AN ANALYSIS OF THE EFFECTIVENESS/IMPACT OF ICTs IN DAIRY PRODUCTION- A CASE OF ZIMBABWE’S MASHONALAND EAST'S BEATRICE-MARIRANWE DAIRY FARMERS

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DECLARATION

I, Million Chauke, do hereby declare that this dissertation is the result of my own investigation and research, except to the extent indicated in the acknowledgements, references and by comments included in the body of the report, and that it has not been submitted in part or in full for any other degree to any other university.

Student’s signature ______________________________     Date_______________

Supervisor’s name ___________________________________________________

Supervisor’s Signature ____________________________    Date: ______________
DEDICATION

This work is dedicated to my beautiful and loving wife Florence, and our two sons Tsembani and Amukelani. Should the Almighty bless us with more children, I also dedicate it to them *apriori*. 
ACKNOWLEDGEMENTS

To the Almighty, for hisson our Saviour Jesus Christ, his Grace and Presence, Hallowed be thy name.

To my supervisor Dr. G.T. Hapanyengwi, who went out of his way to make this piece of work a success, thanks a million times, may the good Lord continue to bless you.

I would also like to express my indebtedness to my family, who continued to walk without me for extended periods and all Graduate School lecturers, without whom this study would be non-existent.

I would like to sincerely acknowledge the dairy farmers in the Beatrice-Marirangwe area whom I interacted with during the data collection exercise, who left their busy farming schedules to attend to my academic pursuit.
ABSTRACT

This study analyses the effectiveness/Impact of ICTs in dairy production. This is a case study of Zimbabwe’s Mashonaland East BEATRICE-MARIRANWE Dairy farmers. By nature, dairy production is a complex business that involves handling of massive data and information. This makes dairy production a good candidate for use of ICTs to improve sector competitiveness. It is against this background that the study sought to investigate the extent of use of ICTs in dairy production in Zimbabwe.

Information from the farmers was gathered through questionnaires and personal interviews. The analysis of the study was both qualitative and quantitative.

The study found out that there is low uptake of ICTs in the dairy sector. The recommendation focused on improving uptake of ICTs, networking and thus improving competitiveness of the dairy sector. Paramount to the recommendations was the designing of the national dairy ICTs architecture. The architecture emphasises on maximising conditions for local innovation and creative public-private partnerships to expand ICT access and services.
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LIST OF ABBREVIATIONS

A.I- Artificial Insemination
Agro-ICTs- Agricultural Information Communication Technologies
ARDA- Agricultural and Rural Development Authority
AREX- Agricultural Research and Extension Services
CA- Contagous Abortion
CSO-Central Statistics Office, now called Zimbabwe Statistics
CZI- Confederation of Zimbabwean Industries
DDP- Dairy Development Programme
DMB- Dairy Marketing Board
DRSS- Department of Research and Special Services
GIS-Geographical Information Systems
GNU- Government of National Unity
GPS- Global Positioning Systems
ICT4D-ICT for Development
ICTs-Information Communication Technologies
IICD-International Institute for Communication and Development
Kg- Kilogrammes
LPD- Livestock production department
MDGs- Millennium Development Goals
MIS- Management Information Systems
MOET- Multi Ovulation and Embryo Transfer
NDFA- National Dairy Farmers Association of Zimbabwe
NGOs- Non Governmental Organisations
PESTEL- Political, Economic, Social, Technological, Environmental and Legal analysis
SPSS- A Statistical Package for Social Scientists
TB- Tuberculosis
UNCTAD- United Nations Conference on Trade and development
UNDP- United Nations Development Programme
ZESA- Zimbabwe Electricity Supply Authority
CHAPTER ONE

INTRODUCTION AND BACKGROUND

INTRODUCTION

Agriculture is the cornerstone of the Zimbabwean economy. Besides informal sources like neighboring farmers and friends, it is generally accepted that information to sustain and increase agricultural production is spread by different agencies, notably, universities, research institutes, extension services, commercial enterprises, and non-governmental organizations (NGOs). However, this knowledge is often poorly documented or difficult to access.

This study looks into the effectiveness/impact of ICTs in dairy production. The chapter provides the background of the study, the problem statement, research objectives, research questions and scope of the study. The justification for carrying out the study and dissertation outline is also provided. The chapter ends with a chapter summary.

1.1 BACKGROUND INFORMATION

There is growing recognition within the business community in and the agricultural sector, that there is potential contribution of Information and Communication Technologies (ICT) in achieving development objectives. In the Agricultural sector, this growing interest in ICT is generating strong demand for new evidence, approaches, and business models.

In developing countries agriculture is the cornerstone of rural development projects. In Zimbabwe it is regarded as ‘the backbone of the economy’. Notwithstanding this potential, concrete evidence of ICT’s impact remains incomplete.
In Zimbabwe, guidance on proper design and deployment of ICT interventions in Agriculture in general and dairy production in particular, is not available.

While the importance of information and communication in business in general is well appreciated, the contribution of ICT to agriculture is less well-understood, and rapidly changing. New technologies, new applications and new business models and their wider availability and affordability, are offering new and broader opportunities for farmers.

Technologies are evolving very fast. These technologies are driving changes in agriculture that make it even more urgent to understand their potential and pitfalls. This dramatic and rapid expansion in global information and communication technologies, and the resultant proliferation of new information and communication devices, applications, services and business models pose significant new opportunities (and of course new threats) for the agricultural industry. Global food markets have both opened market opportunities for developing countries but at the same time creating new risks, volatility, and challenges to agricultural value chains that increasingly depend on technical sophistication for speed, scale, customization and food safety.

The increased global networking in agriculture and the demand of global class higher value-added, more diversified food products necessitate more time-urgent and contextualized information about crop varieties, supporting technologies, market trends, trading partners and the competition.

Poor smallholders face an increased risk of being left at the bottom of the value chain, seeking to earn income from commodity crops that are increasingly volatile in price. These farmers are faced with substantial information disadvantages such as costs imposed by physical isolation, weak infrastructure and asymmetric access. This also limits their leverage at market and their ability to innovate in response to changing business environments.
The challenge for agriculture in developing countries like Zimbabwe, then, is to harness the power of ICT to compete in complex and rapidly-changing regional and global markets. This entails empowering poor smallholders with information and communication assets and services that can increase their productivity and income. This becomes more pertinent in Zimbabwe today because of the existence of many small farmers, most of them financially challenged, following the implementation of the Agrarian Reform.

The increasing diversity and complexity of global agriculture, and the speed of global innovation in ICT tools, services and business models, require maximizing conditions for local innovation and creative public-private partnerships to expand ICT access and services. In Bolivia, Ghana and Jamaica governments are increasingly realising the necessity to link ICT and agriculture and thus incorporate ICT in agricultural sector policies and programmes, (Stienen, Bruinsma and Neuman, 2007). In this regard, the International Institute for Communication and Development (IICD) has been supporting policy processes in these countries for national ICT for Development (ICT4D). It is therefore the aim of this study to deliberate on the impact of ICT in dairy farming.

1.1.1 Overview of Zimbabwean Agricultural Industry
The Zimbabwean Agricultural industry is divided into a matrix of sectors. The horizontal plane consists of the following sectors:

a) Large scale commercial sector (the A2 sector)
b) Small scale (A1) sector
c) Resettlement (refers to those areas resettled before the onset of the land reform programme)
d) Subsistence sector (consists largely of traditional rural farmers)

The vertical plane consists of the following:

a) Livestock production
b) Crop Production and
c) Forests and Plantations
Of relevancy in this study is the livestock industry in which the dairy sector under study belongs. In an attempt to bring out the relative position of the dairy sub-sector in the industry the author has conceptualised the following figure:

![Figure 1.1: The Relative Position of the Dairy Sector in the Agricultural Industry.](image)

### 1.1.2 The Dairy Sub Sector

The Dairy sub-sector in Zimbabwe plays a pivotal role in the country’s agricultural sector, providing the nation with nutrition, while simultaneously creating employment and earning the country much-needed foreign currency. The sector has evolved over the years, gradually transforming itself through the implementation of a Government-driven land reform program, which commenced in the late 1990s. Production systems range from extensive, low cost systems to intensive, zero-grazing (cut-and-carry) systems.
The major trends and developments for the industry are as follows:

i. Milk production has been on the decline since 1990, creating a huge gap between supply and demand. The country's population was 7.6 million in 1982 and is currently estimated at 14 million. Per capita consumption declined from 25 litres in 1990 to an estimated 7 litres in the year 2012.

ii. The number of registered producers increased from 364 in 1980 to 514 in 1990 and is estimated to be around 150 in 2012.

iii. The national dairy herd declined from 119,000 dairy animals in 1992 to an about 26,000 in 2012. The predominant dairy cattle breeds are the Holstein-Friesian breeds, followed by Jersey, Ayrshire, Guernsey, Redpoll, Simmental and Red Dane. These high yielding breeds are more susceptible to diseases and require intensive management.

iv. Due to escalating costs of commercial feeds, there has been a recent trend towards feeds grown on the farm. Feeding in this subsector is based on maize and its by-products for energy, soya beans and cottonseed cake for protein. The major sources of roughage are natural grass, standing (range) hay and maize silage. Where irrigation is available oats, midmar rye and lucerne (Medicago saliva) are grown. Some producers have witnessed decline in productivity per cow per day from an average 26 litres to less than 15 litres due to feed constraints.

v. Zimbabwe benefited from genetic progress by accessing Canadian and American semen for artificial insemination (A.I.) in local herds. There was however some retrogression in this area as semen importation became a ‘luxury’ following the decade of economic malaise.

vi. The country Zimbabwe has seven major processing companies and more than twenty smaller players, including producer-retailers who supply to an established processor as well as process part of their output. Milk distribution covers all areas of the country including the rural areas. (Dairy Services; CSO, 2012).
1.2. THE BEATRICE-MARIRANGWE DAIRY FARMING AREA

This is the case study area. It is a unique area in that two dairy sectors, Beatrice (a large scale sector) and Marirangwe (a small scale sector) are located close to each other. This area lies within forty to a hundred kilometers on both sides of the Harare-Masvingo road.

Marirangwe was set up and run by the Agricultural and Rural Development Agency ARDA under its Dairy Development Programme (DDP).

1.3 ENVIRONMENTAL/PESTEL ANALYSIS

Using the PESTEL model the researcher is going to look at the key points affecting the environment within which telecommunication companies are operating.

1.3.1 Political
The political situation is marked by a quasi-stable environment brought about by Government of National Unity has been ruling the country for the past five years before the 2013 elections. The Indigenization Act has remained a thorny issue in some sectors of the economy.

These and other issues affect the flow of capital into the country, growth is slow and the speculative attitude limits the companies from spending on capital projects which directly impacts our business.

1.3.2 Economic
The relative stable political environment has enabled the economy to grow by an average of 6% between 2009 and 2012. Prices have largely stabilized and the annual inflation averaged 3.1% and compares favorably to regional averages of around 8-15%.

The economy has recorded a real growth per year in 2010 and 2011 of more than 9%, though faced with economic, infrastructural, regulatory deficiencies, policy uncertainty and ongoing indigenization pressures. Lending interest rates declined from as high as 60% per annum (5%/month) to ranges of 15-25% per annum(CZI, 2012).
1.3.3 Technological
The Zimbabwe information and computer technology (ICT) industry is growing and moving in line with global trends. There has been deliberate effort to include computer studies in school curricular. Visible effort is evident in equipping schools with computer hardware.

The ICT industry is tailing global trends but there is still a lag. The industry is expanding network coverage and service provision. The ICT industry’s potential has not yet been fully exploited.

Sector specific applications are being introduced. The financial services sector has had an upper hand. Other sectors such as the transport, health and agriculture are receiving some stimuli, thus ICT applications are still conceived to be at infancy.

1.3.4 Legislative
ICT policy lacks robustness to the extant that sector specific frameworks are absent and rules of fair competition are difficult to monitor amongst players in the industry. A ministry dedicated to ICT was formed during the Government of National Unity.

The impact of the ministry is yet to be realized since the ministry is still new, hence there is dire need for various stakeholders to input into formulation of National ICT policies and their attendant legislation.

1.3.5 Social
Whilst the economy has stabilized, the decade of long economic decline has left the government incapacitated to undertake social responsibilities.

Vulnerable social groups like the elderly, the handicapped, underprivileged and the unemployed do not enjoy any social grants. Government institutions such as hospitals and schools are still under-funded and unable to delivery services to desired levels as per expectations.

Similarly, local government municipalities and state enterprises like Zimbabwe Electricity Supply Authority are failing to delivery basic but essential services such as consistent supply of clean water and electricity for both domestic and industrial use.
Social networks in the telecommunications sector and its impact on the society also falls short in service access and delivery to the vulnerable groups.

1.3.6 Environmental
In line with the Millennium Development Goals (MDGs) and SADC protocols, the country is putting measures to ensure a clean environment. For instances, measures have been put in place to limit the use of unrecyclable plastic materials and the limiting of the importation of motors vehicles that could cause air pollution. Because of the ever changing telecommunications industry, new opportunities for growth need to be created in line with the regulatory framework and international best practice.
1.4 SWOT ANALYSIS OF THE DAIRY INDUSTRY

1.4.1 Strengths

a) Existence of established dairy farms with infrastructure and dairy livestock
b) Experienced farmers still practicing since dairy farms were not designated under the land reform program
c) New indigenous farmers also joined in the industry and thus increased the total number of dairy farmers
d) Many new indigenous farmers have higher potential to increase feed production
e) ICT infrastructure developing in tandem with world standards

1.4.2 Weaknesses

a) Dairy infrastructure is aged and in a dilapidated state of disrepair
b) New farmers still lack technical knowledge and experience
c) Costs of inputs and services to produce feed are too high
d) The processing industry which is a vital cog in the value chain (production of dairy feed) is operating below capacity

1.4.3 Opportunities

a) National milk production is way below estimated aggregate demand
b) There is the global market for dairy products still to be exploited
c) The global dairy industry is well developed the local industry can learn a lot thereon
d) ICTs can be exploited to leverage the local dairy industry
e) The economic stability brought about by the use of multi currencies can be used as a bedrock to revive such sectors of the economy
1.4.4 Threats

a) The local industry is suffocating from imports from neighboring countries
b) Lack of clarity and inconsistency in the indigenization policy may scatter away offshore capital
c) The unacceptability of Offer Letters as collateral by banks to secure loans may choke the resuscitation of the industry

1.5 PROBLEM STATEMENT

In most dairy farms in Zimbabwe, information and record systems are poor, unstructured and costly. In dairy farms, the uptake of Agro-ICTs and their utilization is very low, and thus there is very little collaboration amongst farmers and with other players in the value chain such as; suppliers, buyers of dairy produce, industry regulators and knowledge-generation centers (Universities, Research Institutes and Government and Non-Governmental extension services)

1.6 RESEARCH OBJECTIVES

The objectives of this study are:

1) To identify which ICTs have been adopted by farmers,
2) To establish what factors affect adoption of Agro-ICTs,
3) To ascertain the extent to which farmers are utilizing ICTs in their day-today production and financial information
4) To determine to what extent dairy farms are collaborating with other farmers and other players in the milk production value chain through ICTs, among dairy farmers in Mashonaland East Province of Zimbabwe, and
5) To formulate an Agro-ICT architecture that may be recommended to promote national dairy production.
1.7 RESEARCH QUESTIONS

1) What ICTs have been adopted by Zimbabwean commercial farmers?
2) What are the factors that affect adoption of information technology by the dairy farmers?
3) To what extent are farmers using ICTs in their production and financial records?
4) To what extent is the ICT collaboration between farmers and other players in the value chain?
5) What national architecture can be set up to promote dairy production?

1.8 RESEARCH HYPOTHESIS

Zimbabwe’s dairy production can be improved by increasing uptake of ICTs by farmers.

1.9 SCOPE OF RESEARCH

This study will attempt to find out how the farmers have embraced ICT technologies and how they are connected among themselves and within the value chain. Due to constraints in time, financial and material resources, the study will investigate farmers only and other various players in the industry will not be studied.

The dairy farms to be included in the study will be sampled from dairy farms in the Mashonaland East province of Zimbabwe. The study will focus on Beatrice-Marirangwe dairy farmers because the area has a relatively large concentration of dairy farmers. This part of the country is a good candidate of this research because it has relatively large numbers of farmers from different sectors of the dairy industry in proximity. Both groups of farmers will be included in the study. This means that samples will be taken from both large scale commercial farmers and small scale farmers.
Target respondents in the farms will be the Farm Owners. In the small scale sector members of the family and workers were allowed to represent the farm owners.

In case of commercial farms the responsible Farm Managers or Bookkeepers can act as proxies of the owners.

Data collection from the farms was carried out through questionnaires and face-to-face interviews in December 2014. Data capture and analysis was carried out in the months of January and February 2015.

1.10 JUSTIFICATION OF RESEARCH

1) To increase awareness on the importance of Agro-ICT (ICTs in agriculture)
2) To harness ICT in exploiting dairy production potential to meet increasing demand for dairy products.
3) To promote networking the dairy industry with other sectors of the economy and globally.
4) To recommend a dairy ICT architecture that can be used for policy formulation at national level.
5) To transform dairy into a knowledge-based industry so as to enhance the country’s competitiveness in order to increase the contribution of the dairy industry to economic growth.

1.11 DISSERTATION OUTLINE

This study mainly consists of five chapters. Chapter 1 introduces the whole study. Chapter 2 reviews literature relevant to the objectives of the study. Chapter 3 provides the methodology used in the research. Chapter 4 presents the research findings and discussion Chapter 5 presents the conclusions and recommendations of the study, as well as areas of further research.
CHAPTER SUMMARY

The chapter has provided the introduction of the research study, the background information, and research objectives, research questions, research hypothesis, scope of the study, reasons for justifying the study. The dissertation outline has also been put forward. The following chapter reviews literature on the impact of ICT in dairy farming.
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

Agriculture requires substantial knowledge transfer to and among farmers. This information includes; farming practice advice, new technologies, disease control and selection of markets (van den Ban, 1998). With the advent of information communication technologies (ICT), dairy farming is envisaged to embrace the use of technology in; milk production, on-farm technologies adopted, managing production costs, record-keeping activities, general farm and farmer statistics and collaboration of farm with its external environment.

This chapter provides literature review on the use of information communication technology (ICT) in agricultural practices. The literature review focuses on how ICTs are adopted by commercial farmers. The factors affecting the adoption of ICT by dairy farmers, the collaboration between farmers and other players in the value chain and the policies that are in place in order to promote dairy production.

2.2 DEFINITION OF ICT

Kundishora (unpublished) defined ICT as ‘a generic term referring to technologies that are used for collecting, storing, editing and passing on (communicating) information in various forms.’

Heeks (1999) used the systemic approach to describe ‘the information system’. The author here postulates that ‘information system’ and ‘ICT’ are synonymous and hence can be used interchangeably.

That postulation fits well to Kundishora’s definition.
Heeks viewed the information system as a two tier system. The author argues that there exists the information (the content) and the technology used to deliver the information. These two are in turn the design of the ICT platform, the people and environment.

Heeks (2005) described the information system as a two-way chain. Heeks’ integrated two-way information chain agrees with Toyama’s postulation. Toyama (2010) believes that for the information system to effective it requires ‘to integrate ICTs into organizational systems by focusing on the needs of the users of the technology ……… at the same time, to amplify the developmental intents of the organization.’ This view is also supported by Parker (1999), who adds that without this integration process, the project becomes technology-facing.

In search of the definition of ICT, one fact comes out that: in that ICT mosaic, there are three aspects that feature in these definitions; pieces of gadgets or equipment, information and people. Haag et al. (2007), support this opinion. They viewed IT more holistically, as a ‘mind support tool set’ where the tools help the people to process the information.

The human-computer interaction inherent in IT-based is described by Leeuwis (1993) as a ‘communication of meanings’. Acknowledging the abundance of terms used to describe computer-based management aids, Leeuwis settled on ‘communication technologies’ (CT) to reflect ‘communication of meanings,’ a multidirectional data flow between different IT components and also between computers and people. The convergence of information technology and communications technology has been given a new label of information and communications technology (ICT) (ibid).

For the sake of this agro-oriented study, Stienen, Bruinsma and Neuman (2007), described Agro-ICTs as using computer based applications to enhance food security, agricultural development and support rural livelihoods.
2.3 DEFINITION OF TECHNOLOGY

Definitions for technology vary from being focussed on use of a material object to being very broad in scope. MacKenzie and Wajcman (1985, in Paine 1997) describe technology as consisting of three layers or dimensions. The first layer involves physical objects and artefacts; the second relates to activities or processes; and the third to what people know and do. Farrington and Bebbington (1993, in Paine 1997) express a similar three tiered definition referring to objects as hardware, processes as methods, and what people know (knowledge).

These definitions emphasise an interaction between ideas, material objects, and humans in a system designed to accomplish a task. Perceiving technology in a whole system sense, rather than just the physical components, fits well with the systems approach used to define ICT.

2.4 ROLE OF ICTS IN AGRICULTURE

Van den Ban (1998) highlighted that farmers require access to varied information from many sources. The author adds that such information should be context-specific and includes advice on; best practices, technologies for crop production, weather, and about post-harvest aspects, including storage, handling, processing, and marketing.

Chapman and Slaymaker (2002) argued that ICTs in agriculture are enablers since they have the potential to facilitate greater access to information that drive or support knowledge sharing.

ICTs essentially facilitate the creation, management, storage, retrieval, and dissemination of any relevant data, knowledge, and information that may have been already been processed and adapted (ibid). Kundishora (unpublished) adds that ICT as a sector can contribute immensely to the national GDP of a nation and that it can result in improved market competitiveness of a nation’s products and services.
In turn ICT can effectively assist international economic integration, improve living standards, narrow the digital divide, and improve biodiversity utilisation and management. Furthermore it can ICTs can impact positively on governance of the economy (ibid).

Balaji, Meera, and Dixit (2007) pointed out that traditionally; the primary broadcasting media were the radio and television. However, lately, internet and mobile-based technologies are taking centre stage. This new phenomenon includes applications and communication facets of the order of social media and an array of digital paraphernalia (information repositories, digital cameras and video, including high-tech mobile phones) (ibid).

Llewellyn (2007) posited that information that is properly packaged led to cost reduction of the process of seeking the information. It also makes learning cheaper and affordable. Use of ICTs may lead to strengthen farmers’ capacities and make the better represent their constituencies. ICTs would leverage farmers in negotiating input and output prices, land claims, resource rights and infrastructure projects. It would also enable farming communities to interact with other stakeholders, thus reducing social isolation. It opens up new business opportunities and allows easier contact with friends and relatives, (Stienen et al, 2007). This widens the perspective of local communities in terms of national or global developments.

Stienen et al, (2007) argued that Global Positioning Systems (GPS) linked to Geographical Information Systems (GIS), digital cameras and internet, can assist farmers to document and communicate their situation. Farmers can benefit from better access to credit and banking facilities (ibid). Mobile banking facilities offer further scope to reduce costs and stimulate local trade. In India, the a programme that automates milk collection and payments for its members, enhancing transparency of the milk volume and quality collected, thus and ensures fair payments to farmers (ibid).

With computers becoming available for agricultural management and production use, the need to understand and improve the effectiveness of ICT investment cannot be
overstated. ICT applications in agricultural activities have payoff potential in research activities, extension activities, production and processing (obtaining and sharing information, preparing operational plans, proposals and budgets) and gaining access to markets (ibid).

Proliferation of mobile phone technologies is providing faster and multi-directional communication and information exchange opportunities for farmers, extension workers and agricultural businesses.

But the ICT literacy of farmers in developing countries is very low (Riviera, 1996), in addition to the absent or negligible internet connectivity infrastructure in remote areas. Hence, use of computers and the Internet is mostly absent from rural areas.

2.5 ROLE OF ICT IN THE DAIRY SECTOR

In this section I will discuss the complexity of the dairy farming units. I will demonstrate how large amounts of data evolve, the needs for interacting with a multiplicity of institutions, and how therefore dairy production is a good candidate for ICT.

According to Berman (2010), dairy farming systems probably are the most complex of the agricultural production systems. Other agricultural systems, involving crops plants and livestock, inputs and outputs occur a few times per year. These products usually relate to one or two products. Contrary, in the dairy system inputs and outputs are continuous. The inputs include births, deaths, sales or purchases of animals, feed and labour. The outputs are milk, meat and surplus animals. They are the outputs of individual cows, the cost of which makes them individual production units that vary in performance (Richardson, 2006).

Revenue maximisation requires continuous decision making at both individual cows and herd levels. According to Stoner (2010), productivity response to information flow is greater in the dairy farming system than in other sectors of agriculture.
The dairy farming systems, even the simplest of them, contain a bulk of potential infor-
mation in records of; milk yields, fertility, feed production and usage, animal health, la-
bour input, prices (Aker, 2010). The transformation of this potential into data and later
into information depends on the prevalence of literacy.

The initial phase in the creation of data was for the purpose of breeding that is, improv-
ing productivity through production of better breeds. It was initiated by the farmers’
weighing of milk and keeping of records with the purpose of selecting the higher yielding
animals. This progressed to breeders associations setting breeding schemes based on
regular milk assessment of milk for quantity and composition typical for the breeds
(ibid).

Agrocom (2010) noted that artificial insemination and deep freezing bull’s semen, en-
hanced breeding for milk production. Ali and Kumar (2011) noted that the advances in
quantitative genetics initiated by animal breeders to enhance progress in animal produc-
tivity, was further improved by computerized data analysis.

The dairy farmers formed breeders associations which initiated and supported re-
search. This culminated in the formation of international organizations serving producer
interests. These organisations have developed to the extent of marketing and exporting
frozen semen or live bulls of superior genotypes(ibid).

The rate of genetic progress depends to a significant extent on the size of herds. The
larger herds make possible more accurate predictions of differences in genetic potential
between bulls used in the artificial insemination. This implies that farming systems of
small size may see slower rates of genetic progress, Balaji et al (2007).

The net effect is that: in order to get higher rates of genetic progress, larger herd sizes
are required and several traits have to be monitored on individual animals leading to
handling of massive data.
Batchelor (2002) contends that another pattern of information transfer is evident in animal nutrition. Information flows to and from individual farmers and farmers’ organisations. The pattern of evolution of information transfer is a function of socio-economic state. The initial diffusion of information was by means of verbal communication at farmers meetings or by publications of a more popular style. The acceptance of the information provided was determined by the trust placed by farmers in the providers of information.

Balaji (2009) argued that the presence of extension services, related to universities or government bodies played a significant role in transfer of information in this domain. Aker’s (2010) view is that information sharing resulted in the improvement of feed rations.

Ballantyne (2002) indicated the potential benefits of feeding complete mixed rations. This technology requires mixing of feeds. The advantage of this technology enunciated formation of large commercial stockfeed firms.

Dairy farming was modified by the advent of computers and of computer based systems in several ways. Bowonder et al (2007) found that computer-based feeding programs became available for suggesting the least-cost feed mixtures. According to Cecchini and Scott (2003), computerised milking systems improved the storage of milk records of entire lactations. The most advanced commercially developed milking systems (e.g. the Afimilk system developed in Israel) compiled information on physical activity, electrical conductivity of milk along with that on milk yield. Algorithms were created for detection of sub-clinical mastitis and made possible treatment before the evolution of the inflammation into a clinical state. It also developed algorithms for detection of oestrus, a paramount phase of animal breeding. Singh (2006, as cited in Bowonder et al, 2007) noted that one phase of information transfer in dairy farming systems is that of health control. This was supported by Chapman and Slaymaker (2002). It involves detection and care of diseases. The components of veterinary care usually are performed by different organization bodies.
Therefore the information associated with them may have different flow patterns, according to the distribution of components between these bodies. Some disease control may be carried out commercial bodies and or NGOs. Epidemic diseases control may a government institution exercise.

Further progress in increasing production efficiency may be attained by forming an input-output data bank (Ali, 2010). It includes feeds, labour, purchases, sales, and prices that may serve as an input for analysis of economic performance. Such analyses may point to herd management weaknesses requiring further consideration.

According to Garforth, Angell, Archer, and Green (2003), with the advent of computer networks information may be made available at government, university, and farmer’s organizations websites. This may considerably reduce the time between the recognition of need for information and the access to it. Heeks (1999) added that the efficiency of this information transfer method depends however on the ability of end-user farmer. The farmer needs to identify, analyse, to detect causes for the problem and to know where to turn for information (Garforth, Angell, Archer, and Green, 2003). This requires farmers to be capable of independently screening the available information for relevancy and applying the information to the situation.

Llewellyn (2007) argued that the degree of literacy and of formal education are critical elements in determining the pattern of information flow and its impact, as are the readiness for cooperation and the degree of technological development.

ICT systems are applicable to all functions of management, as they help to gather and organise information for farmers. These include planning and implementation and, in addition to control (Parker, 1999). Through their management strategies, farmers aim to exert control over on-farm system variability. Information gathering is a vital component in the control function and in reducing system uncertainty.
Haag, Cummings, and Philips (2007) and Leeuwis (1993) delineate between structured and non-structured decisions. It is the more structured decisions which lend themselves to programming of decision support systems.

Information requirements, based on key dairy decision-making areas, have been assessed by several authors. (Huurne, Harsh and Dijkhuizen, 1997) examined general critical success factors for Dutch and US dairy farms and related them to information needs. The information needs are summarised as:

- a) Financial issues
- b) Reproduction/breeding
- c) Milk production
- d) Feeding
- e) Herd health
- f) Marketing

The actual decision maker is an often overlooked aspect in the design of decision support systems (Huurne et al., 1997). This failure to consider the actual use and decision making processes of the end user in the creation of technologies will hinder successful implementation. By viewing technology as more than a combination of technical devices, the importance of the end-user, the farmer, becomes apparent. Explicitly including farmers in a more holistic view of technology links them into the creation of innovative farming systems.

### 2.5.1. ICT and Firm Performance

Farming is a business. Dairy farms should be viewed as commercial enterprises or firms. ICT is widely viewed as an enabler. Greater use of ICT may help firms increase their overall efficiency (Pilat, 2004).

Other studies have demonstrated that ICT management capabilities, or the managerial skills associated with the acquisition, management and use of ICT have significant

It has been argued that ICT investment directly affects production processes and permits other productivity enhancing changes, such as business process redesign and organizational change. ICT investments, particularly those that facilitate sharing of information, may also increase the ability firms to innovate. Sambamurthy, Bharadwaj and Grover (2003) advocated a network of factors that reflect the integration of IT into critical organizational processes and business capabilities. In particular, they conceptualized the organizational impacts occurring through ICT-enabled agility capabilities, digitized organizational processes and knowledge management systems. Barua, Kriebel and Mukhopadhyay (1995) proposed a theory of ICT complementarities to argue that the initial effects of IT should occur at the level of organizational processes that use the IT resources.

2.6 FACTORS AFFECTING THE ADOPTION OF ICTS

The United Nations Conference on Trade and Development (UNCTAD) (2006) demonstrated that the success of any ICT project depends on 12 C’s, which comprise: Connectivity, Community, Commerce, Capacity, Culture, Cooperation, Capital, Context, Continuity, Control, Content and Coherence. While UNCTAD contends that these fac-
tors affect the success of ICT projects it can be colloquially inferred that the same factors can affect adoption of ICTs by farmers. This stems from the fact that these factors have been identified by other authors. For example, Alvarez and Nuthall (2006) concluded that in New Zealand and Uruguay, the character, level education, skills, and learning style of farmers were associated with farmers’ use of information communication technologies.

Llewellyn (2007) found that information gathering and learning could be explained by land size, the ability of the farmer to make utilize the information, and access to information packed in a localized content form.

In that regard the UNCTAD framework can be used as a guide in reviewing factors that affect adoption of ICTs although the author has reservations on failure by the UNCTAD to collapse the factors since some of them are interrelated. For instance the author feels that the following aspects could have been collapsed together:

a) Commerce and capital  

b) Content and context  

c) Community, culture and cooperation

2.6.1 Connectivity
For effectiveness, it is imperative that ICT projects are structured and integrated within existing systems of local information exchange and flow in farming areas (Roman and Colle 2003). The integration of the ICTs into organizational activities and individual tasks at the different levels in which it operates is usually the challenging aspect of most projects, but it is an important one for the ICT project’s effectiveness and success (Parker, 1999).
May, Karugia and Ndokweni (2007) observed that skewed ICT policies are a dislocation in the adoption of ICT in agriculture, especially those addressing farming areas, rural communities and development, language barriers, poor information sharing culture.

2.6.2 Community
An array of characteristic of farmers influence the manner in which they seek information, and access to information sources and channels. By understanding how information is used locally, the impact of ICTs could be greater (UNDP, 2001; Chapman and Slaymaker 2002). Information provided through ICTs should be appropriate and relevant to livelihoods of the intended end-users. Localised and contextualized content is an important, as it tends to be more responsive to local needs; in addition, people relate better to content that recognise and own (Chapman and Slaymaker, 2002).

However, not all information is generated on the basis of community needs. For instance, information about environmental concerns, climate issues, and food and nutrition could initially be provided to communities to start creating awareness or as an entry point to provoke discussions on these issues (ibid).

2.6.3 Content
It is paramount to contextualise the content of ICT projects in packaging information for farmers. Relevance is degree to which the information is localised to the situations of the farmer.

Local content is defined as content that is intended for a target audience, as defined by geographic location, socio-economic and political inclinations of a given society (Ballantyne, 2002). Therefore local content is an expression of a community’s knowledge. Local content includes external and global material that has been transformed, adapted, and assimilated into a community.
Relevance of information is destroyed by lack of congruency between service providers and the community (Ballantyne, 2002). This disconnects results in service providers pushing information to people without paying attention to their real needs.

A two-way participatory allows incorporation of farmers’ knowledge base into the program. Such an approach enables farmers to share lessons and best practices related to their farm enterprise among interactions and collaborations assist in farmers expressing their needs, fears and expectations and this lead to establishment of trust, (Chapman and Slaymaker, 2002).

Adhiguru, Birthal, and Kumar (2009) postulated small marginal farmers accessed less information and from fewer sources compared to medium- and large-scale farmers.

2.6.4 Commerce
The nature of business transactions and their levels determine the ICT projects. A case in point is comparisons between one community that has one product and another that has diversified products. Balasubramanian, Thamizoli, Umar and Kanwar, (2010) argued that encouraging diversification of enterprises creates a demand for more information.

2.6.5 capacity
However, in agriculture, despite the rapid proliferation ICTs to facilitate farmers’ access to information, benefits have not accrued due to a myriad of factors including; capacity, costs, sustainability, affordability, applicability, accessibility, scalability, and availability in appropriate languages (Keniston 2002; Dossani, Misra, and Jhaveri, 2005). Another common distortion is that digital information related to agriculture is poor in quantity and generic in quality (Balaji, 2009). This is because institutions are not capacitated to contextualise information and make it more relevant for the users and more useful to their needs (Cecchini and Scott 2003; UNDP, 2001).
2.6.6 Culture
Different communities have different traditions, rites, values and norms. Appropriate packaging and channels of information transmission have to be designed. They should consider the information delivery mechanism (the technology itself) and community language options. One local language is preferred (Mittal, Gandhi, and Tripathi, 2010). This is particularly relevant to the Zimbabwe farming communities because there several languages, and some with different dialects.

2.6.7 Cooperation
What Ballantyne (2004) is insinuating is that there is need for collaboration on those ICT platforms in order to provide the farmer with relevant information.

Instead of a research institution supplying research results to farmers directly there is need for those institutions to work closely or pass their information through extension services that work with farmers very closely and are better placed to know the farmers’ needs with better intimacy. Community meetings, collaborations and participatory approaches as well as by involving farmers in the monitoring and evaluation exercises assist in getting leads to what type, quality and quantity of information is required (Colle and Roman, 2002; Meera, Jhamtani, and Rao, 2004).

2.6.8 Context
The type of information to be packed in an ICT project will be affected by the project’s motives. For instance objectives of private-sector initiatives will differ from Public or civil society initiatives, in terms of rivalry and excludability on one hand, issues of public or common good on the other (Chapman and Slaymaker, 2002).

Generalized content posses challenges to farmers in different regions, which have specific crops, livestock requirements, and agro-ecological peculiarities. Narrowing the scope of information to needs of farmers may have important impacts on the adoption of technologies and could invariably increase productivity of farmers (Samaddar, 2006).
2.7 CASE STUDIES

ICT Use and Impact in Agricultural Firms in Developing Countries

Matambalya and Wolf (2001) explored whether the utilisation of ICTs can improve their competitiveness and performance of firms in the small to medium enterprises category. They concluded that a positive correlation between the size of the firm and use of advanced ICTs. They argued that over and above reducing transactions costs and uncertainties ICTs do increase competitiveness through facilitating information flows.

Lubbe (2004) ascertained the linkages between ICT investment and organisational performance in some e-commerce oriented SME in South Africa. The study provides evidence that shows that firm performance is linked to the level of ICT investment intensity in the sample of companies investigated. De Silva and Ratnadiwakara (2008) found that ICT investment reduced the transaction costs of smallholder vegetable farmers in Sri Lanka. Jenson (2007) used micro-level survey data to show that the adoption of mobile phones by fishermen and wholesalers was associated with a dramatic reduction in price dispersion, the complete elimination of waste, and near-perfect adherence to the law of one price.

Adekunle and Alluri (2004) reported on a pilot project that was implemented in South Western Nigeria which provided a multi-purpose community information access point with basic ICT infrastructure including Internet access. The access point provided links to the Community Help Desk and other sources of information on the Internet, provided training to farmers, linked the farmers directly with inputs and output markets, provided an array of farm equipment that farmers lacked on rental basis, and provided online materials to promote farmers’ learning of innovative methods to increase their productivity, market products and develop enterprises.

Analyses of panel data from the farmers showed that the participating farmers increased their holdings, external inputs used and productivity leading to higher incomes with attendant evidence of graduation into commercial farming.
2.8 CHAPTER CONCLUSION

The chapter has provided literature on the use of ICT in dairy. It was established in the literature that ICT is crucial for the growth of dairy farming. The literature focuses on the adoption of ICTs in dairy farming, factors affecting adoption of ICTs and the role of ICT in farming. A relevant case study was provided. The next chapter presents the research methodology.

CHAPTER 3
3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

The literature review was on the anticipated role, adoption and impact of ICT in Agriculture in general and dairy production in particular. This literature however is not enough to make conclusions on the impact of ICT in the dairy sector in Zimbabwe. With the aim of understanding more on the subject matter, the researcher carried out a primary research. This chapter therefore presents the research methodology. It mainly focuses on the research design, research strategy, population and sampling. The research instrument, data collection method and data presentation and analysis are provided in the chapter.

3.2 RESEARCH DESIGN

Degu and Yigzaw (2006) defined a research design as the process that guides researchers on how to collect, analyse and interpret findings. It can therefore inferred to mean that it is a logical model that guides the researcher though various stages of the research. The research design facilitates efficient collation of information with reduced effort, time and money (Greener, 2008). Research design expresses both the structure of the research problem and the plan of investigation used to obtain empirical evidence that will help solve the problem (Cooper and Schindler, 2003).

According to Wiid and Diggines (2009) research design is simply the outline, framework or plan for the research project that is used to guide data collection and analysis.

The design ensures that the study addresses the relevant problem in the most cost-effective manner.
Therefore the preparation of a research design which is appropriate for this takes cognisance and consideration of the following:

a) Objectives of the research study.
b) Method of data collection to be adopted
c) Source of information (Sample Design)
d) Tools for data collection
e) Data analysis - qualitative or quantitative

3.3 RESEARCH PHILOSOPHY

Easterby-Smith, Thorpe and Lowe (2008) argued that success of business research hinges on through preparation of underlying philosophical issues. They added that also research philosophy points the researcher to the appropriate designs that best suit the project. Saunders, Lewis and Thornhill (2003) also agreed and further argued that research philosophy supports the forms a link between the researcher's thought processes and knowledge on a particular subject area.

All research work is undertaken to find answers to a question or problem and it is assumed apriori that the process is being undertaken within a framework of a set of philosophies (Gasson, 2002). Two major philosophies to research theory development were identified by Perry (1998) and these are; deductive theory and inductive theory. The difference between the two approaches can be viewed in terms of scientific paradigms, with the deductive approach representing the positivist paradigm and the inductive approach representing the phenomenological paradigm (Perry, 1998). These research philosophies also known as research approaches can be also classified as qualitative and quantitative.

Quantitative research techniques include surveys, observation, and experiments. Qualitative research techniques include focus groups, in-depth interviews, and predictive techniques. Parasuraman, Zeithaml, and Berry (2004) defined qualitative research as
the collection, analysis, and interpretation of data that cannot be meaningfully quantified, that is, summarized in the form of numbers. Qualitative research is generally less structured than quantitative research and, due to the detail of data collected, uses smaller sample sizes. To a large extent, qualitative research relies on detailed description by respondents to gain insight into a particular problem. This approach is useful when examining attitudes, perceptions, motivation, and understanding.

Quantitative research is the collection of data that involves larger, more representative respondent samples and the numerical calculation of results. This type of research relies on numbers, measurement and calculations. The scientific approach to research is the guiding framework for quantitative research. This approach tends to be more highly structured than Qualitative research, which makes it easier to measure and analyses the responses.

Hague (2002) in a direct comparison of the two approaches, four important differences can be identified between the two:

a) The type of problem that can be solved.
b) The sampling method used.
c) The methods used to collect the data.
d) The techniques used to analyse the data.

According to Saunders et al (2000), the positivist approach assumes that the world is external to the researcher and in which he is attempting to get an explanation, prediction and control by dividing it into parts and isolating them using mechanistic process for explaining social behaviour.

Thus positivist believes the researcher is objective and that the truth has to be confirmed with empirical evidence using deductions on quantitative data (Saunders, Lewis and Thornhill, 2000).

This is because positivist philosophy was founded on a belief that the study of human behaviour should be conducted in the same way as studies conducted in the natural-sciences.
On the other hand, Gasson (2002) explained that phenomenological approach examines the relationship between consciousness and being. The main assumption here is that phenomenological approaches are particularly concerned with understanding behaviour from the subjects’ own subjective frames of reference (Greener, 2008). Research methods are chosen therefore to try and describe, translate and explain and interpret events from the perspectives of the people who are the subject of the research (Saunders et al 2000).

The research is both quantitative and qualitative in nature. The researcher used both approaches. Using both of these approaches avoids bias. The research will not miss crucial data that is important for the answering of the research objectives.

3.4 RESEARCH STRATEGIES

Saunders, Lewis and Thornhill(2002) posit that there are several strategies that can be used for carrying out a research. These include experiment, survey, case study, action research, grounded theory ethnography and archival research.

The type of research strategies one uses depends on the research questions and objectives, the extent of existing knowledge, the amount of time and other resources available for the research, and the philosophical underpinnings (Saunders et al, 2009). This research adopted the case study approach. A case study of Beatrice-Marirrangwe is used to represent dairy farmers in Zimbabwe.

3.4.1. Case Study

Saunders et al. (2002) defines case study “as a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence”. According to Yin (2003), there is no clear distinction between the phenomenon under study and the context within which it is
being studied. It differs from an experimental strategy in that, in the latter the research is undertaken in a known and controlled environment.

Yin (2008), defined a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context...” (p. 8). Also Kumar (2005) refers the case study as a research study which focuses on understanding the dynamics of the present within a single setting. Thus case studies offer an opportunities to study particular subjects, for example one organisation or a group of people and usually involves gathering and analysing information that may be both qualitative and quantitative (Saunders et al., 2003).

With regards to the foregoing, the researcher undertook a case study approach of Beatrice-Marirangwe dairy farmers. The execution of this research was conducted based on the guidelines supplied by Myers (1997) who suggested that the case study method involve at least four stages of work:

   a) Determining the present situation. In this study this was achieved through the use of questionnaires, interviews and documentary records.

   b) Gathering information about background to the present situation – in this study it was achieved by referring to documentation and other sources available on the case study

   c) Gathering more specific data- this was achieved by piloting the questionnaire to make sure that it is capturing all the objectives of the study.

   d) Presenting and analysing findings and recommendations for action- mainly through the production of the final research report.

3.5 POPULATION

Greener (2008) described a population as the total of individual units under consideration in a study; whether they are people, companies or households. Best (1993) also in
defining population in reference to research, explains that it is any group of individuals that have one or more characteristics in common that are of interest to the researcher.

The concept of population (or universe) is defined by McDaniel and Gates (2001) as the total group of people from whom information is needed. In other words, a population consists of a comprehensive number of individuals, units or items that can become objects for observation. It consists of a specific group of individuals, households, business, professional people from whom data is required.

The population of this study consists of the total number of the large and small scale dairy farmers in Beatrice-Marirangwe dairy farmers. They are a total sixty (60) farmers in number (thirty nine small scale and twenty one large scale farmers).

3.6 SAMPLING

If data regarding each and every member of the population is to be collected, then the exercise is regarded as a census (Kumar, 2005).

Census is cumbersome and almost impossible in some incidences to carry out and researchers have to use samples that represent the population. Therefore, sampling is the scientific process of selecting a number of study units from a defined study population (Saunders et al., 2000). A sample is a statistical selection of part of the population whose properties are studied in order to make some inferences about the whole population and the selected sample must be a close representative of the whole population (Dawson, 2002; Kumar, 2005). Thus Kothari (2008) gave the assumption that there exists enough similarity among the elements of the population that a few of these elements will adequately represent the characteristics of the total population.

The common statistical rule is; a sample must be large enough relative to the population size so that it is reliable and valid (Greener, 2008).

Sampling methods for obtaining representative samples are basically divided into two broad categories. These categories are probability sampling methods and non-probability sampling methods. The concept of probability can be interpreted as the pos-
sibility of something happening in reality. The basic difference between the two methods is:

a) In non-probability sampling methods, no indication can be given of possible bias or error margins of estimates of population characteristics;

b) In probability sampling methods, the sample error of a given sample size can be estimated statistically if the sample design meets certain requirements.

This does not mean that non-probability sampling methods cannot yield good results; the problem is that the user of these methods is unable to give any indication of the reliability of the results that are obtained (Wiid and Diggines, 2009).

3.6.1 Non-probability (Random) Sampling

In probability sampling methods, the probability that a specific unit of the population will be selected is unknown and cannot be determined. Non-probability sampling is based on the judgment of the researcher (Diamantopoulos and Schlegemilch, 1997). Non-probability sampling methods take less time, are more convenient and cheaper than probability sampling methods to implement.

This has led to non-probability methods being preferred, especially in market research and opinion surveys, where speed is of the essence. Non-probability sampling methods do not allow for generalization outside the group of sample units and can only be evaluated subjectively.

3.6.1.1 Convenience Sampling

In convenience sampling, the sample is drawn from a section of the population that is readily accessible or available to the researcher.

Only those people who are at the same place at the same time as the researcher stand a chance of being selected for an interview. In this case, the sample is not representative of the population and no reliable generalizations can be reached. Merely increasing the sample size does not make the sample more representative because only the sampling method can affect a sample’s representation. This sampling method is particularly useful in exploratory research in which ideas and insight are more important than scientific objectivity (Tustin, Lithelm, Martins and Van wyk, 2005)
3.6.1.2 Judgment Sampling
In judgment sampling, the sample elements are selected subjectively and deliberately by the researcher to be representative of the population. For example, a researcher deliberately selects a group of business people for a sample, based on various criteria and the researcher’s own judgment.

The researcher may believe that the sample selected is representative of the population or has the best knowledge and experience of the research subject. A shortcoming of this method is that different ‘experts’ have different opinions about which population elements should be selected. Judgment sampling is particularly useful when large samples are not necessary, for example in pre-testing of questionnaires, pilot studies, and exploratory studies where only ideas and insights generated (Saunders et al., 2000).

3.6.1.3 Snowball Sampling
Snowball sampling is a method of judgment sampling, which is used when samples of special populations are needed. In this case, the researcher deliberately selects a number of respondents with characteristics that are specifically required. These respondents are then used as informants to identify other individuals with the same characteristics (Saunders et al., 2000).

3.6.1.4 Quota Sampling
Quota sampling is a combination of convenience sampling and judgment sampling. The researcher uses census data (or other available sources) to classify the population according to pertinent characteristics such as age, income, sex or geographical area. These elements are known as control variables.

The researcher then determines the sample so that the quota (proportion) of sample elements with certain characteristics is more or less the same as that of elements in the population. The sample quota is then divided among the interviewers, who have to try and find respondents who meet the required characteristics. Quota sampling is faster and less costly for surveys than probability sampling methods. The cost of a quota sample depends on how many control variables were applied when classifying the population: the less limiting the control variables, the lower the cost, although also the greater the risk of selection bias. The quality of the data obtained is to a large extent in-
fluenced by the fact that interviewers use their own judgment or discretion when select-
ing respondents and because of the degree of control over the fieldwork (Parasuraman et al., 2004).

3.6.2 Probability (Random) Sampling
In probability sampling, each unit of the population has a known positive (non-zero) probability of being selected as a unit of the sample (Tustin et al., 2005).

3.6.2.1 Simple Random Sampling
This is a process in which units of the population are selected individually and directly by means of a random process. The selection is done in such a way that each unit has the same probability as any other unit in the population of being selected. Thus, each element of the population has a known and equal chance of being selected for the sample (Parasuraman et al., 2004).

A simple random sample can be drawn with or without replacement. A simple random sample without replacement can be obtained as follows: a specific number of elements is drawn one by one from the elements of the population all the remaining elements in the population have the same probability of being drawn. Sampling with replacement is when a selected element is noted and put back into the population before the next element is selected. In sampling without replacement, a selected element is not put back into the population before the next element is selected. Any element can be selected more than once in sampling with replacement and only once in sampling without.

For simple random sampling to be employed in practice each element in the population must be clearly and unequivocally identifiable and a list of all population elements (sample frame) must be available or be compiled.

The list is used for selecting and identifying the sample elements. When the population elements are people, sufficient information must be available about each person so that they can be identified (Zikmund, 2000; Parasuraman et al., 2004).

3.6.2.2 Systematic Sampling
In systematic sampling, the sample elements are drawn systematically from a complete list of the population elements. Assuming that the population consists of N elements,
numbered from 1 to N, and that \( N = nk \), where \( n \) indicates the sample size and \( k \) is an integer.

A systematic sample size \( n \) consists of an element that has been drawn randomly from the first \( k \) element on the list and every \( k \)th element thereafter. The selection of the first element of the sample automatically determines the whole sample (Proctor, 2000).

### 3.6.2.3 Stratified Sampling

Stratification is a two-step process. First the heterogeneous population is grouped into homogeneous strata that are mutually exclusive (i.e. every element is assigned to only one stratum) and comprehensive (i.e. no population element is excluded). Then a random sample of elements is drawn independently from each stratum using either random sampling or systematic sampling. Effective stratification requires knowledge of the composition of the population, which can be stratified according to variables such as sex, age, income and level of education. If various stratification variables are available, select those stratification variables that are possibly related, or have the closest relation to the variables being studied, and that will represent the population (Wiid and Diggines, 2009).

Stratified random sampling is used when:

a. the population is heterogeneous with regard to the variable or characteristic being studied and is associated with the elements of the population and 

b. the population can be divided into strata that are all more homogeneous with regard to the variable that is being studied than the population as a whole. Elements in the same stratum must be more homogeneous or similar and the strata may not overlap.

In other words, an element may only be included in one stratum and the different strata together make up the whole population.

There are a number of reasons for using stratified random sampling:
a) Through better grouping of the elements of the population into strata, a more precise estimate of the population parameter (for example, the average spending pattern of households) is obtained from the sample data.

b) A far smaller sample size is needed to obtain the same precision in estimating the population parameter using random stratified sampling rather than simple random sampling from the unstratified population.

Stratified sampling guarantees better average representation of the population in the sample. The bigger the stratum and the wider the variation of variables within the stratum, the greater the proportion of elements allotted to it (ibid).

3.6.2.4 Cluster Sampling
Research often requires that a sample be drawn from populations for which it is difficult, impractical or even impossible to compile a sampling frame of the elements. For example: the population of a city, a province or a country, or all school pupils in the country. In such cases, it is necessary to design a more complex sample.

Cluster sampling involves two steps:

a) The total population is divided into mutually exclusive and comprehensive groups called clusters.

b) A random sample of elements is drawn from each of the selected clusters, using one of two approaches. Single-phase cluster sampling is when all the elements in the clusters (that are chosen at random) can be used as sample elements. Two-stage sampling is when a random sample of elements is selected from each cluster.

Cluster sampling is often used in practice. The reason for this is twofold:

a) There is often no comprehensive list or sample frame of the population elements that can be used for drawing a random sample.

b) Even if a complete list of the population elements is available, cluster sampling is often necessary for economic and practical reasons.
Cluster sampling requires some knowledge of the population’s composition. The population must be divided into mutually exclusive and comprehensive groups before selecting a cluster. The more heterogeneous the composition of the clusters of the population elements, the smaller the standard error of the estimates will be. The clusters should be as heterogeneous as the population itself (Wiid and Diggines, 2009).

Although both stratified and cluster sampling divide the population into mutually exclusive and comprehensive subgroups, the criteria used are different. In fact, the two are diametrically opposed: cluster sampling requires heterogeneous clusters, while stratified sampling requires homogeneous strata.

For practical and economic reasons, clusters are normally formed by grouping geographically adjacent households, which means that the elements tend to be more homogeneous or similar than elements that are situated further apart. Consequently, in general a small cluster size produces more precise estimates but also costs more to survey. When selecting the size of a cluster, the researcher has to make a compromise between precision and cost, as well as look at the practical or administrative considerations (Hague, 2002).

**3.6.2.5 Multi-stage Sampling**
Multi-stage sampling draws samples in different stages: the researcher first divides the population into various groups or clusters of elements and then draws a representative sample using the random selection method (Hague, 2002).

**3.7 SAMPLE SELECTION**

Tustin et al. (2005) define a sample as a subset of a population (or universe). Within this context a population is defined as the total group of people or entities from whom information is required. There are many misconceptions and generalizations about the required sample size. For example, that the sample size is a specific/fixed proportion of the population, or that an increase in sample size leads to a corresponding increase in accuracy (Hague, 2002).
The sample size necessary to reflect truly the value of the population parameter depends not only on the population parameter but also on the behavior variable in the population. Therefore, it is fair to assume that the standard error and consequently the confidence level will have some determining effect on the sample size.

Deciding which sample size to use is often a case of judgment rather than calculation. Therefore researchers must choose a sample that is big enough to yield a relatively precise estimate of the population values, but at the same time can be executed economically and practically.

In consideration of:

a) The foregoing literature
b) The small size of the Beatrice –Marirangwe dairy farms community
c) The quantitative part/aspect of the research
d) And the fact that this was a case study,

the researcher intended to deal with every of the sixty farmers in the target area. Unfortunately this was not to be as discussed in the limitations elsewhere in this chapter.

3.8 DATA COLLECTION

Data collection is nothing more than planning for and obtaining useful information on key quality characteristics produced by your process. The issue is not how do we collect the data but how do we obtain useful data. The data is collected in order to establish a factual basis for making decisions. Data collection improves decision making by helping you focus on objective. This study uses primary data gathered from questionnaires and personal interviews to collect information on; milk production, production costs, record-
keeping activities, technologies adopted, general farm and farmer statistics and collaboration of farm with its external environment. Secondary data was also used. This includes dairy farm records and literature done from previous studies on the chosen study area.

3.8.1 Questionnaire

The questionnaire was used as a data collection instrument because of its applicability to the survey research design. Its purpose is to collect accurately and reliably specific qualitative and quantitative information.

Parasuraman et al. (2004) defined a questionnaire as, a set of questions designed to generate the data necessary to accomplish a research project’s objectives’. Designing a questionnaire is difficult. It is very easy to ask questions but difficult to ask the right questions. A poorly designed questionnaire can be disastrous for any research, irrespective of a good sample, well trained interviewers and well implemented, sophisticated statistical techniques. When deciding what type of questions to include in the questionnaire, the researcher must consider the respondent’s possible reaction or expected answer. This will help determine the best question/response format to use (ibid)

The researcher used structured questions. The researcher allowed for flexibility in responses, in that, some responses were structured, but in other cases they were not structured.

a) Structured questions with structured responses.

The purpose of these questions was to collect factual information or to obtain a point of view on a matter of example, ‘agree’ or ‘disagree’. Multiple choice questions were alternative answers are provided were also used and like dichotomous questions, is used to obtain information that can be divided logically into reasonably fixed categories. Ranking questions which assign a relative value to a series of aspects were also made use of by this researcher. The respondent was
asked to rank aspects into a sequence. Scaled questions which are those where the respondent answers questions by marking a certain point on a scale were used. In a scaled question the respondent’s actual position is measured on the attitude continuum.

b) Structured questions with unstructured responses

With this type of question, the open-ended questions encourage respondents to compile and express their own responses freely, which the lack of a fixed response category makes possible. This type of question is used particularly to obtain reasons for specific attitudes or views the respondent may have (Tustin et al, 2005).

3.8.2 Personal Interviews

The research also used personal interviews. These happened to be face-to-face and the interviewer asked the respondent certain questions on a dairy farm performance. In a few cases the researcher had to phone the farmers to gather information, particularly where people on the ground were not privileged to know the issues at stake.

Interviews are a data collection technique involving the researcher following a set procedure in seeking for answers to a set of predetermined questions through one on one interaction with the respondent (Kothari, 2008). (Kothari, 2008; Saunders et al, 2003; Kumar 2005) all have recommended interview method as the most suitable tool in case study researches. Although many authors have recommended interview method, there is no one have mentioned that it is the best method. Usually interviews are carried out in a structured, unstructured and semi-structured way where quality of the information obtained depends upon the ability of the interviewer.

However, Proctor (2000) argues that structured interviews yield data that is easier to analyse compared to unstructured interview data.

3.8.1.1 Structured Interviews

This approach entails the use of questionnaires based on a predetermined and identical set of questions. The researcher asks the questions as s/he reads them. Voice control is important to avoid eliciting biased responses. (Saunders et al, 2000; Kumar 2005
and Greener, 2008). The purpose of the structured interviews is to maintain consistence of findings and also obtain quantitative data.

3.8.1.2 Semi-Structured Interviews and Unstructured Interviews
Under semi-structured interviews the researcher will have a list of areas to be covered using standard questions although the researcher may skip or add to some of these questions or areas, depending in order to get more clarity. Used in greater detail in this case study were unstructured interviews as advised by Kothari (2008); where informal discussions were used to investigate in-depth on specific areas from the subject in an unstructured way. However Kothari (2008) infers that even in unstructured interviews the researcher would have a pre-determined range of areas to be discussed in the interview.

Therefore, for maximum effect, the researcher used both structured and unstructured interviews were used to collect data for this case study.

3.8.1.4 Advantages of using Interviews
- More information in greater depth can be obtained.
- The response success is guaranteed as the respondent is likely to answer to all the questions except those the researcher omits due the discussion environment.
- There is greater flexibility because the researcher can change or drop a question when necessary
- Personal information can be obtained easily in this method.
- The interviewer has an opportunity to catch the respondent by surprise and thus able to record the impulse reactions.
- The language or tone of the interview can be changed according to individual’s literacy.
- The interviewer can obtain additional information about respondent's personal characteristics that can be used while interpreting results Kothari (1985).

3.9 RELIABILITY AND VALIDITY
3.9.1 Reliability

Saunders et al. (2003) defines reliability as the degree to which the data collection techniques or analytic techniques will yield consistent results. In this study validity and reliability was observed by pre-testing the questionnaire in the pilot study. Factors affecting reliability like clarity, specificity of items on the questionnaire and the length of the questionnaire were considered. Items were made as simple as possible and to the point.

For validity, pre-testing helped to ensure the thoroughness and completeness of the questionnaire. Content validity, which entails making sure the major dimensions of the subject matter are covered was ensured through cross checking the content of the instruments against the stated research questions.

3.9.2 Validity

According to Cooper and Schindler (2011) validity is the extent to which a test measures what we actually wish to measure while reliability has to do with the accuracy and precision of a measurement procedure. There are three major forms of validity – content, criterion related and construct validity.

3.9.3 Content validity

The content validity of a measuring instrument is the extent to which it provides adequate coverage of the investigative coverage of the study. The data collection instrument should adequately cover the topics that have been defined.

3.9.4 Construct Validity

According to Cooper and Schindler (2011) when evaluating construct validity both the theory and the measuring instrument are used. Firstly the way in which a construct a defined must correspond to an empirically grounded theory.

Then if a known measure of the construct is available then the results from the new instrument and those obtained using the measure can be correlated.
3.10 PRACTICAL AND RESEARCH ETHICS

According to Cooper and Schindler (2011, p.32), “ethics is made up of norms or standards of behaviour and our relationships with others. The goal of ethics is to ensure that no one is harmed or suffers adverse consequences from research activities” This is echoed by Saunders et al. (2010) who argues that research should not embarrass, harm or disadvantage the research population.

Diener and Crandall (1978, as cited in Bryman and Bell, 2006) divide ethical issues into four recurring ones: Whether there is harm to participants, lack of informed consent, invasion of privacy and deception involved.

According to Coldwell and Herbst (2004), generally three parties are involved in research process:-

The researcher  
The respondent  
The user of the research results

The rights and obligations of the researcher are fairness, accurate reporting of findings, confidentiality, disclosure of defective information and or erroneous conclusions and not stealing ideas from other research proposals.

The rights and obligations of the user are observation of ethics between buyer and seller, ethical relationships with research companies and open relationship with interested parties.

In an attempt to address ethical issues, the following issues were taken into consideration:-

a) The researcher sought authority from the Zimbabwe National Dairy Farmers Association and ARDA to carry out the research and an undertaking to uphold their mutual rights and obligations will be made.

b) The rights and obligations of the respondent are to be honest, privacy, full disclosure of purpose of research.
c) The respondents were requested to give their verbal endeavor to be truthful with their response.

3.11 DATA PROCESSING, ANALYSIS AND PRESENTATION

When the fieldwork was completed, the data was entered, coded and cleaned using Epi-Info. A Statistical Package for Social Scientists was used to run the analysis of data. The information gathered was presented using tables, graphs. These findings were laid out in Chapter 4, together with their detailed discussion.

3.12 LIMITATIONS OF THE STUDY

This research study has the following limitations;

1) The study may not be representative of dairy farmers in Zimbabwe.

2) The study was limited by financial constraints. A case study approach was used instead in order to reduce costs. The researcher had to work within a tight budget which could have compromised information gathering and processing. The use of email could have reduced costs (such as stationary, travel and subsistence of the researcher and research assistant) but could not be adopted as farmers’ email addresses were not known.

3) The researcher drove out to the farms to administer data collection and the following challenges were imminent:
   a) Farmers were visited without notice. It was difficult to make appointments.
   b) Because of absence of appointments some farmers were never dealt with
   c) A few farms were in accessible by a standard vehicle

4) Political hangover among farmers. This elicited different behaviours among farmers. To some, unannounced visitations made them suspicious and therefor timid.
To others, it made them overzealous and over expectant. This could have affected their responses.

3.13 CHAPTER CONCLUSION

The Chapter explored how research instruments were developed, methods of data collection and corresponding justification of the methodology adopted and the reason for rejecting other methods. The research design and reasons of its choice was also discussed. The following chapter presents and discusses the research findings.
CHAPTER FOUR

4.0 RESEARCH FINDINGS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter presents the research findings from the study population. The data was captured using EPI information system and data was analysed using SPSS version 16 by the researcher. In addition, the researcher used Microsoft excel to analyse some of the data. The presentation of the research results was done by using graphs and tables and explained using percentages. Reference was also made to the literature review. The results were based on the views of the sample population that took part in the survey.

The overall objective of the research was to analyse the impact of ICTs in dairy production. The specific objectives of the study were to:

a) identify the ICTs adopted by farmers, establish the factors affecting adoption of Agro-ICTs,
b) ascertain the extent to which farmers are utilising ICTs in their day-today production and financial information.
c) determine the extent dairy farms are collaborating with other farmers and other players in the milk production value chain through ICTs among dairy farmers in Mashonaland East Province of Zimbabwe.
d) to design/formulate an Agro-ICT architecture that may be recommended to promote national dairy production.
4.2 RESPONSE RATE

Sixty (60) questionnaires were used to collect data from Mashonaland west dairy farmers. All questionnaires were targeted to all farmers in target, and forty four (44) were successfully completed giving a response rate of 73.33%. This rate is a fair rate for research conclusions to be rendered valid.

4.3 GENERAL INFORMATION

4.3.1 Age Groups of Survey Participants
The research investigated the age groups of the respondents that participated in the research. The findings are presented in the figure below.

![Figure 4.1: Age groups of survey participants](image)

Figure 4.1: Age groups of survey participants
According to 18.18% of the respondents they stated that they were aged between the ages 26 and 35 years, 27.27% were aged between 36 and 45 years while 13.64% stated that they were aged between the ages 46 and 55 years. Furthermore according to 22.73% of the large and small scale dairy farmers in Marirangwe and Beatrice area they stated that they were aged between 56 and 65 years and 18.18% indicated they are aged above years. The ages of the respondents were above the legal majority age to warrant the findings of this research.

4.3.2 Level of Education

The level of education of the study participants is presented in the figure below.

![Figure 4.2: Level of education](image)

The figure above reveals that 18.18% of the respondents were educated before ordinary level and 31.82% indicated they were educated up to ordinary level. The same percentage as pre-ordinary level indicated they were educated up to certificate level.

On the other hand another minority of 4.55% respondents stated that they were educated up to degree level, making it the same with those that have Masters Degrees.
Lastly, in between the two extremes 22.73% stated that their highest education level was up to diploma level.

This shows that the respondents are fairly educated, with a great proportion having attained a minimum of ordinary level of education, and are therefore presumed to give valid responses for the research. This is at variance with the Riveria (1996) assertion that farmers in developed countries have little education.

Garforth, Angell, Archer, and Green (2003), argued that the use of ICTs requires a farmer capable of making an efficient use of websites’ resources, and a farmer capable of independently screening the available information for relevancy and applying the information gained. Farmers ought to be capable of critical thinking, to evaluate the information availed and to seek for alternatives.

4.3.3 Training in Agriculture
The research further investigated if the respondents acquired formal training in agriculture. The findings are summarized in the figure 4.3 below.

![Figure 4.3: Training in Agriculture](image-url)
Figure 4.3 above shows that 45.45% respondents indicated they have not received any formal training in agriculture. On the contrary 54.55% majority of the dairy farmers in the area stated they have received formal training in agriculture. Information extracted from farmers during interviews indicated that, what the farmers meant by formal training are attendance courses provided by the Dairy Development Programme, Farmers Associations and some suppliers. Further probing revealed that this training was dairying-oriented.

This implies that the majority of the small and large scale farmers in Marirangwe and Beatrice area have received formal training in dairy production. This is in line with Ballantyne (2002), who asserted relevance of information is key in addressing farmers’ problems.

Having undergone some trainings in dairy production farmers are ready to receive production information and advice though ICT programmes. Llewellyn (2007) argued that the degrees of literacy and of formal education are critical elements in determining the pattern of information flow and its impact.

On further probing through interviews, the farmers demonstrated that exposure to training has improved their production knowledge although they required a lot more knowledge. They proffered that the dairy industry is being faced by other challenges beyond the production skills which included, but not limited to:

a) high cost of dairy animals
b) high input costs, particularly dairy feeds
c) high electricity tariffs and frequent blackouts
4.3.4 Classification of Dairy Farming Business

Respondents were asked by the researcher the classification of their farming business. The views of the respondents are presented in the figure 4.4.

![Figure 4.4: Classification of dairy farming business](image)

The majority of respondents representing 54.55% indicated that their dairy farming business is large scale. The other 45.45% farmers stated that their farming business is small scale.

This is contrary to expectations, where twenty one farmers (representing 35% of a population of 60) are from Beatrice (a large scale area) and thirty nine (65%) are from Marirangwe (a small scale area). This shows two things: that, either the research did not stratify the dairy farmers according to scale, or that some small scale farmers have grown and now consider themselves as large scale farmers.

The former assertion is correct as no sampling was done. The research targeted all the farmers in the Case Study area. The latter assertion is difficult to conclude, as neither stratification nor sampling was done.
On further investigations through interviews, farmers were not aware how they are classified into small scale or large scale. One farmer opined that they were just told that they are small scale. Yet another farmer said, “All I know is that I’m a farmer, whether I’m big or small is neither here nor there…..it doesn’t help me in anyway”.

Adhiguru, Birthal, and Ganesh Kumar (2009), argued the size of the enterprise affects the amount, quality and sources of information. This test would be difficult to apply in this case as no stratification was done.
4.4 FARM PRODUCTION STATISTICS

4.4.1 Breed of Cows and Breeding Herd Size
From interviewing the farmers, it was evident that the predominant dairy cattle breeds are the Holstein-Friesian breed, followed by the Jersey and Red Dane. There are also various crosses of these breeds. Of particular interest is that some small scale farmers use the indigenous Mashona and their crosses in their dairy projects.

The breeding herd sizes of the dairy farmers in Marirangwe and Beatrice area are presented below.

![Figure 4.5: Breeding herd size](image)

According to 22.73% of the dairy farmers in the case study area indicated that their herd size is less than 10 cows, and 27.27% are those who own between 10-20 cows. A further 18.18% of respondents said their herd size is between 20-50 cows, whilst 4.5% own herd sizes between 75-100 cows.

On the other hand 22.73% of the dairy farmers in the area added that their breed size is more than 100 cows.
Matambalya and Wolf (2001), studied 300 dairy farmers in Kenya and Tanzania to explore whether use of ICT can enable dairy farmers to improve their herd size, competitiveness and performance. Their survey found a positive correlation between average breeding herd size and use of advanced ICT.

The rate of genetic progress depends on the size of herds. The larger herds make possible more accurate predictions of differences in genetic potential between bulls used in the artificial insemination. This implies that farming systems of small size may see slower rates of genetic progress, (Balaji et al., 2007).

In order to get higher rates of genetic progress, larger herd sizes are required, and thus small herds have to be transformed to larger herds through breeding.

The use of the local Mashona breed can be expedited in cross-breeding programs with the exotic breeds to take advantage of the breed’s natural adaptation to the local environment, to produce robust high yielding breeds. It is also envisaged that ICT should play a major role in livestock breeding since such programs handle massive data (Balaji et al., 2007).
4.4.2 Average Milk Yield

The researcher investigated the average milk yield per cow per day for the dairy farmers in Marirangwe and Beatrice area. The results from the investigation are presented in the figure 4.6

![Figure 4.6: Average milk yield per cow per day](image)

Some 31.82% of respondents said their production is less than 10 litres per cow per day while the majority of the dairy farmers in Marirangwe and Beatrice area (54.55%) indicated that their average milk yield per cow per day is 10-20litres. A further 9.09% respondent said their average milk herd per cow per day is 20-30litres. A mere 4.55% of survey participants indicated that the average milk per cow per day is between 30-40litres. On the other hand 9.09% respondents did not respond.

This shows that the majority 86.37% (54.55%+31.82%) of farmers achieve below twenty litres of milk yields per cow per day. These figures tally with the CSO and Dairy services (2012) observations. These production levels are too low particularly for large scale farmers (van den Ban, 1998). Dairy services (2012) attributed the low milk yields to high production costs, particularly the cost of feeds.
With the proliferation of ICT, dairy farming is intended to embrace the use of these technologies to improve on; milk production, production costs (Bowonder, Gupta, and Singh, 2007), record-keeping, general farm statistics and collaboration of farm with its external environment (van den Ban, 1998).

It is the researcher`s contention that there is scope for improving dairy productivity in terms of daily milk yields and herd sizes, and that such developments should be leveraged on ICT. This assertion was supported by Ali and Kumar, (2011). Stoner (2010) added that productivity response to information flow is greater in the dairy farming systems than in other sectors of agriculture.

4.4.3 Milk Markets
The study sought to find out the market for milk to dairy farmers in Marirangwe and Beatrice area. The findings from the investigation are presented in figure 4.7

Figure 4.7: Where farmers sell their milk
From the figure above it shows that 22.73% dairy farmers sell their milk to Dairiboard Zimbabwe Limited, and similarly to the local community. Also from the findings 4.55% of dairy farmers in the area stated that they sell their milk to Nestle Zimbabwe. The majority of the respondents as evidenced by 50% respondents said they sell their milk to other markets which include; Cheeseman, TN, Innscor, Kefaloes and Marirangwe milk collection centre.

ICT investments and applications in agricultural and/or rural activities have payoff potential in research activities, extension activities, production and processing and marketing /trade (Bowonder, Gupta, and Singh, 2007).

ICTs strengthen farmer’s capacities and better represent their constituencies when negotiating input and output prices Llewellyn, (2007). Stienen et al, (2007) argued that mobile banking facilities offer further scope to cut down on costs and facilitate stimulate business transactions.

4.5 COMPUTER AND TECHNOLOGY

4.5.1 Utilisation of ICT Hardware on Farms
The ICT hardware found on dairy farms in the Beatrice- Marirangwe area are presented in the table below based on the views from the research participants.

Table 4.1: ICT hardware usage on the farms

<table>
<thead>
<tr>
<th>HARDWARE ITEM</th>
<th>USAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell phone</td>
<td>90.09%</td>
</tr>
<tr>
<td>Laptop</td>
<td>45.5%</td>
</tr>
<tr>
<td>Desktop Computer</td>
<td>36.4%</td>
</tr>
<tr>
<td>i-Phone tablet</td>
<td>18.2%</td>
</tr>
</tbody>
</table>
The majority respondents (90.09%) indicated that the ICT hardware they have on their farm is a cellphone and 45.5% indicated they have a laptop as ICT hardware on the farm. Also the research findings reveal that 36.4% of the survey participants indicated that they have a desktop computer, while the minority as represented by 18.2% respondents said they have an i-phone tablet. This implies that the predominant ICT hardware on the dairy farms in the area is a cellphone, while laptops other ICT gadgets are present but in lower frequencies.

From a closer analysis it would appear as if:

a) farmers have various combinations of these gadgets
b) the prevalence of gadgets is based on cost of gadget and thus affordability

This observation is in agreement with Balaji, Meera, and Dixit (2007) assertion who said mobile technologies are coming in to supplement the traditional television and radio as primary broadcast technologies in remote communities. Leeuwis (1993) stresses the importance of ICT hardware in dairy farming in that it institutes the multidirectional data flow between different IT components.
4.5.2 Operation of a Computer and Articulation of ICTs

Respondents were asked by the researcher if they have anyone on the farm that can operate a computer and could articulate ICTs. The findings are summarized in figure 4.9.

Figure 4.8: Operation of a computer

Figure 4.8 shows that 45.45% respondents indicated that they do not have anyone on the farm that that can operate a computer and articulate ICTs. On the other hand 40.91% dairy farmers in the area stated that they have someone on the farm that that can operate a computer and articulate ICTs. Some 4.55% of responses stated that they are in the process learning operating computers. This implies that only an insignificant number of dairy farmers in Beatrice- Marirangwe area can operate a computer and articulate ICTs.
While the uses of digital technologies, especially for communicating agriculture-related information, has been increasing rapidly in developed and emerging market economies the ICT literacy of farmers in the sub-region has remained very low (May, Karugia and Ndokweni (2007).

4.5.3 Connectivity
The research investigated the ways in which dairy farms in Beatrice- Marirangwe area connect to the internet. The responses are analysed and presented in the table below:

Table 4.2: Connection to the internet

<table>
<thead>
<tr>
<th>WAYS OF CONNECTING TO THE INTERNET</th>
<th>PERCENTAGE RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogue modem (dial up via standard phone line)</td>
<td>none</td>
</tr>
<tr>
<td>Integrated Services Digital Network</td>
<td>4.5%</td>
</tr>
<tr>
<td>DSL (ADSL, SDSL, VDSL )</td>
<td>4.5%</td>
</tr>
<tr>
<td>Cable modem</td>
<td>none</td>
</tr>
<tr>
<td>Other narrowband/other broadband</td>
<td>40.9%</td>
</tr>
</tbody>
</table>

Table 4.2 above shows the ways in which dairy business connect to the internet. Only 4.5% indicated they connect via Integrated Services Digital Network, and the same proportion goes for DSL (ADSL, SDSL and VDSL). The majority respondents as indicated by 40.9% stated that their business connects to the internet using other narrowband or broadband. On the contrary none of the survey participants indicated they use cable modem and analogue modem (dial up via standard phone line). This indicates that connectivity is reliant upon the availability on of some service provider networks. In the absence of any network no internet connectivity is possible as it appears that landline telephony is non-existent.

Through personal interviews the majority of farmers concurred that there is a dearth in connectivity. This is in synch with literature Riveria (1996). In contrast Van den Ban (1998) highlighted that farmers require access to varied, multisource, context-specific, faster and multi-directional communication.
In addition to low internet connectivity infrastructure in remote areas; May, Karugia and Ndokweni (2007) had noted that poor policies hindered progress in the use of ICTs in agriculture.

4.5.4 Farm use of Websites
An investigation was carried out to determine the extent to which dairy businesses in Beatrice- Marirangwe area have a web presence. Figure 4.10 presents the findings;

![Figure 4.9: Web presence](image)

Figure 4.9 shows that the majority respondents (81.82%) indicated they do not have a web presence. On the other hand 18.18% of the dairy businesses in the area agreed and stated that they have a web presence.
Such a state of affairs is not desirable in a sector poised to buttress a national economy. Balaji, Meera, and Dixit (2007), posit that information made available at government, university, and farmer’s organizations websites may considerably reduce the time between the recognition of need for information and the access to it.

4.5.5 Use of Dairy Production Software
The study investigated if the dairy businesses use any dairy production software. The result is summarised below:

![Bar Chart]

Figure 4.10: Use of dairy production software

According to figure 4.10 above, 81.82% of respondents indicated that they do not use any dairy production software. On the contrary, minority respondents (18.18%) agreed that they use dairy production software.
The fact that dairy farming systems probably are the most complex of the agricultural production systems (as alluded to in the Literature Review), and also that response to information flow is greater in the dairy farming system than in other components of the agricultural sector, strongly suggest that the dairy sector stands to benefit more from embracing ICTs.

Some of respondents revealed during interviews that they were not aware of the existence of such programmes. Others said they would not afford them.

4.5.6 Use of ICTs in Conducting Dairy Farm Business

The research investigated the use of ICTs in dairy businesses in the area. The results are shown below:

![Figure 4.12: Use of ICTs in conducting dairy farm business](image)

The study findings in figure 4.11 reveal that 63.64% study participants indicated that they do not use ICTs in conducting dairy farm business.
On the other hand 18.18% respondents stated that they use ICTs in conducting dairy farm business. This section is better read with the one that follows.

4.5.7 On-farm Internet Marketing
Research sought to find out if dairy businesses in Marirangwe and Beatrice area receive orders for goods and services via the internet. The chart below presents the study findings.

![Figure 4.12: Sales via the internet](image)

The majority respondents as shown by 90.91% in figure 4.12 indicate that they do not receive orders for goods and services via the internet. On the other hand 9.09% respondents agreed and stated that they make sales over the internet.

For the two sections above, such low statistics represent loss of opportunities to farmers. The conclusion and recommendations of this study will be incomplete if no reference is made to this.
4.5.8 Internet Business Transactions

To those dairy farm businesses that use the internet, the research sought to find out the business activities that farmers transacted over the internet.

Table 4.3: Business activities transacted over the internet

<table>
<thead>
<tr>
<th>BUSINESS ACTIVITIES</th>
<th>PERCENTAGE RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>For getting information</td>
<td>36.4%</td>
</tr>
<tr>
<td>For performing internet banking or accessing other financial services</td>
<td>27.3%</td>
</tr>
<tr>
<td>For sending or receiving emails</td>
<td>50%</td>
</tr>
<tr>
<td>For dealing (interacting) with government organisations/public authorities</td>
<td>4.5%</td>
</tr>
<tr>
<td>For delivering products online</td>
<td>5.5%</td>
</tr>
<tr>
<td>For providing customer services</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

The most popular utilization of internet is for communication through e-mailing and mobile banking. These may be confounded with personal use as ordinary people who are not in business also use the internet for these purposes. The high frequencies may therefore not be indicative of ‘business use’ in that strict sense.

As enterprise managers, dairy farmers attempt to organise available resources to achieve their business goals. The natural systems in which they operate are highly uncertain due to physical resource variability on farm in addition to variability in off farm factors such as international prices for dairy products. Through their management strategies, farmers aim to exert control over on-farm system variability. Control is a key management function, along with planning and implementation (Parker, 1999) and involves monitoring, comparing, and correcting management plans. Information gathering is a vital component in the control function and in reducing system uncertainty. A response rate of 36.4% is too low for such an important function as seeking business information.
The great question that begs to be answered then is; what should be done, with regards to ICT systems as planning and control functions of dairy management, in the pursuit to gather and organise information for decision making by farmers?

4.5.9 Benefits of using ICTs

The research investigated the benefits of the system being used by dairy farmers in the case study area. The question referred to the benefits, as recognized by the farmer, of the mode of connecting to the internet and their attendant use of the internet. The responses were varied depending on the farmers’ connectivity but some of the common benefits mentioned included:

a) low cost
b) efficiency
c) ease of connection
d) flexibility
e) hands on personal interaction
f) improved access to information
g) knowledge gain and sharing
h) instant responses
i) and environment friendly

The question was meant to gauge if farmers appreciated any downstream benefits from utilising ICT, and quite clearly they did. Sambamurthy, Bharadwaj and Grover (2003) advocated a network of factors that reflect the integration of IT into critical organizational processes and business capabilities. In particular, they conceptualized the organizational impacts occurring through ICT-enabled agility capabilities, digitized organizational processes and knowledge management systems. Barua et al. (1995) proposed a theory of ICT complementarities to argue that the initial effects of IT should occur at the level of organizational processes that use the IT resources.
4.5.10 Inhibitions on Using ICT in Dairy Business

The farmers were asked to classify negative inhibitions on using ICT in their dairy business. The results are shown in Table 4.4:

Table 4.4: Classification of negative inhibitions on using ICT in dairy business

<table>
<thead>
<tr>
<th>NEGATIVE INHIBITIONS</th>
<th>PERCENTAGE RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of skills/understanding</td>
<td>59.1%</td>
</tr>
<tr>
<td>Lack of confidence in using ICT</td>
<td>13.6%</td>
</tr>
<tr>
<td>Lack of privacy</td>
<td>5%</td>
</tr>
<tr>
<td>Cyber crimes</td>
<td>14.1%</td>
</tr>
<tr>
<td>Online vulnerability to children</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

Table 4.4 above shows that the majority of the survey respondents (59.1%) classified lack of skills/understanding as a negative inhibition in using ICT in dairy business. Also 13.6% of respondents added that lack of confidence in using ICT on their dairy business. Lack of skills denotes absence of knowledge. It tallies in tandem with low (45.45%) rates of farmers who can use computers and high incidences (54.55) of farmers who do not use ICTs in transacting business issues.

Five percent minority respondents argued that lack of privacy is a negative inhibition on using ICT, 14.1% indicated cyber crimes and 9.1% indicated online vulnerability to children is a negative inhibition in using ICT on their dairy business. These inhibitions are not only restricted to agriculture as they cut across many sections of the community, for example in the issue of accepting use of cellphones in schools. The lid on these negative inhibitions has to be effective, and this is a matter that should seize policy-making. Roman and Colle (2003) argued on the need for intergarting ICTs to local and existing patterns of communication.
4.5.11 Barriers in the Adoption and Use of ICTs by Farmers

The survey also investigated the farmers considered to be barriers in the adoption and use of ICTs. The table below shows the perceived barriers in the adoption, use of ICTs by farmers according to the dairy farmers who participated in the study.

Table 4.5: Barriers in the adoption and use of ICTs by farmers

<table>
<thead>
<tr>
<th>BARRIERS</th>
<th>PERCENTAGE RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of skills/confidence by farmers</td>
<td>36.4%</td>
</tr>
<tr>
<td>Reluctance by current staff</td>
<td>4.5%</td>
</tr>
<tr>
<td>Expenditure too high</td>
<td>68.2%</td>
</tr>
<tr>
<td>Not appropriate/no perceived benefits</td>
<td>9.1%</td>
</tr>
<tr>
<td>Technology changing too fast</td>
<td>19.1%</td>
</tr>
<tr>
<td>Security concerns (fraud/hacking/viruses)</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 4.5 above shows that 36.4% dairy farmers indicated that lack of skills/confidence by farmers is a perceived barrier in the adoption and use of ICTs by farmers and 4.5% said reluctance by current staff. The majority of the survey participants as represented by 68.2% argued that expenditure too high is a barrier to the adoption and use of ICTs by farmers. Moreover the results from the investigation revealed that 19.1% respondents stated that technology is changing too fast and 5% minority highlighted that security concerns (fraud/hacking/viruses) are barriers.

The result further reinforces the notion that lack of knowledge is a major factor in the adoption and use of ICTs by farmers. While the costs of using ICTs are progressively going down, the establishment costs of the systems remain high.

From all those interviewed cited, they cited telephony or cellular network and connectivity as a major challenge in the area. Those that are connected to some networks complained of persistent signal failures or blackouts.
4.5.12 Impact of ICT on Dairy Business

The table below tabulates the considered impact of ICT on dairy business.

Table 4.6: Impact of ICT on dairy business

<table>
<thead>
<tr>
<th>IMPACT OF ICT</th>
<th>PERCENTAGE RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>9.1%</td>
</tr>
<tr>
<td>Reduced costs of internal management processes</td>
<td>13.6%</td>
</tr>
<tr>
<td>Reduced time of internal processes</td>
<td>14%</td>
</tr>
<tr>
<td>Expanding geographic coverage of products</td>
<td>22.7%</td>
</tr>
<tr>
<td>Increasing product quality</td>
<td>18.2%</td>
</tr>
</tbody>
</table>

According to 22.7% of the dairy farmers who participated in the survey they consider expanding geographic coverage of products as having an impact on ICT in the dairy business. Moreover 13.6% respondents stated that the impact of ICT on their business is through reduced costs of internal management processes and 14% consider reduced time of internal processes as the impact of ICT on their business. On the other hand 18.2% dairy farmers stated that increasing product quality is considered to be the impact of ICT on their business.

To further add to the research findings, Toyama (2010) adds that the roles played by information in the course of dairy farming systems evolution, the changes in the sources of information and in the bodies that utilized it, points to a large heterogeneity of potential bottlenecks. The latter depends upon social structure, culture dependent patterns of cooperation, presence of research bodies, involvement of government institutions in the provision of extension services, and of public health care. The degree of literacy and of formal education are critical elements in determining the pattern of information flow and is impact, as are the readiness for cooperation and the degree of technological development.
4.6 CHAPTER SUMMARY

This chapter analysed information which was collected through a questionnaire to acquire information pertaining to the research objectives. Major issues that were discussed include farm production statistics, computer and technology in dairy farming. The next chapter presents the conclusions and recommendations of the study.
CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the major conclusions and recommendations of the research study. These are based on the research findings, analysis and discussions in the previous chapter. An area of further study is also proposed in this chapter to further analyse the subject area.

5.2 CONCLUSIONS

The study provides the following conclusions:

5.2.1 Research Objectives
All the five research objectives have been met. This comes out clearly in the recommendations sections of this chapter. A national ICT architecture has been recommended. Government has to play a pivotal role in policy formulation, network infrastructural development, setting up of an information centre and financing.

The information centres should then be used for networking and sharing of information and knowledge.

5.2.2 Education and Training
On the positive side, the majority of farmers have a minimum of Ordinary Level of education, and as such they are amenable to training. A greater proportion of them have been exposed to training in dairy production. A major drawback is that they don’t have computing skills.
A considerable proportion (54.55%) (13.64%+22.73%+18.18%) of the farmers are above the forty five years age group. Most of them went through their education lifetime before schools and colleges had computers. Deliberate computer skills training programmes for farmers are required.

5.2.3 Classification of Dairy Farming Business
Classification of dairying farming business into small scale or large scale is arbitrary. A farmer chooses to call/classify themselves (whether small scale or large scale) whatever they deem fit of their own volition. There is no industry standard nomenclature.

Classifying farmers into these categories is important for research purposes, policy formulation and special stakeholder interventions.

5.24 Farm Production Statistics
a) The breeding herd sizes of the dairy farmers are small. These are congruent to and/or limited by such factors as finance capital, production skills, input costs and utility tariffs. The net result is that they reduce the aggregate milk yields and retard genetic progress.
b) The above factors also draw down on the average milk yield per cow per day. The daily milk yields per cow are very low.
c) There are good bloodlines in the genetic constitution of dairy herds. The pure-bred exotic lines alone are not suited for the local climatic environment. The exotic breeds are not available in sufficient numbers to boost aggregate milk yield. Their numbers need to be increased by importing semen for artificial insemination.

The local Mashona breed is not a high milk producer. The line is however good for crossbreeding with exotic breeds to produce better adapted animals. Their numbers can be multiplied by adoption of modern techniques such Multi Ovulation and Embryo Transfer (MOET).
5.2.5 Dairy Market
There is a broad market base for the farmer’s milk. But the farmers are not linked with the market players. There is need for information flow between the farmers and the various market players in order for the farmers to compare and optimal markets for their products.

5.2.6 Communication and Technology
The importance of hardware in ICT dairy farming in that it institutes the multidirectional data flow between different IT components also between gadgets and people. Internet- and mobile-based information gadgets are complementing television and radio as the main electronic broadcast technologies used to reach rural and farm communities. The prevalence of the cellphone as a major ICT hardware used on the dairy farms is by reasons of costs. Cellphones are readily affordable. While other gadgets such as laptops, i- phone tablets and desktop computer are other hardware also used by the dairy farmers, they are available on an affordability and scalability basis.

The cause of low utilization rates of ICTs in the dairy sector, non-business-use of internet, farm websites and dairy production software cannot be isolated and pointed to one individual cause as it is a product of a matrix of factors that include:

a) lack of computing skills appreciation
b) lack of knowledge on available technologies
c) high cost of technologies
d) poor infrastructural network
e) lack of Government support on ICT
f) lack of national and sectorial ICT policies.
5.3 RESEARCH HYPOTHESIS

For the avoidance of doubt the hypothesis has been re-stated:
Zimbabwe’s dairy production can be improved by increasing uptake of ICTs by farmers.

The hypothesis cannot be rejected. The uptake of ICTs in the dairy sector remains very low; hence the effectiveness of ICTs in this sector cannot be ascertained. The reasons for the low uptake have been described in the previous section. In view of the foregoing, the impact and/or benefits of ICTs have not been realized. Notwithstanding, the researcher still continues to argue that there is a lot of potential to increase dairy production and competitiveness, but a lot of work still needs to be done to increase uptake of the ICTs.

The following recommendations are proffered as a means to achieve higher ICT utilization by dairy farmers and subsequently realize said benefits for the sector.

5.4 RECOMMENDATIONS

5.4.1 The Government

The Government should promulgate well defined ICT policies. The policies should focus on:

a) infrastructural network expansion
b) Government departments themselves adopting ICTs
c) Security concerns such as cyber crimes (hacking and fraud), privacy and undesirable content
5.4.2 The Government Ministries
The ministry of agriculture, itself having embraced ICTs, should establish an agricultural Information Centre. The Ministry(s) of ICT and information should be the advisors to the ministry of Agriculture, as it leads in the setting up of the information centres.

The ministry of finance should source and make available the financial resources so required. The two ministries of Information and Communications should be merged to synchronise policy. The Government, through the merged ministry, should own the national infrastructural grid and users should pay tariffs.

5.4.3 The Information Centre
This agricultural information centre should have different specific units that relate to each agricultural sector of which dairy production is one. The dairy information centre should consist of:

   a) Commercial ICT service providers
   b) Universities- faculties of agriculture, animal sciences, veterinary sciences, business studies and colleges of agriculture
   c) Suppliers of dairy inputs
   d) Buyers of milk and its products
   e) Providers of extension services

5.4.4 Networking
Dairy farmers should be linked to the information centres and other extension advisory services such as the Livestock production department (LPD), Agricultural Research and Extension Services (AREX), the Veterinary Services department, Farmers associations and Non-Governmental Organisations (NGOs) that work with the farmers in the field. The same centres should be linked to commercial companies.

Commercial companies (suppliers of inputs and buyers of dairy products) should send their product list and prices to the information centres to be packaged for access by farmers. These information centres should prepare the required information for the
farmers. The dairy information centres should have call centres where farmers ask questions and get responses real time.

5.4.5 Continuous Training and Development
Extension and advisory services should design deliberate training programmes for farmers, both in dairy production and use of ICTs.

The extension service providers should be capacitated enough to be able to hire knowledgeable consultants and experienced resource persons depending on the subject matter on the intended training sessions.

5.4.6 The National ICT Architecture
The foregoing recommendations have been summarised in the following diagram, and the figure has been named as the National ICT Architecture.
5.4.6 Who Will Benefit From This Study?
As demonstrated in the above section, the following groups of people stand to benefit:

a) The Consumers/General Public- the prices of milk and its products will go down
b) Dairy Farmers- they will have access to abundant, accurate and timely management decision-making information and thus make the sector more competitive
c) Commercial Business Organisations- their products and prices will be made readily available to the farmers
d) The Government- an improved dairy sector will contribute significantly to the national economy
e) Research Institutions- fruits of their labour will be adopted and put to use by the farmers

5.5 AREA OF FURTHER STUDY

Further research should be carried out to determine the extent of use dairy production software in this sector. These assist farmers in routine decision making. In other business fields they are already in use.

5.6 CHAPTER SUMMARY

This chapter has provided the research conclusions and recommendations. An area of further study was also proposed.
REFERENCES


APPENDICES

APPENDIX 1: QUESTIONNAIRE FOR THE DAIRY FARMERS

INTRODUCTION

My name is Million Chauke, a University of Zimbabwe MBA student and I am carrying out a research entitled ‘An Analysis of the Effectiveness/Impact of ICTs in Dairy Production- A case of Zimbabwe's Mashonaland East BEATRICE-MARIRANWE Dairy farmers’.

You may indicate your name if you so wish, but you are assured of confidentiality as nowhere will your name ever be published concerning this research interview. I thank you for participating in this academic exercise.

STRUCTURED INTERVIEW QUESTIONS

A. DEMOGRAPHICS

1. Name of respondent

.................................................................

2. Sex?

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
</table>

3. What is your age group?

<table>
<thead>
<tr>
<th>26-35 Years</th>
<th>36-45 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>46-55 Years</td>
<td>56-65 Years</td>
</tr>
<tr>
<td>Over 65 Years</td>
<td></td>
</tr>
</tbody>
</table>
4. What is your highest level of Education?

<table>
<thead>
<tr>
<th>Education</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctorate Degree</td>
<td></td>
</tr>
<tr>
<td>Masters Degree</td>
<td></td>
</tr>
<tr>
<td>First Degree</td>
<td></td>
</tr>
<tr>
<td>Diploma</td>
<td></td>
</tr>
<tr>
<td>Certificate</td>
<td></td>
</tr>
<tr>
<td>O’ level</td>
<td></td>
</tr>
<tr>
<td>Before O’ Level</td>
<td></td>
</tr>
</tbody>
</table>

5. Do you have any previous formal training in Agriculture?

<table>
<thead>
<tr>
<th>Training</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

6. Before you venture into dairy farming, what was your professional career?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

7. How do you classify your dairy farming business?

<table>
<thead>
<tr>
<th>Scale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Scale</td>
<td></td>
</tr>
<tr>
<td>Large Scale</td>
<td></td>
</tr>
</tbody>
</table>
B. FARM PRODUCTION STATICS

8. What is the breed of your cows?

9. What is your breeding herd size?

<table>
<thead>
<tr>
<th>Breed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 cows</td>
<td></td>
</tr>
<tr>
<td>10-20 cows</td>
<td></td>
</tr>
<tr>
<td>20-50 cows</td>
<td></td>
</tr>
<tr>
<td>50-75 cows</td>
<td></td>
</tr>
<tr>
<td>75-100 cows</td>
<td></td>
</tr>
<tr>
<td>More than 100</td>
<td></td>
</tr>
</tbody>
</table>

10. What is your average Milk Yield per cow per day?

<table>
<thead>
<tr>
<th>Yield</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 litres</td>
<td></td>
</tr>
<tr>
<td>10-20 litres</td>
<td></td>
</tr>
<tr>
<td>20-30 litres</td>
<td></td>
</tr>
<tr>
<td>30-40 litres</td>
<td></td>
</tr>
<tr>
<td>More than 40 litres</td>
<td></td>
</tr>
</tbody>
</table>

11. Where do you sell your milk?

<table>
<thead>
<tr>
<th>Seller</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairiboard Zimbabwe Limited</td>
<td></td>
</tr>
<tr>
<td>Nestle Zimbabwe</td>
<td></td>
</tr>
<tr>
<td>Other farmers</td>
<td></td>
</tr>
<tr>
<td>Local community</td>
<td></td>
</tr>
<tr>
<td>Local Government institutions</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

12. At what price per litre do you sell your milk?

<table>
<thead>
<tr>
<th>Price</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## C. COMPUTER AND TECHNOLOGY

13. Which ICT hardware do you have on the farm?

<table>
<thead>
<tr>
<th>Hardware</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellphone</td>
<td></td>
</tr>
<tr>
<td>i-phone table</td>
<td></td>
</tr>
<tr>
<td>Desktop computer</td>
<td></td>
</tr>
<tr>
<td>Laptop</td>
<td></td>
</tr>
</tbody>
</table>

14. Do you have anyone on the farm business who can operate a computer and articulate ICTs?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

15. How does your business connect to the Internet?

<table>
<thead>
<tr>
<th>Connection Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogue modem (dial-up via standard phone line)</td>
<td></td>
</tr>
<tr>
<td>ISDN (Integrated Services Digital Network)</td>
<td></td>
</tr>
<tr>
<td>DSL (ASL, SDSL, VDSL ETC.)</td>
<td></td>
</tr>
<tr>
<td>Cable modem</td>
<td></td>
</tr>
<tr>
<td>Other narrowband /Other broadband</td>
<td></td>
</tr>
</tbody>
</table>

16. Does your business have a Web presence?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

17. Do you use any dairy production software?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
18. Do you use ICTs in conducting your dairy farm business?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Planning to</td>
<td></td>
</tr>
</tbody>
</table>

19. Does your business receive orders for goods or services (that is, make sales) via the Internet?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

20. Which of the following activities does your business use the Internet?

<table>
<thead>
<tr>
<th>Activity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For getting information</td>
<td></td>
</tr>
<tr>
<td>For performing Internet banking or accessing other Financial services</td>
<td></td>
</tr>
<tr>
<td>For sending or receiving emails</td>
<td></td>
</tr>
<tr>
<td>For dealing (interacting) with government organizations/Public authorities</td>
<td></td>
</tr>
<tr>
<td>For delivering products online</td>
<td></td>
</tr>
<tr>
<td>For providing customer services</td>
<td></td>
</tr>
</tbody>
</table>

21. To which of the following is your business linked:

<table>
<thead>
<tr>
<th>Link</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Farmers</td>
<td></td>
</tr>
<tr>
<td>Market</td>
<td></td>
</tr>
<tr>
<td>Suppliers</td>
<td></td>
</tr>
<tr>
<td>Bankers</td>
<td></td>
</tr>
<tr>
<td>Dairy Associations</td>
<td></td>
</tr>
<tr>
<td>Others institution outside the country</td>
<td></td>
</tr>
</tbody>
</table>

22. What do you consider to be the benefits of the system you are using?

..........................................................................................................................................................................................
..........................................................................................................................................................................................
23. Do you have any negative inhibitions about using ICT in your dairy business? How would you classify these?

<table>
<thead>
<tr>
<th>Lack of skills/understanding</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of confidence in using ICT</td>
<td></td>
</tr>
<tr>
<td>Lack of privacy</td>
<td></td>
</tr>
<tr>
<td>Cyber crimes</td>
<td></td>
</tr>
<tr>
<td>Online vulnerability to children</td>
<td></td>
</tr>
</tbody>
</table>

24. What do you perceive to be the barriers in the adoption and use of ICTs by framers?

<table>
<thead>
<tr>
<th>Lack of skills/confidence by farmers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reluctance by current staff</td>
<td></td>
</tr>
<tr>
<td>Expenditure is too high</td>
<td></td>
</tr>
<tr>
<td>Not appropriate/no perceived benefits</td>
<td></td>
</tr>
<tr>
<td>Technology is changing too fast</td>
<td></td>
</tr>
<tr>
<td>Security concerns (Fraud/hackings/Viruses)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>
25. What do you consider to be the impact of ICT on your dairy business?

<table>
<thead>
<tr>
<th>Impact</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Reduced cost of internal management processes</td>
<td></td>
</tr>
<tr>
<td>Reduce time of internal processes</td>
<td></td>
</tr>
<tr>
<td>Expanding geographic coverage of your products</td>
<td></td>
</tr>
<tr>
<td>Increasing product quality</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>(please specify)</td>
</tr>
</tbody>
</table>

26. What do you think should be done at a national level to increase the adoption of Agro-ICTs and realize more benefits for this sector?

…………………………………………………………………………………………
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