \alpha_{11} TRAIN + \alpha_{12} EMPLMT + \alpha_{13} ATTI + \alpha_{14} BEE + \alpha_{15} AFFOD + \varepsilon_1$$

Where:
Y =Use of ICT by the farm employee (A binary value of 1 if farm employee is likely to work productively with a set of ICT on the farm, 0 if otherwise)
α_0 = Constant
α_1- α_{15} = Coefficients
ε_1 = Error term

The descriptions and meanings for these variables are presented on Table 4.5 in chapter 4. In a later study, statistical experimentation therefore needs to be conducted to enable the determination of the exact values for the constants, coefficients and error term. For this study, only the variables influencing ICT use were identified.

As mentioned earlier in the study, the final model developed from all the statistical analysis described, can be used to develop a decision-making support tool to be used by different role players in the agriculture sector. The model can be used as a decision making support system for government policy-makers, farmers and farm managers, and farm employees. The use of the model for each stakeholder group was discussed in chapter one.

9.3 Comparison of findings with the literature

It was noted earlier that ICT can be used in almost every stage along the supply chain, from input procurement, production, distribution and marketing of agricultural produce (Winrock, 2003). In every stage, one or more ICT are used, although the number of ICT used in each stage varies. However, it has been noted that in the wine industry, machinery and ICT are not used in grape harvesting because hand picking is highly recommended in order to produce best quality grapes. Through handpicking of grapes, quality grapes and wine are produced.

Unlike in developed countries, very few farmers practice precision agriculture and computerised irrigation in Robertson Wine Valley due to the complex technologies that are needed and the high costs involved. The most popular ICT application used by most farmers is forward and backward traceability which is practised in response to the EU regulation which requires traceability of all wine exported to EU. Besides traceability, farmers use other ICT mainly for e-commerce, online banking, record keeping and information dissemination.

As was observed by the World Bank (2002:7), a number of farmers reported that ICT has enabled direct marketing by eliminating the middlemen, thereby lowering transaction costs and enhancing profits. A number of farmers communicate directly to their international customers without the need for an agent or middlemen, and this has resulted in effective communication, direct customer service, combating of risk, low transaction costs and better service delivery in the wine industry.

Langmia (2006) and Tlabela *et al*. (2007:51) state that poor networks are major factors inhibiting the use of ICT by the farmers and their farm workers in Robertson area. This problem seriously affects those farmers who are located in the low-lying areas where reception of phones is very poor. Some farmers have to climb a hill or go to a high lying area in search of reception when they need to communicate. This and other network problems need rectification for the efficient flow of information between the farmers and other stakeholders in the agriculture industry.

The effects of age, education, off-farm income and experience on ICT use found in this study support the results of Woodburn, *et al*. (1994:190); Hollenstein (2004:326); Alvarez and Nuthall (2006:50) and Sabuhoro and Wunsch (2003:6). However, as opposed to the findings of Batte (2005:8) which showed that the size of the farm has a positive relationship with ICT use, the results of this study showed that farm size is not a determinant of ICT use as it was not statistically significant. On the other hand, Sabuhoro and Wunsch (2003:6) found that ICT use increases if the farmer is female. In this study, gender was not a determinant of ICT use, it was also statistically insignificant. Another variable that was predicted to have influence on ICT use was the Black Economic Empowerment initiative. However, this study proved that BEE is not related to ICT use.

A unique statistically significant variable specifically identified in this study was the market where the farmer sells his product. This was not mentioned in any related literature. The results showed that there was a positive relationship between ICT use and the market. Farmers who sell their products internationally use more ICT than those who sell locally.

9.4 Recommendations for the improvement of ICT use in agriculture

For the effective improvement of ICT use in agriculture and to increase the number of ICT use beneficiaries the following general recommendations need to be taken into consideration.

ICT is playing an important role in the South African agriculture, especially in the commercial sector. However, some farmers are left out in this technological revolution. Opportunities of the digital age are not equally accessible and the gap is even greater in some developing countries. In South Africa, there is a digital divide between the commercial and the small scale subsistence farmers. It is possible that a similar study on ICT use of the small-scale subsistence farmers would have shown a total opposite of what was found in this study about commercial farmers. Equitable access to information is one of the most vital principles in the emerging global information economy but this is lacking in the agriculture sector of South Africa. For agricultural development to be achieved at a national scale, there is need for small-scale subsistence farmers, especially the black counterparts, to be incorporated into this ever-growing information society. Government can play a major role by providing necessary support to the majority of small scale farmers to also use ICT on their farms. This can be done by facilitating ICT training of small scale farmers, improvement of telecommunication infrastructure in poorly developed agricultural communities and providing subsidies to small scale farmers who purchase ICT for farm use.

Although the commercial agricultural sector is advanced in terms of ICT adoption and use, there is still need to empower farm employees with the adequate resources for them to be beneficiaries of the agricultural black economic empowerment. Farm workforce is recruited from the poorest black and coloured communities, where the majority of the people are illiterate, poor and uneducated. As a result, using ICT for farm activities is a great challenge to most of the employees. Although few farmers are providing training and teaching farm workers to be literate, there is still need for more farmers to take part. From the results of the study, most farm employees need ICT training and awareness to be able to use more sophisticated technologies on the farms. This is part of BEE, to equip farm employees for them to participate fully in the agriculture sector as skilled and professional people. In summary, access to ICT is not only a question of connectivity, but also of capability to use the ICT and provision of relevant content in accessible and useful forms. This entails the need for provision of necessary ICT facilities, technical support and relevant content.

As discussed in chapter two, there is need for infrastructural development in South Africa to facilitate efficient transfer and flow of information to agricultural role players. Some areas are still under-serviced in terms of access to telecommunication and are lagging behind in technological development. Major setbacks in infrastructure development include inadequate network connections and unreliable telecommunication infrastructure (Enakrire & Onyenania, 2007).

A number of farmers indicated that they need a world stock exchange system specifically for bulk wine, where daily trading activities are made available to the whole world. This will be a giant step in the dissemination of transparent information about wine prices and marketing. This will also allow farmers to have more options in terms of better pricing for their bulk wine and a lot of options on reliable markets to sell their wine to. This may seem impossible at a national level, but globally it can be achieved through joint efforts of interested countries.

Discussed above are some of the necessary steps that need to be considered in order to accomplish success and development in the use of ICT in agriculture for the benefit of all agricultural role players. The following chapter concludes the study with a brief summary, a discussion of the limitations of the study and the prospects for future studies.

CHAPTER TEN

CONCLUSION

10.1 Introduction

This chapter presents a summary of the study and highlights the main findings and conclusions drawn from the study. The study focused on the use of ICT in Western Cape agriculture with special reference to the commercial wine industry. The study also investigated the different forms of ICT used in agriculture, how they are being used to change the face of agriculture, what they are used for in agriculture and the factors that affect their use.

Unlike most studies which focus on farmers only, and take no cognisance of the participation of the farm employees, this study focused not only on farmers but also on farm employees. The reason is that the farmers and employees are players on a commercial agriculture farm. Leaving one of them will give us inadequate information about their farm activities. Due to the inclusion of these two groups of participants, the study was in two phases. In phase one, a survey of the farmers was conducted in Robertson Wine Valley. Farmers were interviewed face-to-face to get insight on, among other things, how, when and where they use different forms of ICT in their day-to-day agricultural activities. Phase two involved the farm employees who are involved in farm activities ranging from field, winery and administrative work in Robertson Wine Valley. Face-to-face interviews were conducted with the farm employees to investigate, among other things, their use of ICT, ICT literacy, training on ICT use and challenges of using ICT. 60 farm employees and 15 farmers responded to the questionnaire and participated in the face-to-face interviews.

From the study, it was found that ICT is playing a major role in the South African wine industry and in commercial agriculture development. ICT have been successful in improving the dissemination of information to all role players in the agricultural supply chain in the agriculture industry, thereby facilitating easy communication and access to information. This makes the flow of information between farmers, intermediaries and customers easier. Besides communication purposes, using ICT have helped farmers to be aware of the best production times and be consistent in marketing standards. This has led to the production of quality wine, which gets better deals in the competitive market.

ICT has also helped to link the South African farmers with export markets where they can sell their produce. The use of ICT has facilitated not only communication with international customers and stakeholders, but also online advertising, e-commerce and traceability. The

South African wine brands are popular in the European, Asian and Middle East markets. Although they compete with other wine producing countries, they are competitive because of their quality unique wines. Exporting wine has generated income for the commercial farmers and foreign currency earnings for the South African economy. From this study, it was found that farmers have experienced enormous profits especially when the rand was weak against the American dollar. For example, huge profits were achieved in the 2001, 2002, 2006 and 2007 seasons. A summary of the research findings for this study is presented next.

10.2 Summary of research findings

Farmers acknowledged the importance of ICT in their businesses, although some of them cannot afford to adopt all the new ICT that are essential in their farming activities. All the farmers who were interviewed for the purpose of this study used more than four ICT on their farm operations, suggesting the popularity and importance of ICT in the running of farming businesses. In their order of importance, computers, landline phones, tracing/tracking software and Internet were found to be popular with the farmers when carrying out their business transactions. The major ICT primarily used for agriculture is the computer that has proved to be a more advanced and easier way of securing production and marketing information for the farmers. However, among other ICT, mobile phones and television were found to be primarily used for social and entertainment reasons rather than for agricultural purposes.

Table 10.1 shows the variables which were empirically found to be significant in this study.

Table 10.1: Significant variables empirically found in the study

Variable	Description	Type of measure	Sign	
Dependent variables				
ICTUSE (Y)	-Whether ICT is likely to be used productively for farm operations -Whether farm employee is likely to use ICT productively for farm operations	[1]=yes, [0]=no [1]=yes, [0]=no		
Independent variables				
			Farmers	**Farm employees**
AGE	Age of farmer/ employee	Years		**-**
MS	Monthly salary	Rands	**+**	**+**
EDUC	Education level	Years	**+**	**+**
FARMINC	Farm income	Rands	**+**	
HHSIZE	Household size	Numeric		**-**
OCC	Current occupation	[1]=permanent, [0]=seasonal		**+**
RACE	Race	[1]=black,[2]=coloured, [3]=white		**+**
EXP	Farm experience	Years	**+**	**-**
MKT	Market	[1]=export, [2]=local	**+**	
ICTLIT	Employee ICT literacy	[1]= high, [2] medium, [3] low		**+**
ICTTRAIN	Employee ICT training	[1]=yes, [0]=no		**+**
ATTI	Farmer/employee attitude towards ICT	[1]=positive, [0]=negative		**+**

The general findings showed that ICT training, age, race, current occupation on farm, monthly salary, education level and ICT literacy influences the use of ICT by farm employees. Gender and perception on BEE did not play any role in influencing farm employees to use ICT, although they are expected to be major ICT use determinants in normal cases.

In terms of farmers, it was found that a number of variables do not influence the use of ICT directly but may influence their management style and decision making. For example, the market, education level and farm income were highly related to a number of variables and proved to influence the decision-making of the farmers on ICT use on the farms. The market, in particular, influence the type of ICT to be used, since exporting wine entails the use of specific ICT like Internet, e-commerce and emails to facilitate communication and marketing with international customers. Lastly, it was found that farm size does not have an influence on ICT use of the farmers.

10.3 Limitation of the study

The major limitation of this study is the fact that the number of respondents, especially the number of farmers, was very small. This caused the results to differ from expectations. The validity of the results would have been more strengthened with more responses. Since it is a preliminary study, a small sampling frame was used, but for more valid results in the future, studies like these need at least 100 respondents. Unfortunately, in this study the sample was limited because it was difficult to find willing and corporative farmers in the Western Cape Province. A lot of interviews could not be done due to busy farm schedules. The few who were cooperative could only spare a few minutes of their busy harvest time.

Since this study focused on a case study, the results may not be accepted at face value to be representative of all South African commercial agricultural communities and industries. More research and investigation is needed in this area to reach a general conclusion.

10.4 Future studies

The findings, limitations and scope discussed above suggest a number of possible extensions to this study. These include:

Modeling: As already discussed above, the insufficiency in the data gathered for the farmers made it impossible to develop an exact econometric model of ICT use in the wine industry. Therefore, there is need for a larger sample of respondents to be interviewed in order to perform a regression analysis to determine the exact models for both farmers and farm employees.

Expanded study: Clearly, the study reported here gives only a partial picture of ICT use in commercial agriculture. The study will be more useful if ICT applications in other agricultural enterprises, such as livestock, dairy and crop enterprises are also investigated. This would give a broader picture on the use of ICT in the whole commercial agriculture sector. It is also recommended that other regions should be included in the study.

Small and medium scale farmers: An investigation of the ICT needs of South African small and medium scale farmers would assist in determining how best they can be empowered in the information society to use ICT productively for agricultural purposes. This will also assist in the identification of the effects of ICT on the livelihoods of this class of agricultural workers.

Other possible research areas that can be investigated include the development of e-agriculture in South Africa, opportunities and challenges of e-agriculture in South Africa. A

number of issues on e-agriculture in South Africa are still to be explored and investigated. Some include the institutional and policy mechanisms that need to be adopted for ICT use development in agriculture.

10.5 Concluding remarks

In summary, the objectives of the study were achieved. The uses of different ICT used by the farmers and their farm workers have been discussed. The benefits and problems encountered in using ICT were outlined. Some of the benefits identified include easy dissemination of information among the supply chain role players, better storage of farm data and the saving of time and labour. Identification of factors and variables that are related to and influence the use of ICT by the farmers and their farm employees was done and demonstrated by use of chi-square tests and correlation analysis. However, it should be noted that the factors affecting ICT use may differ depending on a number of factors including geographical location and the agricultural enterprise.

From the results of the study, it can be surmised that ICT can have far-reaching development impact in providing agricultural role players access to knowledge, information and markets in the globalized world. Many, if not most, activities in the agricultural marketplace are now mediated by web-linked databases specifying prices, qualities and quantities demanded. One major development that has benefited the farmers is the use of e-commerce. Unlike the previous forms of ICT, such as fax, telephone and telex, e-commerce represents a major step in the ability to bring buyers and sellers closer together. A number of important issues and limitations were not addressed in this study. Based on that, a number of possible future extensions of the study were proposed. In conclusion, the role players in the agricultural food supply chain cannot underestimate the role played by ICT in improving and transforming the face of agriculture.

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APPENDICES

APPENDIX A: ICT penetration in Africa

	Population	*Main telephone lines*		*Mobile subscribers*		*Internet users*	
	000s	*000s*	*per 100 inhabitants*	*000s*	*per 100 inhabitants*	*000s*	*per 100 inhabitants*
Algeria	33'354	2841.3	8.52	20'998.0	62.95	2'460.0	7.38
Egypt	75'437	10807.7	14.33	18'001.1	23.86	6'000.0	7.95
Libya	5'968	483.0	8.09	3'927.6	65.81	*232.0*	*3.96*
Morocco	30'735	1266.1	4.12	16'004.7	52.07	6'100.0	19.85
Tunisia	10'210	1'268.5	12.42	7'339.1	71.88	1'294.9	12.68
North Africa	**155'704**	**16666.6**	**10.70**	**66'270.5**	**42.56**	**16'086.9**	**10.34**
South Africa	47'594	*4729.0*	*9.97*	39'662.0	83.33	*5'100.0*	*10.75*
South Africa	**47'594**	**4729.0**	**9.97**	**39'662.0**	**83.33**	**5'100.0**	**10.75**
Angola	15'802	98.2	0.62	2'264.2	14.33	*85.0*	*0.55*
Benin	8'703	77.3	0.89	1'056.0	12.13	700.0	8.04
Botswana	1'760	136.9	7.78	979.8	55.68	*60.0*	*3.40*
Burkina Faso	13'634	94.8	0.70	1'016.6	7.46	80.0	0.59
Burundi	7'834	31.1	0.41	*153.0*	*2.03*	60.0	0.77
Cameroon	16'601	100.3	0.61	*2'252.5*	*13.80*	370.0	2.23
Cape Verde	519	71.6	13.80	108.9	20.99	*29.0*	*6.09*
Central African Rep.	4'093	10.0	0.25	*100.0*	*2.48*	13.0	0.32
Chad	10'032	13.0	0.13	466.1	4.65	60.0	0.60
Comoros	819	*16.9*	*2.12*	*16.1*	*2.01*	21.0	2.56
Congo	4'117	*15.9*	*0.40*	*490.0*	*12.25*	70.0	1.70
Côte d'Ivoire	18'454	260.9	1.41	4'065.4	22.03	300.0	1.63
D.R. Congo	59'320	9.7	0.02	4'415.0	7.44	180.0	0.30
Djibouti	807	10.8	1.56	*44.1*	*6.37*	11.0	1.36
Equatorial Guinea	515	10.0	1.99	*96.9*	*19.26*	8.0	1.55
Eritrea	4'560	37.5	0.82	62.0	1.36	100.0	2.19
Ethiopia	79'289	725.1	0.91	866.7	1.09	164.0	0.21
Gabon	1'406	36.5	2.59	764.7	54.39	81.0	5.76
Gambia	1'556	52.9	3.40	404.3	25.99	58.0	3.82
Ghana	22'556	356.4	1.58	5'207.2	23.09	609.8	2.70
Guinea	9'603	26.3	0.33	*189.0*	*2.36*	50.0	0.52
Guinea-Bissau	1'634	*10.2*	*0.76*	*95.0*	*7.10*	37.0	2.26
Kenya	35'106	293.4	0.84	6'484.8	18.47	2'770.3	7.89
Lesotho	1'791	*48.0*	*2.67*	*249.8*	*13.92*	*51.5*	*2.87*
Liberia	3'356	6.9	0.21	*160.0*	*4.87*	...	...
Madagascar	19'105	129.8	0.68	1'045.9	5.47	110.0	0.58
Malawi	13'166	*102.7*	*0.80*	*429.3*	*3.33*	59.7	0.45
Mali	13'918	82.5	0.59	1'513.0	10.87	70.0	0.50
Mauritania	3'158	34.9	1.10	1'060.1	33.57	100.0	3.17
Mauritius	1'256	357.3	28.45	722.4	61.50	*300.0*	*24.10*
Mozambique	20'158	67.0	0.33	2'339.3	11.60	*178.0*	*0.90*
Namibia	2'052	*138.9*	*6.84*	*495.0*	*24.37*	80.6	3.97
Niger	14'426	*24.0*	*0.17*	*323.9*	*2.32*	40.0	0.28
Nigeria	134'375	1688.0	1.26	32'322.2	24.05	8'000.0	5.95
Rwanda	9'230	16.5	0.18	314.0	3.40	65.0	0.70
S. Tomé & Principe	160	7.6	4.74	18.0	11.51	29.0	18.11
Senegal	11'936	282.6	2.37	2'982.6	24.99	650.0	5.45
Seychelles	81	20.7	25.44	70.3	86.52	29.0	35.67
Sierra Leone	5'678	24.0	0.49	*113.2*	*2.21*	*10.0*	*0.19*
Somalia	8'496	*100.0*	*1.22*	*500.0*	*6.08*	94.0	1.11
Sudan	36'993	636.9	1.72	4'683.1	12.66	3'500.0	9.46
Swaziland	1'029	44.0	4.27	250.0	24.29	*41.6*	*4.02*
Tanzania	39'025	157.3	0.40	5'767.0	14.78	*384.3*	*1.00*
Togo	6'306	82.1	1.30	708.0	11.23	320.0	5.07
Uganda	29'856	108.1	0.36	2'008.8	6.73	750.0	2.51
Zambia	11'861	93.4	0.79	1'663.0	14.02	500.0	4.22
Zimbabwe	13'085	331.7	2.54	832.5	6.36	1'220.0	9.32
Sub-Saharan	**719'220**	**7080.4**	**0.99**	**92'220.0**	**12.90**	**22'499.7**	**3.16**
Africa	**922'510**	**28475.9**	**3.10**	**198'153.0**	**21.58**	**43'686.7**	**4.77**

(Adapted from International Telecommunication Union, 2007)

APPENDIX B: Questionnaire for farmers

Survey questionnaire to be used for interviews with the farmers

A research survey investigating the use of ICT in agriculture

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, ICT access and factors influencing the use of ICT among agricultural communities in the Western Cape.

The results of the study will portray how ICT is deployed for agricultural purposes. This will help us better to understand the ICT needs of agricultural communities in South Africa. With the final output from the survey, a Master's thesis will be developed and submitted at the end of the academic year 2008.

The questionnaire 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. Your honesty and cooperation is greatly appreciated. We would be grateful for your favourable contribution towards the success of this survey.

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Key definition

Information and Communication Technology (ICT) - A set of activities that consists of hardware, software, networks and media that facilitate or make it easy to collect, store, process, transmit, 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.

Section 1: Farm activities

Q1. Which fruits do you produce on your farm?

[1] ☐ Grapes

[2] ☐ Peaches

[3] ☐ Plums

[4] ☐ Cherries

[5] ☐ Other (specify) ……

Q2. Which of the following enterprises do you have on your farm?

[1] ☐ Livestock

[2] ☐ Fruits

[3] ☐ Dairy

[4] ☐ Field crops

Q3. What is the size of your farm in hectares?

……..

Q4. How many hectares are specifically for fruit production?

Fruit	Hectares
Grapes	
Peaches	
Plums	
Cherries	
Other (specify)	
Total	

Q5. Which of the following assets do you have on your farm? Please tick the appropriate options

Tractors	
Combine harvesters	
Pre-cooling and cold storage facilities	
Others (specify)	

Q6. How many minutes do you take to drive to the nearby town? ……

Section 2: ICT use patterns

Q7. Do you use the following ICT at your farm? Tick the ICT that you use. Also indicate when you started using each ICT

		Year
Computers		
Internet		
Fax		
Printers		
Photocopiers		
Landline telephones		
Mobile phone		
Two-way radios		
Personal digital assistant (PDA)		
Other hardware (specify)		

		Year
Computerized irrigation system		
Bar code system		
Email		
Precision agriculture system		
Global positioning systems (GPS)		
Tracking /tracing software		
Other software (specify)		

Q8. Do you have your own website? If yes, indicate it

[1] ☐ Yes ……..

[2] ☐ No

Q9. Do you have any business goals with regard to ICT?

[1] ☐ Yes

[2] ☐ No

Q9.1 If yes, state them

[1]……

[2]……

[3]……

Q10. How do you purchase ICT for your farm use?

[1] ☐ Personal decision

[2] ☐ Expert advice

[3] ☐ Extension service recommendations

[4] ☐ Response to advertisements on TV/ radio & other media

[5] ☐ Other e.g. combination of the above

Q11. Do you use the following ICT for personal or business purposes?

	[1]=Personal	**[2]=Business**	**[3]=Both**
Computers			
Internet			
Email			
Website			
Fax			
Printers			
Photocopiers			
Landline telephones			
Mobile phone			
Personal digital assistant (PDA)			
Two-way radios			
Television			
Radio			

Q12. How many hours do you spend using the following ICT per week?

Assign **[1]** = 0 - 3 hours, **[2]** = 4 -6 hours, **[3]** = 7+ hours

	Hours
Computer	
Printer	

Internet (worldwide web)	
Email	
Landline phone	
Mobile phone	
Other (specify)	

Q13. Which mobile operator do you use?

[1] ☐ Vodacom

[2] ☐ Cell C

[3] ☐ MTN

[4] ☐ Virgin mobile

Q14. How is your sim card classified?

[1] ☐ Prepaid

[2] ☐ Contract

[3] ☐ Borrowed

[4] ☐ Other (specify)

Q15. Which Computer-Mediated Communication (CMC) services do you use? Please tick

Internet	
Email with customers and suppliers	
Online banking	
E-commerce (transactions online)	

Q16. Which ICT do you use for the following functions?

[1] Traceability of the fruits from the orchard/ vineyard to the consumer ……

[2] Security & emergency management ……

[3] Pre-cooling, storage and safety of fruits……

[4] Other (specify)……

Q17. Select the ICT that you use for the following stages along the supply chain

Technology	[1]=Input procurement	[2]=Production	[3]=Packing	[4]=Marketing	[5]=Sales
Global positioning system					
Precision farming					
Bar codes					
Computer					
Mobile phone					
Internet					
E-commerce					
Fax					
Email					
Printer					
Landline phone					
Computerised irrigation system					

Q18. What are the advantages and disadvantages of using ICT in the following stages?

	Advantages	Disadvantages
Input procurement (e.g. orders)		
Production		
Packing		
Marketing & distribution		
Sales		
Other (specify)		

Q19. What purposes do you use the computer for?

[1] ☐ Preparing farm budgets

[2] ☐ Accounting

[3] ☐ Keeping farm and payroll records

[4] ☐ Tracking system

[5] ☐ Irrigation scheduling and water budgeting

[6] ☐ Other (specify) ……

Q20. Are your computers connected to the Internet?

[1] ☐ Yes

[2] ☐ No

Q21. Where do you access the Internet?

[1] ☐ Nearby Internet café

[2] ☐ Community telecentre

[3] ☐ In town

[4] ☐ At home

[5] ☐ Nowhere

Q22. What do you use the Internet mainly for?

[1] ☐ Accessing agricultural information

[2] ☐ Communication purposes

[3] ☐ Online transactions (e-commerce)

[4] ☐ Other (specify) ……..

Q23. Do you advertise your products?

[1] ☐ Yes

[2] ☐ No

Q23.1 If yes, which ICT do you use?

[1] ☐ Website

[2] ☐ Television

[3] ☐ Posters, newspapers

[4] ☐ Radio

[5] ☐ Other (specify) ……

Q24. Indicate the ICT that you mainly use for the following duties?

	[1]=L/line phone	**[2]=Mobile phone/PDA**	**[3]=Digital radio**	**[4]=E-commerce**	**[5]=Online banking**	**[6]=E-mail**	**[7]=Fax**
Communication with customers							
Customer care							
Communication with input suppliers							
Supplier care							
Communication with marketing agent							
Communication with your bank							
Communication with other farmers							
Communication with your family							

Q25. Do you use ICT specifically for decision- making? If Yes, for which decisions

……

……

……

Q26. What benefits have you gained from using ICT on your farm?

……

……

Q27. Which of the following ICT are convenient to use?

Cell phone	
Land line phone	
Computer	
Internet	
Email	
Fax	
Television	
Personal Digital Assistant (PDA)	
Radio	

Q28. Which ICT do you mainly use for weather report updates and forecasts?

……

……

Q29. From which sources do you get ICT related information?

Assign **[1]** = sources mostly used, **[2]** = sources sometimes used, **[3]** = sources least used/ not used at all

Source	**Use**
ICT suppliers/ vendors	
Internet	
Newspapers, magazines, journals	
Government departments	
Other (specify)	

Q30. Where do you sell the bulk of your fruits / wine?

Produce	[1]=Export	[2] =Local	[3]= Both

Q31. Are you in a contract with any marketing agent?

[1] ☐ Yes

[2] ☐ No

Q31.1 If yes, for how long have you been in that contract?

Marketing agent	Duration (years)

Section 3: ICT costs and constraints

Q32. On average how much do you spend on the following ICT services per month?

Assign **[1]** = <R3 000, **[2]** = R3 000- R6 000, **[3]** = R6 000 +

[1] ☐ Landline phone/Internet

[2] ☐ Fax

[3] ☐ Printer

[4] ☐ Mobile phone

[5] ☐ Other (specify)……

Q33. What are the major problems that you encounter when using ICT, in general?

[1] ☐ Language and content limitations

[2] ☐ Poor network and reception

[3] ☐ Time consuming

[4] ☐ Expensive to use

[5] ☐ Other (specify)……

Q34. What are the constraints that limit you from adopting ICT?

[1] ☐ High cost of ICT

[2] ☐ Poor ICT infrastructure

[3] ☐ Lack of ICT awareness

[4] ☐ Lack of ICT training

[5] ☐ Other (specify) ……

Section 4: Employees and ICT

Q35. Do you communicate with your farm employees using ICT?

[1] ☐ Yes

[2] ☐ No

Q36. Do you provide formal training to your employees on how to use ICT at work?

[1] ☐ Yes

[2] ☐ No

Q36.1 If No, why? ……

Q37. If Yes in question 36, to which employees?

[1] ☐ Permanent orchard/ vineyard employees

[2] ☐ Seasonal orchard/ vineyard employees

[3] ☐ Administrative employees

[4] ☐ Winery employees

Q38. Which source do you use to train your employees?

Assign **[1]** = sources mostly used, **[2]** = sources sometimes used, **[3]** = sources least used/ not used at all

Source	Use
Experts within the farm	
Internet	
Private sector specialists	
Government departments	
Other (specify)	

Section 5: Perceptions and attitudes

Q39. Which ICT do you intend to buy in the future? Rank in order of importance.

[1]……..

[2]……

[3]…….

Q40. Which new technology do you feel is needed to support and improve agriculture? Rank in order of importance

[1] ……

[2] ……...

[3] ……

Q41. The initiative of Black Economic Empowerment (BEE) will have a positive impact on South African agriculture

[1] Strongly agree

[2] Agree

[3] Neutral ☐

[4] Disagree

[5] Strongly disagree

Q42. The benefits of ICT are greater than the costs

[1] Strongly agree

[2] Agree

[3] Neutral ☐

[4] Disagree

[5] Strongly disagree

Q43. Adoption of ICT improves agricultural development

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q44. ICT facilitates the easy flow of and access to information

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q45. ICT could enhance the profitability of farm enterprises

[1] ☐ Yes
[2] ☐ No

Q46. ICT can be used to form farming business partnerships

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q47. Which ICT do you need as a farmer for the improvement of your work?

[1] ☐ Computers & computerized systems
[2] ☐ Landline & mobile phones
[3] ☐ Internet and emails
[4] ☐ Data projectors
[5] ☐ Other (specify)……

Q48. What agricultural information do you consider relevant to your needs? Tick the appropriate options

Market information	
Input and output prices	
Weather forecasts	

General agricultural news	
Latest agriculture practices and technologies	
Warning systems about diseases and pests	
Radio question and answer service	
Farm business and management	
Other (specify)	

Section 6: Demographics

Q49. What is your gender?

[1] Male
[2] Female ☐

Q50. What is your marital status?

[1] Married
[2] Single ☐

Q51. Indicate your race

[1] Black
[2] Coloured ☐
[3] White
[4] Indian
[5] Other (specify) ……..

Q52. State your age

[1] 20 and below
[2] 21 - 40 ☐
[3] 41 - 60
[4] 61 and above

Q53. What is your household size? ☐

Q54. How many years of experience do you have in fruit production on your farm? ☐

Q55. Please indicate your highest level of education

[1] Primary
[2] Matric ☐
[3] College
[4] University

Q56. Do you have any formal agricultural qualification?

[1] ☐ Yes

[2] ☐ No

Q56.1 If yes, indicate its category:

[1] ☐ Certificate

[2] ☐ Diploma

[3] ☐ Degree

Q57. Are you the owner of the farm or the manager?

[1] ☐ Farmer

[2] ☐ Manager

[3] ☐ Both

Q58. What is your average farm income per month?

[1] Less than R200 000
[2] R200 000 – R500 000 ☐
[3] R500 000 +

Q59. What is your average personal salary per month?

[1] Less than R20 000
[2] R20 000 – R50 000 ☐
[3] R50 000 +

Q60. Do you have any permanent off-farm income?

[1] ☐ Yes

[2] ☐ No

Q60.1 If yes in question 60, which of the following is the main source of off-farm income?

[1] ☐ Pension fund

[2] ☐ Remittances

[3] ☐ Government grants

[4] ☐ Investments

[5] ☐ Other (specify)…….

Q61. What is your average off-farm income per month?

[1] Less than R50 000

[2] R50 000 – R100 000 ☐

[3] R100 000 +

THANK YOU FOR YOUR COOPERATION. MAY GOD BLESS YOU!!!!!

APPENDIX C: Questionnaire for farm employees

Survey questionnaire to be used for interviews with the farm employees

A research survey investigating the use of ICT in agriculture

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) for agriculture. It will focus on the use of different forms of ICT, ICT access and factors influencing use of ICT in agricultural communities in the Western Cape.

The results of the study will portray how ICT is deployed for agricultural purposes. This will help us better to understand the ICT needs of agricultural communities in South Africa. With the final output from the survey, a Master's thesis will be developed and submitted at the end of the academic year 2008.

The questionnaire is expected to take approximately 15 to 20 minutes.

Informed consent

Participation of farm employees 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. Your honesty and cooperation is greatly appreciated. We would be grateful for your favourable contribution towards the success of this survey.

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Key definition

Information and Communication Technology (ICT) - A set of activities that consists of hardware, software, networks and media that facilitate or make it easy to collect, store, process, transmit, 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.

Section 1: ICT access

Q1. Do you have access to a computer? (Tick as many options as possible)

[1] ☐ Yes, at home

[2] ☐ Yes, at work

[3] ☐ Yes, at Internet café

[4] ☐ Other (specify) ……

[5] ☐ None

Q2. Do you have access to the Internet? (Tick as many options as possible)

[1] ☐ Yes, at home

[2] ☐ Yes, at work

[3] ☐ Yes, at Internet café

[4] ☐ Yes, at community centre

[5] ☐ None

Q3. Do you use an email?

[1] ☐ Yes

[2] ☐ No

Q4. How long do you take to travel to the nearby town using the following options?

	Minutes
Walking	
Taxi ride	
Driving	

Q5. Which of the following ICT do you have at home? Please tick the options

Cell phone	
Television	
Radio	
Two-way radio	
Landline phone	
Computer	
Personal Digital Assistant (PDA)	
E-mail	
Fax machine	
Printer	
Internet	

Q6. Which mobile operator do you use?

[1] ☐ Vodacom

[2] ☐ Cell C

[3] ☐ MTN

[4] ☐ Virgin mobile

[5] ☐ More than one

Q7. How is your sim card classified?

[1] ☐ Prepaid

[2] ☐ Contract

[3] ☐ Borrowed

[4] ☐ Other (specify) …….

Section 2: ICT awareness and use patterns

Q8. Do you use ICT on your farm to support farming activities?

[1] ☐ Yes

[2] ☐ No

Q9. Do you know how to use the following ICT? Please tick the appropriate options

Computers	
Internet	
Fax	
Printers	
Photocopiers	
Landline telephones	
Mobile phone	
Two-way radios	
Personal digital assistant (PDA)	
Other hardware (specify)	

Computerized irrigation system	
Bar code system	
Email	
Precision agriculture system	
Global positioning systems (GPS)	
Tracking /tracing software	
Other software (specify)	

Q10. Did you receive any formal training to use any of the ICT in Question 9?

[1] ☐ Yes

[2] ☐ No

Q10.1 If yes, who trained you?

[1] ☐ Private consultants

[2] ☐ Experts within the farm

[3] ☐ Other (specify) ……

Q11. Do you know how to access Internet on your own?

[1] ☐ Yes

[2] ☐ No

Q12. Do you use the following ICT for personal or business purposes?

	[1]=Personal	[2]=Business	[3]=Both
Cell phone			
Television			
Radio			
Two-way radio			
Landline phone			
Computer			
Personal Digital Assistant (PDA)			
Email			
Fax machine			
Printer			
Internet			

Q13. Indicate the ICT that you have difficulty using? Tick the appropriate options

Computers	
Internet	
Fax	
Printers	
Photocopiers	
Landline telephones	
Mobile phone	
Two-way radios	
Personal digital assistant (PDA)	
Other hardware (specify)	

Computerized irrigation system	
Bar code system	
Email	
Precision agriculture system	
Global positioning systems (GPS)	
Tracking /tracing software	
Other software (specify)	

Q14. How many hours do you spend using the following ICT per week?

Assign **[1]** = 0 - 3 hours, **[2]** = 4 -6 hours, **[3]** = 7+ hours

	Hours
Computer	
Printer	

Internet (worldwide web)	
Email	
Landline phone	
Mobile phone	
Other(specify)	

Q15. What do you use the following ICT for? Please tick the appropriate option

	[1] = Input Ordering	[2]=Production	[3]=Packing	[4]=Marketing	[5]=Sales
Computer					
Email					
Internet (worldwide web)					
Telephone					
Mobile phone					
Bar code system					
Computerized irrigation system					
Tracking software					
Global positioning system					
Two-way radio					
Fax					
Precision agriculture					

Q16. Which of the following ICT are convenient to use?

Cell phone	
Land line phone	
Computer	
Internet	
Email	
Fax	
Television	
Personal Digital Assistant (PDA)	
Radio	

Q17. Indicate the ICT that you mainly use for the following duties?

	[1]=L/line phone	[2]=Mobile phone	[3]=Digital radio	[4]=E-commerce	[5]=Online banking	[6]=E-mail	[7]=Fax
Communication with the customers							
Customer care							
Communication with your employer							
Communication with your bank							
Communication when there is an emergency							
Communication with your family							
Communication with your relatives & friends							

Section 3: Perceptions and attitudes

Q18. The initiative of Black Economic Empowerment (BEE) will have a positive impact on South African agriculture

[1] Strongly agree
[2] Agree
[3] Neutral
[4] Disagree
[5] Strongly disagree

Q19. ICT promotes access to banking

[1] Strongly agree
[2] Agree
[3] Neutral
[4] Disagree
[5] Strongly disagree

Q20. ICT makes work easier

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q21. The use of ICT saves time

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q22. ICT is not affordable because of high costs

[1] ☐ Yes

[2] ☐ No

Q23. I am satisfied with the services offered by ICT

[1] ☐ Yes

[2] ☐ No

Q24. The use of ICT in agriculture leads to improved productivity

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q25. Adoption of ICT is important for agricultural development

[1] Strongly agree
[2] Agree
[3] Neutral ☐
[4] Disagree
[5] Strongly disagree

Q26. ICT would be more effective if local language is used

[1] Strongly agree
[2] Agree ☐
[3] Neutral
[4] Disagree
[5] Strongly disagree

Q27. Does ICT help to increase your income?

[1] ☐ Yes

[2] ☐ No

Q28. Is it important to educate your children about ICT?

[1] ☐ Yes

[2] ☐ No

Q29. Which local language would you prefer being used in ICT related information?

[1] ☐ Afrikaans

[2] ☐ Xhosa

[3] ☐ English

[4] ☐ Other (specify)……

Q30. What are the major problems that you face when using ICT in general?

[1] ☐ Language and content limitations

[2] ☐ Poor network and reception

[3] ☐ Time consuming

[4] ☐ Expensive to use

[5] ☐ Other (specify)……

Q31. What are the constraints that limit you from adopting ICT?

[1] ☐ High cost of ICT

[2] ☐ Poor ICT infrastructure

[3] ☐ Lack of ICT awareness

[4] ☐ Lack of ICT training

[5] ☐ Other (specify) ……

Q32. Which ICT do you need as farm employees for the improvement of your work?

[1] ☐ Computers & computerized systems

[2] ☐ Landline & mobile phones

[3] ☐ Internet and emails

[4] ☐ Data projectors

[5] ☐ Other (specify)……

Section 4: Demographics

Q33. What is your gender?

[1] Male

[2] Female ☐

Q34. State your age

[1] 30 and below

[2] 31 - 40

[3] 41 - 50 ☐

[4]. 51 and above

Q35. What is your marital status?

[1] Married ☐

[2] Single

Q36. Indicate your race

[1] Black

[2] Coloured

[3] White
[4] Indian
[5] Other (specify) ……..

Q37. What is your current occupation on the farm?

[1] Seasonal vineyard/orchard employee
[2] Permanent vineyard/orchard employee
[3] Administrative employee
[4] Winery employee

Q38. For how many years have you been working on a farm?

Q39. What is your average salary per month?

[1] Less than R4 000
[2] R4 000 – R8 000
[3] R8 000 +

Q40. Do you have any permanent off-farm income?

[1] Yes
[2] No

Q41. If yes in question 40, which of the following is the main source of your off-farm income?

[1] Pension fund
[2] Remittances
[3] Government grants
[4] Investments
[5] Other (specify)……

Q42. What is your average off-farm income per month?

[1] Less than R2 000
[2] R2 000 – R4 000
[3] R4 000 +

Q43. What is your highest level of education?

[1] Primary
[2] Matric
[3] College
[4] University

☐

Q44. What is your household size? ☐

THANK YOU FOR YOUR COOPERATION. MAY GOD BLESS YOU!!!!!