THE STATUS AND IMPACT OF TECHNOLOGY TRANSFER AND INNOVATION ON THE PRODUCTIVITY AND COMPETITIVENESS OF SMALL-SCALE AGRO-PROCESSING BUSINESSES IN MASHONALAND CENTRAL (ZIMBABWE) AND FREE STATE (SOUTH AFRICA)

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DECLARATION

I, Justin Gumbochuma, student number , declare that the thesis entitled "The status and impact of technology transfer and innovation on the productivity and competitiveness of small-scale agro-processing businesses in Mashonaland Central (Zimbabwe) and Free State (South Africa)" hereby submitted for the degree Doctor of Business Administration has not previously been submitted for a degree at this or any other university. I further declare that this is my own independent work in design and execution and that all materials contained herein have been duly acknowledged. I cede the copyright of this thesis in favour of the Central University of Technology, Free State.

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ABSTRACT

The variations in agricultural production and declining food security situations in Zimbabwe and South Africa have been attributed to the low uptake of agricultural technology, the innovation chasm, low mechanisation and persistent climatic changes, which threaten human existence and the sustainable survival of agro-processing firms in both countries. As such, this study explores the status and impact of technology transfer and innovation on the productivity and competitiveness of selected small agro-processing firms in Zimbabwe and South Africa. Founded on a positivist epistemology, a quantitative approach, survey design and probabilistically sampled respondents, the study explored the extent to which technology transfer and innovation influence the levels of productivity and competitiveness in the small agro-processing firms in selected provinces in both countries.

Percentage analyses and a non-parametric technique, the Spearman Correlation, were employed to assess the relationships among technology transfer, innovation, productivity and competitiveness of selected small agro-processing firms in Zimbabwe and South Africa. Multiple regression analysis was conducted to test a number of predictive effects. Firstly, it was used to test the predictive effect of technology transfer and innovation on the financial productivity of these enterprises. Secondly, it was used to assess the predictive effects of technology transfer and innovation on the non-financial productivity of these agro-processing firms.

The results revealed some positive and significant correlations of varying strengths among technology transfer, innovation, productivity and competitiveness in both Zimbabwe and South African samples. Mixed results were also reported on the impact of innovation and technology transfer on financial and non-financial productivity in both samples. For instance, the influence of innovation and technology transfer on financial productivity was non-significant for the Zimbabwean sample. In the South Africa sample, only technology transfer had a significant predictive influence on financial productivity. Furthermore, only technology transfer had a significant predictive effect on non-financial productivity with the Zimbabwean sample, whereas both innovation and technology transfer had a strong predictive effect on non-financial productivity.

To some extent, the results validated the proposed conceptual model as a guiding tool for estimating agricultural productivity. Thus, the proposed model provides important theoretical and analytical lenses for academics, educators and policy-makers' concerned with finding effective ways of enhancing agricultural productivity among small agro-based businesses in Zimbabwe and South Africa.

LIST OF ABBREVIATIONS AND ACRONYMS

ADB	African Development Bank
ANC	African National Congress
APCF	Agro-Processing Competitiveness Fund
APEC	Asia-Pacific Economic Cooperation
ASGISA	Accelerated and Shared Growth Initiative-South Africa
BBBEE	Broad-Based Black Economic Empowerment
BEE	Black Economic Empowerment
BRICS	Brazil, Russia, India, China and South Africa
CAADP	Comprehensive African Agriculture Development Programme
CAPF	Comprehensive Agricultural Policy Framework
CAPSA	Centre for Alleviation of Poverty through Sustainable Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
DAFF	Department of Agriculture, Fisheries and Forestry
DFID	Department for International Development
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
EU-SAFTA	European Union - South Africa Free Trade Agreement
FDI	Foreign Direct Investment
FTLRP	Fast Track Land Redistribution Programme
GDP	Gross Domestic Product
GII	Global Innovation Index
ICRISAT	International Crop Research Institute for the Semi-arid Tropics
ICT	Information and Communication Technology
IFC	International Finance Corporation
ILO	International Labour Organisation
IMF	International Monetary Fund
MAFISA	Micro Agriculture Financial Institutions of South Africa
MATF	Maendeleo Agricultural Technology Fund
NBSSI	National Board for Small-Scale Industries
NGOs	Non-Governmental Organisations

NEPAD	New Partnership for Africa's Development
OECD	Organisation for Economic Co-operation and Development
RAS	Agricultural Research Services
R&D	Research and Development
SADC	Southern African Development Community
SAFTA	South Africa Free Trade Area
SEDA	Small Enterprise Development Agency
SMEs	Small and Medium Enterprises
SMMEs	Small, Micro and Medium Enterprises
SSABs	Small-Scale Agro-Based Businesses
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organisation
USA	United States of America
WFP	World Food Programme
WTO	World Trade Organisation
ZimAsset	Zimbabwe Agenda for Sustainable Socio-Economic Transformation
ZANU-PF	Zimbabwe African National Union – Patriotic Front

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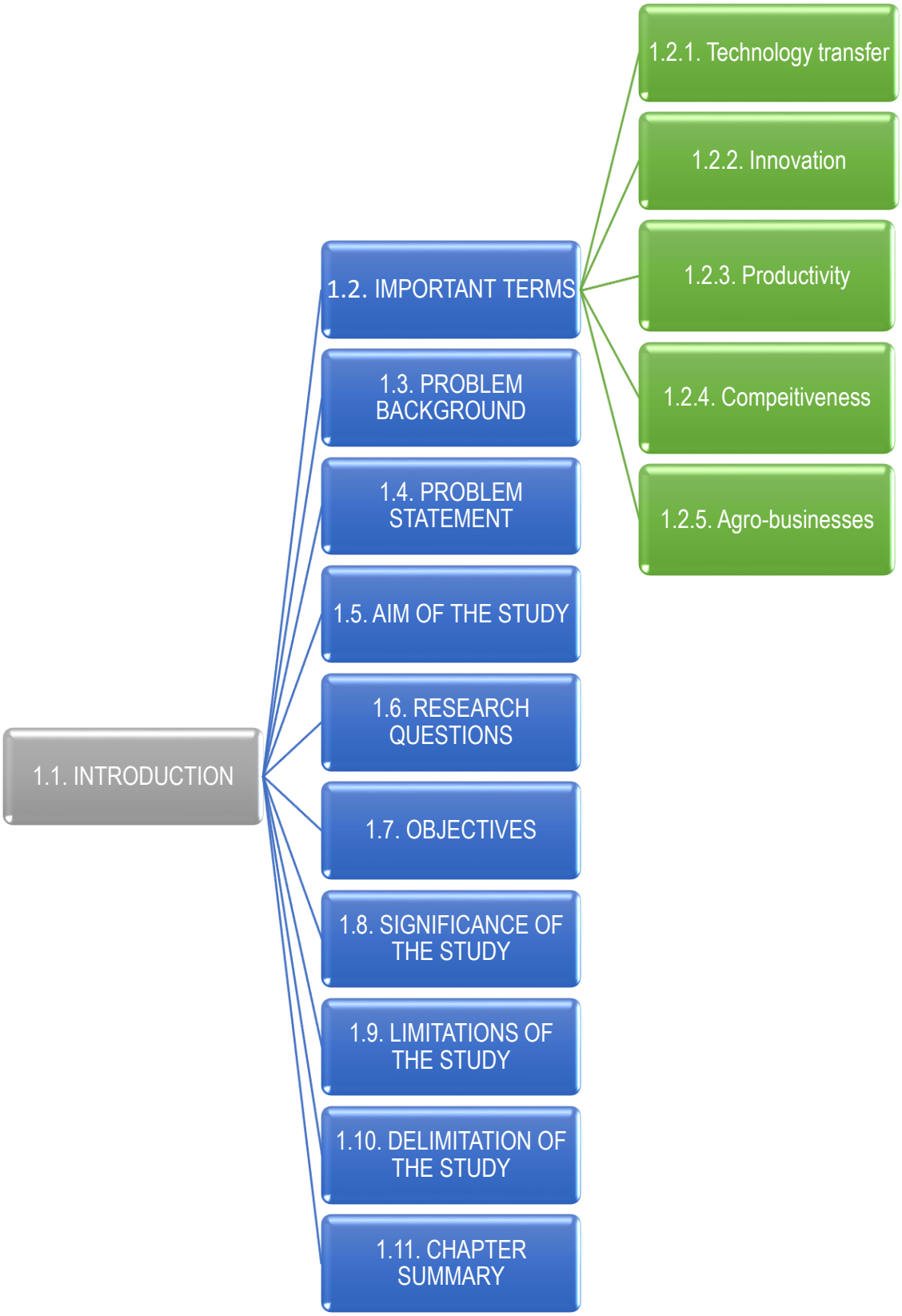
CHAPTER 1: ORIENTATION OF THE STUDY



1.1. Introduction

This comparative study examines status and impact of technology transfer and innovation on the productivity and competitiveness of small-scale agro-processing firms in Zimbabwe focusing on Mashonaland Central region in Zimbabwe and the Free State region in South Africa. The pre-occupation of this study with technology transfer and innovation to optimise the productivity of agro-processing firms in the two countries derives from growing food crises and persistent food insecurity that has led to growing humanitarian aid in Zimbabwe. Although the Free State region has not been aid-dependent like Mashonaland Central and other rural parts of Zimbabwe, the recent cycles of droughts in the Free State region have also threatened the food security situation in this South African region.

Zimbabwe's agro-business activities show signs and symptoms of severe stress - judging from declining production levels, failure to meet domestic consumption demands and international production quality standards, increasing food imports all compounded by structural changes in land ownership and agricultural reform. Makate, Wang, Makate and Mango (2016) note that the switching of Zimbabwean agro farmers from food crop production to cash crops such as tobacco, cotton and sunflowers has contributed to the decrease in national food production, which has contributed to growing food insecurity. In addition, climate change has also exacerbated the frequency of droughts, with 1.3 million people in food insecurity situation in 2016. The production of maize, the staple crop of Zimbabwe, has also declined to 833.000 tons in 2016 from 2 million tons previous harvested before the year 2000 land reform programme. In South Africa, national maize production has retained a constant output of 8.9 to 10 million tons yearly, which is a cause for concern amid the continuous increase in the South Africa population.

Thornton (2010) notes that in emerging economies, farmers are becoming more vulnerable to poverty due to global trends such as declining agricultural commodity prices and consumer prices; increasing gaps between farmers' prices and consumer prices; the changing patterns of food demand; and global changes in agro food system. These challenges point to the rapid changes in the agro-processing sector - including the need for lasting solutions to declining productivity, competitiveness, profitability and sustainability of agro-processing firms in emerging economics such as Zimbabwe and South Africa.

In South Africa, agriculture contributes 12% of Gross Domestic Product (GDP), which is a substantial contribution to the national economy. While the country produces enough food to meet local demand at national level with more than 40% of total population depending on agriculture, the continuous increase in urban and rural population presents a real food security threat to the country unless agro-processing industries change their production systems and processes especially through technology transfer and

innovation. Despite the prevalence of major drivers of agricultural productivity and research and development in agriculture in South Africa such as Agriculture Research Council, Ministry of Agriculture, Fisheries and Forestry, other agricultural institutes and universities, food insecurity remains a perennial feature of some rural, peri-urban and urban informal settlements of the country. Sasson (2012) states that in South Africa, food shortage and insecurity are linked to overpopulation, natural disasters, persistent climate and weather conditions, water shortages, low food production and poor food distribution.

In view of these global sustainability challenges, therefore, technology transfer through acquisition of agro-processing machinery, tools and equipment could be a necessary driver and prerequisite for the successful expansion of the agricultural sector and increased productivity of the agro-processing firms in South Africa. There is growing evidence on the capacity of technology transfer to increase overall agricultural productivity and quality of life (Collier & Dercon, 2014) and contribute to the achievement of the Millennium Development goals of increasing the general level of food production, meeting food and nutritional requirements as well as poverty requirements (Juma, 2015). Recently, technology transfer has also been credited with impacting the agricultural productivity of small-holder farmers substantially (Njeru, 2016).

South Africa's early technology transfer scenario is unique as it is founded on protectionism, self-sufficiency and self-containment during Apartheid and immediately after independence in 1994. Mungai (2015) notes that until early 1998, the South African government regulated and controlled the marketing and production of most agricultural goods in the country while the country remained isolated from the global market. After independence and the integration of the country into the global economy, the government formulated a new policy of rural agriculture development through promoting technology transfer and globalisation. Although anecdotal evidence tends to connect technology transfer to the success of agro-business activities, what remains under-explored in literature is the nature and exact impact of technology transfer and innovation on the productivity and competitiveness of agro-processing products in emerging economies such as South Africa and Zimbabwe.

A study on commercial agriculture in Africa conducted by the World Bank (2017) compared costs of producing agricultural products such as maize, rice, wheat and cassava in countries in South East Asia and Latin America such as Thailand and Argentina with that of Africa countries such as South Africa, Mozambique, and Nigeria. This study reported that the availability and application of technology transfer and innovation research presented opportunities for high productivity, high profitability and high

competitiveness of agro-business firms. The study also confirmed inverse relationship when technology and innovation were not availed. Yet factor-driven economies such as Zimbabwe and efficiency-driven economies like South Africa must be compared in view of their geographical proximity and some shared climatic characteristics to establish variations and similarities in relationships between these variations and basis for vertical and horizontal integration and international agricultural cooperation.

1.2. Important terms

The terms that are fundamental to this investigation, are technology transfer, innovation, competitiveness, productivity and agribusiness. In view of their multiple definitions and characterisations, these terms require sufficient attention as attempted in subsequent sections of this study.

1.2.1. Technology transfer

Technology straddles multiple disciplines, sectors and industries and hence, a broad definition is more appropriate than a narrow, prescriptive one. Lunogelo and Baregu (2013) characterise technology transfer broadly as a process of knowledge creation and application, knowledge mobilisation and exchange, information search and transformation. It denotes the movement of knowledge and skills from the laboratory to industry, firms, and organisations and from one application in one domain to another (Phillips, 2002).

Dogra, Garg and Jatav (2013) adopt a location-specific definition of technological transfer in which it is conceived as a process whereby technology is moved from one physical or geographical location to another for the purpose of application. As such, the process of technology transfer in agro-processing firms can take the form of training and education - in particular farming methods, processes, skills. This ensures that stakeholders and participants acquire agriculture knowledge and information through participation and involvement in agro business activities.

The impact of technology transfer on the productivity of small-scale agribusiness can be conceived from multiple theoretical perspectives, namely Neo-classical theory, Traditional Liberal theory and Industrial Development Theory. In this comparative study of South Africa (Free State) and Zimbabwe (Mashonaland) all theories are going to be considered but a major focus will be on traditional liberal theory, which ensures cooperation, partnership and complementation of government and private sector in promoting agriculture technology transfer and innovation.

1.2.2. Innovation

There is no single definition of innovation because it ranges from the implementation of something new to improvements in products (goods or services), processes, marketing or organisational methods. Gholami, Asli, Shirkouhi and Noruzy (2013) perceive innovation as the application of new knowledge to productive or organisational processes. It comes about when society takes ownership of knowledge, ideas, practices and technologies, translating them into a change that is useful and beneficial to productive or organisational life. In other words, it means applying knowledge, ideas or practices that are new to a particular context with the purpose of creating positive change that will provide a way to meet needs, and take on challenges or seize opportunities. Such novelties and useful changes could be substantial (i.e. a large change or significant improvements) or cumulative (small changes that together produce a significant improvement*).* An innovation system consists of a wide array of public and private organisations, firms and individuals that demand and supply codified or tacit knowledge and technical, commercial and financial competencies. It also includes the rules and mechanisms by which these different stakeholders interact and relate to one another in social, political, economic and institutional settings (World Bank, 2017).

Innovativeness reflects a business' willingness and ability to create new products or services for its customers. Studies report that innovation leads to business competitiveness and success (Verhees & Meulenberg, 2004; Cillo, De Luca & Troilo, 2010; Rubera & Kirca, 2012). While some literature affirm the positive relationship among innovativeness and technology transfer and productivity, it was very low to moderate (GEM Reports 2012, 2013) and the level of innovativeness in South African business is unfortunately on a very low to moderate scale. However, other studies report higher levels of high technology transfer and innovation in South African agricultural firms - depending on the province or region (Agbobli, 20113; Agbotame, 2015).

Innovation focuses on the creation of a new product or service for customers allowing the business to grow and increase its profit levels. Innovation can be defined as the concretisation of an initial idea for a new product development or product improvement (Okanga, 2017). However, others describe innovation as a combination of invention based on creativity and commercialisation of the invention. In this study, innovation is centred on the introduction of new ideas in small agro business farming techniques.

Classifications of innovation include radical (disruptive) innovation, which involves dramatic breakthroughs in ideas or process; reorganisation requiring enormous resources or capital investments. Incremental innovation focuses on the introduction of new products or processes gradually using

relatively smaller amounts of resources (Kuratko, 2009, Toner, 2011). Large investments in agro-businesses may contribute to radical innovations, while incremental innovations are normally implemented by small businesses or already existing knowledge platforms with minor deviations from already existing knowledge. This research study takes cognisance of the classification of innovation as either incremental or radical processes of change.

1.2.3. Productivity

Productivity relates to the outcome of production, which covers various aspects like output, profit generation, expansion of markets including improved systems of production. In the Zimbabwe agriculture sector where low levels of capital endowments are involved, there is restricted uptake of farm technology, which results in low productivity in terms of crop yields and outputs (Moyo, 2014).

One dimension of productivity is the equation of inputs and outputs. As such, Syverson (2011) argues that productivity performance is a reflection of relative growth of factors such as inputs and outputs. The growth of output can be measured with the sum of input elasticity's equals to 1 (i.e. constant returns are assumed). This calculation leaves total factor productivity as residual, which is the difference between output growth and capital labour growth. The growth of the equation is manipulated through intervention mechanisms to effect changes in labour and production productivity.

1.2.4. Competitiveness

The President's Congress Report (2016) defines agricultural competitiveness as the ability of agricultural, agribusiness and agro-industrial concerns to produce and offer products that meet the quality standards of the local and world markets at prices that are competitive and provide adequate returns on the resources employed or consumed in producing them. It describes the ability to compete or sell in the competitive marketplace and underlies the agro-processing's growing ability to achieve a better price result in competitive markets globally. Whether measured by amount of output or reduced level of inputs, increased competitiveness requires increased productivity, marketability and price received.

The Africa Competitiveness Report (2015) recommends application of the Global Competitiveness Index (GCI) when measuring firm competitiveness of a country. The GCI defines competitiveness as the set of institutions, policies, and factors that determine the level of productivity of a country. The current and future levels of productivity, in turn, set the sustainable level of prosperity an economy realises in the medium to long term. The measurement of competitiveness is a complex undertaking. To address this complexity, the distinct pillars of the GCI affirms the idea that diversity matters for competitiveness. These

include public and private institutions, infrastructure, the macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness and market size.

There are two possible ways of measuring competitiveness. The first involves measuring production costs, profitability, and productivity. This measurement is based on production output volumes, yields, unit prices; levels of exports; private investment in the agricultural sector; levels of value addition; and the ability to lower costs and increase input of productivity. Generally, an increase in competitiveness happens when a firm lowers its costs relative to those incurred by rival firms. Similarly, high levels of investment (both domestic and foreign) and rising yields coupled with sustained high productivity are indications of competitiveness. The second method measures trade-related competitiveness using real exchange rates, comparative advantage indices, and export or import indices. If a country can fetch high prices for its agricultural commodities, and is able to maintain or increase its market share of that particular commodity in the world market, it is generally understood to be competitive in that particular commodity or industry.

1.2.5. Agro-businesses

The diverse range of agro-processing activities in Zimbabwe and South Africa complicates the development of a single universal definition of agribusiness for these countries. Gandhi (2014) defines agribusiness as all market and private business-oriented entities involved in the production, storage, distribution, and processing of agro-based products; in the supply of production inputs; and in the provision of services, such as extension and research.

Louw (2007) defines agribusinesses as industries from suppliers of inputs and services to producers, to processors and markets of agricultural products, manufacturers, exporters, retailers, the distribution systems and to consumers. It suffices to say that agribusinesses are directly and/or indirectly connected to primary agriculture as well as to value-adding enterprises further down the agricultural value chain. In most Southern African countries, agribusinesses and agricultural sectors are critical for economic growth and poverty eradication as a large portion of the poor population depends on agricultural production for their livelihoods. It also plays a major role in industrial, urban and regional development as it contributes to the gross domestic product, and promotes exports and stimulates wider investments in the economy. This helps to increase food security through the provision of food, improves employment creation, generation and redistribution of income and improvement in the standard of living. As such, agriculture offers the best hope of initiating national economic growth.

South Africa plays a dominant role in Africa, particularly in the Southern African region. The South African economy contributes about 20% of the continent's GDP and about 40% and 70% of the output of sub-Saharan Africa and Southern Africa respectively (Louw, Nhemachena & van Zyl, 2008). There is no doubt as Louw et al. (2008) state, that agribusinesses are important stakeholders in the agricultural supply chain in Southern Africa as major receivers, processors of and marketers of agricultural products, as well as suppliers of production inputs and services. Therefore, the agribusiness sector is important vehicle for economic growth and poverty eradication in Africa and the Southern African region.

This scholar contends that there has been positive growth in agro-business in South Africa due to changes in agricultural markets. Louw et al. (2008) affirm that Southern Africa has experienced erratic growth and transformation in agricultural markets and restructuring of food marketing chains from traditional markets, with the entry of new major players, such as supermarkets and convenience stores, in urban centres. Factors such as globalization, trade liberalization (increases in migration, urbanization and the emergence and growth of the economic middle class), information and technological changes and improvements in quality standards were and are still the driving forces of change in the agribusiness sector. There has been a substantial increase in large retailers and processors in the agribusiness supply.

Khan (1995) identifies two types of agro-based businesses; firstly, those that are engaged in the processing of agro products; and secondly, those that are engaged in the processing and production of a number of agricultural inputs. These characterisations include firms that produce agricultural inputs such as farm machinery, agricultural inputs, fertilizers, seeds and other modern inputs including businesses engaged in the supply of these inputs to farmers, all of which will be considered in this study. The Ministry of Agriculture, Forestry and Fisheries in the Free State Province in South Africa has an estimated 240 000 small-scale agribusinesses, while the Mashonaland Province in Zimbabwe has an estimated 50 0000 small agribusinesses.

In view of the definitions and characterisations of agri-businesses, this research conceives agro-based firms as business entities or industries that add value to agricultural raw materials, both food and non-food, through their processing, marketing, usability or being edible, while enhancing the income and production of agriculture products in African countries. In South Africa and Zimbabwe, as in the EU, the characterisation of these firms approximates small businesses called small, micro and medium enterprises (SMMEs) (Makanyeza & Dzvuke, 2015). For the purpose of this study, the South African definition of small business, which generally implies businesses with not more than 200 employees, is applied because the study is focused on South Africa and Zimbabwe, of which Zimbabwe has a definition

which is closer to the South guideline on SMMEs. In addition, the terms small businesses and SMMEs are used interchangeably to mean the same business category in Africa.

Suffice to say, all these small agro-processing firms engage in processing and value addition. However, it is important to distinguish between these two terms that are often confused namely, “processing” and “value addition”. “Processing” entails changing the form of a product, while “value addition” implies addition of value to a product after which a buyer is willing to pay a higher price for the product that compensates for the cost of the inputs used in the process. However, value can be added to products without changing their physical form and cleaning, grading or labelling are examples of such value addition. To an extent that a product undergoes some process, say grading, then value addition does involve processing, even though the physical form of the products does not change (Department of Agriculture, Forestry and Fisheries [DAFF], 2012).

1.2.6. Knowledge transfer capacity

This emphasises the creation of tacit knowledge and the ability to transfer the knowledge (that is, efficiency in its transmission to a different user). Just as firms and their business units possess differing abilities to create knowledge, they also differ in their ability to transfer knowledge (Kogut & Zander, 1993; Szulanski, 1996).

Conceptually, knowledge creation and transfer of skills are separate dimensions. Again, some firms may be simultaneously strong at creating and transferring knowledge. All knowledge transfer events involve both a source, or transferor, and a recipient, or transferee (Szulanski, 1996; Paulin & Suneson, 2012). This comparative study of South Africa and Zimbabwe refers to a transferor’s ability to transfer knowledge effectively as source transfer capacity. It defines source transfer capacity (STC) as the ability of a firm (or the relevant business unit within it) to articulate uses of its own knowledge, assess the needs and capabilities of the potential recipient thereof, and transmit knowledge so that it can be put to use in another.

Arrigo (2012) states that external knowledge is increasingly critical to the creation of new technology. With today’s competitive landscape, there is a need to secure knowledge in a flexible way to accommodate new technology developments, changing market conditions, new agro-business financing such as corporate venture capital investments, equity technology alliance, joint ventures, minority holding mergers and acquisitions to fund external knowledge in technology transfer.

1.3. Problem Background

South Africa is dual agriculture economy with both well-developed commercial and small subsistence producers. The country has a population of 54 million, contributes about 40% of Gross National Income of sub-Saharan Africa. The Free State Province is the fourth largest of South Africa's provinces representing 10.6% of agriculture arable land. The traditional breadbasket of South Africa with extensive commercial farmers is Free State and Western Cape with three quarters of maize and wheat being produced in these areas. Genetically modified agriculture produce are allowed in South Africa causing threat to sustainable farming due exotic chemicals such as pesticides, herbicides. This also resulted in the 2007 ban on South African inorganic food crops exports to European Union countries giving rise to global uncompetitive agriculture production and agro-business status that needs to be assessed in this study.

At face value, the South Africa and Zimbabwean government failed to transform the configuration of nature of the inherited settler agricultural systems bequeathed by colonial regimes, in particular, the colonial settler agriculture, which had differentiated mechanized systems and support. In reality, Ngie (2016) notes that the national story is different from that of the Free State, the breadbasket of South Africa. The agriculture output levels have been preserved by over 50 000 commercial farmers and also 240 000 small-scale agro business famers who maintain comparatively high agriculture production levels. However, such productivity is threatened continually by rising cost of inputs, oil prices, foreign currency exchanges and water scarcity.

Zimbabwe has a population of 14 million with the Mashonaland region being the breadbasket of the country, with most arable land in Zimbabwe. Before the land reform distribution programme, the commercial farm sector owned 56% of the total arable land, while the subsistence sector owned 44% nationally. However, the land reform programme resulted in an increase by area and numbers in smallholder subsistence agriculture (74%) in relation to commercial agriculture - even though poor farming methods have contributed to a decline in agriculture output and food insecurity (Toringepi, 2016).

In this research, the problem is that South Africa has a stagnant agriculture production level, which is a concern given continuous population increase, which might lead to food insecurity. In contrast, Zimbabwe has a declining agricultural output production. Although Zimbabwe is an agro-based economy with 30% of its GDP coming from agriculture (Development Bank of Southern Africa Report, 2014), there has been a sharp decline in agricultural output in the country, forcing the country to slide from being the "bread basket of Southern Africa" (as it was called before 1990) to a "basket curse" to date. Notwithstanding the

government's propaganda about a thriving agricultural revolution and persistent use of droughts as scapegoats for intermittent agricultural losses, there is sufficient evidence of agricultural strain and contracting agricultural output in the country.

Bahta, Willemse and Grove (2014) outline that the Free State Province is one of nine provinces in South Africa with a population of 2.8 million people, which is approximately 5.7% of the South African population. The Free State has a surface area of 129 480 km^2, which makes it the fourth largest province in South Africa, covering 10.6% of the total area of the country. The Free State is subdivided into five district council municipalities, namely Xhariep, Motheo, Lejweleputswa, Thabo Mofutsanyane and Fezile Dabi (Northern Free State). These district councils comprise 20 municipalities (Speelman & Olifant, 2016). The Free State is aptly referred to as the "breadbasket" of South Africa (Kanyane, 2006) because of its thriving agricultural sector.

In analysing the literature on land reform in both Zimbabwe and South Africa, there has been a land paradigm shift due to the history of colonialism and apartheid. Kloppers and Pienaar (2014) indicate that South Africa's government introduced land and agrarian reform in the constitution after the 1994 independence based on tenure reform, restitution and redistribution to distribute agriculture land. The Broad Based Black Economic Empowerment (BBBEE) and Accelerated and Shared Growth Initiative also supported these policy interventions. In the Zimbabwean scenario, Makunike (2014) highlights that the government introduced various policies such as Economic Structural Adjustment Programme (ESAP), Fast Track Land Reform programme, indigenisation and economic empowerment and mechanisation of agribusiness and input scheme. The challenge, however, lies in funding and transfer of technology to farmers for provision of farming knowledge and equipment to improve productivity levels in the agriculture sector.

As far as agro-processing firms and agriculture in general is concerned, Duvenage (2013) suggests that both governments and donors should shift from the aid approach to a developmental approach, which is productive, profitable and sustainable. Consistent with the developmental approach, the South African government embarked on Accelerated and Shared Growth Initiative to support the development of the agriculture economy, while Zimbabwe's efforts were hinged on the promotion of various social, political, legal and economic development engraved in the current economic blueprint policy document named Zimbabwe Agenda for Social Sustainable Economic Transformation (ZimAsset). However, the agriculture reforms from both countries have been undermined by soaring global food price crises and, of late, global economic recession.

The Land Reform Programme in Zimbabwe resulted in smaller holder farmers and more than 4 million hectares owned earlier by commercial farmers previously being transferred to small-scale farmers. The involvement of small-scale agricultural farmers with limited experience in agricultural farming meant that systematic planning of the institutional framework, relevant technology transfer, human capacity and skills development, agricultural research and, agricultural inputs and financial services were needed to improve their chances of scaling up productivity. Pienaar (2015) notes that South Africa also embarked on land agrarian reform after independence, with the constitution providing legal foundation for state land reform with three distinct components namely tenure reform, restitution and redistribution.

Accordingly, this study acknowledges the decline of agriculture production in Zimbabwe in the past decade, which has led to an increase in humanitarian AID from Non-Governmental Organisations (NGOs) in the country. Tawodzera (2010) highlights that the food crisis in Zimbabwe has been evidenced by the government's importation of maize from neighbouring countries such as Zambia, Malawi and South Africa. More so, the Zimbabwe African National Union Patriotic Front (ZANU PF) government has also requested humanitarian food aid from NGOs in various parts of the country due to persistent droughts. At a continental level, Asante and Amuakwa-Mensah (2015) also provide a disturbing account of low agricultural output and starvation because of persistent droughts and global warming leading to escalating humanitarian assistance in sub-Saharan countries.

Dube and Sigauke (2015) also note that food insecurity in developing countries is an enormous challenge - especially in the African and Asian continents. In rural communities, food insecurity is a perennial problem that requires undivided attention to ensure household survival and sustainability. The failed politics, climate change and weather extreme events in the agriculture sector and unclear government policies operating in the agro-processing sector have increased food deficit in Zimbabwe. The importance of rural irrigation schemes in addressing agricultural community development, increasing sustainable household food security and ensuring health nutrition uptake are equally paramount. Rural irrigation systems enable farmers to become net food sellers allowing them to benefit from food price volatility over a period of time and seasons due to irrigation water availability. Therefore, it is uncontested that smallholder farmers play a pivotal role in the global agricultural village as they account for a significant amount of food produced and consumed in less developed countries. Despite smallholder farmers' significant contribution to ensuring food security, they are faced with a host of challenges such as increased population growth, lack of funding and climate change hindering their capacity to increase food production.

Dube and Sigauke (2015) suggest that in most developing countries such as Zimbabwe, climate change has exacerbated the challenge of food insecurity by reducing crop yields and increasing production variability. This challenge is also prevalent in the Sub-Sahara African region, which has low adaptive capacity to climate change due to poor economic performance and technical incapacity - as indicated by its overreliance on dry land farming. These challenges in the African region necessitate the adoption of innovative technologies to ensure food security. Irrigation schemes represent one example of a critical technology considered to enhance food production through efficient usage of water. Nhundu and Mushunje (2010) and Dube and Sigauke (2015) indicate that irrigation farming is a critical industry that increases per unit area food production leading to improvements in food availability and accessibility. Crucially, irrigation and mechanisation are examples of crop technologies that can trigger sustainable household economic performance and a broad spectrum of crop production as it facilitates the use of fertilizers and adoption of high-yielding seed varieties that doubled yields between 1995 and 2001 (Hussain & Hanjra, 2004).

1.4. Problem Statement

Evidence of continual and increased humanitarian assistance by food aid organisations in Zimbabwe after the land redistribution exercise shows signs of a distressed agriculture sector and growing food security in the country. Toringepi (2016) notes Zimbabwe is now characterised by chronic food insecurity and is entirely dependent on international food aid. The declining agriculture production and heightened food insecurity in a country that used to be the food basket of Southern Africa is grave cause for concern in the Southern African region, especially neighbouring South Africa, which has seen a growing number of economic migrants from Zimbabwe permeating its porous borders.

The FAO (2012) highlightes that while food for human and commercial use should be between 1.825 million and 2 million tons of maize to ensure food security in the country, the nation has recorded a decline to 800 000 tons and 350 thousand tons of wheat. While South Africa has recorded 8.9 million tons of maize in 2012 and continues to sustain its agricultural output, the lack of significant increases in production may threaten food security due to rapid population increases. Poor farming methods have exacerbated low productivity, contributed to uncompetitive agricultural commodities on the global market and reduced the viability and profitability of agribusinesses.

Khapayi and Celliers (2016) assert that smallholder farming in Zimbabwe is affected by dwindling maize yields due to declining soil fertility and the negative effects of climate variability and change and soil quality indicators such as infiltration. This highlights the need for technology transfer and greater

innovation to allow for better resource utilisation, application of inputs, vibrant and efficient extension services and ensure that land is used for specific purposes such farming, animal ranching or game ranching to maximize land usage. Land uses such as extensive livestock production or game ranching may be better and more profitable alternatives for farmers in these situations.

The evidence of sub-optimal agricultural competitiveness in Zimbabwe include contracting maize and wheat outputs, plummeting of agricultural exports and rising maize imports from South Africa, a ballooning import bill on agricultural foodstuffs (Department of Agriculture, Forestry and Fisheries [DAFF], 2017). A large spectacle has been the continual demand for food humanitarian assistance from International food donor organisations in the country. The efforts by agro-processing firms at improving agriculture production through agriculture technology transfer and innovation to correct this food crisis in Zimbabwe should be explored to establish their impact on product and competitiveness in Zimbabwe.

While agro-processing firms in South Africa contribute 20% to agriculture production, their capacity to harness technology transfer and innovation to contribute to increased food security in the country through increased production and competitiveness has not been tested. While 80% of arable land is under commercial agriculture, the majority of the 16% contribution of small agro-businesses in the Free State comes from commercial agriculture. Therefore, the need to increase the profitability and productivity of agro-processing firms in the Free State cannot be overemphasised. Greyling (2012) noted that South Africa's annual food production remained constant, which is a great concern in view of the increasing food consumption and growing population. Therefore, the current trends in food production will not meet the rising national demand resulting in growing food insecurity.

The challenge, therefore, is our limited understanding of the impacts of technology transfer and innovation on small-scale agro businesses productivity and competitiveness in resource dependent and efficiency driven economies. As the literature on technology transfer-productivity and innovation-productivity relationships will show in the literature review chapters, the relationships between these variables have been explored independently. This study fill this gap by exploring the influence of technology transfer and innovation on the productivity and competitiveness of agro-processing agribusinesses, drawing on a comparative study covering two agriculturally productive regions in Zimbabwe and South Africa.

1.5. Aim of the study

The aim of the study is to contribute to the development of sustainable agro-processing economies in South Africa and Zimbabwe through the advancement of innovation and technology transfer knowledge.

The study also endeavours to contribute to efficient and effective agro-processing firms through promoting a paradigm shift that ingrains innovation processes and technology transfer into their in production and marketing processes.

1.6. Research Questions

1 What is the status and level of productivity of small-scale agro-processing firms operating in Mashonaland Central Province in Zimbabwe and the Free State Province in South Africa?
2 What is the level of competitiveness and quality of products of agro-processing firms in Mashonaland and Free State provinces?
3 What is the relationship among technology transfer, profitability and productivity of agro-processing firms in Mashonaland and Free State provinces?
4 Which variable (technology transfer or innovation) has a greater impact on the productivity of small-scale agro-processing firms in these countries' provinces?
5 How can a sustainable agro-processing production model be constituted to ensure effective and efficient agro-processing business in Mashonaland and Free State provinces?

1.7. Objectives

1 To establish the status and productivity levels of small-scale agro-processing firms operating in Mashonaland Central province in Zimbabwe and Free State province in South Africa.
2 To examine the level of competitiveness and quality of products of agro-processing firms in Mashonaland and Free State provinces.
3 To establish the relationship between technology transfer, profitability and productivity of agro-processing firms in Mashonaland and Free State provinces.
4 To explore which variable (technology transfer or innovation) has a greater impact on the productivity of small-scale agro-processing firms in these countries' provinces.
5 To develop a sustainable agro-processing production model for effective and efficient agro-processing business in Mashonaland and the Free State.

1.8. Significance of the study

This research will contribute to the development of sustainable agribusiness model for small South African and Zimbabwean firms through the utilisation of technology transfer and innovation. Sustainable agriculture is considered critical to the alleviation of the growing food crisis and deteriorating food security situation in both countries. The study will also contribute to literature on effective technology transfer

knowledge based on the understanding of the impacts technology transfer on productivity and agriculture competitiveness in the two countries.

Given the agro-based nature of the Free State economy, the development of best practices on innovation and technology transfer in the agro-business sector will be relevant to the government's discourses on socio-economic empowerment through agriculture and productive use of indigenous resources. The best practice model of technology transfer and innovation founded on these variables' interaction with productivity, quality and competitiveness can positively impact national economic development through reducing the cost of production, the use of modern, efficient production methods, and viable agriculture cost per unit among other considerations.

1.9. Limitation of the study

The determination and calculation of agricultural productivity represent one of the limitations of agro-processing research. The researcher avoided inquiring about exact production and profit figures as these would vary significantly as well as cause uneasiness in respondents. The researcher opted to use classified ranges and frequencies to encourage respondents to respond. To increase the response rate, the researcher also avoided asking direct questions - which might typically increase reluctance to respond. Although the sample sizes were sufficient for making generalisations about the population in both provinces, increasing the sample size in future studies may contribute to results that are more robust.

1.10. Delimitation of the study

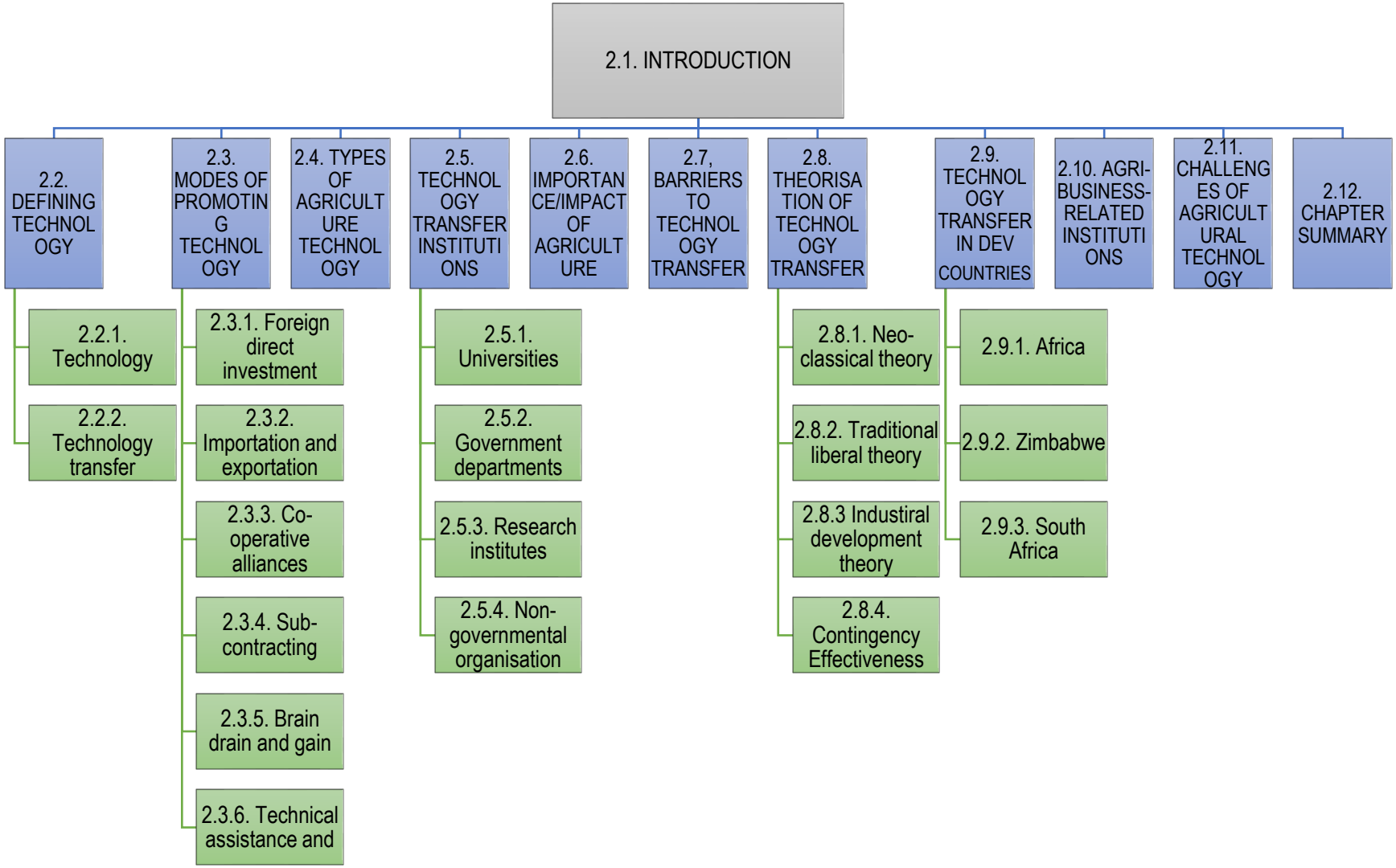
The research covered two provinces in the two countries and, therefore, cannot generalise about the agricultural processes at national levels. The generalisations made are restricted to the provinces covered in this study.

The study was also specific in terms of the concepts examined, namely, technology transfer and innovation. Despite the wider application of technology, the specific technology in question was agricultural technology and not other high technologies applied in other industries and sectors.

1.11. Chapter summary

This chapter focused on the problem background, enunciated the research problem, and presented the research questions, methodology, the significance and limitations of the study. The next chapter reviews the literature on technology transfer.

CHAPTER 2: TECHNOLOGY TRANSFER AND AGRO-PROCESSING FIRMS IN EMERGING ECONOMIES



2.1. Introduction

The introductory chapter presented an overarching narrative on the influence of technology transfer on the productivity of small agro-processing businesses in South Africa and Zimbabwe. This chapter augments the previous chapter by rendering an elaborate literature review on agricultural technology transfer, one of the variables adopted in the current study. Notwithstanding the fragmented nature of the extant literature on the transfer of agricultural technology particularly in the developing world, this chapter attempts to present a comprehensive and synthesised literature covering the diverse facets of technology transfer with specific reference to South Africa and Zimbabwe. The ensuing sections will render comprehensive narrative of the theorisation and contextual application of technology transfer.

2.2. Defining technology and technology transfer

In spite of their currency and popular usage in diverse fields of study, the concepts, technology and technology transfer are difficult to distinguish from each other due to the fluidity of their definitions and lack of uniformity in their application. Nevertheless, in view of Gilsing, Bekkers, Freitas and Van der Steen's (2011) proclamation that 'good science has to begin with good definitions', this subsection provides some definitions of technology and technology transfer to prevent confusion and misconceptions arising from their use in this study.

2.2.1. Technology

There is no one single definition for the term *technology* as its conceptualisation and reference varies with people's diverse knowledge, skills, processes and systems - which leads to the flourishing of multiple definitions. For instance, the International Code of Conduct on the Transfer of Technology (1985: chapter 1, para.1.2.) defines technology as "systematic knowledge for the application of a process that results in the manufacture of a product or the delivery of a service." This definition emphasises the practical application of knowledge in situ irrespective of its scale, location and agent (i.e. the person applying or transferring the knowledge). To Wahab, Rose and Osman (2012), technology relates to the theoretical and practical knowledge, skills, and artefacts that can be used to develop products and services as well as their production and delivery systems. Like the previous definition, an instrumental perspective is foregrounded where technology is conceived as a means (i.e. tool and strategy) to realise socially desirable ends rather than something pursued for its own sake. According to Wahab et al. (2012) technology is embodied in products, processes, and managerial methods. Viewed from this perspective, technology is perceived as a manufactured product or service ready for transfer from the producer to the consumer. Collectively, the aforementioned definitions treat technology as the conversion of knowledge, information, skills and artefacts into products, services, processes and methods that are conveniently

reproducible and exchangeable. This form of technology constitutes the first category of technology, namely *technology as a public good or service*.

However, technology can also encompass knowledge about particular applications that are not conveniently produced, recyclable or transferable. To illustrate this point, some knowledge and technical know–how can be generated by and secured within a particular organisation for internal usage, without any specific intention for rolling them on a wider scale. Specialised technologies, which are specifically developed for research and development, such as space aircrafts, advanced military technology (e.g. long-range ballistic missiles) and genetically modified foods, may not have been developed with wide scale commercialisation in mind, and they fall into this category. In this way, technology accumulates within the confines of the institutions/organisations, beyond the reach of the general public. In this way, technology is defined as firm-specific knowledge and techniques whose production and transfer would involve an initial learning process by the acquiring party (Mateso, 2014).

Other definitions characterise technology as either software, hardware or ideas relevant to practical problem solving within society (Hämäläine, De Wever, Malin & Cincinnato, 2015). This definition is suitable for the agro-processing firms as it encompasses all complementary aspects that are utilised in the production of goods with market value. Examples of such technology include new crop varieties, manufactured inputs, machinery, management techniques and agricultural training. The outcome of the effective adoption of a particular technology in agricultural institutions and societal settings is improved productivity. Having defined technology, it is logical to unravel the meaning of technology transfer.

2.2.2. Technology transfer

Like the concept of technology, defining technology transfer (TT) is a complicated task given its multi-faceted and multi-disciplinary nature (Bozeman, Rimes & Youtie, 2015). A survey of extant literature reveals that the concept has received scholarly attention from diverse fields of study including economics, agriculture, science, management and engineering among others (Reddy, 2015). As a consequence of this popularity, the concept has rapidly evolved and attracted multiple characterisations, reflecting the diverse disciplinary research origins.

In separate studies, Longo, Clark, Shriver and Clausen (2016) contend that in view of the diversity of research fields that have addressed the technological transfer concept, three broad categories of definitions emerge from literature, namely economics/management/business-related, sociology-related and anthropology-related definitions. The scholars observe that the economics and other business-

related characterisations directly link TT to a nation's economic growth (Audretsch, Lehmann, Paleari & Vismara, 2016). Thus, such economics/management/business-related definitions explain TT in terms of aspects of production and design and hence emphasise appropriate versus inappropriate technology transfer, labour versus capital-intensive technology transfer, and small-scale versus large-scale technology transfer.

Sociology-based definitions make a connection between TT and diffusion of innovations in society/social systems (Hornung, 2014). In essence, they focus on how TT affects the members of a social system's ability to cope with modernity and the change that accompanies it. Even though Roger's (1962) Diffusion of Innovation Theory has a strong technological inclination and has been applied extensively in technological studies, it falls squarely in this category.

Another variant of TT categorisation is the anthropological perspective, which depicts how technology influences the pattern of culture and way of life of humans within a particular social system (Bozeman, 2000; Abidin, Hasnan, Abdullah, Mohtar & Zulhumadi, 2013). The use of indigenous technologies and knowledge systems to preserve agricultural products (Derbile, 2013) and the integration of indigenous knowledge systems, artificial intelligence and information and Communication Technology (ICTs) to develop drought prediction software applications (Masinde, 2015) fall into this category. One definition of TT that fall into this category is a process of knowledge creation and application, knowledge mobilisation and exchange of information (Lunogelo & Baregu, 2013) within particular socio-economic and cultural contexts. The central point here is that technology transfer does not unfold in a vacuum, but evolves in a specific situated context.

From an institutional perspective, this study defines technology transfer as "the process of movement or transfer of information, technical know-how and people among corporate technical functions such as research and development (R&D), engineering, manufacturing and non-technical functions such as sales in order to yield innovative products and services that meet corporate business goals and fulfil customer needs" (Henry, Kneller & Milner, 2009: 238). This definition postulates that although the outcomes of TT such as innovative products and services can be inter-organisational and of social nature, the organisations remains the main source and incubator of technology. From a societal perspective, however, TT involves the sharing or introduction of technology from one country to another followed by the spread or expanded utilization of the new technology, generally proceeding from central points to the periphery (Masum, Lackman & Bartleson, 2013). This definition advances the international diffusion of technology, even though it acknowledges the centrality of origin. This modernist perspective, however, is

problematic to the extent that it fails to acknowledge the reverse flow of technology - from the periphery to the centre.

In view of the foregoing discussion on institutional and society-centred perspectives on TT, the current study adopts the following operational definition of TT as: the movement of organisational scientific knowledge, skills, expertise and artefacts from the manufacturing organisation/partner (individuals, institutions and enterprises) to enhance the receiving partner's knowledge, expertise and competitive position to meet society's developmental needs such as improved agricultural practices, increased productivity, and better management practices.

2.3. Modes of promoting technology transfer

Technology transfer in agriculture and rural development, a primary vehicle for elimination of inequality and poverty mainly in the rural areas, is achieved through various means. These methods are as follows: foreign direct investment (FDI), joint ventures and licencing; import and export of capital goods; co-operative alliances; sub-contracting; brain drain/gain; and technical assistance and co-operation. These are briefly discussed below.

2.3.1. Foreign direct investment, joint ventures and licensing

According to Hall (2014), foreign direct investment (FDI) relates to resource commitments made outside the home country of the investor but inside the investing company. The resource commitments include but are not limited to fixed assets, capital, technology, management skills, access to markets and entrepreneurship. The investor retains ownership and has greater control over the use of the invested resources. The activities of multinational companies such as FDI and other forms of investment remain a key mechanism for technology transfer - particularly in developing countries which are still industrialising (Iwasaki & Tokunaga, 2016). The significance of licensing as key form of technology transfer can be noted through the receipts generated by transnational companies from licence fees and royalties of disembodied technologies (Hall, 2014). In efficiency-driven economies with less stringent monetary systems such as South Africa, foreign investors could opt for portfolio investments compared to FDI, which are comparably less movable. That said, in this country, both FDI and portfolio investments tend to flourish due to a more sophisticated financial and economic infrastructure compared to Zimbabwe.

2.3.2. Importation and exportation of capital goods

Capital goods generally have some technological content that is regionally transferred each time these type of goods are imported or exported (Mitra, Sharma & Véganzonès-Varoudakis, 2014). That being the case, the importation of capital goods remains a key means for technology transfer in the developing world because of the large volume of such imports, which at times exceed the value of FDI (Parrado & De Cian, 2014). However, Munemo (2013) underscores the decreasing importance of importation/exportation of capital goods as a single source of technology transfer, pointing out the increasingly intangible content of new technologies, which makes the emphasis on equipment alone out-dated. However, this channel remains relevant if complemented by other transfer mechanisms that are appropriate for intangible technology.

2.3.3. Co-operative alliances

At the outset, it is essential to distinguish co-operative alliances from proximal technology transfer mechanisms like FDI, mergers, acquisitions or any other arm's length corporate relationships. While the notion of co-operative alliances is difficult to define, Nepelski, and De Prato (2015) defines them as an increasingly popular form of technology partnerships characterised by a two-way flow of technology. In this mode of technology transfer, there is increasing interdependence between the parties who are involved in joint knowledge production and sharing. This form of technology transfer is an increasingly important complement to traditional mechanisms like FDI.

2.3.4. Sub-contracting

According to Radosevic (1999), sub-contracting occurs when a firm (the principal) places an order with another firm (the subcontractor) for the manufacture of parts, components, sub-assemblies or assemblies to be incorporated into a product that the principal will sell. Such areas may include the treatment, processing or finishing materials or parts by the sub-contractor at the principal's request. The arrangement usually involves technology exchange and co-operation between the partaking firms in which sub-contracted entities have the opportunity to absorb production and design methods. In the automobile industry, this model is not normally employed as companies prefer to establish subsidiary companies in the host country rather than sub-contract their services for fear of exposing and externalising their value creating competencies.

Generally, sub-contracting is an underrated mode of technology transfer, given that technology is not explicitly mentioned as an object of exchange in such arrangements. This form of technology transfer is common in secondary industries and is increasingly popular following the growth of international

production outsourcing to cut labour costs. Geographically, the phenomenon of sub-contracting is popular in East Asia and some Eastern Europe countries.

2.3.5. Brain drain and gain

The significance of human movement across the globe as a vehicle for technology transfer cannot be underrated (Clemens, Özden & Rapoport, 2015). Researchers highlight the role of the migration of researchers and engineers in the industrialisation of the United States of America and Europe (Nunn, Qian & Sequeira, 2017). However, the contribution of the migration of skilled labour towards agriculture technology transfer in developing countries has not been empirically verified. Also, some scholars acknowledge the contribution of returning individuals (i.e. brain gain) in some of the economically vibrant Asian economies. Lin and Rasiah (2014) attribute the technological sophistication of electronics sectors in East Asia countries over the years to reverse brain drain or reverse engineering.

2.3.6. Technical assistance and co-operation

Technical assistance and co-operation through aid programmes by international development agencies like the World Bank and the International Monetary Fund (IMF) and other NGOs from economically developed countries constitute an important channel for technology transfer. Perhaps, a historically significant form of this assistance is the USA technical assistance to post-war Europe through the Marshall Plan. However, the success of this channel as a platform for technology transfer in the contemporary world is generally questionable. Its shortcomings are attributed mainly to over-investment in capital equipment and less focus on the development of host country human resource capabilities.

One form of technical assistance is agricultural mechanization, which Nowak and Kijek (2017) define as the application of mechanical technology and increased potential of agriculture to enhance the productivity of human labour and to achieve results beyond the capacity of human labour. Where technical assistance is effectively adopted, production increases and as such, productivity differences in agriculture are increasingly a function of scientific technology, industrial capacity and education of people in the farming business (Enete & Amusa, 2010).

Technical assistance can also take the form of imported irrigation equipment and various water sources that are critical for the success of agro businesses. Van Averbeke, Denison and Mnkeni (2011) highlight that irrigation schemes address the declining level of agro business production and output due to erratic

rains in the South Africa agriculture sector. Many farmers with irrigation schemes have more significant income from farming activities compared to those who rely on rain agriculture.

Technology transfer through acquisition of agro-processing machinery, tools and equipment is, therefore, a precondition and prerequisite for the successful expansion of the agricultural sector and improvement of outputs of the agro-processing firms in South Africa. Mungai (2015) notes that in South Africa until early 1998, the production and marketing of most agriculture goods were regulated and controlled as South Africa was isolated from global market. This resulted in the government's formulation of a new policy of rural agriculture development policy through technology transfer, even though it was not yet sophisticated.

2.4. Types of agriculture technology

Agriculture technology encompasses various tools and machinery used primarily to support agricultural enterprise such as ploughs, threshers, and irrigation systems (Rockefeller Foundation, 2017). An illustration of the implementation and adoption of agricultural technology is agricultural mechanisation, which involves use of machinery and equipment to maximise productivity. Asoegwu and Asoegwu (2007) and Sims and Kienzle (2016) consider agricultural mechanisation to be the application of mechanical technology and increased creative potential of the agriculture sector to enhance the productivity of human labour and to achieve results beyond capacity of human labour. Such mechanisation include the use of technology such as tractors, irrigation systems, food processing, related technology and equipment, and provision of mechanical technology that is appropriate and compatible with local, agronomic socio–economic environment and industrial conditions of the countries involved. However, technology transfer is not entirely limited to agricultural technology, but extends to cover various forms of knowledge, skills, and capabilities, which can positively be identified with improving production systems and efficient delivery of goods and services.

2.5. Theorisation of technology transfer

A survey of literature reveals four main theories of technology transfer namely Neo-classical theory, Traditional Liberal theory, Industrial Development Policy theory and Contingency effectiveness model. The Neo-classical theory focuses on the market as the most efficient allocator of technology, while the role of government is to deregulate and remove the barriers through free trade, reduced taxation and the promotion of research development. Traditional Liberal theory illustrates the collaborative efforts among government, research institutions and universities through the creation of good technological, innovation

and competitive policies. The Industrial Development Policy theory takes into consideration the reality that markets are not always efficient for innovation diffusion and economic growth to happen and hence the need for the government to play a very critical and significant role in development. The Contingency Effectiveness acknowledges the involvement of different players in the technology transfer process and their ever-competing strategies, intentions and transfer processes. This study deals with these theories in detail in the following sub-sections.

2.5.1. Neo-classical theory

The basic assumption of the Neo-classical theory is that technology is freely available within and between countries, and to all economic entities. To the extent that technology is available to any technology agent who intends to adopt it and all individuals have the means to acquire it, it is considered non-exclusive (Camagni, 2017). This theory, therefore, postulates that there is free-flow of technology among parties in the market and that firms operate on the same production function (Cecere, 2015). Firms decide on the factors to acquire based on their relative factor prices. In other words, there is no economic value in developing world agricultural firms' acquisition of advanced agricultural technologies from developed countries and their adaptation to the local conditions. Should TT happen, however, the transfer process should be smooth, seamless and unhindered. Since the market is conceived as an effective allocator of technological resources, investments and private businesses, it becomes the ideal vehicle for and effective transmitter of new technologies from their areas of production and origin to their context of use. The theory assumes the absence of market imperfections, which is an erroneous assumption in developing countries were market failures persist, hence its limited application to these countries (Collier & Dercon, 2014).

For the Neo-classical theory, the role of the government is to eliminate barriers in business, promote competitive trade, relax or even deregulate stringent trade conditions, ensure effective tax credit and promote a business-friendly environment. The main source of new technologies and innovations in the market are research and development institutions such as agriculture research institutions, universities, agriculture training institutions, various private sector and Non-Governmental Organisations that encourage innovation and diffusion of technology transfer in agro-businesses. Apart from that, foreign direct investment is also an important source of such technologies.

2.5.2. Traditional Liberal theory

The Traditional Liberal theory notes that business agencies and government can collaborate and assist each other, though this partnership will be limited to missions or agencies in research and development

(R&D) relating to technology transfer. In identifying with this theory, it is possible that a cooperation model whereby government complements private business' efforts to ensure technology transfer would be more effective to technology diffusion than one in which these sectors compete for space and influence. To illustrate this co-operation, the Agriculture Research Council in South Africa is an important vehicle through which the government intervenes to shape agricultural research, innovation and the transfer of technology from government to technology consumers. The Agriculture Research Board is also a vital conduit through which agricultural research and technology are applied to areas of need in various sectors.

Bozeman (2000) argues that the theory is useful for informing government and business relations and their impact on technology transfer, which invariably influences the productivity and competitiveness of small agribusiness. For the sake of brevity, the theory promotes private-public partnerships that ensure the availability and transfer of agricultural technology from the source to intended technology recipients and across various sectors.

2.5.3. Industrial Development theory

Bozeman (2000) notes that this theory dwells on centralised cooperative technology and affirms that markets are not always the most efficient route to innovation and economic development. Hence, the global economy requires centralised planning and broader support for public technology development, which will ensure that industries are developed. Government institutions and agriculture institutions can play a role in technology development influenced by sustainable development goals and applied research and development (R&D).

Sampath (2015) concurs with the Industrial Development theory by arguing that technology transfer is determined by choice of development induced by political system, which is predominantly shaped by the central government. In the case of South Africa and Zimbabwe, technology transfer in the agriculture sector is also facilitated through industrial development policies in the agriculture sector through these nations' respective national budgets, government policy and economic blueprints. In both countries, the Industrial Development Corporation (IDC) is instrumental in shaping the industrial expansion policy and the transfer of technology across sectors in both countries. The IDC offices seek to enhance the industrial capability of South Africa and Zimbabwe, and the rest of the continent, thereby boosting economic growth and industrial development of both countries. These offices achieve this through the funding of entrepreneurs starting new enterprises or supporting companies that want to extend existing operations. In the case of assistance to agro-processing firms, the South African IDC runs the Agro-Processing

Competitiveness Fund (APCF) valued at R250 million, whose objective is to facilitate increased competition, growth and development in the agro-processing and beverage sector.

2.5.4. Contingency Effectiveness Model on technology transfer

The Contingency Effectiveness Model derives its name from its assumption that the parties involved in technology transfer have many objectives and effectiveness yardstick. The model argues that the effect of technology transfer can be fully comprehended in terms of who is doing the transfer, how they are transferring it, what is being transferred and to whom. Bozeman (2000) and Bozeman et al. (2015) state that in the Contingency Effectiveness Model, technology transfer is determined by the following factors: (1) characteristics of the transfer agent, (2) characteristics of the transfer media, (3) characteristics of the transfer object, (4) demand environment, and (5) characteristics of the transfer recipient.

First, the transfer agent relates to the institution or organisation seeking to transfer technology. This can be a government agency, university or any private firm and their individual character and nature of their transferring mode informs the effectiveness of transfer process. Second, the characteristics of the transfer media relates to the vehicle through which technology is transferred. This generally takes the form of *inter alia*, license, copyright, person-to-person, formal literature and transfer arrangements such as partnerships and collaborations. Third, the transfer object refers to the technology that needs to be transferred. This takes the form of scientific knowledge, technological device, process, know-how and specific characteristics of each. The alignment of the transfer object to the situated conditions such as cultural norms and value systems and natural resource endowments is instrumental in ensuring effective and sustainable transfer of the technology. Fourth, the transfer recipient is the organisation or institution that is accepting and adopting the transfer object. This could be a firm, agency, organisation, consumer, informal group or any form of institution whose internal systems and organisational culture would also facilitate or hinder the transfer of the technology. Last, the demand environment relates to the factors driving the need for the object of transfer. This can be forces like the price for technology, substitutability, relation to technologies currently in use and availability of subsidies. While these determinants are not exhaustive, they encompass the critical factors that influence technology transfer in diverse contexts. The model is diagrammatically presented in Figure 2.1. The arrows on the diagram indicate the relationship between variables.

Bozemen's model suggests a comprehensive list of criteria for evaluating the effectiveness of technology transfer. The list includes items like (i) impact on scientific and technical human capital (ii) opportunity

costs (iii) extent of political reward emanating from participation in technology transfer (iv) effects on a regional or national economy and (v) market impact.

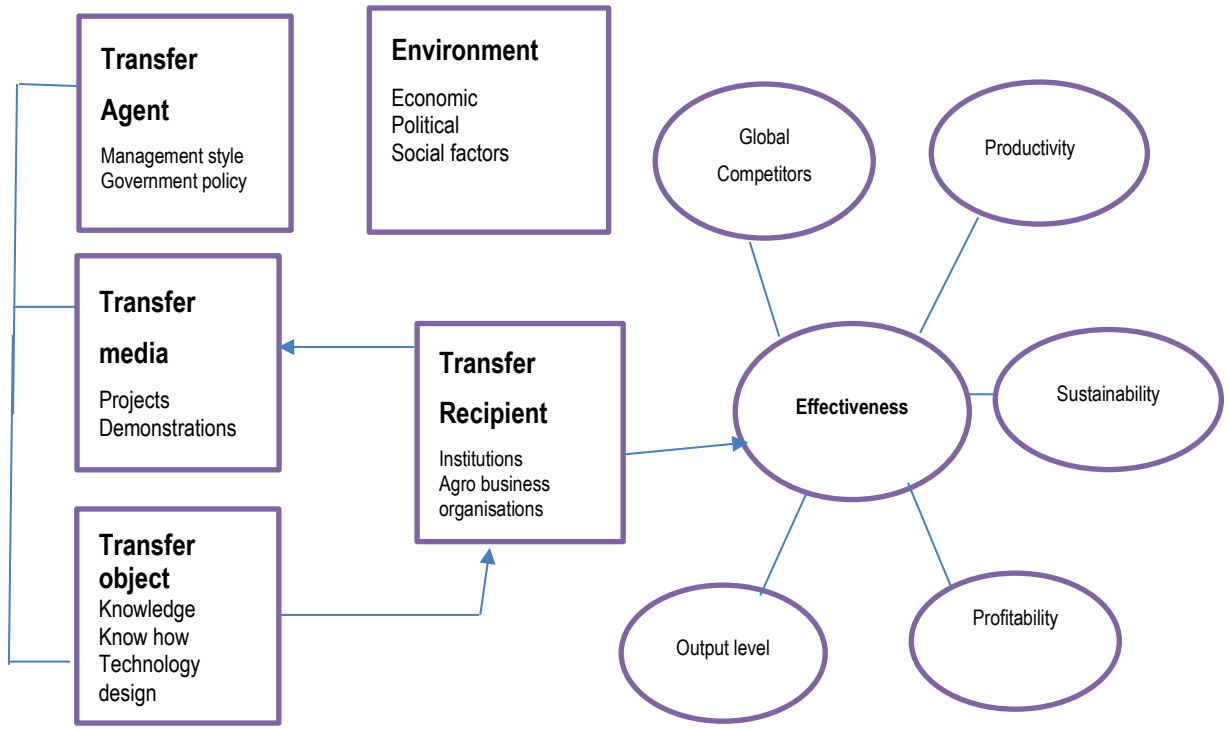


Figure 2.1: The Contingent Effectiveness Model of technology transfer
(Adapted from Bozeman 2000:636)

Figure 2.1. illustrates the Contingence Effectiveness Model, some of whose components are technology transfer, agricultural technology, productivity and effectiveness, will be used in the current study. Agricultural effectiveness is measured by agricultural productivity, profitability, sustainability, stable agricultural prices, which are governed by the agricultural environment - such as the government, droughts and climatic change.

2.6. Technology transfer institutions

There is growing consensus that the process of technology transfer is primarily achieved through the deliberate interventions of institutions like universities, government departments, research institutes and non-governmental organisations (Costantini & Liberati, 2014; Nelsen, 2016). In fact, TT in various spheres of life including in the agriculture sector, is largely a conscious and deliberate decision - even though they may be some chance occurrences. The contribution of these aforementioned institutions is discussed in the following sub-sections.

2.6.1. Universities

Several studies have revealed that universities are uniquely positioned to facilitate technology transfer from its producers to the beneficiaries in any economic sector through their centres of excellence, research units and company spin offs. According to Nelsen (2016), higher learning institutions, through university-industry relationships, have special roles in national innovation systems to develop and transfer technology. Through these relationships and special networks, universities create and deploy knowledge thereby contributing to economic growth and prosperity of the nation. At South African higher educational institutions, Departments of Agriculture, Genetics, Chemistry and Bio Technology are known for developing livestock vaccination drugs, experimentation with high yielding varieties and the testing of genetically produced products. Cesaroni and Piccaluga (2016) highlight how senior university faculty and other staff spearhead the commercialisation of knowledge, which results in the creation of new spin-off of companies. The Central University of Technology's (CUT) Department of Electrical Engineering is renowned for having developed one of the first energy serving, photo-voltaic panel systems, which could support the electrification of various agricultural projects. The aforementioned view is corroborated by Boh, De-Haan and Strom (2016) who claim that more established university ecosystems have a substantial influence on technology transfer with their university technology transfer office and university commercial policies being the primary technology transfer mechanisms.

Many South African Universities have Idea Generators that facilitate the experimentation with new technologies, commercialisation of technological breakthroughs and the diffusion of university innovation spin offs into society, and Intellectual Property Office that are responsible for the patenting and protection of innovative ideas. Therefore, universities are key drivers of technology transfer and are expected to reap the rewards of such endeavours because of their rich knowledge networks, greater funding potential and depth of expertise (Wright, 2014). The challenge, however, is that universities do not always commercialize technological breakthroughs, which may otherwise remain unexploited (Van Burg, Romme, Gilsing & Reymen (2008) and the thinking of universities as agents of technology transfer sustains the monolithic argument where academic entrepreneurship and innovation are only achieved through the exploitation of research and development (R&D) results (Malele, Mpofu & Muchie, 2017). However, as it may, universities in Zimbabwe also continue to play an important role in the dissemination of technological breakthroughs. For instance, the National Institute of Health Research, an affiliate of the University of Zimbabwe, then named the Blair Research Laboratory was instrumental in the development of the Blair toilet (or pit latrine) which revolutionised sanitation in many African countries.

2.6.2. Government departments in advanced economies

Although many governments across the world have contributed significantly to technology transfer, the most popular examples of technology transfer include the United States, European Union and Japan. These "best examples" of agricultural technology transfer are highlighted in subsequent sections of this study.

2.6.2.1. United States

In the United States, the main forces of technology transfer include the Department of Homeland and Security, Energy and Agriculture. The Department of Homeland and Security's (DHS) Science and Technology's Technology Transfer and Commercialization section serves as the nerve centre responsible for managing technology transition throughout DHS and the DHS laboratory network. Most of the technologies that are generated in the department can have commercial applications in the USA, in the process enhancing the competitiveness of small businesses (Organisation for Economic Co-operation and Development [OECD], 2017). Separately, the National Institute of Food and Agriculture in the United States' Department of Agriculture offers technical assistance to establish and enhance small businesses, promote technology transfer through partnerships among businesses, academic and non-profit research institutions, or helping small businesses apply for funding and technical assistance. In the same department, Agricultural Research Service's (ARS) Office of Technology Transfer helps transfer ARS-developed technology to the marketplace. At the same time, the office actively seeks technology transfer partnerships to augment research programmes, expedite research results to the private sector, exchange information and knowledge, stimulate new business and economic development, enhance U.S. trade, preserve the environment, and improve the quality of life for all Americans (National Institute of Food and Agriculture, 2017).

2.6.2.2. European Union

While agricultural technology transfer predominantly unfolds in the United States through various government departments, it is implemented in the European Union through research institutes, public agencies, NGOs/Civil society, regional and international organisations, the private sector and universities. Global food security is a top priority for the EU and in times of crises, the Union works to help poor countries. As a result, the EU continues to play an active role in various regional and global initiatives on agriculture, food security and nutrition. An illustration of an EU supported technology transfer programme is The Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and South-East Asia (SATNET Asia) which is a three-year project funded by the European Union (EU) (SATNET, 2017). The target countries for the programme are

Afghanistan, Bangladesh, Bhutan, Cambodia, India, Indonesia, Lao People's Democratic Republic (PDR), Myanmar, Nepal and Pakistan. The direct project participants in these countries are change agents along domestic and regional value chains, national agricultural scientists, extension workers and policymakers. The expected final beneficiaries encompass value chain actors – poor and vulnerable small farmers, agricultural intermediaries, retailers, importers and exporters in target countries. The implementing agencies for the programme include:

- Centre for Alleviation of Poverty through Sustainable Agriculture (CAPSA) of the Economic and Social Commission for Asia and the Pacific (ESCAP), Indonesia; (United Nations Centre for Alleviation of Poverty through Sustainable Agriculture (CAPSA) http://uncapsa.org/).
- Asian and Pacific Centre for Transfer of Technology (APCTT) of ESCAP, India;
- Trade and Investment Division of ESCAP, Thailand;
- The World Vegetable Center-AVRDC, Thailand; and
- Food Security Center of the University of Hohenheim, Germany (Food Security Center, https://fsc.uni-hohenheim.de/en)

2.6.2.3. Japan

Ito, Kaneta and Sundstrom (2016) note that the Japanese government has embarked on a number technology transfer initiatives meant to facilitate the transfer of technology from Japanese universities to local industries. For instance, they put into place technology licencing officers in several Japanese universities to increase the patenting and licensing of technologies generated by such institutions. This was by then a rare technology transfer model. However, such efforts are not without hindrances - most of which are of a historical and institutional nature. To illustrate this point, patenting and licencing of university-generated technology was traditionally left to collaborating partners who themselves were external to universities. Thus, university themselves rarely performed this role and only concentrate on the research aspect. However, Bradley, Hayter and Link (2013) proclaim that there is a severe handicap in the efforts of universities in facilitating technology transfer. These scholars criticise universities' over-simplification and straightjacket approach to the process as well as putting too much emphasis on patenting and licensing.

2.6.3. Government departments in emerging economies

For the sake of brevity, the technology transfer of activities in Brazil, Russia, India and China (the BRIC countries), will be collectively examined, thereafter Nigeria, Kenya and then the selected country studies of South Africa and Zimbabwe. These are discussed in the subsequent sections of this study.

2.6.3.1. South Africa and Zimbabwe

In African emerging economies, government departments such as their Ministries of Agriculture, play a critical function in the transfer of agriculture technology such as biotechnology products, machinery, high yielding varieties and pest control chemicals (Zhou, 2015; Ahuja, Ma & Howell, 2016). For example, the South African Department of Agriculture, Fisheries and Forestry has partnered with private entrepreneurs to provide water conservation technologies to farmers to cushion them against the negative consequences of continuous droughts. In the South African contexts, where there is dire need for food security due to climatic change leading to droughts, the application of suitable empirically-tested agricultural technologies to enhance agricultural productivity remains a key priority. As a result, agriculture departments (i.e. the Ministry of Agriculture in Zimbabwe and the Department of Agriculture, Forestry and Fisheries in South Africa) employ extension workers, usually highly trained and experienced subject-matter specialists, who are responsible for effectively transmitting such technologies to farmers (Juma, 2015; Wheeler, Zuo, Bjornlund, Mdemu, van Rooyen & Munguambe, 2017). Since the majority of farmers in the developing nations are engaged in subsistence farming in rural areas and are of diverse socio-economic backgrounds, academic abilities and learning requirements (Abate, Fisher, Abdoulaye, Kassie, Lunduka, Marenya & Asnake, 2017), the agriculture extension workers who are under the employ of government ministries have to find the appropriate means and techniques to transmit as well as encourage the adoption of new technologies (Machila, Lyne & Nuthall, 2016). In this way, government facilitates the flow of agricultural technology to the farmers and employ applied research and development to provide customised solutions to farmers' problems. The success of government interventions in technology transfer depends on the extension workers' comprehension of farmers' knowledge requirements, priorities and opportunities as well as the obstacles to technology acceptance.

The Zimbabwean experience with general technology transfer and agricultural technology transfer has generally been a fruitful one with the government agricultural extension services and aid agencies adopting a participatory approach to technology transfer. However, the uptake of certain technologies like conservation agriculture has been negative owing to negligible increases in yields following the adoption of these new technologies.

In spite of the reported responsibilities of government agricultural extension services, some scholars have criticised the role of such extension services (Elias, Nohmi, Yasunobu & Ishida, 2016). The key concerns raised are the over-emphasis of technology transfer of cash crop varieties at the expense of dietary crops, absence of technology collaboration arrangements with technology-generating centres to reduce technology dependence, as well as low levels of training and compensation of extension workers. Overall,

these limitations negatively impact on the ability of government departments to facilitate the timely appropriation, predictable transfer of appropriate technology services. Notwithstanding, some success stories of government-driven technology transfer programmes can be observed in some emerging economies.

Charles, Godfray and Garnett (2014) argues that increasing yields depends upon fertility of the area cultivated, the use of better seeds and technologies - hence reducing the risk of food insecurity in emerging economies. In the African agro-business community, long-term food security depends on sustainable intensification of production through usage on tested seeds, fertilizers, equipment and agriculture technologies usage. The application of technology transfer includes the use of organic inputs, soil conservation methods, well-functioning agro based markets, sustainable and appropriate agricultural inputs, which contribute to intensified agriculture output levels and increase in productivity. Abdu-Raheem, and Worth (2011) consider technology transfer as a means of meeting the goals of income growth, increased food security and improved social well-being in Africa.

2.6.4. Research institutes

Apart from individual governments, research institutes are critical drivers in the transfer of technology. Research institutes often liaise and collaborate with government departments responsible for agricultural extension and agricultural teaching institutions, in their efforts to transfer agricultural technology such as hardware stores and farms to technology recipients (Ahuja et al., 2016). The research institutes, with their assemblages of agriculture experts and scientific facilities, are a key source of useful ideas and practical information related to agriculture.

2.6.4.1. BRIC countries

In the BRIC countries, the main research institutions responsible for agricultural technology transfer are universities, agricultural institutes and some cognate government ministries. As an illustration, the Chinese University of Agriculture and the Chinese Academy of Agricultural Sciences are at the forefront of agricultural knowledge and technology transfer in China. Similarly, Brazilian universities and the Brazilian Agricultural Research Corporation (Embrapa), which was created in 1973 as an agricultural research organisation under Brazil's Ministry of Agriculture and was almost entirely funded by government resources, are at the forefront of agricultural technology transfer in Brazil.

In September 2016, the Ministers of Agriculture from Brazil, Russia, India, China, South Africa (BRICS) met in New Delhi (India) to set up a research centre for greater agriculture cooperation (Upadhyay, 2016).

The BRICS countries, which account for 45% of global agricultural output, concurred to establish an Agricultural Research Centre to generate and share models for sustainable agriculture. The Centre is intended to promote food security, sustainable agri-development and poverty alleviation through strategic cooperation in agriculture within the BRICS countries. Its key focus areas include agriculture science, policy research and development extension, technology transfer, training and capacity building and scientific information sharing.

2.6.4.2. South Africa

In South Africa, the Agriculture Research Council (ARC) whose mandate is to conduct research, promote development and transfer technology in order to promote agriculture and industry, contributes to a better quality of life, facilitates natural resource conservation and alleviate poverty, plays a critical role in technology transfer in the South African context. The Council's Agricultural Economics and Capacity Development Division facilitates the transfer of technology by translating the ARC's research results into useable outputs in support of agrarian transformation and the efficiency and competitiveness of the sector. This is achieved through analysis of research activity in order to allow the ARC to exploit its intellectual property, maximise utilisation of research and development outputs and transfer technology to farmers and agribusiness. In addition, the Research and Innovation Systems (RIS) Division provides a wide range of technologies that are integrated with both the Crop Sciences and Animal Sciences divisions. RIS includes Agricultural Engineering, Biotechnology, Natural Resource Management, Climate Smart Agriculture, Informatics, Biometry and Knowledge Management Systems. With a wide range of service, development and research functions, the RIS Division provides collaborative and support functions to a wide range of technologies in areas such as genomics, phenomics, remote sensing, agricultural systems modelling and engineering systems.

2.6.4.3. Zimbabwe

In Zimbabwe, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Zimbabwe conducts research with partners, develops human capital and fosters innovation to support and develop the agricultural sector in the respective countries. The organisation, which has been in the country since 1984, collaborates with multilateral organisations, including national and regional agricultural research institutes, civil society organisations, academia and the private sector. It is active in agricultural research for sustainable development, reducing rural poverty, improving food security, improving nutrition and health, and sustainably managing natural resources via donor funding. The significance of organisations like ICRISAT needs not to be over-emphasized given the current climatic changes and rainfall pattern unreliability currently experienced across the globe. The climatic changes,

which are accompanied by droughts, negatively affect crop yields and food security. Hence, the vital intervention of research institutes whose aim is to produce the necessary research to help mitigate and promote agricultural development, cannot be over emphasised.

However, the contribution of such institutes has been called into question. Not discrediting the capability of research institutes to generate knowledge, Hoffmann, Probst and Christinck (2007) argue that because of their independent nature, their research priorities may not be in line with national technology needs or strategies. At the same time, the often isolated nature of research institutes, both physically and in terms of research objectives, may disrupt the flow of technology from the source (technology agents) to the consumers (Shiva, 2016). Davis (2008) proffers that research institutes often have tenuous or non-existent relations with government agricultural extension workers whose traditional role enables a two-way information exchange between the two parties. As a result, research institutes may accumulate vast research findings, which have the potential to enhance the agricultural productivity of farmers but still remain stuck with such data because of weak or absence of technology dissemination and implementation linkages. Thus, for research institutes to fulfil their role in agriculture technology transfer effectively, robust reciprocal task-relationships between research institutes and government departments/ministries should be nurtured and supported. This, in turn, requires cohesion and integration of national technology transfer strategies (Spithoven, Clarysse & Knockaert, 2011) to ensure wide-scale rollout of technology in places of need such as farms, forestry and hardware stores.

2.6.5. Non-Governmental Organisations

Non-governmental organisations and international aid agencies from more developed economies are actively engaged in technology transfer processes in the least developed economies. The following sections will summarise African experiences before examining the experiences in the two case studies, the focus of this study.

2.6.5.1 Selected African experiences

Through their highly structured and well-co-ordinated developmental projects, aid agencies and other Non-Governmental Organisations (NGOs) provide technical expertise and funding to agriculture and farming-related activities (Andersson & D'Souza, 2014; Pedzisa, Rugube, Winter-Nelson, Baylis & Mazvimavi, 2015). As an illustration, between 1996 and 1998, the Department of Agricultural Technical and Extension Services in Zimbabwe's Ministry of Agriculture together with the German Technical Cooperation Agency engaged in a joint project to implement reduced tillage in smallholder farming systems. The primary objective was to disseminate cultivation technologies to redress the problems of

soil loss, runoff and erosion. From 2003, a consortium of organisations including Food and Agriculture Organisation of the United Nations (FAO), Department for International Development (DFID), European Union, International Crop Research Institute for the Semi-arid Tropics (ICRISAT), International Maize and Wheat Improvement Centre (CIMMYT), University of Zimbabwe, various non-governmental organisations (NGOs) and extension services were actively involved in research and advancement of conservation agriculture technologies across Zimbabwe (Mafongoya, Rusinamhodzi, Siziba, Thierfelder, Mvumi, Nhau, Hove & Chivenge, 2016). While some tillage knowledge, the practice of gully reclamation and the prevention of stream bank cultivation were disseminated over the years, these gains could have been reversed during the land reform programme, when grass burning to clear arable land and the cultivation of steep slopes and cultivation of riverbanks increased among small-scale farmers.

Aid agencies and NGO-driven technology transfer projects are usually acclaimed for being soundly conceived and internally well-co-ordinated (Xu, Li, Qi, Tang & Mukwereza, 2016). However, they are often criticised for pursuing wrong developmental priorities, imposing what has worked in their home countries to host countries. As a result, foreign NGOs from different countries fail to support each other's efforts and pursue their individual national interests instead. Apart from that, Ockwell, Sagar and de Coninck (2015) observe that while different projects by different autonomous bodies may pursue a common developmental agenda, their prescriptions in relation to technology may differ. In the case of farming technologies, species selection, management strategies, and assumptions about the farming system may differ widely (Grabowski & Kerr, 2014). This makes co-ordination of such technology transfer efforts sometimes costly and time-consuming. Alemu, Cook and Gubo (2015), nonetheless, advises that for multi-donor technology projects to succeed in the developing world, there is need to fit in local agents of the technology transfer system to promote uniformity with the national strategy and agrarian requirements.

Having discussed the various institutions and organisations that drive the technology transfer process, the next section examines the importance of agricultural technology transfer in Africa.

2.7. Importance/impact of agriculture technology transfer in Africa

The introduction of new technology to agricultural producers has the potential to raise overall productivity and quality of life within an area (Collier & Dercon, 2014). According to Juma (2015), technology transfer is a key mechanism through which agricultural advancement can achieve the millennium development goals of increasing the general level of food production, meeting food and nutritional requirements as well as reducing poverty levels. For example, the Maendeleo Agricultural Technology Fund (MATF),

which was started in 2002, has had a substantive impact on the agricultural productivity of smallholder farmers in some East African countries (Njeru, 2016). The Fund was setup by FARM-Africa, a United Kingdom non-governmental organisation, to promote the adoption of new agricultural technologies so as to the increase agricultural production and improve the livelihoods of smallholder farmers in East Africa. In the past, the fund had supported agricultural projects in Kenya, Uganda and Tanzania and covered a range of farm enterprises like bananas, chickens, sunflower and honey, sweet potato, beans, cassava and silage for dairy cows (Roothaert & Magado, 2011; Roothaert, Ssalongo & Fulgensio, 2011). The most successful of the technology transfer projects are those that have involved the active participation of the intended recipients with smallholder farmers benefiting from agriculture training and input support.

Studies proclaim that TT has a greater role to play in the economic development of developing countries given the very limited agricultural research and development activities are carried out in these countries (Tittonell & Giller, 2013; Collier & Dercon, 2014; Juma, 2015; Meijer, Catacutan, Ajayi, Sileshi & Nieuwenhuis, 2015). In view of the restrictions of local sources of new agricultural technology in emerging economies, the acquisition of new technologies by developing countries will help to enhance the local technological capabilities and meet the national socio-economic targets. The reason behind the promotion of TT from developed countries to the developing world is to help the lagging economies to transition from traditional-based agriculture to technology-based agriculture through agriculture-related technical and material assistance (Collier & Dercon, 2014). For instance, smallholder farmers from several West African countries have benefited from institutional changes meant to support sustainable agricultural practices from European countries such as France (Struik, Klerkx, van Huis & Röling, 2014).

Santacreu (2015) suggests three different objectives and areas of impact for which technology transfer is undertaken. First, these scholars argue that new and innovative technology are acquired from foreign nations for the purpose of import substitution. This means that the acquired technology is used to enhance the productivity and competitiveness of an existing indigenous production system and reduce reliance on foreign supplies. Second, the acquisition of new technology is done to enhance a country's export competitiveness through enhancing the productivity of domestic export-oriented industries. Last, technology transfer helps developing countries to boost their already existing capabilities, in the process helping them to compete on the global arena. Examples include the adoption of no-tillage agriculture and bioenergy crops in some countries (Kraucunas, Clarke, Dirks, Hathaway, Hejazi, Hibbard & Leung, 2015).

Given the above-cited significance of technology transfer to developing economies, it is evident that African agricultural activities stand to benefit more from such technology exchange relationships through

improved local production and the meeting of local food security requirements. Obi and Nwakaire (2014) argue that African countries should thus target to acquire new agriculture technology, first, to meet local food requirements and, second, to promote import substitution and export-promotion or any other goal. For instance, the Zimbabwean government has permitted non-governmental organisation to transfer agricultural technology that promotes food security and sustainable practices like conservation agriculture (Andersson & D'Souza, 2014).

2.8. Technology transfer in developing economies

The subsequent sections of this study will examine literature on technology transfer processes in African, South African and Zimbabwean countries.

2.8.1. Africa

Several scholars underscore the significance of effective technology transfer processes and mechanisms for the success of any modern economy, particularly in developing countries where the governments are ill-funded or poorly resourced to develop their own technology or conduct any meaningful research (Collier & Dercon, 2014; Juma, 2015; Ahuja et al., 2016). There is convergence of scholarly opinion on the need for agriculture systems to evolve from the less productive, labour intensive subsistence agriculture systems to the capital intensive, commercially-driven one (Juma, 2015; Meijer et al., 2015; Amanor & Chichava, 2016). Literature affirm the need for African countries to import agriculture related technology in order to substitute imports, augment export-oriented products, and as well enhance the prevailing indigenous capabilities (Ulrich, 2014; Juma, 2015; Adenle, Manning & Azadi, 2017).

Previous research conducted on the African continent point to the significance of agriculture technology transfer in increasing productivity, distribution and consumption of agricultural produce (Obi & Nwakaire, 2014). For a continent which is poverty-ridden and whose majority lives off subsistence farming, effective transfer of technology such as hybrid seed, fertiliser and agriculture biotechnology and the adoption of transformative agricultural practices such as crop rotation, soil protection and land tenure arrangements provide a solid foundation for improved agricultural productivity (Andersson & D'Souza, 2014; Juma, 2015). This is particularly so for agro-driven economies like Gambia where the agricultural sector employs three quarters of the country's total labour force and accounts for 30% of the country's Gross Domestic Product (Gibba & Mark, 2016). Therefore, the capacity of existing technology transfer institutions and the speed of technology adoption accounts for the marked disparities in productivity and high costs of production in African countries.

In regions where TT structures are weak or non-existent, the contribution of technology has been non-existent. As an illustration, the poor productivity and performance of the Gambian horticulture sector is often attributed to poor supply of sophisticated agriculture inputs, low crop yields and poor market access (Mehra & Rojas, 2008). In the Nigerian case, the shunning of careers in agriculture by the educated youth due to poor rewards and seasonality of the sector creates a disturbing eventuality where the country's agriculture sector is manned by the elderly whose resistance to change contributes to the persistence only small-scale, rural agriculture based on traditional methods (Maiga, Christiaensen & Palacios-Lopez, 2017). Such methods are not productive enough even to meet the needs of the local population, often leading to food imports and solicitation of aid. As such, resistance to many radical technological changes and institutional inertia has contributed to the limited acceptance, adoption and adaptation of transferred technology.

For Obi and Nwakaire (2014), the effective transfer of agricultural technology in Africa will only happen if the whole process is synchronised to the needs and culture of the recipient communities. Instead of emphasising high technology, which might not suit the physical environment and institutional preparedness of the local governments and communities, emphasis should on appropriate innovations that meet the needs of local communities and embrace participatory processes of technology adoption. According to Juma (2015) and Kaushik et al. (2014) the technology transfer process is successful if accepted and adapted to local people's knowledge base, value systems, resource endowments and situated conditions.

A good example of a sustained effort at transferring agricultural technology to Africa is the establishment in some countries of Agriculture Technology Demonstration Centres (ATDC) by the Chinese government as new forms of foreign aid and South-South co-operation (Xu et al., 2016). The Chinese government believes that the failure of the African agriculture system despite vast tracts of land lies in poor farming techniques and know-how (Gu et al., 2016). Thus, according to them, the solution lies the transfer of agriculture technology to the African continent through bundling aid with business to ensure the continuity of the established programmes once the co-operation period lapses. Under this arrangement, rather than sell/send/transfer the technology (knowledge/know-how/artefacts/ ideological and political arrangements) only to the continent as part of the aid arrangement, the Chinese government sends technical experts as well. However, like similar attempts at transferring western technology, the process has also encountered some obstacles. For instance, the technologies that yielded high productivity in China fail to do so in Africa once the Chinese expatriates withdraw, a factor that is blamed on the local people's obstinacy and

resistance to Chinese technology. To this end, Wekesa (2016) laments that the African farmers need a revolution of the mind-set for them to accept Chinese technologies.

2.8.2. Zimbabwe

A survey of literature reveals that post-1980, the process of agricultural technology transfer in Zimbabwe has involved numerous parties including farmers, traditional and local leaders, extension officers, Non-Governmental Organisations, donors, research organisations and researchers, media organisations, product marketers among several other interested parties (Gisselquist, Nash & Pray, 2002; Tilman, Balzer, Hill & Befort, 2011). Up to 2000, the process was mainly targeted at small-scale rural farmers given their limited agriculture resources and technical expertise (Chiputwa, Langyintuo & Wall, 2011). Given the diversity and often diverging interests of the numerous stakeholders involved in the technology transfer process, the process has achieved mild success. Before the recipients of agriculture technology accept and implement it, they are expected to evaluate its perceived merits and demerits, an evaluative process that could be complicated for small-scale farmers due to their limited agricultural technology knowledge. In fact, the process of technology acceptance and diffusion is complex and often is influenced by aspects like age, gender, socio-economic status of targeted households, and the physical environment of the targeted area (Abdullah & Samah, 2013).

However, the Zimbabwean agriculture sector undoubtedly requires the support of appropriate technology to enhance its productivity. To a large extent, the sector is rain-fed and therefore relies on seasonal rains which are unreliable in terms of amount, spatial distribution and timing (Andersson & D'Souza, 2014). Owing to this condition, agriculture crop output is perennially not guaranteed and perpetuates food insecurity within the country (Cheesman, Andersson & Frossard, 2017). Hence, the sector stands to benefit more from the adoption of new agriculture technology such as planting hydroponically produced crops, green house effects, gravel and wire-covered storm drains and gully reclamation in addition to preservation of productive conservative farming methods (e.g. compost farming, mulching, inter-cropping).

The need for new technology was felt more following the Fast Track Land Reform Programme (FTLRP) of 2000 in Zimbabwe that introduced new, unskilled and ill-equipped cadres in the formerly white-owned commercial farming areas (Chambati, 2013). One of the unintended outcomes of the process was the sharp drop in the land under irrigation from approximately 200 000 ha to around 120 000 ha. Arguably, the intensification of the transfer and implementation of the new technologies that enhance water

conservation and agricultural land productivity would put the country's agriculture sector on sound footing and regain its breadbasket status.

A classic illustration of attempts at transferring agricultural technology as a countermeasure to the unreliable rainfall patterns in Zimbabwe is the joint effort of the Zimbabwean government and some NGOs to entrench water conservation farming techniques such as building dams, use of drip irrigation and modern water harvesting methods in rural areas. Conservation agriculture involves ensuring no soil disturbance, permanent soil cover and crop rotation (Thierfelder & Wall, 2012). The purpose of this farming technique is to increase crop yields, even though literature reveals that its adoption has yielded limited success with recipients reporting insignificant changes in their crop yields (Baudron, Andersson, Corbeels & Giller, 2012). This raises doubts about the suitability of this knowledge to the Zimbabwean physical conditions.

Another example of institutional arrangements aimed at supporting agriculture technology transfer from outside is the establishment of China Zimbabwe Agriculture Demonstration Centre in Zimbabwe in 2012 (Gu, Zhang, Vaz & Mukwereza, 2016). This gesture is an effort by the Chinese government to provide sustainable technological support to the Zimbabwean agriculture sector. Though funded by the Chinese government, the project is overseen by a private Chinese company whose human resources have previous agriculture experience gained in China. Apart from transferring agriculture knowledge at the Centre, the private company engages in commercial activities like selling farm equipment and products, as well as ploughing services to farmers. However, there are doubts relating to the appropriateness of this technology transfer model. The feasibility of extending Chinese domestic models to foreign contexts - especially when all human resources are expatriates from China comprises the legitimacy and suitability of the model, which could be perceived as new cultural imperialism.

2.8.3. South Africa

South African policy documents emphasise the importance of the agriculture sector to the South African economy (Lipper, Thornton & Campbell, 2014; Springer & Duchin, 2014). Politicians and other stakeholders also underscore the role of agriculture in stabilising food prices, ensuring domestic food security, provision of employment and promotion of export-led growth. However, hard evidence shows that 95% of the nation's prime land is under large-scale commercial farming, while the remainder is composed of former homeland farming. In total, the two sectors constitute only 3% of the total economy (Bernstein, 2013). In fact, some academic evidence suggests that the SA agriculture sector perennially performs below expectations and has not meaningfully contributed towards economic growth when

compared to other economic sectors (Aliber & Cousins, 2013). Although the reasons for such underperformance could be many, limited application of technology transferred could be a contributing factor (Okudoh, Trois, Workneh, Schmidt & Cibati, 2014).

Findings from a study by Greyling (2012) suggest that there is scope for growth and improvement of the agricultural sector if there is substantial investment in infrastructure and technology. A historical overview of the SA agriculture sector helps increase understanding of the transfer and adoption of agriculture technology. Until 1994, the SA agriculture industry was dominated by white-owned commercial farming activities (Schirmer, 2015). Following the end of apartheid, this was followed by de-segregation of land-ownership, diverse institutions invested in encouraging black participation in commercial agriculture. This brought marginal changes in the racial composition of participants in the sector partly because of the highly capital-intensive nature of commercial agriculture, limited culture of high investments and limited agricultural knowledge of most black Africans at independence.

The introduction of trade liberalisation in South Africa after the abolition of apartheid contributed to relaxed trade barriers and increased modern farming opportunities to the majority of South Africans. Historically, agriculture accounted for approximately 15.2% of GDP in the 1950's and 10% in the 1960's before decelerating to less than 3% during 2001 and 2009. This downward trend has continued to date. Although the relative size of the agricultural sector is small, the value added by agriculture showed an upward trend, perhaps demonstrating the contribution of technology transfer to farming per unit of land. This can be attributed to the IDC and other financial institutions' substantial investment in agriculture as well as other government interventions in the sector.

There has been some paradoxes in technology transfer in South Africa's agriculture. Schirmer (2015) notes that in the twentieth century, South Africa saw substantial shifts in structures of production, innovation and the level of technology transfer due to the fact that she introduced land reform restitution initiatives beginning in 1994 when she got independence from the apartheid regime. The land reform was part of initiatives to support native black farmers through land redistribution coupled with agriculture support programmes. The latter would require a more interventionist developmental state to ensure that transformative land reform and technology transfer happens, while the former would perhaps require gradualist Traditional Liberalist Model, where market forces would drive land reform based on market value. The post independent agricultural reform also witnessed the introduction of a comprehensive agriculture support programme for post-land resettlement support and the introduction of Micro

Agriculture Financial Institutions of South Africa (MAFISA) supported through the Land Bank to promote technology transfer in the agricultural sector.

It can be argued that agriculture technology development and transfer (TDT) affects virtually all aspects of the economy from short-term run changes in export and imports volumes and domestic prices to long-term changes in health, nutrition, employment, institutional development and economic development. TDT will provide an opportunity for low-income producers and consumers to improve their real income and create rural enterprise to grow into global competitive agro business farmers.

The New Partnership for Africa's Development [NEPAD] (2014) noted that information and technologies in the agricultural sector in Africa have contributed to improved agro-business production and productivity. The process of embracing technology in South African agribusiness has contributed to increased agricultural productivity, improvement in farmers' practices, higher efficiency in production processes and agro-business products of higher quality, which contribute to their improved competitiveness.

Technology transfer has the potential to contribute to economic development and growth of the agro-business sector. Kamoyo and Chidoko (2013) suggest that developing capacity to transfer appropriate and affordable technology is essential to accelerating the process of economic development. In the same vein, poor technology management is the cause of failures in technology programmes in developing countries (Marais, 2012).

2.9. Agro-business-related institutions in Zimbabwe and South Africa

Zimbabwe has various agriculture departments that cascade from national level to provinces and districts - such as research and specialist services like the Agriculture and Extension Services, Institute of Agriculture Engineering, Veterinary Services, Tobacco Research Board, Agriculture Research Institute, University Zimbabwe's Faculty of Agriculture, Agriculture Marketing Authority, agricultural training colleges. While these institutions play a critical role in the implementation of government programmes and addressing food security, the overall contribution of these institutes and departments need to be evaluated in future studies to determine if they are instrumental in sustainable technological transfer in Zimbabwe.

The Government of South Africa placed importance on subsistence agriculture through improved food production, the development of policy intervention such as land technology, credit financing in agro-processing, irrigation machinery and equipment, and food processing technology. However, trends of

agriculture production has shown a stagnancy in agriculture production and its contribution to the Gross Domestic Product (GDP), which needs further investigation.

2.10. Barriers to technology transfer

A survey of literature reveals three broad categories of obstacles to effective technology transfer, namely technical, attitudinal and market-related barriers (Kaushik, Kumar, Luthra & Haleem, 2014; Kumar, Luthra & Haleem, 2015; Luthra, Kumar, Garg & Haleem, 2015). While technical barriers relate to scientific and technical limitations to technology use - such as industry-specific equipment, materials and equipment for the research, attitudinal barriers relate to technology recipients' negative perceptions towards imported technology. Market-related barriers relate to the cost of purchasing the technology, recipient's ability to afford the technology, the extent to which it is marketed, the marketing medium and its effectiveness in promoting the transfer of the technology. All three may contribute towards to the resistance to change agricultural practices, which is a key hindrance to agriculture technology adoption and adaptation in the developing world. Other often-cited barriers include issues such as language barriers, cultural differences, customary law, technological development maturity of the locality, economic strength, proximity of the locality to and from the transfer location and available natural materials (Rupf, Bahri, de Boer & McHenry, 2015; Xu et al., 2016) which may contribute to the questioning of, scepticism about and even open resistance to the implementation of transferred technologies.

Technology transfer efforts go beyond focusing on the individual farmer or farming entity. Generally, agricultural development based on new technology acquisition depends on the availability and efficient operation of certain institutions and infrastructure systems (Ockwell & Byrne, 2016). According to Obi and Nwakaire (2016), technology transfer in African countries is hamstrung by the absence of institutional support frameworks to accept, adopt and adapt transferred technologies. Thus, African governments have a key role to provide the institutional support fundamental frameworks and the basic infrastructure for technological transfer, adaptation, adoption and acceptance. In most instances, however, international cooperation programmes involving international non-governmental organisations and other world development agencies like the United Nations and the World Bank often plug this support gap through the aid and technical assistance that they offer (Zhou, 2015). However, Juma (2015) observes that international aid does not always incorporate technology transfer arrangements from advance economies to developing economies. It should, however, be noted that development assistance agencies are not a major carrier of technology to poor and developing countries as their assistance is often channelled through pandemic prevention, relief aid and other humanitarian programmes. Juma (2015) adds that if technical assistance and aid are not carefully crafted, they will simply pile-up funding and agricultural

equipment that developing countries cannot effectively use. One of the white elephant projects arising from this is the Chinese-Zimbabwe Agricultural Technology Demonstration Centre (ATDC) (Lixia, Yan, Wenjie, Mukwereza & Xiaoyun, 2015).

The quick pace of change in the operational environment also presents a challenge to technology transfer efforts - particularly in the developing world. The technology transfer process is complicated by numerous innovations in agricultural technology itself, dynamism of political and socioeconomic environments, changes in the human capita with unique characteristic needs, and evolutions that push people into new jobs areas (Rodrik, 2014).

2.11. Challenges of agricultural technology transfer

It is critical to examine challenges of agricultural technology transfer focusing on the countries considered in this research. One of the challenges is that South Africa and Zimbabwe are increasingly relying on imports of cereal crops (e.g. wheat) and livestock products (e.g. poultry), while their agriculture increasingly depends on imports of inputs (e.g. fertiliser, feed, mechanisation). This points to the need to strengthen agricultural competitiveness by supporting import substitution and depending on indigenous agricultural technologies in farming activities and industries where both countries have the potential. Technology transfer should also contribute to increased rural development, poverty alleviation and increased participation of small-scale agro-processing firms.

Broadly, the main challenges of agricultural technology transfer in both countries relate to limited access for small-scale producers, imperfect information, regulative and institutional arrangements that do not render and support integrated approaches to technology transfer and dissemination. For instance, while the Department of Agriculture, Fisheries and Forestry [DAFF] (2014) emphasises the critical relevance of new farming knowledge, information management, integrated spatial economic planning, access to such information also remains a challenge - especially for small-scale producers, which affects their productivity and competitiveness. Inadequate information also undermines government's ability to plan and implement agricultural technology transfer and support interventions, complicates the identification of priority areas where interventions are required and therefore, compromises the overall impact of these interventions. The reluctance to adopt or integrate indigenous knowledge systems into new technology transferred also limits the scope of options available making interventions less context-informed and undermining the legitimacy of such technology transfer programmes.

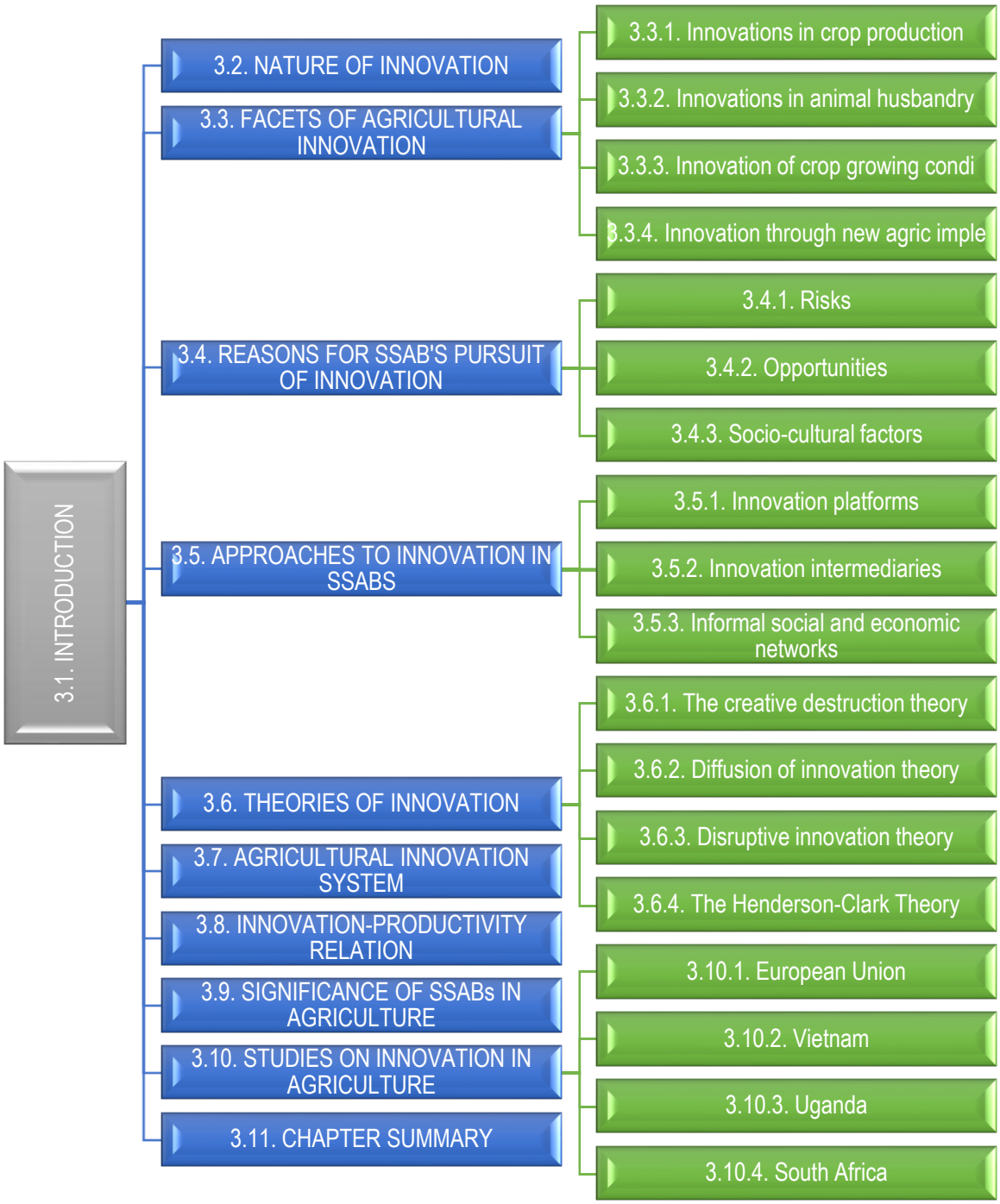
In spite of training and education of Zimbabwean farmers being fundamental forms of technology transfer, Zimbabwe just like other Southern African countries, has not sufficiently explored and exploited them for transmitting agricultural innovations and transferring technologies. The education and training of agro-processing business owners and farmers would be integral to their acquisition of appropriate knowledge and information relevant to agricultural production, processing, distribution and consumption and other farming operations. The acquisition of knowledge on usage of farming inputs, capital-intensive machinery and equipment is integral to successful agro-processing and farming businesses.

Manyati (2014) cites the difficulties that small-scale farmers encounter in introducing innovation and developing technological innovations to include limited economies of scale, financial constraints, antiquated knowledge systems, poor communication of weather and climatic information, ever-changing socio-economic and climatic conditions, which undermine agro farming and agro-processing productivity. Other challenges of small-scale agro-processors in Mashonaland include lack of synergy and proper coordination of efforts of rural farmers, technology transfer agencies and the innovators' skills and knowledge gaps. As such, production-oriented practices such the adoption of high yielding varieties (HYVs), irrigation systems, use of agricultural inputs such as fertilizers, chemicals, pesticides and use of agricultural machinery often fail to yield the intended outcomes due to incongruence of technology supplied to the context of application and coordination challenges.

2.12. Chapter summary

This chapter addressed the concept of technology transfer and its relevance to the agricultural sectors in Zimbabwe and South Africa. Issues relating to the definition of technology transfer, its importance for the agricultural sector, barriers to technology transfer, institutions and modes for technology transfer were dealt with. Case studies of agriculture technology transfer in the African context were also discussed. The next chapter addresses the issue of agricultural innovation as it relates to agro-processing productivity and competitiveness.

CHAPTER 3: INNOVATION AND SMALL-SCALE AGRO-PROCESSING FIRMS IN DEVELOPED AND EMERGING ECONOMIES



3.1. Introduction

The previous chapter examined agricultural technology transfer, its modes of application and associated barriers to implementation in developed and emerging economies. This chapter focuses on innovation, its theorisation, approaches to implementation and case studies of its practical application in agro-processing contexts. In the new global economy, innovation has become a central issue in the performance of nations and business-related entities. The presence of innovation within organisations as expressed by new product development and creation of new businesses is claimed to drive organisational productivity (Hung & Chou, 2013; Camisón & Villar-López, 2014), while the absence of innovation contributes to the slow death of businesses entities. The need for innovation is felt now more than ever because of the combination of the rapid transformation of the present business environment as well as the increased pace of globalisation (Prepletaný, 2013). This has in turn presented new gaps and niches for innovating firms and threats to the obstinate ones.

The concept of innovation, which spans many disciplines including economics, management, sociology and psychology, also has a significant impact on the agricultural sector (Fischer & Fröhlich, 2013). Acknowledging Drucker's (2014) observation that innovation is the tool for entrepreneurs in pursuit of business opportunities, there is a need to trace the sources of and opportunities for innovation. Also, the study of innovation requires a sector-specific approach - such as innovation in agriculture considered in this study. This approach is appropriate given the need to expand and guarantee global food supply and security amidst an ever-expanding world population.

3.2. Nature of innovation

The concept of innovation is multi-faceted and complex (Fischer & Fröhlich, 2013) and hence the difficulty of developing a precise definition for it. A survey of extant literature on the concept reveals the multi-disciplinary nature of innovation with studies having been carried out in management sociology, geography, management sciences and natural sciences, among others (Fromhold-Eisebith, Werker & Vojnic, 2014; Maghsoudi, Duffield & Wilson, 2015). In broad terms, an innovation is defined as a new product, service, idea or way of doing things. Tidd and Bessant (2014) draw on Schumpeter's (1934) distinction between innovation and invention, the latter referring to a separate concept defined as an idea, sketch, model for a new or improved device, product or process which has not been commercialised.

An innovation is a commercialised invention and is, therefore, already part of the economic system (Tidd & Bessant, 2014). The term innovation is commonly used in connection with technological innovations. This category of innovations comprises new products, processes and significant technological changes

of products and services (Baden-Fuller & Haefliger, 2013). The salient features of innovation are as follows: novelty, technology, creativity and commercialisation. Thus, invention on its own is a subset of innovation. In a nutshell, an innovation comes in the form of new products, services, production processes and organisational/management structures (Tidd & Bessant, 2014). It has different characteristics that can either be technological, intellectual, physical and behavioural.

In the context of agriculture, innovation is an outcome of the collective efforts of farmers, researchers, extension workers, traders, service providers and development organisations (Kilelu, Klerkx, Leeuwis, & Hall, 2013). Kilelu et al (2013) elaborate that the phenomenon of innovation is often accompanied by technological, institutional and social change. Bragdon and Smith (2015) proclaim that for small-scale farmers, innovation encompasses the following aspects:

- Technological innovations,
- Institutional innovation,
- The application of indigenous knowledge systems to changing circumstances,
- The maintenance, use and development of agro-biodiversity and farm management practices,
- Responding to changing socio-economic, technological or environmental conditions and
- The adaptation of modern technologies to suit specific local needs.

According to Van der Veen (2010), the goal of agricultural innovation is to increase the levels of production in terms of food, fodder, secondary products at the same time improving the quality of output, growing conditions and the production process. Thus, agricultural innovation will touch on areas related to crops, animals, growing conditions and implements. These are covered in the next subsection.

3.3. Facets of agricultural innovation

As highlighted in the preceding paragraph, agricultural innovations are wide ranging and impinge on the following areas: crops, animals, growing conditions, implements and management practices. The subsequent sections discuss these dimensions each in turn.

3.3.1. Innovations in crop production

Crop innovations incorporate biological or genetic modification of crops leading to new breeds and varieties (Barrows, Sexton & Zilberman, 2014; Klumper & Qaim, 2014). The outcomes of such innovations include higher-yielding or drought-resistant varieties leading to food security (Qaim & Kouser, 2013). Apart from improved productivity and greater food availability, the biological and or genetic modification of crops introduces new species that extend the farming calendar or the type of farming, a

development that may improve the farmers' income (Barrows et al., 2014; Fuglie, 2016). Other innovations in crop production include new farming techniques like conservation agriculture, which albeit its supposed merits, has not been fully supported in the developing world where it is supposed to bring benefits (World Trade Report, 2014).

3.3.2. Innovations in animal husbandry

Over the years, animal husbandry, a branch of agriculture that entails the day-to-day care, breeding and the raising of livestock for the purpose of meat, milk, fibre and eggs has also encompassed biological and/or genetic changes to improve yields (Eisler, Lee, Tarlton, Martin, Beddington, Dungait & Misselbrook, 2014). Although ethically controversial, biotechnological techniques like cloning have been widely used to preserve good quality animal species and enhance disease resistance in livestock (Laible, Wei & Wagner, 2015). Apart from that, finding new and innovative ways to extract more value from domesticated animals had been emphasised. For instance, secondary products like wool, blood and milk extracted from animals, in addition to the primary products like meat and hides, is a growing focus of attention.

3.3.3. Innovation of crop growing conditions

Like in crop and animal husbandry, the whole practice of farming has evolved in its application. For instance, innovative methods of farming like the adoption of organic agriculture and use of bio-fertilisers, natural pesticides; crop rotations, intercropping and relay intercropping and mulching, among others, are widely practiced in emerging economies (Wezel, Casagrande, Celette, Vian, Ferrer & Peigné, 2014). However, organic agriculture is contentious as far as efficiency and productivity is concerned. As an illustration, Reganold and Wachter (2016) note that organic agriculture gives lower yields in comparison to orthodox agriculture. However, its redeeming features are: (i) its profitability, given that it serves dedicated and loyal markets (ii) its environmental friendliness, and (iii) its low or no pesticide deposits compared with conventional farming (Levidow, Zaccaria, Maia, Vivas, Todorovic & Scardigno, 2014). However, there has been a low uptake of some innovative farming practices like water-efficient irrigation practices, because intended beneficiaries have no inducements to adopt more efficient agricultural practices (Levidow et al., 2014).

3.3.4. Innovation through new agricultural implements

Innovation in agriculture also lies in the introduction of more efficient farming implements (Long, Blok & Coninx, 2016). The need for innovation in agricultural equipment cannot be over-emphasised, given that farmers in developing countries generally find generic agricultural equipment such as soil tillers, planters

and harvesters expensive (Family farm, 2014). Thus, innovative, scale appropriate farm implements afford small-scale farmers in the developing world the opportunity to conserve natural resources, improve productivity and increase profits (Spiegel, Mocollo & Cady, 2016). As an illustration, Bangladesh has been a source of agricultural implement innovations, chiefly those that are jointly used with two wheel tractors that are suitable for small-scale farmers (Baudron, Needle, Rijnsdorp, & Marshall 2014). Such made-in-Bangladesh innovations include zero tillage and strip tillage seed and fertilizer drills, bed planters, axial flow irrigation pumps, strip tillage blades, improved furrow openers and seed metering mechanisms. For a country where small-scale farmers constitute a large component of the agrarian economy, the adoption of innovative agricultural implements has developed the accuracy and swiftness of planting and harvesting processes while dropping fuel, irrigation water and labour needs.

3.4. Reasons for small-scale agricultural enterprises' pursuit of innovation

A review of literature reveals a number of reasons why small-scale agro-businesses seek to innovate. These can be categorised as the need to mitigate exposure to risk, the need to take advantage of business opportunities, as well as preserving particular local socio-cultural practices. These reasons are dealt with in detail in the following section.

3.4.1. Risks

One of the reasons why small-scale agri-businesses are under pressure to innovate, is the increasing risk on agricultural competitiveness and productivity created by the rising environmental unpredictability and intensifying environmental pressures. As an example, Uddin, Bokelmann and Entsminger (2014) observe that there has been an increase in the frequency of drought and soil nutrients' depletion, phenomena which compromise agricultural productivity and competitiveness - particularly in the developing world. In the case of climate change, farmers are forced to be innovative in terms of crop selections, crop rotation and timing of planting seasons to cope with increasingly shorter and unpredictable rain seasons (Mehar, Mittal & Prasad, 2016). With regard to environmental degradation, small-scale farmers are forced to be innovative in terms of their land rehabilitation and adaptation methods so as enhance their agricultural output (Shiferaw, Tesfaye, Kassie, Abate, Prasanna & Menkir, 2014).

Subsidised agricultural imports force down local prices - in the process creating market risks for local small-scale agro-businesses as their products will be uncompetitive against the imports (Takeshima & Liverpool-Tasie, 2015). Thus, local small-scale businesses are forced to come-up with improved ways of lowering production costs and earning revenue. Lastly, concerns about food insecurity in the face of a

growing global population also calls for better ways of producing more food to counter starvation and malnutrition (Juma, 2015).

3.4.2. Opportunities

Like any other forms of business, small-scale businesses innovate as a response to windows of opportunities in the market place. Such windows that present opportunities to generate more income and make profit increase as the market for agricultural produce grow. For instance, participation in foreign trade creates more opportunities for cash crops (e.g. tobacco, cotton, and sunflowers) and further processed products for high value markets crops, as well as the opportunity to participate in downstream and upstream activities in the agricultural value chain. Apart from this, the availability of funds and supporting infrastructure for innovation gives small-scale agro-businesses the impetus to experiment with ideas in order to improve the manner in which they conduct their economic activities.

3.4.3. Socio-cultural and demographic factors

In the case of small-scale farmers in the developing world, the aspiration for communal respect and prestige within society also incentivises them to engage in innovative activities. As an illustration, findings from Eyhorn's (2007) study on the adoption of organic farming for sustainable livelihoods in developing countries revealed that farmers who adopted organic agriculture envisioned themselves as community leaders. In addition, they also felt that their social status had improved because of their improved economic conditions. This observation is corroborated by Wolfenson (2013) and BenYishay and Mobarak (2013) who proclaim that one's designation as a lead farmer ascribes higher social standing and respect.

It can also be stressed that the inclination of small-scale agro-businesses is also a function of inquisitiveness, the tendency to try-out new things (Ololube, Uriah & Dudafa, 2014) and other personal characteristics like age, gender and education (Parrotta, Pozzoli & Pytlikova, 2014; Läpple, Renwick & Thorne, 2015). A study on the relationship between individual work-related curiosity and worker innovation conducted by Celik, Storme, Davila and Myszkowski (2016) revealed that individual work-related curiosity was a positive predictor of worker innovation and that worker-divergent thinking mediated this relationship. When juxtaposed to the agricultural context, the implication of this finding is that individual inquisitiveness supports exploratory skills, which in turn support agricultural innovation.

3.5. Approaches to innovation in small-scale agri-businesses

Owing to the reasons mentioned in Section 3.3, small-scale agri-businesses are continuously innovating, generating their own creations. A review of literature reveals a number of approaches through which small-scale agri-businesses innovate. The next sub-section discusses these approaches.

3.5.1. Innovation platforms

One approach to agro-processing innovation is the use of innovation platforms, also known as multi-stakeholder platforms, innovation networks or learning alliances. According to Cullen, Tucker, Snyder, Lema and Duncan (2014:263) innovation platforms (IPs) are "forums that are designed to bring together stakeholders from different interest groups, disciplines, sectors and organisations to exchange knowledge, ideas and resources and take action to solve common problems in order to bring about a desired change." The system of innovation is generally adopted as a way of including all stakeholders in the innovation process. Such stakeholder may include government, public sector agricultural research institutes, private companies, universities, the agri-food industry and farmers' organisations. In the context of agriculture, innovation platforms are a new framework for inclusive innovation. For example, Sanyang, Pyburn, Mur and Audet-Bélanger (2014) provide evidence of the success of innovative platforms in maize value-chain projects that support smallholder farmers in West-Africa. According to these scholars, Burkina Faso saw a marked increase in the level of commercial maize seed production following the adoption of innovation platforms through *Institut de l'environment et de recherche agricoles* (INERA) in 2008.

The chief merit of innovation platforms lies in their perceived potential as a robust means for fostering agricultural research for development (Schut, Klerkx, Sartas, Lamers Mc Campbell, Ogbonna, & Leeuwis, 2016). Through increasing interaction, innovation platforms facilitate integrated, systemic innovation that is essential for achieving agricultural development impacts. However, there have been calls for more robust evidence of the impact of the interventions (Sanyang et al., 2014).

3.5.2. Innovation intermediaries

Innovation intermediaries are organisations or bodies that act as middlemen in any respect of the innovation process between two or more parties (Katzy, Turgut, Holzmann & Sailer, 2013). In agricultural contexts, the concept relate to "supporting actors that facilitate interaction among disparate or isolated farmer innovation systems, or between farmer innovators and formal innovation systems" (Bragdon & Smith, 2015:12). The role of the middlemen includes being translators and disseminators of research or

facilitators of access to knowledge rather than translators and transmitters of this knowledge (Kilelu, 2013).

According to Bragdon and Smith (2015), the generic roles of innovation intermediaries in agriculture include but are not limited to the following:

- Facilitating closer cooperation between farmers and rural extension and advisory service providers and articulating the needs and demands of farmers.
- Providing farmers with information and technical expertise directly and facilitating farmers' access to market.
- Helping in designing and supporting participatory research and social learning processes.
- Building personal relations among actors, building and managing social networks based on trust.
- Connecting farmers with investors and service providers such as banks, marketing boards or supermarkets.
- Handling paperwork such as farming records for certification and project funding applications.
- Interpreting public standards and developing technical guides for water, pesticide and fertilizer management and food safety.
- Creating an overarching vision regarding the scope and nature of the innovation (i.e. its role in societal transformation, poverty alleviation and environmental sustainability).
- Helping innovators reflect upon and re-interpret their position relative to outside institutional and economic factors, i.e. provide perspective and facilitate 'systems learning'.
- Bringing awareness of farmers' creativity and capacity for experimentation into policy dialogues, participate in farmers' advocacy and help give farmers a voice to influence national innovation priorities.

3.5.3. Informal social and economic networks

Because communities are held together by diverse relationships, the actions of players within them cannot be fully comprehended unless these are linked to those of other community members to whom they are connected through social networks. According to Farinha, Ferreira and Gouveia (2016), social and economic ties present individuals and firms with opportunities for learning and robust knowledge creation. The knowledge created through the networks is used to generate new products and production processes. Such social ties, which rest on dependence and mutuality can enhance collaboration, lessen transaction costs, increase market leverage and afford groups of individuals the opportunity to share the hazards concomitant with carrying out tests and adopting new innovations (Bragdon & Smith, 2015). These scholars elaborate that small-scale farmers' innovation is positively correlated with the strength of

intra-community linkages and that small farmers are more inclined to adopt new farming technologies and practices from their fellow farmers than from any other source.

3.6. Theories of innovation

While innovation is a multifaceted concept that has enticed numerous theories traversing across fields, only four and most applicable theories apply to this study. These are the Creative Destruction Theory (Schumpeter, 1942), the Disruptive Innovation Theory (Christensen, 1997), the Diffusion of Innovation Theory (Rogers, 1962) and the Henderson and Clark theory (1990).

3.6.1. The Creative Destruction Theory

The Creative Destruction Theory, a brainchild of Joseph Schumpeter - an Austrian economist, takes an economics perspective to innovation. At the heart of the theory is the revolutionary role of innovation in bringing about market and economic changes. Schumpeter (1942) argues that economic change comes through the creative destruction that is initiated by innovation and innovation arises when a new order replaces an old order. Creative destruction is the explanatory force behind the morphing of markets from competitive to monopolistic structures, or vice versa.

The theory reasons that small firms, because of their size and concomitant flexibility, are optimally placed to innovate when compared to larger firms, which are handicapped by their bureaucratic structures. However, Schumpeter recognised the advantages that large firms, because of their better resources and market leverage, have over small firms in terms of innovation.

3.6.2. Diffusion of Innovation Theory

Rooted in the sociological realm, this theory is a brainchild of Rogers (1962). The theory fundamentally explains how societies adopt new things and innovations. Thus, the process of adoption is here termed innovation. Rogers (1962) observed that the process takes place over a long period of time, and can be slow or fast. According to him, the process of diffusion of innovations is affected by four main factors i.e. inventions, channels of communication, time and social systems. Other factors include the features of an innovation, the nature of the decision-making process involved, individual characteristics, effect of innovation on society, and lastly, the communication channels used by adopters. There is a wide spectrum of adopters of innovation and these include innovators, early adopters, early majority, late majority and laggards. The Diffusion of Innovations Theory underscores the role of opinion leaders and information networks in the adoption of innovations, which mirrors small-scale agro-processers'

occasional dependence on informal peer community and informal decision makers for their adoption of agricultural innovations.

3.6.3. Disruptive Innovation Theory

Christensen's (1997), the *Innovator's dilemma* summarises this theory. According to the theory, a disruptive innovation is any new product that leads to new markets and value networks culminating in the displacement of old technology with the new technology. In essence, such innovations bring about radical changes to markets. The theory focuses mainly on technological innovations and draws attention to how seemingly invincible technological products can be abruptly displaced by new ones, creating new growth pathways for entities that initiate them.

The process of introducing disruptive innovations takes time and follows a number of stages:

i. Early stage- at this stage innovation serves a niche market.

ii. Later stage-the product attributes would be modified to suit and serve the traditional markets.

iii. Disruption-at this stage, the new technology completely displaces the old technology.

3.6.4. The Henderson and Clark Theory

A subset of the Product Innovation Theory, the Henderson-Clark Model gives insight into the different types of product innovations and how these can be distinguished. The theory emerged following the realisation of the inadequacies of a simple categorisation of innovations as either incremental or radical. The theory argues that such a categorisation badly explained why and how firms innovate. Thus, the Henderson-Clark Theory proposes a different framework to addressing the said shortcomings from previous models. The theory proposes that innovative knowledge arises from two types of knowledge i.e. knowledge about components and knowledge about the links between these components. Knowledge about components relates to the design of components, while knowledge about links is about how components connect to form a whole entity.

The differences between the two sets of knowledge clarify how innovators differ from each other. Figure 3.1 shows the four types of innovations arising from such distinctions.

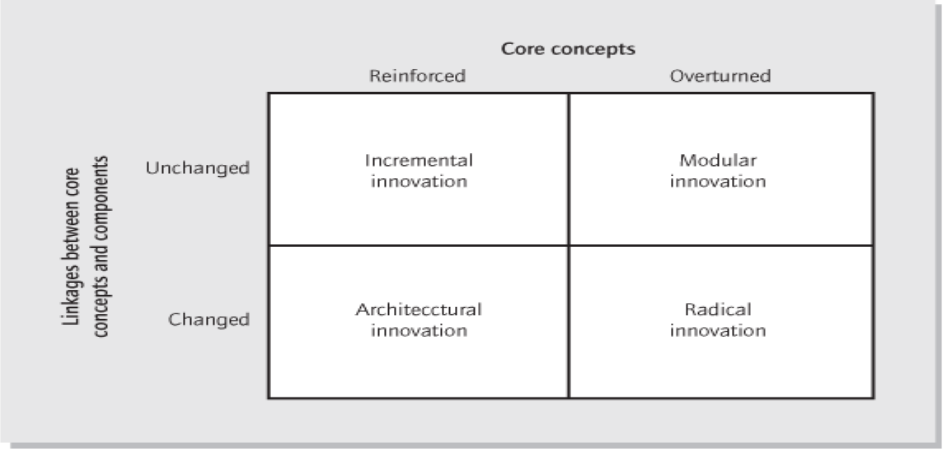


Figure 3.1. Henderson-Clark model

According to the model presented in Figure 3.1, four different innovation cases are postulated; incremental innovation, which involves the reinforcement of current component knowledge. In this case, the linkages between core concepts and components are unchanged. In the case of modular innovation, radical alterations are made to the core product while the linkages between core concepts and components remain unchanged.

Shifting attention to architectural innovation, the knowledge about component linkages is altered but the linkages between core concepts and components remain unaltered. Lastly, radical innovation encompasses radical alterations to both knowledge about core concepts and the linkages between concepts and components.

3.7. Agricultural innovation systems

Agricultural innovation systems relate to the various players or networks that affect the flow of agricultural knowledge. Such systems comprise those who demand and those who supply such knowledge. Thus, an agricultural innovation system includes researchers, extension work and other stakeholders that affect the enhancement or operationalisation of innovations (Lamprinopoulou, Renwick, Klerkx, Hermans & Roep, 2014). Usually they straddle sectors to include individuals, the government, the private sector and non-governmental organisations.

According to Hermans, Stuiver, Beers and Kok (2013), robust agricultural systems have proven to be important for enhancing agricultural productivity and enhancing food security in developing countries. However, the effectiveness of such systems depends on how they meets the diverse needs of participants. Therefore, the sustainability of agricultural innovation systems depends on the interaction

between the participants or stakeholders, institutions and the existence of an environment that supports innovation (Schut, Rodenburg, Klerkx, van Ast, & Bastiaans, 2014).

3.8. Innovation-productivity relationship-An overview

According to Carayannis and Grigoroudis (2016), the notions of innovation, productivity, and competitiveness are innately linked. The introduction of novel products in the market generates new demand, often leading to improved economies of scale (Kritikos, 2014). Assuming a new production process, technique or technology may have a knock effect on the level of productivity because of the production of new products and efficient use of inputs (Mohnen & Hall, 2013). Most relevant to agro-based firms is process innovation, which essentially is accompanied by new production processes that are implemented to lower production costs through greater returns to scale. The positive impact of innovation on productivity emerges from enhanced price competitiveness of a firm's products due to price reduction following the initial improvement in productivity (Roos, 2016). In target markets where demand is price elastic, a disproportionate growth in sales often follows on initial improvements in productivity. This leads to productivity enhancements due to improved returns to scale.

3.9. Significance of SSABs in agricultural innovation and development

There is a convergence of opinion among policy-makers and academics on the important role of innovation in generating small-scale agricultural businesses' (SSABs) growth and promoting social development in factor driven-economies of the developing world (Hung & Chou, 2013; Camisón & Villar-López, 2014). The significance of innovations in such contexts is ascribed to the contemporary competitive environment arising from increased globalisation, deregulated foreign trade and improved information and communication technologies. Extant literature suggests that in any economic sector, SMMEs are more inclined towards innovation compared to larger firms (Spithoven, Vanhaverbeke & Roijakkers, 2013; Deschryvere, 2014; Klewitz & Hansen, 2014; Triguero, Córcoles & Cuerva, 2014). This readiness to innovate is attributed to the economic factor mobility in small firms leading to more relative dynamism and responsiveness to market trends. Results from Annan-Diab's (2012) study on the role of SMMEs in innovation in the European Union underscores the fact that the impact of SMMEs in innovative systems is appreciated in circumstances where these are many, representing a large bloc of economic activity within a particular country.

While this may not readily apply to the agriculture sector, technology-based SMMEs in other spheres of economic activity generate and exploit new technologies (Lin and Rasiah (2014). This leads to the development of new economic sector, setting the scene for future innovations of the economy (Chen &

Zhang, 2014). Thus, high-tech SMMEs will provide a robust source of new technologies to larger firms. Arguably, countries with such innovative SMMEs will be an ideal investment destination for related businesses. Evidently, the significance of innovative SMMEs, SSABs included, cannot be over-emphasized. However, literature suggests that SMMEs are naturally disadvantaged as far as generating innovations is concerned. According to Annan-Diab (2012), larger entities operating in a concentrated market are the major source and instigators of technological evolutions. The underlying argument is that large firms are better positioned to foot the bill needed to undertake the research and development activities that are a major source of innovation. The Sillicon Valley project involving large start-up firms in the United States attests to this. Their size affords them the opportunity to enjoy economies of scale in the production of innovations. Moreover, external funders are more willing to support research and development projects of large firms (Hottenrott, Lopes-Bento & Veugelers, 2015; Lee, Sameen & Cowling, 2015).

Notwithstanding, past studies on the relationship between firm size and innovation have not found a significant direct effect of firm size. Regardless of this observation, there is evidence that small firms encounter numerous hindrances to their efforts to innovate. These hindrances include restricted access to capital, excessive perceived economic risks, exorbitant innovation costs, lack of qualified personnel and information on technology, among many factors (Klewitz,& Hansen, 2014; Pinget, Bocquet & Mothe, 2015; Bigliardi & Galati, 2016). The next section deals with the area studies for agro-based industries in different contexts.

3.10. Studies on innovation in agro-based firms in advanced AND emerging economies

3.10.1. European Union

While innovation drives the productivity, profitability and competitiveness in the agricultural sector (Organisation for Economic Cooperation and Development [OECD], 2013). Läpple, et al., (2016) contend that the European agricultural sector operates below potential in terms of innovation capacity. The scholars believe that such a scenario undermines the competitiveness of the European Union agro-food industry. The OECD (2013) argues that there are marked differences in agricultural innovation across member states of the European Union, owing to a number of factors among which are differing policies, institutions and operational environments.

Renwick, Läpple, O'Malley and Thorne's (2014) investigation into the performance of the Agri-food Innovation System within Ireland made some interesting revelations. Using indicators categorised in

terms of innovation inputs (e.g. private and public investment in research and development [R&D]), innovation outputs (e.g. patents, publications) and innovation outcomes (firm and farm performance), the findings from the study showed that Ireland has the 5th most innovative agri-food sector in the European Union according to this index, behind Denmark, Finland, Germany and the Netherlands. The country's research capacity, education levels, physical infrastructure, tax regime, government support, regulation, advisory services and training in agri-food skills were identified as the major facilitators of innovation at farm-level. On the other hand, land mobility, age structure, farm business structure, power of supermarkets and availability of finance were acknowledged as the key impediments to innovation.

The major conclusion drawn from Renwick et al.'s (2014) study was that although Ireland's agro-food sector is comparatively strong in innovation, it had relatively limited capacity to develop new products. It was also noted that although Ireland had innovative and globally competitive companies, the number was very limited to make the country a global leader in agro-innovation.

3.10.2. Vietnam

Vietnam is one of the most populated countries in the world with 93.5 million people. The population is projected to rise to 98.2 million by 2020. A surging population size brings along the responsibility to guarantee a secure supply of food. The country's agriculture sector contributes 18.1% of the GDP and employs 47% of the adult population. The sector has experienced steady growth in recent years, with rice being the primary agricultural product. Table 3.2 presents the trends in Vietnam's agriculture production over the years.

Table 3.1: Crop Production and Livestock in Vietnam

Top ten crops ('000 tonnes)	2010	2011	2012	2013	2014
Rice	40,005.6	42,398.3	43,661.6	44,076.1	45,206.8
Sugar cane	16,161.7	17,539.6	19,017.2	20,018.4	21,089.7
Maize	4,606.8	4,835.7	4,803.2	5,193.5	5,356.5
Bananas	1,489.7	1,523.4	1,560.0	1,596.6	1,626.3
Cashews	1,242.0	1,237.3	1,190.9	1,197.9	1,185.7
Cabbages and other brassicas	805.3	774.9	785.0	796.2	793.7
Pineapples	521.6	533.4	540.0	551.1	559.3
Watermelons	388.5	467.6	470.0	478.3	503.3
Groundnuts	487.2	468.4	470.6	468.4	463.2
Potatoes	394.9	425.0	440.0	445.0	458.9

Source: Euromonitor, FAOSTAT Agricultural Production, February 2015

Meat indigenous ('000 tonnes)	2010	2011	2012	2013	2014
Pork	3,036.4	3,098.9	3,160.0	3,194.5	3,238.5
Poultry	531.4	599.4	617.9	620.7	645.5
Beef and Veal	384.3	386.5	393.3	400.1	404.5

Source: Euromonitor, FAOSTAT Agricultural Production, February 2015

Livestock ('000 head)	2010	2011	2012	2013	2014
Chickens	218,201.0	225,820.0	215,950.0	220,290.0	220,870.3
Pigs	27,373.3	27,056.0	26,493.9	26,261.4	25,952.5
Cattle	5,808.3	5,436.6	5,194.2	5,156.7	4,975.7

Source: Euromonitor, FAOSTAT Agricultural Production, February 2015

Despite the seemingly upward trend in agricultural productivity, the World Bank (2017) in its report entitled "Transforming Vietnamese Agriculture: Gaining more from less" underscores the need for Vietnam to restructure its agricultural sector in order to make it more viable and sustainable. The suggestion is that the focus should switch from primary production to agro-processing. However, this measure has a downside in that employment in the primary agricultural sector will sharply fall from the current 47% if agro-processing comes in as it requires more technology and mechanisation, which has the potential to reduce labour intensity. Another suggestion is for the country to improve the quality of the product for export purposes. According to the Food and agriculture organisation of the United Nations [FAO] (2016), the Vietnamese government is considering revamping the agricultural sector by increasing the adoption of innovative products and technology in the value-addition process.

3.10.3. Uganda

Uganda is one African state that has taken huge steps to enhance innovation in its agricultural sector. The country boasts of one of the most diversified agro-business sectors, which is characterised by different sized suppliers of agricultural inputs, agro-dealers, farming activities, harvesting and post-harvest undertakings like processing of raw output, branding, and marketing of value-added agri-food products that are targeted towards the final consumers (Kearney, 2016). The country's Global Innovation Index rankings (GII) between the years 2013 to 2016 reveal it to have consistently outperformed other countries in Africa, which are at the same level of economic development. The agricultural sector is key to Uganda's economy constituting 73% of the total employment in the country and contributing 14% towards the country's GDP at the end of 2014. However, the overall competitiveness and productivity of the country's agricultural sector has encountered a series of setbacks as shown by a general lack of profitability in recent years.

Lybbert, Saxena, Ecuru, Kawooya and Wunsch-Vincent (2017) proclaim that the output from the Uganda agri-food sector fell from 7.9% in 2001 to 3% in 2014, a rate which is lower than the 6% annual agricultural sector growth rate that was proposed by the African governments under the Comprehensive Africa Agriculture Development Programme. Innovation in the country's agro-sector is hindered mainly by the fact that most of the agriculture producers are small and thus total arable land under cultivation is in the hands of small farmers who have neither the ability nor motivation to invest in innovation and productivity. The same farmers are hampered by erratic rainfall patterns; natural disasters; uninsured production; inadequate funding, poor training and narrow market prospects among others. Thus, Uganda has to act on the barriers to innovation and productivity if it is to reap any economic rewards from the agriculture sector. Such actions may include strengthening its institutions to sponsor and safeguard intellectual property rights, nurture innovation, and afford a supporting milieu to encourage cooperative action.

3.10.4. South Africa

Although the South African agriculture sector contributes only about 2.5% to the country's GDP and approximately 8% to formal employment, it is among the most established and innovative in Africa, producing various products for both the domestic and international markets. The country's agro-business sector is well supported by the research, development and innovation efforts from the Agricultural Research Council (ARC) and universities. Different from most sub-Saharan African countries, commercial farming contributes the bulk of agriculture production in South Africa, with subsistence farmers producing only 10%.

According to the Department of Agriculture, Forestry and Fisheries' (2016) Operation Phakisa policy document, a disturbing feature of South Africa's agriculture sector is the technological imbalance across participants. As an illustration, South African commercial farming activities are technologically advanced as compared to smallholders and subsistence producers. Most of the technology which may be in the form of agricultural inputs or implements is either imported or locally operated under licence. Thus, most of the growth in the productivity levels of the South African agriculture sector has been driven by innovations in the commercial sector and through imports.

Apart from a large and commercially driven primary production sector, South Africa boasts of a highly developed and growing agro-processing sector. This is attributed to an increase in the consumption rate of processed food in the country. According to Trade and Industrial Policy Strategies (TIPS) (2017), the industry is skewed and concentrated in the hands of a few big players at the expense of smaller players. Table 3.2 presents a summary of the statistics on the levels of dominance in the sector.

Table 3.2: Levels of dominance in the South African agricultural sector

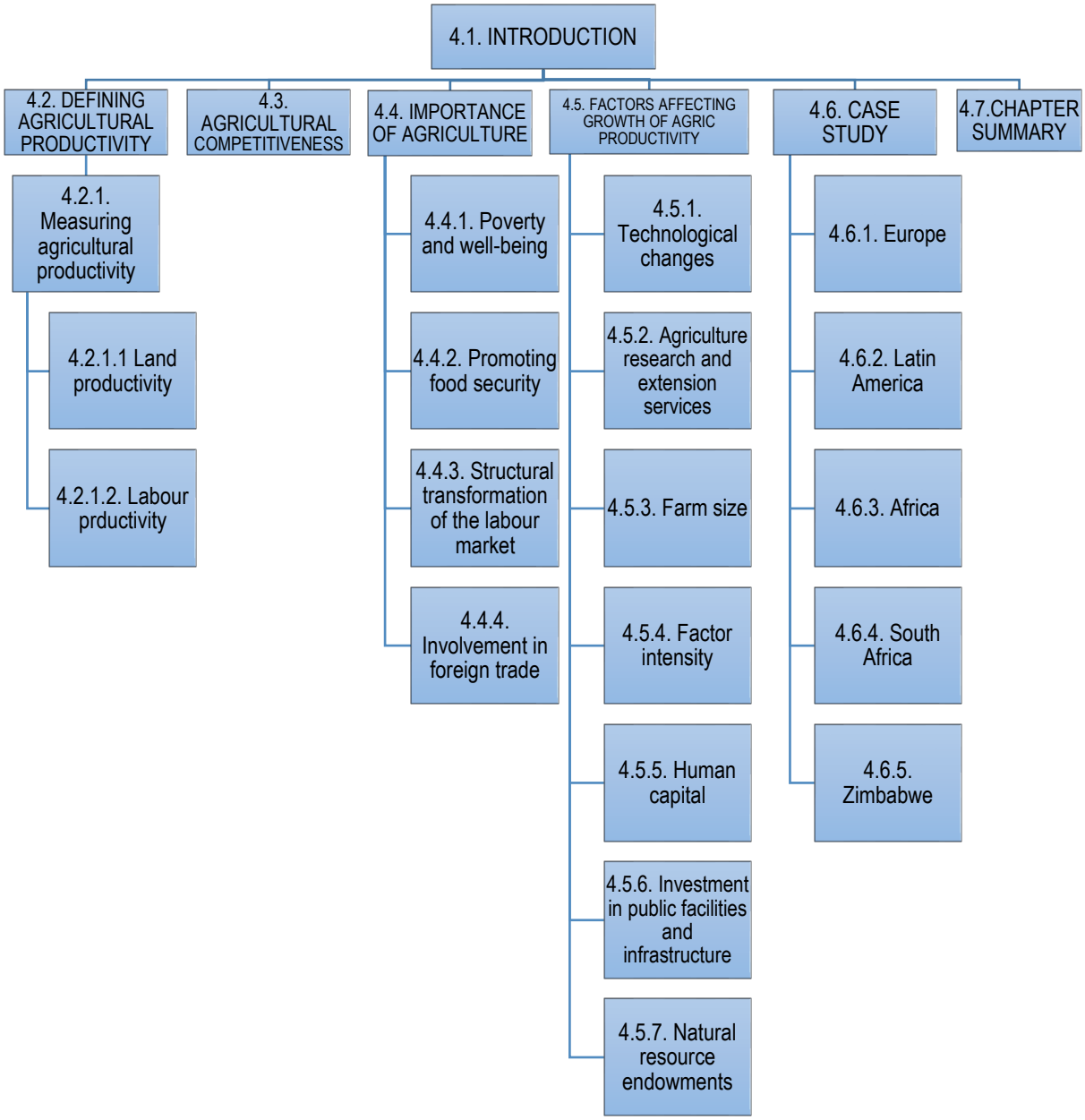
	CR5	CR10
Agro-processors		
Food products and beverages	30%	40%
Prodn, processing and preserving of meat, fish, fruit, veg, oils and fats	30%	43%
Dairy products	71%	81%
Grain milling products, starches and starch products etc	70%	79%
Bakery products, sugar, chocolate, etc	58%	84%
Beverages	80%	86%
Textiles, clothing, leather and footwear	17%	23%
Wood, wood products, paper, publishing and printing	30%	41%
Agro-input manufacturers		
Fertilisers, nitrogen compounds, plastics and synthetic rubber	87%	92%
Agricultural and forestry machinery	23%	33%

SOURCE: Dr Michael Aliber, 2013
1 CR= Concentration Ratio → Market share of the most important companies in the sector, here top 5 and top 10

The skewed pattern observed in Table 3.2 where few firms dominate the agro-industry reduces the number of market access points for smaller agricultural producers. Arguably, this scenario can be ameliorated by innovation in the operations, structure, marketing and location of agro-processing firms and infrastructure in the economy. Such innovations help to lower the small producers' costs of transport, post-harvest storage and cold storage.

3.11. Chapter summary

This chapter reviewed literature related to the concept of agricultural innovation. It highlighted the complexities associated with defining the concept as well as the importance of the concept in different geographical contexts. The next chapter focuses on the agricultural productivity concept.



4.1. Introduction

The previous chapter examined the concept of innovation to provide a comprehensive perspective on the influence of agricultural innovation on the productivity and competitiveness of small-scale agricultural firms. In view of economists and policy-makers' growing concerns about the sustainability of current and future food supply and future food requirements across the globe, the current chapter examines the intricate relationship between agricultural productivity and competitiveness of agro-processing firms. The World Bank (2015) projects that the world's population will be at 9 billion by the year 2050, while the United Nations (2015) forecasts it to swell from 7.3 billion in 2015 to 9.7 billion by 2050. In the same time frame, the global middleclass is expected to increase from 50% to 70% with developing countries contributing a large proportion to this growth, and contributing to increased pressure in global consumption. This growth of the middle class is expected to be accompanied by a substantial increase in spending on expensive food, feed, fibre and fuel (Steensland, 2016) raising critical questions about the capacity of agro-processing firms to meet this growth in demand.

The United Nations (2014) projects that the urban populations across the world will increase by 2.5 billion. As such, the consequence of this rapid urban sprawl could be the dwindling of the world's countryside population leading to the shrinking of human capital needed for farming and food production in labour intensive rural farms. The World Bank (2015) highlights that the increased urban population would require a 50% increase in the level of output of crops, livestock and fisheries. The dependence on agricultural inputs in developing countries can also be offset by improved agricultural productivity of agro-processing firms and its implications for the competitiveness of such firms.

This chapter addresses the meaning, determinants and methods of measuring agricultural productivity and competitiveness. In addition, case studies on agricultural productivity and competitiveness from across the world are presented.

4.2. Defining agricultural productivity

Although it is uncontested that the effectiveness of a business' application of resources in the production of goods and services contributes to its productivity, the exact meaning of agricultural productivity is contested. In the agricultural sector, productivity refers to the relationship between inputs and outputs (United Nations Conference for Trade and Development, 2015) implying that a more productive entity will have a higher proportion of outputs in relation to its inputs in comparison to a less productive one. In other words, the concept of productivity relates to the effectiveness of the farming process involving the

conversion of inputs into outputs (agricultural goods and services). By extension, a temporal variation in the ratio of outputs to inputs is known as productivity growth.

4.2.1. Measuring agricultural productivity

While national governments, non-governmental organisations and world bodies recognise the need for a drastic improvement in the level of performance of the agriculture sector to ensure food security (Juma, 2015), the precise measurement of agricultural productivity is inherently complex. However, a review of literature reveals that the performance of the agriculture sector is assessed using production (i.e. level of output), productivity (i.e. output per unit of input) and efficiency (i.e. actual output relative to potential output) (Gollin, Lagakos & Waugh, 2014). Although these three are generally acceptable measures, productivity is the commonly used measure because of its contribution to a healthy and thriving economy (Giannakis & Bruggeman, 2015). Capalbo and Antle (2015) observe that the agricultural productivity measures can be sub-divided into three broad categories; namely total, multi-factor and partial productivity.

The term total factor productivity is generally understood to mean an index of total outputs over an index of total inputs (Capalbo & Antle, 2015). This measure evaluates how an entity can make the best use of a set of inputs to produce outputs. In deriving this index, factors used in farm production like land, labour, physical capital and material inputs (seed, fertilisers, chemicals and livestock) are rated against total quantity of agricultural output. Like all index numbers, however, total factor productivity depends on the approach used to aggregate various outputs and various inputs. Because of this sensitivity, different aggregation methods lead to different indices being derived, complicating the accuracy of the measure particularly in some least developed countries where the quality of statistics is poor.

Given that it is difficult to deduce the full set of inputs used to produce particular agricultural outputs, multi-factor productivity is used in place of total factor productivity. A common characteristic of both multi-factor productivity (MFP) and total factor productivity (TFP) is that they are calculated on the basis of more than one input factor (Alston & Pardey, 2016). Thus, they compare agricultural output at a particular time against a basket of input factors. The measures demonstrate the collective impact of diverse factors like the adoption of new agricultural technologies, improvement in agricultural expertise and restructuring of the production process on agricultural production. An alternative productivity indicator to multiple factor productivity and total factor productivity is partial factor productivity. In literature, this term refers to an index used to measure how output per unit of a particular input changes over time (Kimura & Sauer,

2015). The main partial factors in agriculture are labour and land. These sub-components are addressed below.

4.2.1.1. Land productivity

Agricultural productivity needs to be understood with reference to land productivity as much of the former unfolds on arable land. Land productivity refers to the quantity of land needed to meet food requirements (Desiere & Jolliffe, 2017) with in given country or geographical region. This can be interpreted to mean the crop yield per amount of land such as tons of maize per hectare of land, which depends on among other considerations on the quality of land.

4.2.1.2. Labour productivity

According to Dorward (2013), labour/work productivity is the amount of work undertaken within a specific time unit by an individual worker. This type of productivity depends on aspects like agriculture related knowledge, technology and nature of administration systems (Andrews, Criscuolo & Gal, 2016). As an example, small-scale subsistence farmers tend to engage in labour-intensive agricultural activities in the developing nations whose output per unit of labour applied is relatively low. Based on a study conducted in Bangladesh, Hussain, Talukde and Ahmed (2015) assert that, generally, labour productivity in agriculture is relatively lower compared to non-agriculture-based economic sectors.

Small-scale agricultural enterprises (SSAEs) in both South Africa and Zimbabwe tend to employ less than 10 persons and are owned and or managed by the same person (Agbobli, 2013). While labour productivity statistics unique to the agriculture sector are not available, Food and agriculture organisation of the United Nations [FAO] (2015) suggests that the agricultural value added per worker in South Africa rose from US$3 866 in 2000 to US$7 238 in 2014. In the case of Zimbabwe, the trend has been downward with US$474 in 2000 and US$ 279 in 2014.

For the purpose of fulfilling the objectives of this study, financial and non-financial measures of productivity are used. As for financial measures, aspects like sales revenue, gross profit, net profit, percentage return on investment among others are used. In the case non-financial productivity, the following measures are used: output levels, output per hectare, capacity utilisation per hectare and growth are used.

4.3. Agricultural competitiveness

The definition of agricultural competitiveness is heavily contested in literature as no single definition is comprehensive enough to cover all the nuances of the concept (Wigier, 2014). The diverse characterisation of agricultural competitiveness arise from the varying units of analysis, which range from national, sectoral, or firm-level indicators. As such, agricultural competitiveness is a relative measure founded on multiple contexts of application. The definitions are summarised in Table 4.1 below.

Being competitive refers to the ability of an agro-processing firm to deliver goods and services at the time, place and form sought by overseas buyers at prices as good as or better than those of other potential suppliers, whilst earning the least opportunity cost returns on resources employed (Sharples & Milham, 1990). This definition takes an economics perspective and is more applicable to firms engaged in international trade. It is the ability to compete or sell in the competitive marketplace (Latruffe, 2010). The implication of this definition is that firms with lesser competitive capabilities in terms of price, quality and quantities are vulnerable and less likely to succeed in a competitive market.

Dlamini (2012) refers to agricultural competitiveness as the ability of agricultural, agribusiness and agro-industrial concerns to produce and offer products that meet the quality standards of the local and world markets at prices that are competitive and provide adequate returns on the resources employed or consumed in producing them. Compared to others, this definition is dedicated to agriculture-related firms, covers a wide set of variables relating to a firm's capabilities and is more applicable to the current study. Conceived as the capability to remunerate its factors of production (Bielik & Rajčániová, 2004) - this definition adopts an economic perspective where a firm's competitiveness is evaluated based on its ability to reward its economic resources. Thus, a firms' competitiveness is reflected through the level of its profits, interest and wages paid. The current study adopts an operational definition of agricultural competitiveness founded at the firm level as follows; "the ability of agricultural, agribusiness and agro-industrial concerns to produce, process, market and avail products and services that meet the quality standards of the local and world markets at competitive prices while providing adequate returns on the resources employed or consumed in producing them." As such, enhanced competitiveness is conceived to entail the capacity of an agro-processing firm to overcome inter-firm competition through optimal pricing or better product offerings in domestic and foreign markets. Drawing on these definitions, it is logical to argue that enhanced productivity encompasses the productivity, marketability and competent pricing of product offering, which collectively form the yardsticks for measuring agricultural productivity.

As already alluded to, small-scale agricultural enterprises (SSAEs) in South Africa operate in the agricultural sector which substantially contribute to national output and exports. Equally important, the sector guarantees the nation's food security. Apart from that, the agricultural sector employs about 4.8% of the country's workforce (Statistics SA, 2013). Thus, the need for competitiveness of SSAEs in the sector needs not be over-emphasized. Similarly, SSAEs in Zimbabwe are also major contributors towards food security, economic development and employment. Numerous scholars refer to the need to improve the competitiveness of the agricultural sector if Zimbabwe is to reduce its food import bill and regain its status as the breadbasket of Southern Africa (Mango, Mapemba, Tchale, Makate, Dunjana & Lundy, 2015; Dube, 2016; Mutsvangwa-Sammie, Manzungu & Siziba, 2016). Enhanced competitiveness can also strengthen the manufacturing sector as agro-processing firms provide adequate raw material inputs for the domestic processing and value addition of agricultural goods and products. It also contributes to increased revenue collection by government, which improves the funding of social sectors, infrastructure and other development programmes, enhances export earnings and expands the country's foreign currency reserves (Nworu, 2017). A competitive agriculture sector also increases employment opportunities, improves standards of living in rural areas and reduces poverty. The next subsection deals with measuring agricultural competitiveness (Thondhlana, 2015).

4.3.1. Measuring agricultural competitiveness.

As earlier alluded to, agricultural competitiveness is multi-faceted and is therefore measured using multiple criteria. At firm level, Awale and Rowlinson (2014) proffer that the concept be measured using economic criteria like agricultural costs, profitability, and productivity. Agricultural competitiveness can also be assessed using output volumes, yields, unit prices; levels of exports; private investment in the agricultural sector; value addition; and the ability to lower costs and increase input productivity. The justification for using such measurements is that the overall focus of firms in the short to long term is on business efficiency, growth and success.

For the purpose of fulfilling the objectives of this study, agricultural competitiveness is conceptualized in terms of commercial performance parameters like the product's market competitiveness, customer satisfaction, market price competitiveness, business market dominance, product quality, promotional strategy and organisational competitiveness.

4.4. Importance of agricultural productivity

The value of agricultural productivity can be conceived from the perspective of reducing poverty and improving well-being of people in different countries, promoting food security and stability of staple food prices, structural transformation of the labour market and involvement in foreign trade. These issues are dealt with in the following subsection.

4.4.1. Poverty reduction and promoting well-being

Agriculture competitiveness is a primary determinant of levels of income and quality of life in most developing countries since it is a key source of employment in such areas (Gollin, Lagakos & Waugh, 2014; Grindling & Newhouse, 2014; Shiferaw, Tesfaye, Kassie & Abate, 2014). For instance, the International Labour Organisation's (ILO) labour market statistics reveal that 67.23% of Zimbabwe's workforce was employed in the agriculture sector in 2015. In fact, the persistence of low levels of productivity in the agriculture sector explains why low incomes and standards of life continue to ravage most agro-based economies in the developing world (Tittonell & Giller, 2013) including Zimbabwe. In the case of South Africa, with a population of 49 million in 2009 which is growing at 2% per annum, either food production or imports must expanded by more than double to meet the population explosion (Wise, 2013). This has to be done using the same or fewer natural resources. Recent trends reveal that the growth in South Africa's middle class has enabled a substantial section of the South African population to switch from staple grain crops to a more diversified diet.

The direct relationship between low productivity and income levels is more pronounced in the rural areas where the low productivity levels are linked to low earnings due to the poor adoption of agriculture technology (Collier & Dercon, 2014). The end result is that a significant number of households in rural areas are poor, undernourished and are vulnerable to nutrition deficiency illnesses (Tittonell & Giller, 2013). As can be seen, a growth agricultural productivity is imperative for the well-being of a significant number households in both Zimbabwe and South Africa.

4.4.2. Promoting food security and stability of staple food prices

According to Chavas, Hummels and Wright (2014), improved agricultural productivity is a leading indicator of lower food prices in many low-income countries. Lower or stable food prices afford rural people greater income at their disposal, benefiting food-deficit households in the process (Dorward, 2012). Thus, the stability of such prices contributes directly to improved food security as more poor-prone rural and peri-urban dwellers gain access to more affordable food in the process. According to the Food and Agriculture Organisation of the United Nations (FAO, 2015), food security prevails when all people,

at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Thus, any improvement in agricultural productivity contributes to increased food security, stabilising food supply eradication of hunger and starvation. The Department of Agriculture, Fisheries and Forestry (2016) Economic Review of the South African Agriculture Report reveals that the estimated volume of agricultural production during 2016 was 2.8% lower than in 2015, with the volume of field crop production having decreased by 6.0%. This was a result of a decrease in the production of summer grains (maize and sorghum), oilseeds (especially soya beans and peanuts), as well as sugar cane due to the devastating drought experienced in 2016. Following this negative development in agricultural production, consumer prices of all agricultural items increased by 6.3% for the year that ended 31 December 2016. This development serves to show how instability in production leads to unstable prices and price increases.

4.4.3. Structural transformation of the labour market

According to McMillan, Rodrik and Verduzco-Gallo (2014), there is a huge rift in labour productivity in the old and current parts of the economy in the least developed countries, creating a situation of allocative resource inefficiency. For developing economies where most economically active people partake in agriculture related activities, the augmentation of agricultural productivity through technology transfer and adoption helps transform the structure of the agriculture sector and labour market (Juma, 2015). That is to say, increasing the capital intensity of agriculture leads to lower dependence on human labour (Adekunle, Osazuwa & Raghavan, 2016), and in the process releases essential human capital needed for other productive sectors of the economy leading to the reconfiguration of the labour market.

According to Olaoye (2014), improved agricultural productivity enhances the supply path for agro-processing firms and other related service providers. Thus, growth in agriculture competitiveness and productivity spills over and enhances productivity in other economic sectors. Although the supporting evidence on this relationship in extant literature is inconclusive, these connections explain the longstanding economic belief in the need to enhance productivity in the agriculture sector as a prerequisite for industrial development (Hayami & Yamada, 1969; Adenle, Manning & Azadi, 2017). As an illustration, Awokuse and Xie's (2014) investigation of the cause and effect relationships between agriculture and gross domestic product growth in nine developing countries revealed that although agriculture productivity affected the economic performance of a country, the influence fluctuates from country to country. There was evidence of agriculture productivity-led economic growth in some instances and the need for a vibrant economy as a pre-condition for successful agriculture development in other cases.

4.4.4. Involvement in foreign trade

Growth in agricultural productivity potentially nurtures exports by reducing the pressure on farmers to choose between using land for either cash or food crops as room for both alternatives is created (Awokuse & Xie, 2015). In the process, surplus products that could otherwise have been imported, can be produced domestically. Such produce can be exported - leading to increased export earnings and the accumulation of capital reserves, which can be re-invested in other economic sectors (Robinson, 2013). Another way that agricultural productivity can improve export trade is through the ripple effect of lower food prices on export competitiveness. Lower food prices make locally produced goods comparatively cheaper on the international market. In the case of the Zimbabwean situation, Kanyenze, Chitambara and Tyson (2017) proclaim that the use of the overvalued USD as the main currency of transacting has undermined export competitiveness, while imports - especially from the major trading partner South Africa, have become more affordable due to the depreciation of the rand.

4.5. Factors affecting growth of agriculture productivity and competitiveness

There is no universally accepted set of self-contained factors that determine agriculture productivity. Previously, the economists' perspective proposed that agriculture productivity is an outcome of the combination of traditional economic resources like capital, labour, land and entrepreneurship (Gollin, 2010). However, the inadequacy of these explanatory factors has opened avenues for the consideration of other factors such as climatic and geographical conditions, consumer demand, government intervention in the agricultural sector among others. Latruffe (2010) separates these factors into those which agro-processing managers can control and those beyond their control. Factors subject to the managers' control include size of the business, its legal status, factor intensity, product specialisation, production and marketing practices, structure of the land, labour and capital, and the characteristics of farm labour. Those outside managers' control include climatic and geographical conditions, consumer demand, government intervention in the agricultural sector, expenditures in agricultural research, agricultural extension services, infrastructure and location of activities. The most prominent among the alternative factors are human capital, public goods, education, agriculture research and extension and public infrastructure (Tey & Brindal, 2012; Capalbo & Antle, 2015). The paragraphs below address some of the factors influencing agricultural productivity and competitiveness.

4.5.1. Technological changes

The adoption of modern farming technologies such as combine harvesters and drip irrigation equipment in least developing countries over the years has transformed agriculture in unprecedented ways. According to King (2017) a technological revolution in farming led by advances in robotics and sensing

technologies is projected to disrupt modern agricultural practice. The impact of technology, agricultural mechanisation, use of modern transport, genetically modified plants, development plant feeds, breeding of disease resistant animals as well as plant irrigation on agricultural productivity and competitiveness is felt through increased yields per input, lower overhead costs and improved earnings (National Institute of Food and Agriculture [NIFA], 2017). Sasmal's (2016) study of the impact of technological change and adoption on the growth of productivity of the agriculture sector in India reveal positive results. As an illustration, the study findings show that agricultural productivity in the country significantly increased over the years owing to the adoption of novel farming technologies like high yielding seed varieties, intensive farming methods, chemical inputs and the use of ground water irrigation by small-scale farmers.

However, the adoption of these technologies is accompanied by a number of downsides such as excessive depletion of ground water and serious damage to natural resources. As such, the increasing consciousness about the shortcomings of some farming technologies has generated calls for adoption of environmentally sustainable technologies only (Campbell, Thornton & Zougmoré, 2014; Springer & Duchin, 2014). In the case of Zimbabwe, NGOs have increasingly propagated for new conservation farming methods in communal farming areas where the adoption of the farming techniques has contributed to improved yields (Nyamangara, Masvaya, Tirivavi Nyengerai, & 2013). Overall, the adoption of modern agriculture techniques has generated some growth in productivity, albeit some shortcomings. The South African agricultural sector is comparatively more technologically sophisticated compared to those of most sub-Sahara African countries because of a well-established agriculture support infrastructure and robust agricultural value chain (Bernstein, 2014). This has afforded role-players the opportunity to develop leading innovations and technologies attuned to the South African environment.

4.5.2. Agriculture research and extension services

Agriculture research and extension services influence agricultural productivity through the generation of new ideas and knowledge (Aguilar, Carranza, Goldstein, Kilic & Oseni, 2015). They are often conceived as a potential source of agricultural innovations as they often generate finished goods, services and technologies (Organisation for Economic Co-operation Development [OECD], 2011). Since agricultural research and extension services encompasses substantial commitments of resources, the various stakeholders in the agriculture sector would be concerned about the extent to which such investments translate into future productivity and competitiveness in the agriculture sector.

Agricultural research and development literature affirms a positive association between the extent and quality of research and extension and agricultural productivity in the developing world context (Abebaw

& Haile, 2013; Kilelu, Klerkx & Leeuwis, 2013; Ragasa, Berhane, Tadesse & Taffesse, 2013; Berhanu & Poulton, 2014). In spite of this association, it is difficult to find a suitable methodology for measuring both agricultural productivity and investment in research and development to provide convincing empirical evidence on this perceived relationship. As such, there is no documented method of reliably and validly identifying research and development induced agricultural productivity - hence the complexity of linking research and development to agricultural productivity. The measurement of the relationship is further complicated by the reality that findings on agriculture research carried out by private sector are often proprietary property hidden from the public domain. In some cases, research on agriculture productivity is not consistently carried out on a sustainable long-term basis, creating gaps in the data inventory on the subject. However, there is widespread acknowledgement of the trickle-down effect of the benefits of investment in research and development on productivity (Zhang, Chen & Vitousek, 2013; Hurley, Rao & Pardey, 2014; Vanlauwe, Coyne & Gockowski, et al., 2014).

4.5.3. Farm size

The relationship between farm-size and productivity is not clear cut (Savastano & Scandizzo, 2017). A survey of literature on agricultural productivity from across the globe demonstrates that the nature of the relationship is influenced by contingent factors like the individual characteristics of the farmer, available agriculture support infrastructure, and the technology in use among others (Adamopoulos & Restuccia, 2014; Ali & Deininger, 2015; Savastano & Scandizzo, 2017). The simple logic in the economic perspective dictates that productivity increases as farm size increases. The reasoning behind this view is that larger farms tend to provide larger economies of scale and have better access to output and input markets compared to smaller ones. Other studies question this simple logic casting doubt on its applicability. For instance, Savastano and Scandizzo's (2017) study revealed that there is no unidirectional relationship between farm size and agriculture productivity. Drawing on their findings and those made from other scholars in Ethiopia, they deduced an inverted "U" relationship (i.e. direct-inverse-direct) relationship between farm-size and agricultural productivity. The scholars noted that the relationship was positive for smallholders, negative for middle scale farmers and positive for large-scale farmers.

Deininger, Nizalou and Singh (2013) explored the farm size-productivity linkage using panel data for the years 2000-2011 on farming activities in the Ukraine farming estates of a size above 200 hectares. They observed that higher yields from the farms were a function other unobserved farm level factors rather than farm size. To illustrate the effect of the unobserved, these scholars argued that the exit of unproductive farmers and entrance of effective farmers had a significant effect on the productive farms.

4.5.4. Factor intensity

Factor intensity is an economics concept that compares factors of production across various industries to emphasise the intensity with which an industry employs a given factor (Syverson, 2011; Jian, Deng & Seto, 2013). In the context of agriculture, extant literature suggests that there is no consistent linkage between the level of productivity and factor intensity indicators such as capital-labour ratio, or land- labour ratio (OECD, 2011). For instance, an attempt to enhance technical efficiency by hiring highly skilled and qualified labour may bring in a new problem related to supervisory issues (Capalbo & Vo, 2015). In the same vein, there are suggestions that farmers who borrow skilled labour in order to fund their agricultural activities are most likely to be technically efficient because of the effort these experts exert in order to meet their debt obligations (Sujan, Islam, Azad & Rayhan, 2017). This observation is corroborated by Afrin, Haider and Islam's (in press) investigation of the impact of financial inclusion on the enhancement of paddy farmers' Technical Efficiency (TE) in Bangladesh, which reports that "…farmers were approximately 86% technically efficient and amongst them, credit takers were more efficient than non-credit takers." The implication is that developing world farmers can enhance the productivity of their agricultural activities through committing more technical efficiency and capital.

4.5.5. Human capital

The human capital factor which relates to "a general notion of the knowledge and skills embodied in a human being which plays an important role in determining their labour productivity" (Yamauchi, 2010:1) arguably influences the agricultural productivity in any context. Previous studies have reported the influence of human capital on farm/agricultural technical efficiency and productivity transformation using pointers like farmers' age or number of years of experience, education level or type, gender, and time spent on the farm (Carletto, Savastano & Zezza, 2013; Kilic, Palacios-López & Goldstein, 2015). Vu (2012) describes the unproductive phenomenon of cell-phone or absentee landlord farming in the Zimbabwean context where landowners resident in towns give the charge of conducting farming activities to their labourers while they infrequently visit their farms.

The impact of a farmer's age on technical efficiency can be either positive or negative as found in various studies (Latruffe, 2010; Asante, Villano & Battese, 2014; Chiona, Kalinda & Tembo, 2014). While older farmers may be reluctant or unable to adopt technological innovations, they are more experienced and can use their knowledge to use inputs more efficiently. However, Zagata and Sutherland's (2015) findings from their European study revealed that lesser participation in agricultural activities by younger generations undercut the efficiency and economic potential of European agriculture.

Ndour's (2017) study on the effects of human capital on agricultural productivity in Senegal revealed that improving the level of education and experience of participants in agriculture is likely to increase yields and to make the farmers more efficient. The study affirmed that better education and more agricultural experience enhanced technical efficiency because of the more developed farm-running skills. All things considered, it can be inferred that investment in the development of agriculture-related human capital can enhance the level of agricultural productivity.

4.5.6. Investment in public facilities and infrastructure

Empirical studies suggest that farming enterprises operating in areas with more developed public facilities and infrastructure like transport, water and market facilities tend to have higher farm technical efficiency (Collier & Dercon, 2014). Tong, Yu, Cho, Jensen and Ugarte's (2013) study of the spatial spill over effects of transportation infrastructure on agricultural output across the United States revealed that a state's road disbursement had positive effect on the state's agricultural output - meaning that spending on roads in a state also had spill-over effect on the state's agriculture. Bah and Fang (2015) claim that a poor business environment characterised by low investment in public infrastructure in large parts of sub-Sahara Africa causes a misallocation of resources - leading to considerable reductions in productivity and output.

4.5.7. Natural resource endowment

Geographic disparities in agricultural productivity may be explained by the features of the physical milieu in which farms operate (Noltze, Schwarze & Qaim, 2013). For instance, good quality soils are associated with high technical efficiency of farming activities and better crop yields (Bhardwaj, Ansari, Sahoo & Tuteja, 2014). Wheeler and Von Braun (2013) also mention the negative influence of climate on agricultural productivity. They elaborate that there is a marked trend involving climate change negatively affecting stability of food supply, a development that may disturb the efforts towards a world free from hunger. The increased frequency of occurrence of catastrophic climatic events like storms, floods and landslides are also cited as being behind the fall in agricultural labour productivity in some developing countries across the globe (Burke & Lobell, 2017).

4.6. Case studies

Agricultural development and input utilisation varies spatially and from time to time depending on *inter alia*, the individual nation's stage of economic development, government policy, resource endowment, market conditions and ecological conditions. In spite of the disparities in terms of productivity, economies follow the same phases of agricultural development. For instance, Chang and Zepeda (2001) profess that there are three stages of the agriculture transformation process i.e. land augmentation phase, labour

substitution phase and the knowledge and input intensity phase. This subsection addresses cases relating to agricultural production, productivity and competitiveness from regions across the world.

4.6.1. Europe

According to the Tangermann, and von Cramon-Taubade (2013) agricultural productivity in the European Union (EU) is following a steady upward trend. There is a renewed interest in agricultural activity in the EU as shown by its attempt to adopt resource efficiency by 2020. This is quite a difficult task as human beings are often resistant to change their conduct. A useful tool monitoring productivity growth is the Total Factor Productivity (TFP) measure, which the EU seeks to apply consistently in the region. As highlighted in the earlier sections of the current chapter, this measure indicates the joint effects of numerous factors such as new technologies, efficiency gains, economies of scale, managerial skill, and changes in the organisation of production.

According to the Tangermann, and von Cramon-Taubade (2013) the average EU countries' annual growth rate for productivity between 1995 and 2005 exceeded 1%. However, it fell to 0.8% between 2005 and 2015. The TFP sharply increased by 9% in 2015 owing to conditions that favoured crop and animal production. Equally important, this growth in TFP is attributable to the lesser dependency on human labour and increasing capital investments in the agriculture sector. In the decade preceding 2015, the agricultural sector in the EU cut its labour force by an estimated 25%.

4.6.2. Latin America

Agricultural activity is arguably at the heart of Brazil's economy with crops like sugarcane, coffee, soybeans, beef, and crop-based ethanol being the key output and export products. The country is one of the major producers of food and bio-fuels in the world. According to the FAO (2015), the land area under harvest in Brazil increased from 263 million hectares in 1990 to 739 million hectares in 2014 (see Figure 4.1 below). Correspondingly, the agriculture sectors contribution to GDP rose from US$9 997 million in 1990 to US$14 555 million in 2014, which is about 33% of the total GDP. The agricultural sector has undergone significant structural differences compared to what it was like during the 1970s (Filho, Eustáquio & Fornazier, 2016). For instance, the increasing mechanisation of the sector reduced the percentage of people employed in the agricultural sector from 22.8% in 1990 to 15.3% in 2014. However, all agriculture related businesses employ about 17.7 million rural workers in Brazil and contributes 42% of the country exports.

Significantly, Brazil is a net food exporter with the cereal import dependency ratio percentage at - 3% in 2014. Under those circumstances, the percentage prevalence of under-nourishment population in the country dropped significantly from 14.8% in 1990 to less than 5% in 2014 (FAO, 2015). All things considered, Brazil has a vibrant agricultural sector with high levels of crop production which has led to the country being termed the world's bread basket.

However, the growth of agriculture in Brazil comes amidst a growing population, increasing demand for food and competition for land and water resources. For this reason, some scholars argue for more efficient use of the available resources. In fact, estimates suggest that at least 80% of the expansion of agricultural output will come from improved productivity associated with technology adoption and mechanisation (Filho et al., 2016). In that case, Brazil is well-placed for such a development given the country's strong capital investment and technological innovation that have contributed to an estimated 70% increase in value-added crop production over the past decade. Export growth in beef, poultry, sugar and ethanol and soya beans testifies to such technology innovation even though such innovation is not uniform across the country.

To further illustrate the productivity improvements in the country, Brazil produced 150.8 million tons of grain compared to 17.2 million in 1960, in the face of an estimated 190.7 million inhabitants in 2010 compared with 70 million in 1960. The 2010 tonnage was produced using 47.5 million hectares of land. Had the farmers been using the 1960 technology, they could have required estimated 145 million hectares. In terms of productivity level, the country had 783 kilogrammes per hectare of cereals in 1960 compared to 3 173 kilogrammes per hectare in 2010. Livestock productivity rose from 0.47 heads per hectare in 1960 to 1.2 heads/hectare in 2010 (Lora, 2012; FAO, 2015).

Brazil			
	1990	2000	2014
The setting			
Population, total (mln)	149.6	174.5	202
Population, rural (mln)	39	32.8	29.4
Govt expenditure on ag (% total outlays)			
Area harvested (mln ha)	263	328	739
Cropping intensity ratio	1.1	1.3	
Water resources (1 000 m^3/person/year)	58	50	43
Area equipped for irrigation (1 000 ha)			5400
Area irrigated (% area equipped for irrigation)			96.8
Employment in agriculture (%)	22.8	20.7	15.3
Employment in agriculture, female (%)	13.3	16.1	11
Fertilizers, Nitrogen (kg of nutrients per ha)		37.2	58.6
Fertilizers, Phosphate (kg of nutrients per ha)		55.4	59.8
Fertilizers, Potash (kg nutrients per ha)		59.7	63.4
Energy consump, power irrigation (mln kWh)	44	2 565	6 084
Agr value added per worker (constant US$)	1 712	2 464	5 470
Hunger dimensions			
Dietary energy supply (kcal/pc/day)	2 756	2 879	3 302
Average dietary energy supply adequacy (%)	118	122	135
Dietary en supp, cereals/roots/tubers (%)	38	35	34
Prevalence of undernourishment (%)	14.8	12.3	<5.0
GDP per capita (US$, PPP)	9 997	11 015	14 555
Domestic food price volatility (index)		6	6.2
Cereal import dependency ratio (%)	16.4	15.3	-3
Underweight, children under-5 (%)		3.7	2.2
Improved water source (% pop)	88.5	93.5	97.5
Food supply			
Food production value, (2004-2006 mln I$)	52 671	78 722	140 046
Agriculture, value added (% GDP)	8	6	6
Food exports (mln US$)	4 690	8 031	59 994
Food imports (mln US$)	1 797	3 373	8 276
Production indices (2004-06=100)			
Net food	51	77	137
Net crops	59	77	140
Cereals	54	78	157
Vegetable oils	41	65	157
Roots and tubers	92	90	90
Fruit and vegetables	74	92	108
Sugar	60	75	175
Livestock	45	78	128
Milk	59	81	135
Meat	41	76	125
Fish	62	82	121
Net trade (mln US$)			
Cereals	-749	-1 586	3 439
Fruit and vegetables	1 328	985	1 491
Meat	316	1 795	14 937
Dairy products	-168	-374	-536
Fish	-55	-85	-1 086

Table 4.1: Agricultural productivity in Brazil (Source: FAO 2015)

4.6.3. Africa

Zambia is a typical example of an African country that boasts of a well-supported and vibrant agricultural sector that ranks among the best on the African continent. Participants in this sector range from large, medium and small-scale subsistence farmers who actively participate in the country's agricultural value chain. Table 4.2 presents data on Zambia's farming sector.

Table 4.2: Characteristics of Zambia's agriculture sector

Category	LARGE-SCALE	MEDIUM-SCALE	SMALL-SCALE	SUBSISTENCE
Characteristics	2,000 enterprises cultivating 20 to 10,000+ hectares, Produce for export markets, Land tenure, access to mechanization, advanced inputs and irrigation	56,000 enterprises cultivating 5 to 20 hectares, Regularly sell to domestic markets, land tenure, some access to mechanization, advanced inputs and irrigation	1.03 million households cultivating less than 2 hectares Food buyers who obtain cash from wage labour, No land tenure, limited access to advanced inputs, mechanization or irrigation	334,000 households cultivating 2 to 5 hectares, Occasionally sell into local markets, with income from wage labour, Limited access to land tenure, advanced inputs, mechanization and irrigation, may practice conservation farming

(Source: Global Agricultural Productivity Report, 2015)

Although crop production is the bedrock of Zambian agricultural productivity, animal husbandry is steadily rising to significant proportions despite the negative impact of diseases on livestock. According to the Global Agricultural Report (2015), the livestock population in 2013 was as follows: 38 million chickens, 4 million head of cattle, 2.74 million sheep and goats and 1 million pigs. Zambia is a net exporter of some animal products, such as raw hides and leather, but almost all animal protein products are consumed domestically.

Low milk productivity is a challenge in Zambia, and throughout Africa, which possesses 20% of the dairy cattle in the world but produces only 5% of the global milk supply. For a country that had traditionally

relied on minerals as a source of wealth, the Zambian government has over the past decade attempted to diversify its economy, and shift to other sectors like agriculture. As evidence of this new economic thrust, Zambia committed to increasing its annual expenditures for agriculture to 10 per cent of its annual budget in 2015. Actually, income from agriculture constitutes between 7% and 10% of GDP. Apart from government support, the agricultural sector benefits from public-private partnerships in maize, livestock, groundnuts and horticulture production. There is evidence of small-scale farmers adopting innovative farming technologies that include improved hybrid seeds, fertilizer, mechanisation and conservation farming techniques.

4.6.3.1. Socio-economic challenges

However, rural poverty rates remain high (those living on less than $1.25/ day) at about 80 % of the national population. Zambia's agricultural value chains are still vulnerable to environmental shocks and changing climate patterns. Arguably, they can draw substantial benefits from the knowledge, resources and opportunities that arise from technological transfer arrangements with developed agricultural systems. For Hichaambwa, Sitko and Chamberlin (2014), most farmers particularly small-scale ones, are undercapitalised and face challenges of investment in productivity-enhancing and labour-saving agricultural technologies.

Table 4.3: Agricultural productivity in Zambia (1990-2014)

Year	**1990**	**2000**	**2014**
The setting			
Government expenditure on aggregate (% total outlays)			9.7
Area harvested (million hectares)	1	2	4
Cropping intensity ratio	0.1	0.1	
Hunger dimensions			
GDP per capita (US$)	2407	2 202	3 800
Domestic food price volatility (index)		9.2	3.2
Cereal import dependency ratio (%)	24.3	7.1	-8.2
Food supply			
Food production value, (million US$)	709	812	1 772
Agriculture, value added (% GDP)	21	18	10
Food exports (million US $)	11	42	756
Food imports (million US$)	49	62	378

Production indices			
Net food	74	84	184
Net crops	61	72	158
Livestock	78	91	216

(Source: FAO 2015 Report)

4.6.4. South Africa

Even though at least 80% of South Africa's land is arable, only 13% is being used for agricultural purposes. Notably, the country is prone to unpredictable rainfall patterns and significant soil erosion even though agricultural land use is projected to be at most 15% in the near future. The aforementioned challenges, therefore, calls for increased efficiency and productivity in the use of the available land given the adverse conditions (Du Toit, Van Eyden & Ground, 2006). Despite the country's relative self-reliance in terms of agricultural produce, it still imports rice, tea, coffee, and cocoa. Figure 4.1 shows the country's crop yields over the years.

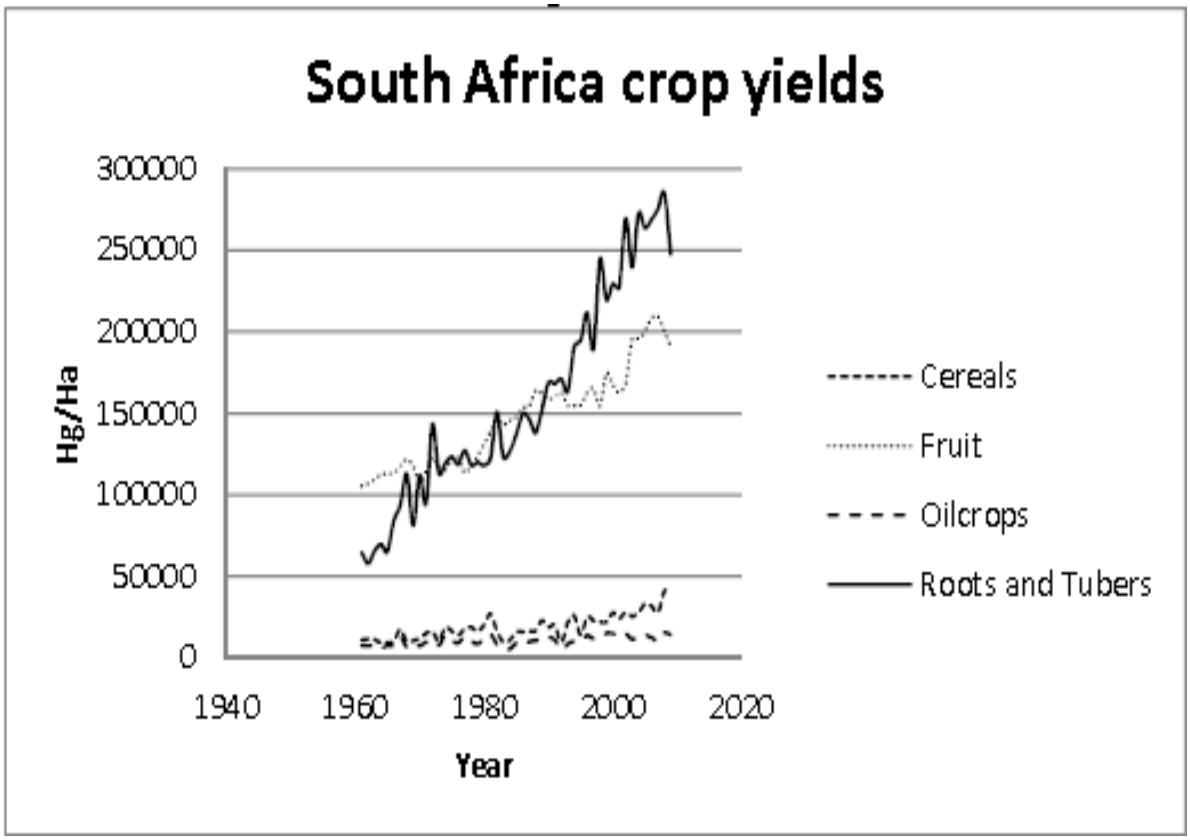


Figure 4.1: Trends in South Africa's agricultural yields (UNDP, 2012:26)

As can be seen from the diagram, yields for cereals, fruit, roots and tubers generally followed an upward, long-term trend - even though at a subdued rate.

A number scholars have studied South African agricultural productivity trends in the past decade. Conradie, Piesse and Thirtle (2009) studied the district, regional and national measures of agricultural productivity in the Western Cape Province of South Africa. Using statistics for the period ranging from 1952-2002, the scholars noted that production in the province grew at double the national rate - even though there were variations across the districts in the region. They reported that while a positive growth trend was experienced in the Boland area, negative growth rates were noted in the Karoo area.

In a separate study, Liebenberg and Pardey (2010) examined agricultural production and productivity patterns in South Africa and found some interesting aspects. Although there has been a shift towards capitalised agriculture and decrease in the use of human labour, emphasis has also shifted from animal husbandry and staple crop farming towards market gardening. However, in spite of some improvements in agricultural output levels, the growth rate is generally below the continental average. The results of Liebenberg and Pardey's (2010) indicate that land productivity grew at an average rate of 2.49% per year from 1911 to 2008, slightly slower than the corresponding rate of labour productivity growth, which averaged at 2.83% per year. Multifactor productivity (MFP) grew by 1.49% on average per year from 1947 to 2008. MFP was stagnant during 1989 to 2008, owing to a decline in the rate of output growth coupled with an increase in the rate of input use in agriculture. With the evidence presented, investments and the incentive structures that affect agricultural research and development were suggested to better the situation.

Ramaila, Mahlangu and Du Toit's (2011) draw attention to the fact that overall national agricultural productivity in South Africa has been more or less unchanged since the turn of the millennium. Such a situation is problematic given the increasing concerns about food security, poverty and unemployment in the country. The findings from Ramaila et al.'s (2011) study suggest that the little growth rate in agricultural productivity that has been accumulated over the years have been inadequate for meet South Africa's food requirements.

South Africa

	1990	2000	2014
The setting			
Population, total (mln)	36.8	44.8	53.1
Population, rural (mln)	17.6	19.3	19.5
Govt expenditure on ag (% total outlays)			
Area harvested (mln ha)	18	24	18
Cropping intensity ratio	0.2	0.2	
Water resources (1 000 m^3/person/year)	1	1	*1*
Area equipped for irrigation (1 000 ha)			*1 670*
Area irrigated (% area equipped for irrigation)			*95.9*
Employment in agriculture (%)		15.6	*4.6*
Employment in agriculture, female (%)		16.1	*3.9*
Fertilizers, Nitrogen (kg of nutrients per ha)		*30.9*	*35.8*
Fertilizers, Phosphate (kg of nutrients per ha)		*14.8*	*15.8*
Fertilizers, Potash (kg nutrients per ha)		*9.4*	*10.3*
Energy consump, power irrigation (mln kWh)	246	2 406	*2 406*
Agr value added per worker (constant US$)	3 308	3 866	7 238
Hunger dimensions			
Dietary energy supply (kcal/pc/day)	2 814	2 878	3 155
Average dietary energy supply adequacy (%)	121	121	131
Dietary en supp, cereals/roots/tubers (%)	*57*	57	*53*
Prevalence of undernourishment (%)	<5.0	<5.0	<5.0
GDP per capita (US$, PPP)	10 364	9 927	*12 454*
Domestic food price volatility (index)		7.1	*7.3*
Cereal import dependency ratio (%)	*10*	4.8	*2.8*
Underweight, children under-5 (%)		*10.1*	*8.7*
Improved water source (% pop)	81.3	86.8	*95.1*
Food supply			
Food production value, (2004-2006 mln I$)	8 301	10 029	*12 753*
Agriculture, value added (% GDP)	5	3	2
Food exports (mln US$)	1 286	1 501	*4 764*
Food imports (mln US$)	593	876	*4 679*
Production indices (2004-06=100)			
Net food	80	96	*122*
Net crops	84	103	*115*
Cereals	97	123	*125*
Vegetable oils	102	92	*120*
Roots and tubers	68	95	*124*
Fruit and vegetables	72	89	*113*
Sugar	89	118	*89*
Livestock	80	90	*131*
Milk	87	89	*119*
Meat	77	89	*134*
Fish	69	83	*54*
Net trade (mln US$)			
Cereals	60	-181	*-855*
Fruit and vegetables	585	739	*2 404*
Meat	-52	-48	*-533*
Dairy products	22	-9	*-77*
Fish	-13	211	*255*

Table 4.4: Agriculture production statistics 1990-2014 (Source: FAO, 2015)

Figure 4.4 shows some relatively recent statistics on the performance of the South African agriculture sector. Some of the agricultural productivity and competitiveness indices shown on Figure 4.4 reveal some positive trends. For instance, agriculture value added per worker and the food import dependency ratio reveal some positive trends. In addition, food exports and the net food production indices also show positive trends, indicating a country with a robust agricultural sector and secure food supplies for the foreseeable future.

4.6.5. Zimbabwe

Agriculture is the backbone of Zimbabwe's economy and underpins the economic, social and political lives of the majority of the people of Zimbabwe (Maiyaki, 2010; FAO, 2015). The sector sustains the livelihoods of an estimated 70% of the population, contributes 15% - 20% of GDP and 40% of exports and supplies 63% of agro-industrial raw materials. The preceding statistics underscores the growing dependence of Zimbabwe's economy on the agriculture sector for employment and food security. They also signal the need to pay attention to the levels of productivity and competitiveness in the sector if their contributions are to be enhanced. The Government of Zimbabwe's 2012 Comprehensive Agricultural Policy Framework (CAPF) (2012-2032) affirms that the Zimbabwean agriculture sector grew by 33% in 2010, 9.6% in 2011 and 4.6% in 2012. Women contribute about 70% of the agricultural labour and the bulk of them are subsistence farmers. The agricultural sector, which saw a sharp increase in the number of farmers and relatively smaller sizes of farms following the fast-track land reform programme in 2000, is operating at sub-optimal levels and will benefit greatly from an increase of investment in farming technology (Mashingaidze, Belder, Twomlow, Hove & Moyo, 2013).

The Zimbabwe agricultural sector produces various commodities that contribute to agricultural GDP as follows: maize 14%, tobacco 25%, cotton 12.5%, sugar and horticulture 7%, beef and fish 10%, livestock 24%, and subsistence crops 0.5% (Zimbabwe Agricultural Investment Plan, 2013). This output is generated by the country's three farming clusters i.e. 4 317 large-scale commercial farms, 22 072 small to medium scale commercial farms and 1 313 656 farmers in the smallholder sector (ZimStats, 2015). The sector which historically had very strong links with the manufacturing sector has performed poorly over the years causing downstream and upstream factories connected to farming to operate at less than 40% of their potential throughput capacity. The negative effect has been felt in both the domestic and export markets. Figure 4.5 demonstrates the trend of agricultural productivity in Zimbabwe since 1990.

Zimbabwe

	1990	2000	2014
The setting			
Population, total (mln)	10.5	12.5	14.6
Population, rural (mln)	7.4	8.3	8.7
Govt expenditure on ag (% total outlays)			16
Area harvested (mln ha)	3	4	4
Cropping intensity ratio	0.2	0.3	
Water resources (1 000 m^3/person/year)	2	2	1
Area equipped for irrigation (1 000 ha)			174
Area irrigated (% area equipped for irrigation)		71.4	
Employment in agriculture (%)		60	
Employment in agriculture, female (%)		69.5	
Fertilizers, Nitrogen (kg of nutrients per ha)		21.2	16.6
Fertilizers, Phosphate (kg of nutrients per ha)		12.2	10.3
Fertilizers, Potash (kg nutrients per ha)		6.6	2.2
Energy consump, power irrigation (mln kWh)	197	305	305
Agr value added per worker (constant US$)	399	474	279
Hunger dimensions			
Dietary energy supply (kcal/pc/day)	1977	2001	2214
Average dietary energy supply adequacy (%)	91	89	98
Dietary en supp, cereals/roots/tubers (%)	65	58	60
Prevalence of undernourishment (%)	42.7	45.7	33.4
GDP per capita (US$, PPP)	2532	2521	1773
Domestic food price volatility (index)			
Cereal import dependency ratio (%)	8.3	1.8	43.9
Underweight, children under-5 (%)		11.5	10.1
Improved water source (% pop)	79.2	79.5	79.9
Food supply			
Food production value, (2004-2006 mln I$)	1199	1422	1261
Agriculture, value added (% GDP)	16	18	14
Food exports (mln US$)	225	243	147
Food imports (mln US$)	40	87	1121
Production indices (2004-06=100)			
Net food	93	110	98
Net crops	117	157	108
Cereals	146	142	55
Vegetable oils	156	203	128
Roots and tubers	53	83	118
Fruit and vegetables	73	85	110
Sugar	82	112	103
Livestock	76	97	105
Milk	119	121	104
Meat	66	91	105
Fish	196	116	157
Net trade (mln US$)			
Cereals	83	-7	-583
Fruit and vegetables	10	31	-62
Meat	7	22	-25
Dairy products	5	6	-40
Fish	-1	-4	-21

Table 4.5: Agricultural productivity in Zimbabwe

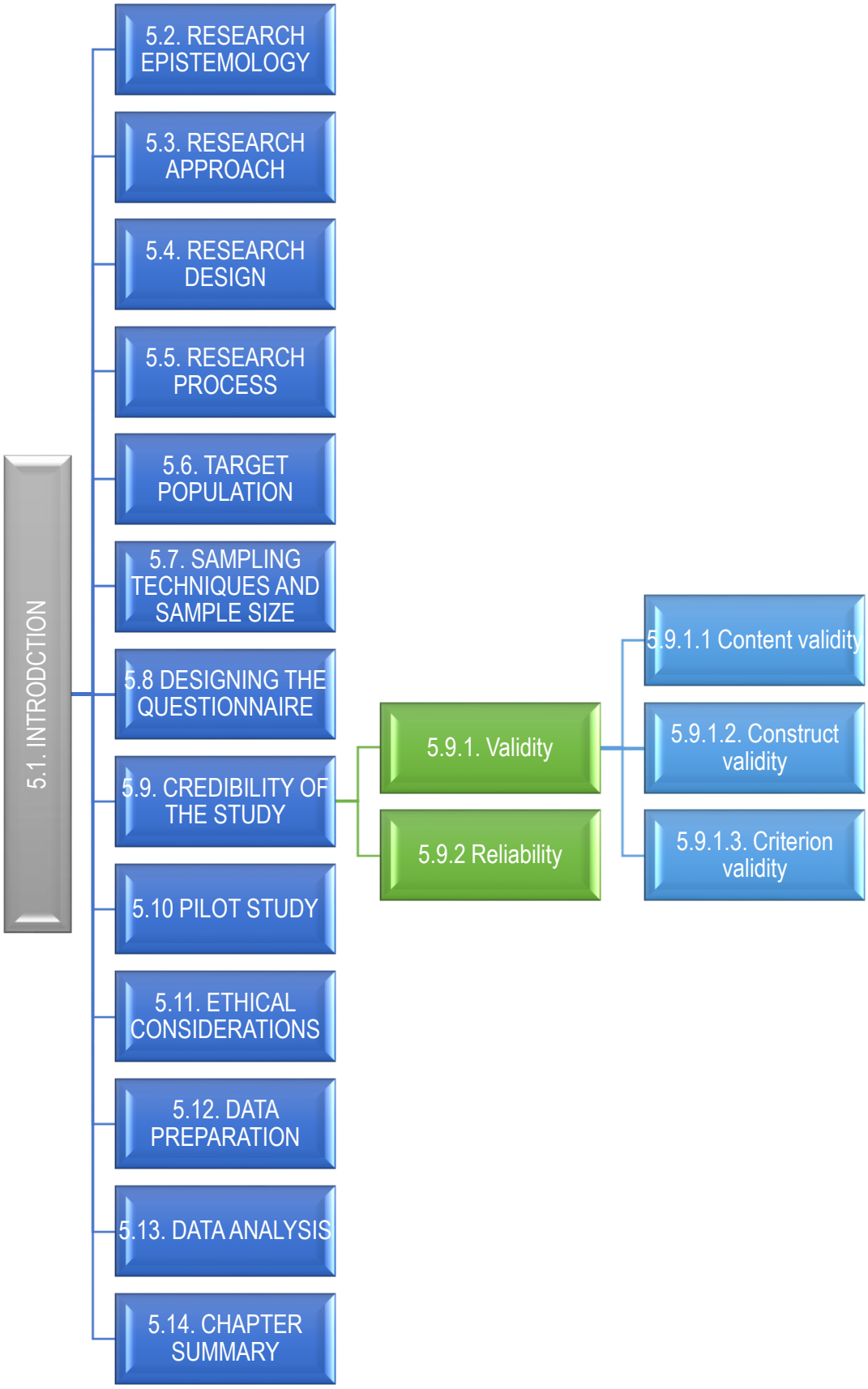
The statistics in Figure 4.5 shows interesting trends in agricultural production statistics. While the population size growth trend is upward from 1990 to 2014, most indicators of agricultural production and productivity reveal an upward trend from 1990 to 2000 and then a downward trend from 2000 to 2014.

Note that the drop in productivity indices (e.g. agriculture value added per worker, cereal import dependency ratio and food production value) coincide with the year 2000 when the fast-track land reform programme was launched. Arguably, while the programme promoted new, smaller-scale farming activities, it certainly disrupted the long-established commercial farming sector and cognate agro-processing firms.

4.7. Chapter summary

This chapter addressed the issues of agricultural productivity and competitiveness with special emphasis on definitional issues, measurement and significance of the agricultural sector. Special attention was also drawn to the factors influencing agricultural productivity. Lastly, the chapter provided case studies of agricultural productivity from selected regions across the globe. The next chapter deals with the research design and methodology.

CHAPTER 5: RESEARCH METHODOLOGY



5.1. Introduction

The previous chapter addressed the literature on the agricultural productivity and competitiveness, variables associated with the current study. According to Cooper and Schindler (2011:11), "writers usually treat the research study as a sequential process involving several clearly defined steps." Concurring with the preceding view, Leedy and Ormrod (2005) explain that research involves a systematic process that entails data collection, analysis and interpretation for the understanding of a phenomenon of interest.

This chapter outlines the research methodology used to address the research questions of the present study. Howell (2013) explains that the research methodology is a systematic, theoretical analysis of the methods applied to a field of study in research, theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses various concepts such as the research paradigm, theoretical model, phases of conducting research and quantitative or qualitative techniques. This study was quantitative in nature. Creswell (2003) proffers that quantitative research studies are concerned with cause and effect linking to hypotheses, use of measurement and observation, and the test of various theories in the area of study.

This research adopts a quantitative approach that seeks to get a broad understanding of the productivity and competitiveness of agro-business firms from both countries. To the researcher's knowledge, no comparative study has been conducted on the status and the impact of technology transfer and innovation on productivity and competitiveness covering Zimbabwean and South African regions.

5.2. Research epistemology

A positivist epistemology was adopted for this study. Since positivists are hard realists who believe in a single reality and total objectivity (Guba & Lincoln, 2005; Merriam, 2007), they argue that there is a single truth that can be studied and measured. Since this study sought to establish the objective condition (i.e. status and exact impact of technology transfer and innovation on the productivity and competitiveness of agro-processing firms in two regions of Zimbabwe and South Africa), a positivist epistemology was ideal for scientifically determining the levels of technology transfer and innovation and ascertaining the associative and predictive relationships in this study.

The purpose of positivist research is to predict and control nature (Guba & Lincoln, 2005; Merriam, 2007) and hence there is no reason to interact with who or what is studied. The use of a quantitative approach, a structured questionnaire, and quantitative analysis was therefore selected to ensure objectivity, allow the researcher to direct and control the research processes, and allow for the prediction of relationships

between variables respectively. These research processes would be inconceivable using interpretive epistemology and qualitative research approaches.

5.3. Research approach

This comparative study been South Africa and Zimbabwe agro-processing firms adopted a quantitative research approach, which is based on the positivist world-view. Positivism assumes that science or knowledge creation is confined to what is observed and measurable. In addition, the process rests exclusively on testable theories and hypotheses that can be confirmed or disconfirmed (Cohen, Manion and Morrison, 2007). The study employs theories of technology transfer and innovation and addresses quantitative and relational questions to make inferences about the relationships between variables.

The choice of a quantitative approach was informed by the need to ascertain the status and impact of technology transfer on the productivity and competitiveness of small agro-processing business firms in Zimbabwe (Mashonaland) and South Africa (Free State). Hence, the quantitative approach afforded the opportunity to test for any associative or predictive relationships between independent variables and dependent variables. The approach was deemed appropriate since the current study was guided by a conceptual model of hypothesised relationships whose interaction could be met through the collection of precise self-reported data. Evidently, the choice of a research paradigm or approach influences the research design. According to Saunders, Lewis and Thornhill (2013), an appropriate research design must be clearly constructed and defended before any study is undertaken. Naturally, this leads to the need to explain the research design adopted for the current study briefly.

5.4. Research Design

The research design is a process of creating an empirical test to support or refute a knowledge claim with support of knowledge in the research area of interest. Delport and Fouche (2011) proclaim that the research design is a plan for the collection of data so that the desired information can be obtained with sufficient precision. A research design involves a set of decisions regarding the topic to be studied: the population, formulation of knowledge and choice of research methods.

The study adopted a survey approach as the research design. Saunders et al. (2013) proclaim that a survey approach is adopted as one's research design if the information required needs broader explanation and empirical evidence. To the extent that this study seeks to provide a descriptive account of the status of technology transfer and innovation levels including uncovering the relationships among

technology transfer, innovation and productivity of small-scale agro-processing firms, the survey approach is ideal for the exploring and explicating these relationships.

5.5. Research process

The research process involved defining the problem statement, the postulation of important questions (some of which can be converted into hypothesis), conduct of an in-depth literature review of concepts, determination of sampling procedures, development of measurement instrument, administering the questionnaire, and analysing and interpreting results. The first stage is the problem statement and this was defined and clarified in the first chapter of the study. Zikmund, Babin, Carr and Griffin (2013) state that a problem well defined is a problem -solved. The other stage was the setting of the research objectives, which involved in the setting of the research goals (Cooper & Schindler, 2011; Zikmund et al., 2013). Once research objectives were formulated, they were converted into research questions as research hypotheses were not tested. Once a problem was defined, and the research objectives and questions were formulated, the next stage focused on establishing relevant knowledge through conducting an in-depth literature review.

The next critical stage involved the determination of the study population, sampling procedures and methods relevant to the study**.** This was then followed by the design and pilot-testing of the measurement tools used in the study. The next stage involved the administering of the questionnaire, a process that essentially encompassed the data collection procedure. The last stage involved statistical analysis and interpretation of results, which is made up of descriptive and inferential statistical analyses.

5.6. Target Population

It is essential for the researcher to determine the population of the study. Doing so affords the researcher the opportunity to decide whether to use the entire population of elements to be studied or only a sample of elements. The target population is the researcher's interest group. It is to this group that the results of the study will be generalised. The target population for this study comprised all small-scale agro-based firms covering small-scale agro-processing farmers, suppliers of agricultural equipment and inputs, farming associations and other farm-related businesses in Zimbabwe (Mashonaland Central) and South Africa (Free State). In the absence of hard current data relating to the actual numbers of small-scale agro-businesses (i.e. the population of small-scale agro-businesses) in the Free State and Mashonaland Central provinces, the researcher relied on data estimates from the Ministry of Agriculture in Zimbabwe and South Africa. The Department of Agriculture, Forestry and Fisheries in the Free State estimated that there was approximately 12 000 agro-processing firms (comprising predominantly agro-farming

businesses) in South Africa and of this total, the Free State Province had approximately 3000 agro-processing firms. The Ministry of Agriculture, Mechanisation and Crop Production in Zimbabwe estimated the number of agro-processing firms in Mashonaland Central to be 4000. The total population for the two countries was therefore, 7000 agro-processing firms.

The primary unit of analysis was the individual owners or managers of the small businesses. A unit of analysis is the entity or object that is being studied and analysed (Blumberg, Cooper & Schindler, 2008). Rubin and Babbie (2016:163) explain the unit of analysis as "those things that we examine in order to create summaries and explain the differences among them." The units can be individuals, objects or groupings. The next sub-section addresses the issues relating to sampling.

5.7. Sampling technique and sample size

Banerjee and Chaudhury(2010) states that researchers can rarely study the entire population because it is simply too large; hence, researchers should devise ways of drawing a sample from the target population. The sample needs to be smaller, more manageable set of elements, which is a subset of population selected to represent the entire population. Other issues that make sampling unavoidable include the logistical constraints, exorbitant costs and long duration required to collect information from a whole target population.

However, Leedy and Ormody (2010) proffer that the process of sample selection should be in line with sound empirical research guidelines. Put differently, the target population needs to be framed in a manner that the results of a sample drawn from the population can be generalised to the entire population. A sampling frame describes the list of the items or people forming a population from which a sample is to be drawn from. The sampling frame for the current study comprised lists of all small agro-businesses registered with the Ministry of Agriculture, Mechanisation and Crop Production in Zimbabwe, and the Department of Agriculture, Forestry and Fisheries in South Africa. The researcher relied on the estimates from these two institutions already highlighted in this study.

Sampling techniques fall into two groups, that is, probability and non-probability sampling. Probability-based sampling can be further sub-divided into random sampling and non-random sampling. With random sampling, every element in the target population has a chance of being considered as part of the sample. In this study, simple random sampling was used because of its suitability for quantitative studies that use statistical techniques for data analysis. The researcher used an online random number generator that utilises statistical algorithm to produce random numbers to select elements from the sampling frame.

Random numbers were picked from the sampling frame until the desired size was achieved. This method is presumed to be free from sampling bias and thus preserves the representativeness of the sample. This is important because of the need to generalise the findings and make precise generalisations to the target population.

Ascertaining an appropriate number of elements to include in a sample that represents a particular target population is one of the challenging tasks that are encountered in conducting a scientific study. The law of large numbers suggests that the larger a sample size is, the greater the probability that it is normally distributed. Therefore, larger samples afford the researcher more latitude for conducting different statistical analyses (Saunders, Lewis & Thornhill, 2009). The process of choosing a particular sample size is guided by factors that include cost, time frame, the size of the target population and the level of representativeness which is required (Martínez-Mesa, González-Chica, Duquia, Bonamigo, & Bastos, 2016). In the cases of quantitative research, mathematical formulae are often used to ascertain a suitable size.

According to Saunders et al. (2009), an unwritten rule in quantitative studies is to adopt a minimum sample size of 30 elements. Usually, the distribution around the mean of such elements is nearly normal (Cohen et al., 2007; Saunders et al., 2009). Findings from a sample whose elements are not normally distributed cannot be generalised to the target population. Guetterman (2015) proclaims that the choice of a particular sample size is ultimately an informed, personal choice. A total sample size of 400 respondents, 200 from each of the two countries was chosen for this study. The process of determining sample size was guided by Strydom and De Vos' (2005) statistical tables for determining sample size (see Table 5.1).

Table 5.1: Sample size selection guide

Population	Percentage suggested	No. of respondents
20	100 %	20
30	80 %	24
50	64 %	32
100	45 %	45
200	32 %	64
500	20 %	100
1000	14 %	140
10 000	4.5 %	450
100 000	2 %	2000
200 000	1 %	2000

In view of the estimate of 4 000 registered agro-processing firms in Mashonaland Central Province provided by the Ministry of Agriculture, Mechanisation and Crop Production in Zimbabwe, and the 3 000 registered agro-processing firms in Free State Province given by the Department of Agriculture, Forestry and Fisheries in South Africa, the total estimate of agro-processing firms in the two provinces was 7 000. Given that the approximate total number of small–scale businesses in the two provinces was less than 10 000 but more than 1 000, the sample size of 400 was consistent.

5.8. Designing the questionnaire

The researcher developed a single, structured questionnaire, which was used to collect data from owners and or managers of small-agro-based businesses in Mashonaland Province and the Free State Province. The questionnaire was pre-coded in preparation for further statistical analysis. A structured questionnaire limits the respondents' answers to a supplied set of alternatives. The goal of using a structured questionnaire in this study was to collect accurate data from a sample of respondents in a short time and at minimal cost. An effort was made to ensure that the questionnaire was balanced, clear and easy to understand such that the respondents developed an interest and were encouraged to complete it (Babbie, 2007). The questionnaire was developed in English, which is one of the official languages in both South Africa and Zimbabwe.

5.8.1. Contents of the questionnaire

The questionnaire used to collect the data requested respondents to provide information on the following issues:

Demographic information

- Age
- Gender
- Highest academic qualification
- Race/Ethnic
- Level of education at which entrepreneurial skills were acquired

Business information

- Length of time business has been operating
- Nature of business activity engaged in
- Number of employees including owner/manager
- Percentage growth in pre-tax profit over past five years
- Percentage growth in employment over past five years

Information on technology transfer, innovation, productivity and competitiveness of small agro-business firms in South Africa and Zimbabwe

- Indication of the status and level of productivity.
- Indication of the state and level of business competitiveness
- Indications of the state and relevance of innovation and technology in the participating firms
- Relevance/importance of availability of foreign technology and quality.

The non-demographic response items were outlined in the Likert scale format. A five-point Likert scale was provided for respondents to specify their level of agreement or disagreement on a scale for a series of statements. The scale ranged from 1, 'strongly disagree', to 5, 'strongly agree'.

5.8.2. Data collection

As indicated earlier, a structured questionnaire was used to collect primary data from small-scale agricultural businesses in Mashonaland and the Free State Province. Small-scale agricultural businesses were considered as those agro-based businesses that employ between 1 and 50 employees (Department of Trade and Industry). The researcher with the assistance of trained research assistants administered 400 questionnaires to respondents to fill in. Some of the questionnaires were completed whilst the researchers waited, while the others were dropped at the respondents' workplace and collected afterwards.

5.9. Credibility of the study

Any shortcomings in designing research instruments threaten the credibility of the findings of any research (Leedy & Ormrod, 2010). The researcher may measure or observe the wrong things, or may not measure or observe variables accurately. The end result is that wrong results and subsequently flawed conclusions and generalisations are made. According to Blumberg, Copper and Schindler (2008), the extent of error and bias in any scientific study can be curtailed through ensuring the validity and reliability of the research instrument used in a particular study. Validity relates to the extent to which a measure adequately represents the underlying construct that it purports to measure. This instrument should be designed in such a way that it reduces biases within a research tool. The consequence is that researchers should design research instruments that measure what they are intended to measure.

On the other hand, reliability is about the degree to which the measurement of a construct is consistent or dependable. Put differently, if an instrument is used to measure the same construct numerous times, the outcome should be the same every time, supposing that the core phenomenon is not fluctuating. The next part is dedicated to how the concerns of augmenting validity and reliability were dealt with in the current study.

5.9.1. Validity

According to Cooper and Schindler (2011), validity refers to the degree to which a research instrument serves the purpose for which it was constructed. The preceding authors recognise three types of validity, namely: content, construct and criterion validity. These are discussed below.

5.9.1.1. Content validity

Content validity (or face validity) of a measuring instrument refers to the degree to which the research tool covers the domain of the subject of interest. The study ensured content validity by including elements that adequately covered the constructs of productivity, competitiveness, innovation and technology transfer by drawing on dimensions of these concepts presented in the literature review. In addition, the questionnaire received input from two subject experts and the statistician.

5.9.1.2. Construct validity

According to Leedy and Ormord (2010), construct validity refers to the extent to which an instrument measures a characteristic that cannot be directly observed. In other words, it shows the degree to which the research instrument measures what it anticipates to measure and whether a suitable identification of the independent and dependent factors was done in the study (Hair, Anderson, Tatham & Black, 2008).

To ensure this, the researcher operationally defined the dependent and independent variables and extensively used literature to generate the questionnaire items.

5.9.1.3. Criterion validity

Criterion validity demonstrates the prognostic capacity of the items used to measure a variable against a certain yardstick (Blumberg, Cooper & Schindler, 2014). More directly, it refers to the level to which a measure is related with some other standard yardstick that is known to indicate the same construct accurately. According to Maree and Pietersen (2016), for criterion validity of an instrument to be assessed, the 'existing scores of an existing instrument which is known to measure the same construct should be available for the same sample of respondents.' Nonetheless, there is no devoted, existing research tool that relates to the numerous variables mentioned in this study.

5.9.2. Reliability

Reliability refers to freedom from random or unstable error (Saunders et al., 2009). According to Maree and Pietersen (2016), the following are the most commonly used techniques for determining the reliability of an instrument: test-retest reliability; split-half reliability and internal consistency. This study adopted the internal consistency reliability test for its purposes. This is a technique that seeks to ascertain the extent of likeness among items in a scale intended to measure a particular construct. The indicator of internal consistency is known as the Cronbach's alpha coefficient (r)**.** The coefficient indicates the strength of the correlations among the items measuring a particular item. A strong correlation among items is reflected by an alpha coefficient close to one. In contrast, an alpha coefficient close to zero reflects a weak correlation and poor internal consistency. The scale items for the current study showed acceptable internal consistency, as the alpha values were above 0.5 (see Table 6.2).

5.10. Pilot study

A pilot study is a limited run of a full-scale study. It can be equated to a practicality study whose goal is to pre-test the research instrument. Such a study uses elements of the target population who are not part of the current study. According to Blessing and Chakrabarti (2009), a pilot study increases the probability of study success by checking the lucidity of the research instrument items, guidelines and design. The outcome of a pilot study is a better research instrument with higher validity, reliability and feasibility.

The researcher carried out two pilot studies in Mashonaland West Province of Zimbabwe and the other in North West Province, South Africa from 2 to 7 May 2016 and 14 to 20 July 2016 in turn. A total of 16 questionnaires were administered on small agricultural businesses in each of the two study areas. The

respondents in the pilot study were selected in such a manner that they closely reflected the characteristics of the sampled elements. While the pilot study tested the questionnaires, it also provided a training ground for the research assistants. Following the outcome, they were no major alterations to the instrument except for further clarification of the instructions.

5.11. Ethical considerations

The researcher encountered numerous ethical challenges in carrying this study. The issues related to informed and voluntary participation, anonymity, and confidentiality. Prior to the study, the researcher informed the respondents in the research project of their right to voluntarily participate or withdraw from the study at any stage of the study without suffering any unfavourable consequences. The respondents were also assured that any information they provided in the course of the study would be treated confidentially and would be used for the purposes of the study.

To elicit honest answers, the researcher made it clear that respondents would not be recognisable, by protecting their identities during the course of the research process. The researcher attached a covering letter to the questionnaire, promising the respondents their anonymity and confidentiality.

5.12. Data preparation

5.12.1. Data cleaning

The filled-in questionnaires from the respondents were examined for faults which could conceivably undermine the data analysis process. The main problems that were noted during the data preparation process encompassed half-completed and even blank questionnaires. These were left out of the data analysis altogether. Overall, a total of 268 questionnaires were analysed.

5.12.2. Data coding and entry

Since the questionnaires used in this study were pre-coded through assigning numbers to alternative options to statements/questions on the questionnaire, the data was immediately entered into a statistical software, statistical package for the social sciences (SPSS) 23 following the data cleaning process. This was done in preparation for detailed statistical analysis.

5.13. Data analysis

All the data collected during the study was analysed using SPSS 23. Preliminary analyses involved summarising the responses to the questionnaire using descriptive techniques like percentage analysis, frequency tables and summary statistics.

Advanced statistical techniques were then used to ascertain the relationships between the variables in the study. Non-parametric tests were used to determine any relationships between the variables since the datasets were not normally distributed. Thus, the Spearman's correlation test was used to assess the nature and strength of relationships amongst the numerous pairs of dependent and independent variables scale. Lastly, multiple regression analyses were then applied to assess the posited prognostic connections between the independent variables and the dependent variables. This process enabled the calculation of the regression coefficients for each independent variable to assess their relative effects on the dependent variable.

5.14. Chapter summary

This chapter presented the methodology used in this study. The research methodology was guided by the positivist research paradigm. Hence, the chapter addressed issues relating to a quantitative research approach, survey research design, target population, sampling frame, probability sampling procedure, sample size, the research instrument and it administration, quantitative data collection and data analysis. In addition, the credibility of the research instrument was also discussed. The next chapter presents the findings of the study.

CHAPTER 6: FINDINGS AND DISCUSSION

6.1. Introduction

The previous chapter presented the research methodology adopted in conducting this study. This chapter presents the results of the surveys carried out in the Free State Province in South Africa and Mashonaland Province in Zimbabwe. Thus, the chapter presents and discusses the demographic profiles of these respondents, and the inferential statistics employed to test the diverse relationships of association and prediction between variables. Since the preliminary checks conducted on the two data sets generated from the two samples were not normally distributed and, therefore, could not meet the stringent requirements of parametric techniques, non-parametric statistical analysis techniques were harnessed to draw inferences from the data. Correlation analysis was employed to test relations of association among predictor and outcome variables. Lastly, multiple regression analyses were carried out to evaluate the prognostic effect of the independent variables on the dependent variables.

6.2. Response rate

The survey questionnaire was administered on 400 respondents sampled from small agro-processing businesses in Zimbabwe and South Africa. There were 165 questionnaires returned from the Zimbabwean sample and 112 returned from the South African sample, and hence a total of 277 questionnaires were completed and returned. There were nine (9) incorrectly filled questionnaires among the 277 and these were excluded from the analyses. This means that 268 questionnaires were analysed, representing a 69% response rate.

6.3. demographics

This section addresses the demographic characteristic of the respondents. Frequencies were calculated for gender, age, race, years of business operation, number of employees, value of business assets, nature of agriculture-related business activity, and highest level of agriculture qualification. The details are presented in Table 6.1.

Table 6.1: Demographic details of respondents

Personal details	Category	Zimbabwe		South Africa	
		Frequency	Percentage	Frequency	Percentage
Gender	Male	74	70%	98	60%
	Female	32	30%	63	39%
	Other	-	-	1	1%
Race	Black	64	60%	42	26%
	White	12	11%	61	38%
	Coloured	11	10%	11	7%
	Asian	9	8%	8	5%
	European	10	9%	38	23%
	Other			2	1%
	Missing			14	9%
Age	Below 20	-	-	4	2%
	21-30 Years	19	18%	6	4%
	31--40 Years	50	47%	30	19%
	41-50 Years	33	31%	82	51%
	51-60 Years	2	2%	23	14%
	61 Years+	2	2%	14	9%
	Missing			3	2%
Agriculture-related qualification	Other	6	6%	7	4%
	High school	23	22%	16	10%
	Bachelor degree	43	41%	74	46%
	Postgraduate	4	4%	17	10%
	Vocational course	27	25%	37	23%
	Missing	2		2	1%
Nature of agro-business	Animal husbandry	22	21%	3	2%
	Crop production	29	27%	55	34%
	Horticulture	23	22%	35	22%
	Manufacturing/processing	16	15%	36	22%
	Sale of equipment	9	8%	16	10%
	Other	7	7%	17	10%
		-	-		

	Missing				
Business assets-value in US$	Less than $200000-00	44	42%	8	5%
	$200000-$499000	42	40%	79	49%
	$500000-$999999	9	8%	32	20%
	$1000000-$4999999	5	5%	15	9%
	$5000000-$9999999	4	4%	12	7%
	Over 10 million	2	2%	16	10%
Years of existence of Business	1 to 5	18	17%	13	8%
	6 to 10	43	41%	45	28%
	11 to 15	36	34%	62	38%
	16 to 20	8	8%	21	13%
	21 to 50	1	1%	11	7%
	Over 50	0	0%	7	4%
	Missing	0	0%	3	2%
Number of employees	1 to 10	29	27%	11	7%
	11 to 20	25	24%	71	44%
	21 to 50	34	32%	46	28%
	51 to 100	17	16%	9	6%
	101 to 200	1	1%	16	10%
	Over 200	0	0%	6	4%
	Missing	0	0%	3	2%

Note. Due to rounding errors, percentages may not equal 100%. Also note that those respondents below 20 years were not necessarily minors as they were aged 18 years or older but less than 20 years of age.

6.3.1. Gender composition of respondents

For the Zimbabwean sample, the largest proportion of respondents was males within the 31 to 40 (47%) and 41 to 50 (31%) years of age. Similarly, some males in the 31 to 40 (19%) and 41 to 50 (51%) years age groups dominated the South African sample. This implies that the active male population dominates

the ownership and management of small-scale agro-businesses in both samples. The finding on male domination of ownership and management of agro-processing businesses in the South African sample resonates with Agbobli's (2013) study which reported that most (58%) of South African small scale agricultural enterprises (SSAEs) in the Vryburg area were owner-managed. The domination of male respondents in both regions is also in consonant with Agbotame's (2015) study, which affirmed the prevalence (79.5%) of male respondents in his South African sample of SSAEs. Studies carried out by Bhatasara and Chiweshe (2017) and Mutopo and Chiweshe (2014) on Zimbabwean agro-processing firms also stress the male domination of the ownership and management of agriculture related resources.

6.3.2. Age composition of respondents

The findings also revealed that young people (under the age of 20 years) and females were not much involved in the management of agro-related businesses in both Mashonaland Central (Zimbabwe) and Free State provinces (South Africa). Although these respondents were below 20 years of age, they were mature enough to start businesses (that is, they were older than 18 years of age). The limited youth and female participation in agro-processing businesses can be attributed to financial, social, institutional and cultural barriers. There is a general consensus that agro-processing businesses engage in hard manual labour, requires large capital outlays and women and young people tend to be prejudiced against doing business deals by men and mature adults (World Bank, 2009; Sahan & Mikhail, 2012; Agbotame, 2015). The dominance (over 70%) of the mature adult population (36-55 years) was also reported in previous South African agro-based studies (Agbobli, 2013; Agbotame, 2015) and Zimbabwean studies (Machila, Lyne, & Nuthall, 2015; Scoones, Mavedzenge, Murimbarimba & Sukume, 2017). The dominance of the 31-50 years age group in the Zimbabwean sample may also be a direct result of year 2000 land reform and redistribution programme where middle-aged individuals were the largest beneficiaries and therefore had the head-start to establish small-scale agro businesses (Mwiturubani & van Wyk, 2010).

Apart from the above, the dominant age groups possibly consists of individuals with substantial work experience from various sectors of the economy, which gives them a strong foundation to establish businesses in the agro-sector. This finding buttress the claim on the existence of a direct relationship between the establishment and survival of small scale agricultural businesses (SSABs) and the age of owners and managers as older agro-processing business owners/managers have better practical experience and financial resources to run business successfully than the younger ones (Agbotame, 2015).

6.3.3. Educational status

In terms of educational status of respondents, Table 6.1 illustrates that a sizable number of respondents (41%) for Mashonaland (Zimbabwe) at least had a bachelor's degree. As for the South African sample, most respondents (46%) had bachelor's degrees. Only 6% of the respondents did not have any formal education. Perhaps the demands for agricultural knowledge, skills and expertise to effectively run agricultural businesses explains the sizable number of respondents in both samples who had tertiary qualification. This can be contrasted with Chamboko, Mwakiwa and Mugabe's (2017) study on the determinants of participation in the milk market and volume of sales to milk collection centres of the smallholder dairy value chain in Zimbabwe, which revealed that non-graduates constituted a majority of participants in small-scale agricultural business in rural areas.

6.3.4. Number of years in business

When it comes to number of years in business, Table 6.1 shows that those with the highest number of years in business ranges from 6-10 (41%) in Zimbabwe followed by those with 11-15 years (38%). This finding suggests that most businesses in this country had survived their first years of existence. This can be compared to the South African sample where those who had 11 to 15 years in business constituted the largest chunk (38%), followed by 6 to 10 years (28%). The findings from the South African sample corroborate Agbobli's findings, which revealed a similar pattern of surviving businesses.

6.3.5. Racial composition

For the Zimbabwean respondents, the modal response category of race was Black (*n* = 64, 60%). The dominance of black participation in small scale agro-processing activities in this sample can be attributed to the reality that a majority of citizens (99.7%) in this country are black (Zimbabwe National Statistics Agency [ZimStat], 2012). More so, the higher representation of blacks can also be a consequence of the controversial land reform programme, which increased black ownership of land and participation in agricultural activities (Makunike, 2014).

Compared to the Zimbabwean sample, the South African sample was white dominated (n = 61, 38%); European (n=85, 53%). These statistics are representative of the predominantly untransformed character of land ownership and agricultural activity in the country – one in which the racial groups that owned land in the country before independence continue to do so in the post-independence era (Cousins, 2013). Therefore, parallels can be made between the two samples, with the Zimbabwean sample demonstrating some evidence of transformation in land ownership and management in a post-independent era.

6.3.6. Number of employees

A comparative analysis of the number of employees employed small scale agro-processing firms in Zimbabwe and South Africa reveals minor variations. For instance, most South African firms who participated in the study employed between 11 to 50 employees (68%), while in the case of the Zimbabwean sample most of the firms employed between 1 and 50 employees (83%). These highlight the significance of small firms as an employment provider for both economies.

6.3.7. Value of assets

The majority (82%) of the Zimbabwean sample had agri-business owner/managers whose asset values were less than US$499 999. On the contrary, the majority (69%) of the South African sample had respondents whose asset values ranged from US$200 000 to US$999 999. Perhaps the advanced nature of the South African economy and the higher resource endowments in the country relative to Zimbabwe explains these variations (Giampiccoli, Lee & Nauright, 2015).

6.3.8 Agro-business activities

Table 6.1 shows that the majority of Zimbabwean respondents were involved in crop production, animal husbandry and horticulture. The popularity of these activities can be explained by Zimbabwe's traditional agrarian status of being Southern Africa's breadbasket and Zimbabwe's wish to ensure food security for its citizenry (Nhundu & Mushunje, 2010). The country's history of agricultural production (especially cereal and cash crop production and animal rearing) explain the dominance of these agricultural activities (Dube, Homann-Kee Tui, Van Rooyen & Rodriguez, 2014; Nezomba, Mtambanengwe, Tittonell & Mapfumo, 2015). In the case of the South African sample, most of the respondents were involved in animal husbandry, horticulture or agro-processing/manufacturing. The prevalence of agro-processing/manufacturing in the South African sample could be a consequence of the higher capital base which makes the acquisition of heavy machinery and value chain processing more feasible in the country compared to the Zimbabwean sample.

6.4. Construction of composite scores

Before carrying out the various statistical analyses on the collected data, composite scores were created for the continuous variables. In other words, distinct questionnaire items concerning a particular variable were combined to create a total score for that variable. The purpose of performing this procedure was to transform the raw data to continuous or scale data, which is suitable for the conduct of inferential statistical analysis of the data. The following scale variables were consequently produced for agricultural productivity, agricultural competitiveness, innovation, technology transfer and agriculture technology

types. The productivity variable was generated using items 1 to 28 on the questionnaire; agricultural competitiveness was generated using items 29 to 53; innovation was constructed using items 54 to 70; technology transfer was produced using items 71 to 93; and agriculture technology types using items 94 to 113.

6.5. Reliability

Reliability tests were performed on the newly created composite scores. Reliability testing is done to assess the consistency of responses among a group of items that are intended to measure a particular variable. Reliability is also referred to as internal consistency or inter-item reliability. It is commonly measured using Cronbach's alpha coefficient.

The purpose of reliability testing, therefore, is to determine if a group of questions credibly measure the same construct, concept, or idea. This test is used when creating a composite score to ensure that all of the items that make up the composite score are consistent with each other. The Cronbach reliability test calculates the reliability coefficient alpha (α), which indicates the degree of consistency among the items. George and Mallery (2010) suggest the following guidelines for evaluating an α value: > 0.9 excellent, > 0.8 good, > 0.7 acceptable, > 0.6 questionable, > 0.5 poor, ≤ 0.5 unacceptable. As such, the Cronbach reliability test assumes that the items being tested measure a single construct (i.e. the construct is one-dimensional), and that observations are independent of each other. The results of the tests are presented in Table 6.2.

Table 6.2: Reliability test results

	Zimbabwe				South Africa			
Section	**N**	No. of items	Cronbach's Alpha	Comment	N	No. of items	Cronbach's Alpha	Comment
Financial productivity	106	7	0.807	Good internal consistency	162	7	0.549	Poor but acceptable internal consistency
Non-financial productivity	106	21	0.929	Excellent internal consistency	162	21	0.787	Acceptable internal consistency
Agricultural competitiveness	106	25	0.825	Good internal consistency	162	25	0.666	Acceptable internal consistency
Innovation	106	17	0.610		162	17	0.547	

			Acceptable internal consistency				Poor but acceptable internal consistency
Technology transfer	106	22	0.920	Excellent internal consistency	162	22	0.954	Excellent internal consistency
Technology types	106	22	0.935	Excellent internal consistency	162	22	0.935	Excellent internal consistency

6.6. Test for normality

The selection of a suitable statistical analysis technique to use for a particular data-set is contingent on whether the datasets is normally distributed or not. Parametric tests, which have specific pre-conditions, are suitable for normally distributed data-sets. On the other hand, non-parametric techniques (which do not carry stringent conditions) are appropriate for datasets which are not normally distributed. With this in mind, the Kolmogorov-Smirnov (KS) test was performed on the data-set for all scale variables to ascertain its normality, and consequently select the appropriate category of inferential statistics to apply. The results are presented in Table 6.3.

Table 6.3: Normality test results

	Zimbabwe		South Africa	
Variables	**KS Statistic**	***p*-value**	**KS Statistic**	***p*-value**
Financial productivity	1.736	0.000	2.734	0.000
Non-financial productivity	1.302	0.007	0.801	0.542
Agricultural competitiveness	1.523	0.019	1,755	0.004
Innovation	1.858	0.002	1.870	0.002
Technology transfer	2.564	0.000	1.955	0.001
Technology types	0.618	0.840	2.190	0.000

In order to make inferences from the results of the KS test, the *p*-value provided by the test is assessed. This evaluation is made at either 0.01 or 0.05 significance levels, depending on the degree of precision which is needed (0.01 is more precise than 0.05). A dataset for a specific variable is not normally distributed if it has a significant *p*-value i.e. one that is less than 0.01 or 0.05. On the other hand, it is normally distributed if its *p*-value is greater than the stated significance level of 0.01 or 0.05. The findings presented in Table 6.3 demonstrate that most of the variables that were tested, except for technology types (for Zimbabwe) and non-financial productivity (for South Africa), had *p*-values less than 0.05, suggesting that the data sets were not normally distributed. Put differently, the data had a skewed distribution. Consequently, non-parametric tests had to be used for inferential statistical analysis.

6.7. The status and level of productivity of agro-processing firms operating in Mashonaland central province in Zimbabwe (Mashonaland) and Free State province (South Africa)

This sub-section addresses the following research question: *What is the status and level of productivity of agro-processing firms operating in Mashonaland Central province in Zimbabwe and Free State province in South Africa?*

Percentage analyses of responses to questionnaire statements relating to financial productivity, non-financial productivity, output productivity, output per hectare, capacity utilisation per hectare, market growth and market reputation were performed to answer this research question. The analysis of each of the sub-components is presented in the ensuing sub-sections.

6.7.1. Financial productivity

Table 6.4a presents summaries of findings relating to the status and level of financial productivity of Zimbabwean and South African agro-processing firms. Between 21% and 31% of the Zimbabwe respondents indicated that there was, at least, an increase in each of the elements of financial productivity

in the past 5 years. This means that the most frequent response category to each of the statements presented on the questionnaire was either “decrease by between 1-10%” (statement 1) or “no change” (statements 2 to 7). These results are clearly consistent with the current recession and negative growth affecting the country.

Table 6.4a: Status and level of financial productivity of Mashonaland Central Province (Zimbabwe)

Financial Productivity (Zimbabwean sample)		Frequency Distribution						
		Decreased by over 10%	Decreased by between 1%-10%	No change	Increased by 1%-10%	Increased by over 10%	Total % increase	Latent Factor (Principal component)
Please indicate the extent to which the agro-business’ sales from agricultural products/services increased/decreased over the past 1-5 years	Count	0	42	36	26	2	27%	0.879
	%	0%	40%	34%	25%	2%		
Please indicate the extent to which the agro-business’ sales from agricultural products/services increased/decreased compared to production costs over the past 1-5 years	Count	0	42	42	18	4	21%	0.962
	%	0%	40%	40%	17%	4%		
Please indicate the extent to which the agro-business’ total revenue increased/decreased compared to production costs over the past 1-5 years	Count	1	41	42	18	4	21%	0.955
	%	1%	39%	40%	17%	4%		
Please indicate the extent to which the agro-business’ gross profit increased /decreased over the last 1-5 years	Count	5	33	38	26	4	29%	0.958
	%	5%	31%	36%	25%	4%		
Please indicate the extent to which the agro-business’ net profit increased/declined over the last 1-5 years	Count	8	30	40	24	4	27%	0.933
	%	8%	28%	38%	23%	4%		
Please indicate the extent to which the agro-business’ return on investment (financial returns generated from the business’ start-up capital/initial investment) grew/declined over the last 1-5 years	Count	9	30	34	29	4		0.453
	%	9%	28%	32%	27%	4%	31%	
Please indicate the extent to which the agro-business’ total finances grew/ fell over the last 1-5 years	Count	12	25	43	22	4		0.915
	%	11%	24%	41%	21%	4%	25%	
	Total variance explained by latent factors=77.75%							

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

In contrast to the Mashonaland Central Province respondents (i.e. Zimbabwean sample) where the majority of respondents reported no change on financial productivity or decline in productivity, most

respondents from the Free State Province (i.e. the South African sample) indicated that agricultural productivity was at least increasing. As can be illustrated in Table 6.4b, the responses that indicated at least an increase in the status and level of productivity ranged from 87% to 94%. Thus, the majority of respondents indicated an increase in the level of financial productivity of their business in the previous 5 years.

Very little current disaggregated information was found in the literature on the financial productivity of small-scale agro-processing firms in Zimbabwe due to unavailability of data. However, the Reserve Bank of Zimbabwe's Quarterly Economic Review of June 2017, the Ministry of Finance and Economic Development's First Quarter Economic Bulletin of 2017, and the Zimbabwe National Statistics Agency (ZIMSTAT)'s Agriculture and Livestock Survey (ALS) in Small-Scale Commercial Farming Report for the 2014/2015 agriculture season from February to December 2015 reveal lacklustre financial performance of the small scale agricultural sector in the Zimbabwean economy as a whole. This is in sync with the findings from the current study which revealed significantly lower levels of agricultural financial productivity based on the respondents' perceptions. In fact, this collaborates Masunda's (2014) observation that the sustainability of Zimbabwe's agriculture sector as a whole has been undermined by high operational costs, which undercut the profits of agro-processing firms in the sector. Therefore, the high cost of operations and low capital efficiency compel most small-scale agro-processing firms in Zimbabwe to operate on a subsistence basis and below optimal levels. With reference to the South Africa sample, the very high rates of financial productivity reported by agro-processing firm owner/managers were surprising given the often-cited insurmountable challenges faced by small-scale firms in the South African agriculture sector - such as access to resources and support services including marketing constraints (Ducastel & Anseeuw, 2017).

Table 6.4b: Status and level of financial productivity of the Free State Province (South Africa)

Financial Productivity (South African sample)		Frequency Distribution						
		Decreased by over 10%	Decreased by between 1%-10%	No change	Increased by 1%-10%	Increased by over 10%	% Total increase	Latent Factor (Principal
Please indicate the extent to which the agro-business' financial sales from agricultural products/services increased/decreased over the past 1-5 years	Count	2	4	9	103	44		0.787
	%	1%	2%	6%	64%	27%	91%	
Please indicate the extent to which the agro-business' sales from agricultural products/services increased/decreased compared to production costs over the past 1-5 years	Count	1	2	19	110	30		0.752
	%	1%	1%	12%	68%	19%	87%	
Please indicate the extent to which the agro-business' total revenue increased/decreased compared to production costs over the past 1-5 years	Count	1	3	12	113	33		0.851
	%	1%	2%	7%	70%	20%	90%	
Please indicate the extent to which the agro-business' gross profit increased /decreased over the last 1-5 years	Count	1	2	14	118	27		0.820
	%	1%	1%	95%	73%	17%	90%	
Please indicate the extent to which the agro-business' net profit rose/declined over the last 1-5 years	Count	0	2	15	118	27		0.821
	%	0%	1%	9%	73%	17%	90%	
Please indicate the extent to which the agro-business' return on investment (financial returns generated from the business' start-up capital/initial investment) increased/declined over the last 1-5 years	Count	0	2	12	119	29		0.421
	%	0%	1%	7%	73%	18%	91%	
Please indicate the extent to which the agro-business' total finances grew /fell over the last 1-5 years	Count	0	2	9	124	27		0.810
	%	0%	1%	6%	77%	17%	94%	
		Total variance explained by latent factors=56.29%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.7.2. Non-financial productivity

Tables 6.5a and 6.5b present the findings on the status and level of non-financial productivity in Zimbabwe and South Africa samples respectively. The frequently observed categories of responses for the Zimbabwean sample was "no change" (*n* = 35, 33%) for statement 1 and (*n* = 39, 37%) for statement 2. While the percentage of responses that indicated at least an increase in non-financial productivity among agro-processing firms ranged between 27% and 31%, a sizable number of respondents emphasised negative growth in employment and market share.

Table 6.5a: Status and level of non-financial productivity of Mashonaland Central Province (Zimbabwe)

Non-financial productivity (Zimbabwean sample)		Frequency Distribution						
		Decreased by over 10%	Decreased by 1-10%	No change	Increased 1-10%	Increased by over 10%	Total increased	Factor (Principal component
Please indicate the extent to which the agro-business' employment levels grew/fell over the last 1-5 years	Count	16	22	35	29	4	31%	0.942
	%	15%	21%	33%	27%	4%		
Please indicate the extent to which the agro-business' market share grew/fell over the last 1-5 years	Count	13	26	39	24	4	27%	0.942
	%	12%	25%	37%	23%	4%		
		Total variance explained by latent factors=88.74%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Compared to the Zimbabwean sample in which varying responses were reported ranging from negative growth, no change to positive growth were reported, the most observed category of responses on non-financial productivity in the South African sample was "increased by 1-10%" (*n* = 112, 69% and *n* = 121, 75% respectively. Thus, the average total of percentage responses that showed, at least, an increase in non-financial productivity in the previous 5 years was 86%. These findings demonstrate a marked contrast between the respondents' perception of the status and levels of non-financial productivity in Mashonaland and Free State's agricultural sectors. While no much current data on productivity is available on the Zimbabwean sample due to inconsistent agricultural productivity record keeping, South African research suggest that non-financial productivity has steadily grown over the years (Food and Agriculture Organisation of the United Nations [FAO], 2015).

Table 6.5b: Status and level of non-financial productivity of the Free State Province (South Africa)

Non-financial productivity (South African sample)		Frequency Distribution						
		Decreased by over 10%	Decreased by 1-10%	No change	Increased 1-10%	Increased by over 10%	Total increased	Factor (Principal component
Please indicate the extent to which the agro-business' employment levels rose/declined over the last 1-5 years	Count	0	2	20	112	28		0.928
	%	0%	1%	12%	69%	17%	86%	
Please indicate the extent to which the agro-business' market share increased/shrunk over the last 1-5 years	Count	1	2	20	121	18		0.928
	%	1%	1%	12%	75%	11%	86%	
		Total variance explained by latent factors=86.06%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.7.3. Output productivity levels

Tables 6.6a and 6.6b present a summary of the results of the percentage analysis for the questionnaire items relating to the status and level of output productivity in Zimbabwe and South Africa respectively. The possible responses ranged from very low to very high. For the Zimbabwean sample, the most frequently observed response for the three statements was "moderate". The details for each of the statements are as follows: (i) Please rate the business' level of agro-processing production over the past 5 years (*n* = 48, 45%), (ii) How would you rate the total revenue from agro-processing production compared to total production costs (*n* = 43, 41%), (iii) How would you rate total outputs (total products/services) compared with total inputs (total raw materials) used in the agro-processing businesses over the past 1-5 years (*n* = 48, 45%). The second largest group of respondents were those who reported low or very low growth of all output productivity items (see Table 6.6a). Overall, the total percentage of respondents who selected, at least, high on each of the three statements ranged from 23% to 25%. These scores are relatively lower than those derived from the South African sample.

Table 6.6a: Status and level of output productivity (Zimbabwe)

Output productivity (Zimbabwe)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	%Total high/very high	Factor (Principal component
Please rate the business' level of agro-processing production over the past 5 years	Count	8	26	48	24	0	23%	0.876
	%	8%	25%	45%	23%	0%		
How would you rate the total revenue from agro-processing production compared to total production costs	Count	11	27	43	25	0	24%	0.948
	%	10%	25%	41%	24%	0%		
How would you rate total outputs (total products/services) compared with total inputs (total raw materials) used in the agro-processing businesses over the past 1-5 years	Count	6	26	48	26	0	25%	0.924
	%	6%	25%	45%	25%	0%		
		Total variance explained by latent factors=83.99%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.6b demonstrates that the majority of responses to each of the three questionnaire items relating to output productivity for the South African sample selected, at least, "high" with the total scores ranging from 68% to 74%. These scores are relatively high compared to those derived from the Zimbabwean sample. These findings reveal that the status and level of output productivity for the South African sample was comparatively higher than that of the Zimbabwean sample. These findings on the South African sample were unsurprising given the good rains in the Free State Province, which contributed to a bumper harvest in 2017. Stunted and negative growth that dominated the Zimbabwean sample is surprising given that the rain-fed dependent area of Mashonaland also received good rains in 2017 and the much needed government support in terms of farm implements and high variety seeds (Nkala, 2017).

Table 6.6b: Status and level of output productivity (South Africa)

Output productivity(South Africa)		Frequency Distribution						
		Very low	Low	moderate	High	Very high	% Total high	Factor (Principal component
Please rate the business' level of agro-processing production over the past 5 years	Count	1	2	39	96	24	74%	0.547
	%	1%	1%	24%	59%	15%		
How would you rate the total revenue from agro-processing production compared to total production costs	Count	1	2	48	91	20	68%	0.644
	%	1%	1%	30%	56%	12%		
How would you rate total outputs (total products/services) compared with total inputs (total raw materials) used in the agro-processing businesses over the past 1-5 years	Count	1	1	50	88	22	68%	0.565
	%	1%	1%	31%	54%	14%		
		Total explained variance-=34.465%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.7.4. Productivity output per hectare

Tables 6.7a and 6.7b present a summary of the results of the percentage analysis for the questionnaire items relating to the level of productivity output per hectare in Zimbabwe and South Africa respectively. These questionnaire items only applied to respondents who were involved in crop production and horticulture. For the Zimbabwean sample, the most frequently observed response for most of the five statements was "moderate". Overall, the respondents who selected, at least, high on each of the five statements ranged from 25% to 33%. This means that the majority of Zimbabwean respondents perceived productivity output per hectare to be either moderate or lower. This could be a consequence fluctuating weather conditions, inadequate resources and increasing costs of agricultural inputs (Cheesman, Andersson & Frossard, 2017).

For the South African sample, the modal response for the five statements was "high". Overall, the total percentage of respondents who selected "high" on each of the five statements ranged from 55% to 61%. This means that the majority of South African respondents perceived the level of productivity

output per hectare to be generally high. Such positive developments in the South African context are a result of the intensive nature of farming activities and the availability of substantial support for agricultural activity in the country (Bernstein, 2013).

Table 6.7a: Level of productivity-output per hectare (Mashonaland Central Province, Zimbabwe)

Productivity output per hectare (Zimbabwe)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	% Total high / very high	Factor (Principal component
Rate the business' level of productivity in input per hectare	Count	0	18	17	17	0	33%	0.897
	%	0%	35%	33%	33%	0%		
Rate the business' level of productivity in output per hectare	Count	4	13	20	15	0	28%	0.894
	%	8%	25%	38%	29%	0%		
Rate the business' level of productivity in terms of outputs per hectare compared to the input used per hectare	Count	2	14	20	16	0	31%	0.919
	%	4%	27%	38%	31%	0%		
Please rate the business' output per unit cost compared to the input per unit cost	Count	0	15	21	16	0	31%	0.788
	%	0%	29%	40%	31%	0%		
Rate the business's overall level of output in hectares (ha)	Count	4	10	25	13	0	25%	0.666
	%	8%	19%	38%	25%	0%		
		Total variance explained=64.10%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.7b: Level of productivity - output per hectare (Free State Province, South Africa)

Productivity output per hectare (South Africa)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	% Total high/very high	Factor (Principal component
Rate the business' level of productivity in input per hectare	Count	0	2	33	46	9	61%	0.809
	%	0%	2%	37%	51%	10%		
Rate the business' level of productivity in output per hectare	Count	0	1	39	46	4	55%	0.834
	%	0%	1%	43%	51%	4%		
Rate the business' level of productivity in terms of outputs per hectare compared to the input used per hectare	Count	0	4	35	48	3	56%	0.859
	%	0%	4%	39%	53%	3%		
Please rate the business' output per unit cost compared to the input per unit cost	Count	0	2	37	42	9	57%	0.844
	%	0%	2%	41%	47%	10%		
Rate the business's overall level of output in hectares ha	Count	0	3	33	50	4	60%	0.813
	%	0%	3%	37%	56%	4%		
		Total variance explained by latent factors=69.21%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.7.5. Capacity utilisation output per hectare

Tables 6.8a and 6.8b present a summary of the results of the percentage analysis for the questionnaire items relating to the status and level of capacity utilisation output per hectare in Zimbabwe and South Africa respectively. This questionnaire items only applied to respondents who were involved in crop production and horticulture. For the Zimbabwean sample, the most frequently observed response for most of the five statements was "moderate". Generally, the total percentage of respondents who selected, at least, "high" for each of the five statements ranged from 17% to 35%. This means that most Zimbabwean respondents observed productivity output per hectare to be either moderate or lower. The fall in the level of capacity utilisation of productive agricultural land since the fast-track land reform program is recognised in Zimbabwean literature (Sukume, Mavedzenge, Murimbarima & Scoones, 2015).

For the South African sample, the modal response category for the five statements was "high". The total percentage of respondents who selected "high" on each of the five statements ranged from 42% to 65%.

This means that the majority of South African respondents perceived the level of capacity utilisation in terms output per hectare as at least high. This finding somewhat contradicts statistics from FAO (2015) which reveal that the agricultural area from which crop harvesting took place dropped from 24 million hectares in 2000 to 18 million hectares in 2015.

Table 6.8a: Level of capacity utilisation - output per hectare (Mashonaland Central Province, Zimbabwe)

Capacity utilisation output per hectare (Zimbabwe)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	% Total high/ very high	Factor (Principal component
Rate the level of business' capacity utilisation (i.e. production potential from the exploitation of available resources) currently experienced by business	Count	2	13	19	18	0	35%	0.868
	%	4%	25%	37%	35%	0%		
Rate the level of business' capacity utilisation enabled by agricultural technology	Count	3	13	20	16	0	31%	0.867
	%	6%	25%	38%	31%	0%		
Rate the level of business' capacity utilization enabled by agricultural innovations	Count	1	11	25	15	0	29%	0.796
	%	2%	21%	48%	29%	0%		
Please rate the business' capacity utilization assisted by the use of specialized expatriate labour	Count	6	14	20	12	0	23%	0.874
	%	11%	27%	38%	23%	0%		
Please rate the business' capacity utilization assisted by foreign direct investment	Count	6	13	24	9	0	17%	0.763
	%	11%	25%	46%	17%	0%		
		Total variance explained by latent factors 69.696%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.8b: Level of capacity utilisation output per hectare (Free State Province, South Africa)

Capacity utilisation output per hectare (South Africa)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	% Total high/ Very high	Factor (Principal component
Rate the level of business' capacity utilisation (i.e. production potential from the exploitation of available resources) currently experienced by the business	Count	0	4	30	54	2	62%	0.793
	%	0%	4%	33%	60%	2%		
Rate the level of business' capacity utilisation enabled by agricultural technology	Count	0	4	37	32	5	42%	0.810
	%	0%	4%	41%	36%	6%		
Rate the level of business' capacity utilization enabled by agricultural innovations	Count	0	1	37	45	7	58%	0.827
	%	0%	1%	41%	50%	8%		
Please rate the business' capacity utilization assisted by the use of specialized expatriate labour	Count	0	1	37	45	7	58%	0.777
	%	0%	1%	41%	50%	8%		
Please rate the business' capacity utilization assisted by foreign direct investment	Count	0	1	30	47	12	65%	0.803
	%	0%	1%	33%	52%	13%		
	Total variance explained by latent factors=63.36%							

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

The findings for the SA example shows that the overall adoption of technology to support improved agriculture capacity utilisation is lower compared to other items. This shows that small scale agricultural processing firms may be underutilising or may not be optimally employing agricultural technology to support their agricultural activities (Gandure, Walker & Botha, 2013).

6.7.6 Market productivity-growth

Tables 6.9a and 6.9b provide the results of the preliminary analysis of the data derived from the responses to questionnaire items relating to market productivity (growth). Table 6.9a illustrates that most respondents reported "no change" on all the statements (Statement 1, *n* = 47, 44%; Statement 2, *n* = 52, 49%; Statement 3, *n* = 55, 52%) that related to market productivity. It is apparent from this table that very

few respondents from the Zimbabwean sample indicated that the market productivity (growth rate) of their businesses increased. On average, the total percentage of responses which indicated "increased 1-10%/increased by over 10%) ranged from 17% to 23%. This means that the majority of agri-business owner/managers either realised no change or realised a decline in market productivity. The reduction in market productivity of Zimbabwean agriculture could be attributed to the disruption of normal farming activity following the fast-track land reform programme, which is well documented (Sachikonye, 2003). The smart sanctions imposed by western trading blocs also aggravated the situation (Portela, 2016).

Table 6.9a: Status and level of market productivity-growth (Mashonaland Central Province, Zimbabwe)

Market productivity-growth (Zimbabwe)		Frequency Distribution						
		Decreased by over 10%	Decrease 1-10%	No change	Increased 1-10%	Increased by over 10 %	Total % increased	Factor (Principal component
Please rate the business' extent of growth/ decline in its share of the domestic market over the last five years	Count	8	27	47	24	0	23%	0.922
	%	8%	25%	44%	23%	0%		
Please rate the business' extent of growth/ decline in its share of the regional market over the last five years	Count	9	24	52	21	0	20%	0.939
	%	8%	23%	49%	20%	0%		
Please rate the business' extent of growth/ decline in its share of the international market over the last five years	Count	13	20	55	18	0	17%	0.917
	%	12%	19%	52%	17%	0%		
		Total variance explained by latent factors=85.72%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

The pattern of data derived from the South Africa sample is in stark contrast to the pattern from the Zimbabwean sample. For instance, Table 6.9b reveals that the modal response for each of the three statements relating to market productivity (growth) was "increased 1-10%" were high (Statement 1, *n* = 108, 67%; Statement 2, *n* = 114, 70% and Statement 3, *n* = 108, 67%). What is interesting in this data is that the total percentage of responses which indicated "Increased 1-10%/Increased by over 10 %" for each of the three statements ranged from 82% to 84% for South Africa. Compared to the Zimbabwean sample, the result demonstrates that the majority of respondents in the South African sample perceived their businesses to have experienced considerable growth in the past five years.

Table 6.9b: Status and level of market productivity-growth (Free State Province, South Africa)

Market productivity-growth (South Africa)		Frequency Distribution						
		Decreased by over 10%	Decrease 1-10%	No change	Increased 1-10%	Increased by over 10 %	%Total increased	Factor (Principal component
Please rate the business' extent of growth/ decline in its share of the domestic market over the last five years	Count	0	3	24	108	27	84%	0.783
	%	0%	2%	15%	67%	17%		
Please rate the business' extent of growth/ decline in its share of the regional market over the last five years	Count	0	3	22	114	23	84%	0.862
	%	0%	2%	14%	70%	14%		
Please rate the business' extent of growth/ decline in its share of the international market over the last five years	Count	0	3	27	108	24	82%	0.782
	%	0%	2%	17%	67%	15%		
		Total variance explained=65.56%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.7.7 Market productivity-reputation

Tables 6.10a and 6.10b show the results from the preliminary analysis of the responses on the status and level of market productivity (reputation) for the Zimbabwean and South African samples. With regard to Zimbabwe, Table 6.10a reveals that the modal response for the three items relating to market productivity was "moderate" (Statement 1, *n* = 49, 46%; Statement 2, *n* = 49, 46% and Statement 3, *n* = 56, 53%). Between 21% and 22% of the respondents indicated that the extent of reputation of their agro-processing products was at least high. In other words, the majority of respondents felt that the reputation of their firms were low.

Table 6.10b which relates to the South Africa sample, provides a comparatively different picture to the one of Zimbabwe. Firstly, the most frequent response to all the three questionnaire items relating to reputation for the SA sample was "high" (Statement 1, *n* = 104, 64%; Statement 2, *n* = 106, 65% and

Statement 3, *n* = 109, 67%). The predominantly positive belief in the reputation of South African small-scale agro-processing firms can be attributed to the perceived high quality of their products in both the domestic and international markets (Vellema & van Wijk, 2015).

Table 6.10a: Status and level of market productivity-reputation (Mashonaland Central Province, Zimbabwe)

Market productivity-reputation (Zimbabwe)		Frequency Distribution						
		Very low	Low	moderate	High	Very high	% Total high/very high	Factor (Principal component
Please indicate the extent of reputation of the business' agro-processing products in the domestic market	Count	9	25	49	23	0	22%	0.906
	%	8%	24%	46%	22%	0%		
Please indicate the extent of reputation of the business' agro-processing products in the regional market	Count	14	20	49	23	0	22%	0.958
	%	13%	19%	46%	22%	0%		
Please indicate the business' economies of scale as it relates to the international regional market of its products	Count	18	10	56	22	0	21%	0.921
	%	17%	9%	53%	21%	0%		
		Total variance explained by latent factor 86.18%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.10b: Status and level of market productivity-reputation (Free State Province, South Africa)

Market productivity-reputation (South Africa)		Frequency Distribution						
		Very low	Low	moderate	High	Very high	Total % high/very high	Factor (Principal component
Please indicate the extent of reputation of the business' agro-processing products in the domestic market	Count	0	1	35	104	22	78%	0.774
	%	0%	1%	22%	64%	14%		
Please indicate the extent of reputation of the business' agro-processing products in the regional market	Count	0	1	37	106	18	76%	0.869
	%	0%	1%	23%	65%	11%		
Please indicate the business' economies of scale as it relates the international regional market of its products	Count	0	1	31	109	21	80%	0.769
	%	0%	1%	19%	67%	13%		
		Total variance explained by latent factors 64.87%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

The findings confirm the prevalence of the non-financial productivity levels among South African small-scale agricultural firms compared to Zimbabwe's firms. This observation corroborates Cousins' (2013) and Aliber and Cousins' (2013) observation on the South African entities having access to better agriculture support programmes and superior agricultural technologies, which contribute to higher productivity. Yet the Zimbabwean small-scale businesses involved in agriculture-related activities have struggled to enhance their productivity post the year 2000 Fast-track Land Reform Programme (Cliffe, Alexander, Cousins & Gaidzanwa, 2014). This poor performance has perpetuated food insecurity in country to the extent of perennial dependence on food imports (Tawodzera, 2014; Moyo, Maharaj & Mambondiani, 2017).

6.8. The level of competitiveness and quality of products of agro-processing firms in Mashonaland and Free State region

To answer the research question "What is the level of competitiveness and quality of products of agro-processing firms in Mashonaland and Free State regions?" percentage analyses were performed on the

data solicited from respondents. The level of competitiveness was ascertained using Likert-scale statements which were grouped under the following constructs: general market competitiveness, market price competitiveness, market domination, customer satisfaction, promotion and organisational effectiveness. These sub-components are dealt with each in turn.

6.8.1. General market competitiveness

As shown in Table 6.11a, the most frequently observed category of the responses to the questionnaire items measuring general market competitiveness was "neutral" for the Zimbabwe sample (Item 1, *n* = 62, 58%; Item 2, *n* = 49, 46%; Item 3, *n* = 54, 51%; Item 4, *n* = 56, 53%; Item 5, *n* = 46, 43%). Essentially, the total percentage of respondents who indicated "agree/strongly agree" to the questionnaire items ranged between 16% and 39%. Based on the distribution of these responses, it can be concluded that status and level of general market competitiveness of Zimbabwean firms was relatively lower than the South African ones.

A close analysis of Table 6.11b shows that, save for item 1, the modal response to most of the items measuring general market competitiveness was "agree" for the South African sample (Item 2, *n* = 124, Item 3, *n* = 126, 78%; Item 4, *n* = 137, 85%; Item 5, *n* = 140, 86%). Except for item 1, the percentage total of respondents who "agreed/strongly agreed" to each of the questionnaire items was, on average, above 90%. Founded on these observations, it can be concluded that the state and level of general market competitiveness for the South African firms was comparatively high. This market competitiveness can be attributed to marketing efficiencies, multiple electronic marketing platforms, and social media platforms, which are highly developed in the South African context (Bernstein, 2013).

Table 6.11a: Status and level of general market competitiveness of Mashonaland Central agro-processing firms

General market competitiveness (Zimbabwe)		Frequency Distribution						
		Strongly Disagree	Disagree	indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The business has established strong agro-processing brands/services in the market compared to its competitors	Count	1	26	62	3	14	16%	0.885
	%	1%	25%	25%	3%	13%		
The business' agro-processing products/services have considerable competitive advantage over those of its competitors	Count	8	14	49	35	0	33%	0.920
	%	8%	13%	46%	33%	0%		
The business' agro-processing products or services are easily recognizable in the market compared to those of its competitors	Count	5	16	54	30	1	29%	0.907
	%	5%	15%	51%	28%	1%		
The business' agro-processing products/services enjoy higher sales in the market compared to those of competitors	Count	2	14	56	32	2	32%	0.312
	%	2%	13%	53%	30%	2%		
The agro-processed products or services have more dominance over those of the firm's competitors	Count	4	15	46	40	1	39%	0.864
	%	4%	14%	53%	38%	1%		
	Total variance explained by latent factors=65.919%							

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.11b: Status and level of general market competitiveness of Free State agro-processing firms

General market competitiveness (South Africa)		Frequency Distribution						
		Strongly Disagree	Disagree	indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The business has established strong agro-processing brands/services in the market compared to its competitors	Count	25	112	25	0	0	0%	0.748
	%	15%	69%	15%	0%	0%		
The business' agro-processing products/services have considerable competitive advantage those of its competitors	Count	0	1	14	124	23	91%	0.801
	%	0%	1%	9%	77%	14%		
The business' agro-processing products or services are easily recognizable in the market compared to those of its competitors	Count	0	1	9	127	25	94%	0.707
	%	0%	1%	6%	79%	15%		
The business' agro-processing products or services enjoy higher sales in the market compared to those of competitors	Count	0	2	7	137	16	95%	0.756
	%	0%	1%	4%	85%	10%		
The agro-processed products or services have more dominance over those of the firm's competitors	Count	0	3	4	140	15	95%	0.670
	%	0%	2%	2%	86%	9%		
		Total variance explained by latent factor=45.295%						

Note: Totals of percentages may not add up to 100 because of rounding off figures.

6.8.2 Customer satisfaction of agro-processing firms

In the current study, the customer satisfaction variable also formed part of the criteria used for assessing the status and level of competitiveness of agro-processing firms in Zimbabwe and South Africa. An

analysis of Tables 6.12a and 6.12b reveals a stark contrast between the results derived from the samples from the two participating countries. In the case of the Zimbabwean sample, the most frequent response to the five questionnaire items measuring customer satisfaction was "indifferent" (Item 2, *n* = 50, 47%; Item 3, *n* = 56, 53%; Item 4, *n* = 49, 46%; Item 5, *n* = 57, 54%). Apart from that, the percentage total of the responses which fall under the "Agree/ Strongly agree" categories ranged from 30% to 40% for all the five questionnaire items measuring customer satisfaction. This means that the majority of Zimbabwean respondents (agro-business owners) felt that their customers were either undecided or not satisfied with the level of service they received from local agro-businesses. This supports the findings of Makate, Siziba, Hanyani-Mlambo, Sadomba and Mango (2016) which suggest that small and medium enterprises in the agro-processing industry in Zimbabwe were modestly efficient, profitable and competitive owing to the moderate satisfaction enjoyed by their customers.

Table 6.12b illustrates the results from the South African sample. Unlike the Zimbabwean sample, results where the modal response was "indifferent", the most frequently observed response category for the five items category was "agree" (Item 1, *n* = 133, 82%; Item 2, *n* = 131, 81%; Item 3, *n* = 128, 79%; Item 4, *n* = 127, 78%; Item 5, *n* = 123, 76%). In addition, percentage totals of "agree or strongly agree" responses were above 80% for all the five items measuring customer satisfaction. The results suggest that the majority of South African agri-business owners who participated in this study believed that their customers were satisfied with the level of service they received. Since these are self-reports, it is difficult to establish whether these accounts were authentic reflections of these agro-processing business' customers experiences or they were just self-constructions of their beliefs (Kormos & Gifford, 2014).

Table 6.12a: Status and level of customers' satisfaction with Mashonaland Central agro-processing firms' products/services

Customer satisfaction (Zimbabwe)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The customers are satisfied with the business' agro-business brands/services compared to those of its competitors	Count	1	15	40	49	1	47%	0.871
	%	1%	14%	38%	46%	1%		
The business' agro-processing products /services are bought by customers ahead of those of competitors	Count	4	12	50	39	1	38%	0.910
	%	4%	11%	47%	37%	1%		
The business' agro-processing products/services are preferred by customers compared to those of competitors	Count	10	5	56	33	2	33%	0.933
	%	9%	5%	53%	31%	2%		
The price of the business' agro-processing products /services are preferred by customers compared to those of its competitors	Count	8	6	49	41	2	41%	0.886
	%	8%	6%	46%	39%	2%		
The business has strong relationship with its customers base compared to its competitors	Count	4	13	57	31	1	30%	0.851
	%	4%	12%	54%	29%	1%		
		Total variance explained by latent factors=79.356%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.12b: Status and level of customers' satisfaction with Free State agro-processing firms' products/ services

Customer satisfaction (South Africa)		Frequency Distribution						
		Strongly Disagree	Disagree	Don't know	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The customers are satisfied with the business' agro-business brands/services compared to those of its competitors	Count	0	1	6	133	22	96%	0.597%
	%	0%	1%	4%	82%	14%		
The business' agro-processing products /services are bought by customers ahead of those of competitors	Count	1	0	8	131	1	82%	0.715
	%	1%	0%	5%	81%	1%		
The business' agro-processing products/services are preferred by customers compared to those of competitors	Count	1	2	11	128	19	91%	0.825
	%	1%	1%	7%	79%	12%		
The price of the business' agro-processing products /services are preferred by customers compared to those of its competitors	Count	1	0	14	127	20	91%	0.416
	%	1%	0%	9%	78%	13%		
The business has strong relationship with its customers base compared to its competitors	Count	0	2	12	123	24	91%	0.713
	%	0%	1%	7%	76%	15%		
		Total variance explained by latent factors 44.588%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.8.3. Market price competitiveness

Market price competitiveness was used to measure the level of competitiveness of the products and services offered by agro-processing firms in Zimbabwe and South Africa. The results presented in Table 6.13a suggest that the Zimbabwean respondents believed that the market price competitiveness of their products and services was low. This is evidenced by the low percentage total (19% and 30%) of respondents who indicated "agree" of "strongly agree" to the two questionnaire items which sought to

ascertain the level of market competitiveness. In fact, for both items, "neutral" was the modal response (*n* = 57, 54% and *n* = 72, 68% respectively).

In contrast, the results presented in Table 6.13b (South Africa sample) depict a different narrative. For instance, the percentage total of respondents who indicated either "Agree" or strongly agree" in response to the questionnaire items measuring market price competitiveness was comparatively high (90% and 80% respectively). In fact, the modal response for both questionnaire items was "Agree" (*n* = 121, 75% and *n* = 114, 70% respectively). The results from Table 6.13b, therefore, suggest a comparatively high level of market price competitiveness for South African agro-firms. This could probably be an outcome of knowledge of appropriate pricing of commodities, the role of Competition Commission of South Africa, which regulates and prevents collusion and irregular activities among businesses operating in the same industry (Nesamvuni, Tshikolomo, Mpandeli & Makhuvha, 2017).

Table 6.13a: Status and level of market price competitiveness of Mashonaland Central agro-processing firms

Market price competitiveness (Zimbabwe)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
My business in agro-processing has developed competitive pricing models	Count	1	16	57	31	1	30%	0.856
	%	1%	15%	54%	29%	1%		
The agro business has favourable pricing compared with other businesses	Count	2	12	72	20	0	19%	0.856
	%	2%	11%	68%	19%	0%		
		Total variance explained by latent factors=73.34%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.13b: Status and level of market price competitiveness of Free State agro-processing firms

Market price competitiveness (South Africa)		Frequency Distribution						
		Strongly Disagree	Disagree	Don't know	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
My business in agro-processing has developed competitive pricing models	Count	0	0	17	121	24	90%	0.874
	%	0%	0%	10%	75%	15%		
The agro business has favourable pricing compared with other businesses	Count	0	1	30	114	17	80%	0.874
	%	0%	1%	19%	70%	10%		
		Total variance explained by latent factors 76.34%						

Note: Totals of percentages may not add up to 100 because of rounding off figures.

6.8.4 Market domination

Another factor used to assess the level of competitiveness of selected Zimbabwean and South African agro-businesses in the current study was the level of market domination. Table 6.14a provides the results from the preliminary analysis of the Zimbabwean sample data. An examination of the results reveals that the most frequent response was “moderate” (Item 1, *n* = 69, 65%; Item 2, *n* = 53, 50%; Item 3, *n* = 55, 52%; Item 4, *n* = 47, 44%; Item 5, *n* = 44, 42%). In addition, the percentage total of respondents who believed the market domination of their business to be “high” or “very high” ranged from 10% to 41%. This suggests a low perception of market domination agro-processing firms in this country.

On the other hand, Table 6.14b (South Africa) depicts a different picture to the one presented in Table 6.14a. The modal response category for questionnaire items measuring market domination was “high” (Item 1, *n* = 99, 61%; Item 2, *n* = 95, 59%; Item 3, *n* = 95, 59%; Item 4, *n* = 102, 63%; Item 5, *n* = 105, 65%). Apart from that, the percentage totals of responses “high” or “very high” ranged from 67% to 72% and so indicates a relatively high perception of market domination among the South African respondents.

Table 6.14a: Status and level of market domination of Mashonaland Central agro-processing firms

Market domination (Zimbabwe)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	%high/very high	Factor (Principal component
Please state the business' level of dominance of the domestic market over competitors	Count	6	20	69	11	0	10%	0.729
	%	6%	19%	65%	10%	0%		
Please state the business' level of dominance of its research and development (R&D) locally	Count	5	28	53	20	0	19%	0.809
	%	5%	26%	50%	19%	0%		
Please state the business' level of dominance of its research and development (R&D) internationally	Count	5	26	55	20	0	19%	0.838
	%	5%	25%	52%	19%	0%		
Please state the business' level of dominance of production of agro products and services	Count	6	25	47	28	0	26%	0.851
	%	6%	24%	44%	26%	0%		
Please state the marketing skills dominance of the business' employees	Count	3	16	44	43	0	41%	0.819
	%	3%	15%	42%	41%	0%		
	Total variance explained by latent factors=65.635%							

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.14b: Status and level of market domination of Free State agro-processing firms

Market domination (South Africa)		Frequency Distribution						
		Very low	Low	Moderate	High	Very high	%Total high/very high	Factor (Principal component
Please state the business' level of dominance of the domestic market over competitors	Count	0	6	38	99	18	72%	0.708
	%	0%	4%	23%	61%	11%		
Please state the business' level of dominance of its research and development (R&D) locally	Count	0	4	50	95	13	67%	0.835
	%	0%	2%	31%	59%	8%		
Please state the business' level of dominance of its research and development (R&D) internationally	Count	0	0	51	95	16	69%	0.810
	%	0%	0%	31%	59%	10%		
Please state the business' level of production dominance of agro products and services	Count	0	1	44	102	15	72%	0.783
	%	0%	1%	27%	63%	9%		
Please state the marketing skills dominance of the business' employees	Count	0	1	38	105	18	76%	0.675
	%	0%	1%	23%	65%	11%		
	Total variance explained by latent factors=58.45%							

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.8.5. Product quality

An examination of Table 6.15a shows that the majority of Zimbabwean respondents believed their products to be of a high quality. The percentage total of responses which indicated "agree" or "strongly agree" to the four Likert scale items measuring product quality ranged from 57% to 66%. In addition, "agree" was the modal response to all the four items. However, the perception of product quality was comparatively higher among South African respondents. Table 6.15b illustrates that the percentage totals for "agree" or "strongly agree" ranged from 89% to 92%, suggesting a stronger perception of product quality among the South African respondents. This finding is surprising for the Zimbabwean sample, in view of all responses to variables which were either neutral or negative. This suggests that despite the harsh economic climate, agro-processing firms in the country still strive to meet international standards of quality production. Perhaps the role of the Standards Association of Zimbabwe in maintaining global standards of quality to improve competitiveness contribute to this pre-occupation with quality maintenance (Macheka, Manditsera, Ngadze, Mubaiwa & Nyanga, 2013).

Table 6.15a: Level of quality of Mashonaland Central agro-processing firms' products/services

Product quality (Zimbabwe)		Frequency Distribution						
		Strongly Disagree	Disagree	Don't know	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The business develops / produces high quality agro product/services	Count	0	0	36	69	1	66%	0.662
	%	0%	0%	34%	65%	1%		
The business has ISO certification of products to meet local quality	Count	0	8	28	69	1	66%	0.878
	%	0%	8%	26%	65%	1%		
The business' products or services meet the international quality standards set by global institutions	Count	0	11	30	65	0	61%	0.803
	%	0%	10%	28%	61%	0%		
The business is involved in continuous agro product development and improvement	Count	1	4	41	60	0	57%	0.568
	%	1%	4%	39%	57%	0%		
		Total variance explained by latent factors=54.428%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

The comparatively lower agreement for the Zimbabwean sample suggests that even though these firms strive to attain high quality production standards, perhaps the lack of resources, lack of government technical and financial support and international drift of highly experienced agricultural personnel (especially to South Africa, New Zealand, Canada and Australia) could be contributing to the lowering of standards (Edgar & Lucas, 2016) compared to those of international players. This can be contrasted to the South African experience where resources are comparatively higher, government technical and financial support is mostly guaranteed for established agro-processing firms (Masutha & Rogerson, 2014).

Table 6.15b: Level of quality of Free State agro-processing firms' products/services

Product quality (South Africa)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The business develops / produces high quality agro product/services	Count	0	0	28	116	18	89%	0.712
	%	0%	0%	17%	72%	17%		
The business has ISO certification of products to meet local quality	Count	0	1	15	124	22	91%	0772
	%	0%	1%	9%	77%	14%		
The business' products or services meet the international quality standards set by global institutions	Count	1	0	8	138	15	94%	0.766
	%	1%	0%	5%	85%	9%		
The business is involved in continuous agro product development and improvement	Count	1	0	12	124	25	92%	0.731
	%	1%	0%	7%	77%	15%		
		Total variance explained by latent factor= 55.59%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

The level of agro-business product quality for South Africa agri-businesses has been ranked higher and this can be attributed to the level of investment in research and development, agro-processing firms' partnership with international institutions with higher innovation capabilities, higher levels of technology transfer by the government and tertiary institutions, which contribute to the production of high quality products. Kang, Khan and Ma (2009) argues that increasing the quality and quantity of agricultural yields depends on the fertility of the area cultivated, the use of better seeds and investment in new technologies, which reduce the risk of food insecurity in agro-business areas, and improves the competitiveness of agriculture commodities.

6.8.6. Promotion

Tables 6.16a and 6.16b present the results of the percentage analysis of data relating to the respondents' perception of the effectiveness of promotion activities among agro-business owners in Zimbabwe and South Africa. A closer examination of the results shows that "agree" was the modal response to the measurement scales related to effectiveness of promotional activities for both samples. However, the

perception was stronger among South African respondents as shown by the relatively high percentage totals (above 80%) for "agree/strongly agree". The percentages for the Zimbabwean sample ranged between 58% and 61%. An inference from the preceding findings is that promotional activities were more effective for South African agro-businesses compared to the Zimbabwean ones. Perhaps the more diversified broadcasting architecture (comprising several independent and national broadcasting channels), the flourishing of social media platforms, the resources to promote the marketing of products and services in South Africa compared to Zimbabwe where there is one, state-controlled broadcasting station that has limited reach to rural areas, explain these variations.

Table 6.16a: Status of promotional activities of Mashonaland Central agro-processing firms

Promotion (Zimbabwe)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The business' product promotion has helped it to be dominant on the market	Count	0	10	35	61	0	58%	0.766
	%	0%	9%	33%	58%	0%		
The business emphasises effective and unique agro product/service promotion techniques	Count	0	7	34	65	0	61%	0.766
	%	0%	7%	32%	61%	0%		
		Total variance explained by latent factors= 58.63%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.16b: Status of promotional activities of Free State agro-processing firms

Promotion (South Africa)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The business' product promotion has helped it to be dominant on the market	Count	0	1	13	133	15	91%	0.875
	%	0%	1%	8%	82%	9%		
The business emphasises effective and unique agro product/service promotion techniques	Count	0	1	28	115	18	82%	0.875
	%	0%	1%	17%	71%	11%		
		Total variance explained by latent factors=76.486%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

6.8.7. Organisational competitiveness

Organisational competitiveness was the last construct used to assess overall competitiveness of Zimbabwean and South African agro-businesses. Table 6.17a and 6.17b show that the perception of organisational competitiveness was comparatively stronger for South Africa respondents than for the Zimbabwean sample. This is shown by the higher total percentages of responses falling under the "agree" and "strongly agree" categories. The figures for South Africa are 71% and 76% while those for the Zimbabwean sample are comparatively lower at 44% and 54%. These results suggests the international competitiveness of South African goods, which could be attributed to among other considerations: the higher value added nature of goods, international cooperation arrangements e.g. through BRICS, bi-lateral arrangements with the EU, Comesa in addition to SADC, most of which Zimbabwe agri-processing products/services does not have. Another factor in favour of South Africa is the bulk production of goods which allows the country to negotiate on almost equal terms with larger trading blocs like EU.

Table 6.17a: Level of organisational competitiveness of Mashonaland Central agro-processing firms

Organisational competitiveness (Zimbabwe)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The organisation has invested in production capacity enhancement	Count	0	6	53	45	2	44%	0.871
	%	0%	6%	50%	42%	2%		
The agro business has developed competitive ,efficient and effective agro organisational structure	Count	0	4	45	56	1	54%	0.871
	%	0%	4%	42%	53%	1%		
		Total variance explained by latent factors =75.80%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Table 6.17b: Level of Organisational effectiveness of Free State agro-processing firms

Organisational competitiveness (South Africa)		Frequency Distribution						
		Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree	% Agree/ Strongly Agree	Factor (Principal component
The organisation has invested in production capacity enhancement	Count	0	2	37	111	12	76%	0.864
	%	0%	1%	23%	69%	7%		
The agro business has developed competitive, efficient and effective agro organisational structure	Count	0	2	45	99	16	71%	0.864
	%	0%	1%	28%	61%	10%		
		Total variance explained by latent factors=74.728%						

Note: Totals of percentages may not add up to 100 because of rounding off of figures.

Consistent with findings on research question 1, the results presented in this section confirm the dominance of South African small-scale agro-processing firms over Zimbabwean ones as shown by the various indicators of agricultural competitiveness. The findings also confirmed a positive link between agricultural competitiveness and productivity, which has long been established by numerous scholars (Latruffe, 2010; Mullen & Keogh, 2013; Bahta & Malope, 2014; Posadas-Dominguez, Arriaga-Jordan &

Martinez-Castaneda, 2014; Capalbo & Antle, 2015). The findings also lend support to the frequently cited technological sophistication of South Africa's agriculture sector which is arguably among the most innovative and capital-intensive on the African continent (Francis, Mytalka, Huis, & Röling, 2016; Hart, Jacobs, Ramoroka, Mhula-Links & Letty, 2016; Senyolo, Long, Blok & Omta, 2017). The present finding also support Chawarika, Chamboko and Mutambara's (2017) study, which concluded that certain areas of crop farming in the Zimbabwean sector were not productive and competitive because of high operational costs associated with such activities.

6.9. The relationship among technology transfer, financial and non-financial productivity of agribusinesses in Mashonaland Central Province (Zimbabwe) and Free State Province (South Africa)

Because the data collected for the current study did not conform to the requirements of parametric techniques, a Spearman correlation analysis (a non-parametric technique) was conducted among technology transfer, financial and non-financial productivity. Cohen's standard was used to evaluate the strength of the relationships, where correlation coefficients between 0.10 and 0.29 represent a small effect size, coefficients between 0.30 and 0.49 represent a moderate effect size, and coefficients above 0.50 indicate a large effect size (Cohen, 1988). A Spearman correlation requires that the relationship between each pair of variables does not change direction (Conover & Iman, 1981). This assumption is violated if the points on the scatterplot between any pair of variables appear to shift from a positive to negative or negative to positive relationship. This assumption was complied with in this study. Table 6.18 presents the correlation matrix of the relationship among technology transfer, financial and non-financial productivity.

For the Zimbabwean sample, there was a significant positive correlation between financial productivity and non-financial productivity (r_s = 0.771, p < 0.001). The correlation coefficient between financial productivity and non-financial productivity was 0.771 indicating a large effect size. This indicates that as financial productivity increases, non-financial productivity tends to increase. This means that as financial growth improves for small-scale agro-businesses, there could be excess revenue available for the pursuit of non-financial activities.

There was also a significant positive correlation between financial productivity and technology transfer (r_s = 0.339, p < 0.001). This indicated a moderate effect size. Thus, as financial productivity increased, technology transfer also tends to increase. This means that the small firms' capacity to acquire and

transfer technology improves as the firm's financial position becomes healthier, even though the size of the impact is moderate.

Table 6.18: Correlation among technology transfer, financial and non-financial productivity

Country of origin			Financial productivity	Non-financial productivity	Technology Transfer
Zimbabwe	Financial productivity	Correlation Coefficient	1.000	0.771**	0.339**
		Sig. (2-tailed)	.	0.000	0.000
	Non-financial productivity	Correlation Coefficient	0.771**	1.000	0.402**
		Sig. (2-tailed)	0.000	.	0.000
	Technology Transfer	Correlation Coefficient	0.339**	0.402**	1.000
		Sig. (2-tailed)	0.000	0.000	.
South Africa	Financial productivity	Correlation Coefficient	1.000	0.670**	0.493**
		Sig. (2-tailed)	.	0.000	0.000
	Non-financial productivity	Correlation Coefficient	0.670**	1.000	0.516**
		Sig. (2-tailed)	0.000	.	0.000
	Technology Transfer	Correlation Coefficient	0.493**	0.516**	1.000
		Sig. (2-tailed)	0.000	0.000	.

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

Apart from that, there was a positive correlation coefficient between non-financial productivity and technology transfer (r_s=0.402, p < 0.000). The correlation coefficient indicates a moderate effect size. This indicates that as non-financial productivity increases, technology transfer also increases. This means that the more small firms engage in non-financial activities, so does their capacity to engage in technology transfer.

For the South African sample, there was a significant positive correlation between financial productivity and non-financial productivity (r_s= 0.670, p < 0.000). The correlation coefficient between financial productivity and non-financial productivity of 0.670 indicates a large effect size. This shows that as financial productivity increases, non-financial productivity also tends to increase. There was also a significant positive correlation between financial productivity and technology transfer (r_s = 0.493, p < 0.001). The correlation coefficient between financial productivity and technology transfer was 0.493,

indicating a moderate effect size. This reveals that as financial productivity increases, the capacity of the agro-processing firms to transfer technology also increases. Separately, there was a positive correlation coefficient between non-financial productivity and technology transfer (r_s=0.516, $p < 0.000$). The positive correlation coefficient (0.516) indicates a large effect size. This indicates that as non-financial productivity increases, technology transfer also increases. The result corresponds with earlier literature (Awang et al., 2016; Fuglie, 2016; Xu, Li, Qi, Tang & Mukwereza, 2016; Zhan, Tian, Zhang, Yang, Qu, & Tan 2017) which proposes a strong connection between technology transfer in the agriculture sector, and the status and level of productivity including non-financial productivity. The striking observation that emerges from the data comparison was the similar pattern of outcomes from the Zimbabwean and South Africa samples given the already observed disparities between the two countries in terms of innovation, technology transfer and agricultural productivity.

6.10. Impact of technology transfer and innovation on the productivity of small scale agro-processing firms in the two regions

Multiple regression analysis was performed in order to ascertain which factor, between technology transfer or innovation, had the greatest predictive effect on financial productivity and non-financial-productivity. Multiple regression analysis is a statistical technique which strives to ascertain if a prognostic connection exists between a single dependent variable and more than one independent variable Sreejesh, Mohapatra & Anusree (2014). Among other things, the technique assumes a linear relationship between the independent(s) and the dependent variables, as well as no multi-collinearity or perfect correlation between predictor variables.

Prior to conducting the multiple regression analysis, a correlation analysis of the variables involved was performed to check the nature of the linkage among the variables. As was seen in Table 18, they were significant and positive correlations among all the variables, thus meeting all the pre-conditions for regression analysis. Also, multi-collinearity between the predictors was assessed using variance inflation factors (VIF). High VIFs i.e. above 10 are unacceptable since they indicate increased effects of multi-collinearity in the model. All the predictors in the proposed regression model had variance inflation factors (VIF) which are less than 2, implying a lack of multicollinearity and satisfying the conditions for multiple regression analysis.

To understand the impacts of technology and innovation on productivity, multiple regression analysis was performed in order to ascertain which factor, between technology transfer and innovation, had the greatest predictive effect on productivity.

Table 6.19: Relationship among financial productivity, non-financial productivity, technology transfer and innovation

Country of origin			Financial productivity	Non-financial productivity	Technology transfer	Innovation
Zimbabwe	Financial productivity	Correlation Coefficient	1.000	0.771**	0.339**	0.219*
		Sig. (2-tailed)	.	0.000	0.000	0.028
	Non-financial productivity	Correlation Coefficient	0.771**	1.000	0.402**	0.396**
		Sig. (2-tailed)	0.000	.	0.000	0.000
	Technology transfer	Correlation Coefficient	0.339**	0.402**	1.000	0.510**
		Sig. (2-tailed)	0.000	0.000	.	0.000
	Innovation	Correlation Coefficient	0.219*	0.396**	0.510**	1.000
		Sig. (2-tailed)	0.028	0.000	0.000	.
South Africa	Financial productivity	Correlation Coefficient	1.000	0.670**	0.493**	0.473**
		Sig. (2-tailed)	.	0.000	0.000	0.000
	Non-financial productivity	Correlation Coefficient	0.670**	1.000	0.516**	0.540**
		Sig. (2-tailed)	0.000	.	0.000	0.000
	Technology transfer	Correlation Coefficient	0.493**	0.516**	1.000	0.644**
		Sig. (2-tailed)	0.000	0.000	.	0.000
	Innovation	Correlation Coefficient	0.473**	0.540**	0.644**	1.000
		Sig. (2-tailed)	0.000	0.000	0.000	.

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

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

The Zimbabwean sample regression results testing the influence of technology transfer and innovation on financial productivity shows that the two predictor variables have no statistically significant influence respectively (Coefficient=0.065, t=1.235, *p*-value=0.220 and Coefficient=-0.19, t=-0.137, *p*-value=0.892) on the dependent variable (financial productivity) (See Table 6.20a). This relationship is fascinating as financial productivity increases while innovation declines. This could imply as the firm realises increased

financial productivity, the relentless pursuit for financial growth may cause the firm to ignore its innovative thrust.

Table 6.20a: Regression analysis results of innovation and technology transfer predicting financial productivity (Zimbabwe)

Dependent Variable: financial productivity	Parameter estimates		t-tests	
	Coefficient	Std. Error	T	p-value
Technology transfer	0.065	0.053	1.235	0.220
Innovation	-0.19	0.138	-0.137	0.892
R	R-Square			
0.138	0.019			

For the South African sample, the regression analysis results show that technology transfer and innovation collectively influence 48.7% (R^2= 0.237) of the variance in financial productivity. However, a closer look at the regression analysis results reveals that only technology transfer had the greater and statistically significant influence (coefficient=0.416, t=5.068, p < 0.000) on financial productivity. Innovation had a non-significant effect as indicated by the p-value of 0.159. The results of the regression test are presented in Table 6.20b.

Table 6.20b: Regression analysis results of innovation and technology transfer predicting financial productivity (South Africa)

Dependent Variable: financial productivity		Parameter estimates		t-tests	
		Coefficient	Std. Error	T	p-value
Technology transfer		0.416	0.030	5.068	0.000
Innovation		0.116	0.35	1.414	0.159
R		R-Square			
0.487		0.237			

While the insignificance of innovation as a predictor of financial productivity is surprising given its strong correlation with technology transfer, the outcome of this test confirms findings by some authors that technology transfer models are the major way through which agricultural development and productivity occurs in most developing countries including African countries (Stone, 2011; Capalbo & Antle, 2015; Juma, 2015).

The regression analysis results for the Zimbabwean sample in Table 6.21a highlights that technology transfer and innovation collectively explained 9% (R^2=0.099) of the variance in non-financial productivity. An examination of the contribution of each of the two predictor variables shows that only technology transfer had a statistically significant (coefficient=0.228, t=2.010, p=0.047) effect on the dependent variable. The coefficient 0.228 means that every unit change in technology transfer results in a 0.228 unit change in non-financial productivity. The effect of Innovation on non-financial productivity was non-significant (p=0.265) for the Zimbabwean sample.

Table 6.21a: Regression analysis results of innovation and technology transfer predicting non-financial productivity (Zimbabwe)

Dependent Variable: non-financial productivity	Parameter estimates		t-tests	
	Coefficient	Std. Error	T	p-value
Technology transfer	0.228	0.107	2.010	0.047
Innovation	0.127	0.280	1.122	0.265
R	R-Square			
0.315	0.099			

The regression analysis results for the South African sample in Table 6.21b reveal that technology transfer and innovation jointly explained 37.7% (R^2=0.377) of the variance in non-financial productivity. An examination of the contribution of each of the two predictor variables shows that technology transfer had a greater and statistically significant (coefficient=0.528, t=7.123, p=0.000) effect on the dependent variable (non-financial productivity). The coefficient 0.528 means that every unit change in technology transfer results in a 0.528 unit change in non-financial productivity. Although innovation had a statistically significant effect (p=0.049), the coefficient (0.141) suggest a lesser effect on non-financial productivity than technology transfer.

Table 6.21b: Regression analysis results of innovation and technology transfer predicting non-financial productivity (South Africa)

Dependent Variable: Non-financial productivity	Parameter estimates		t-tests	
	Coefficient	Std. Error	T	p-value
Innovation	0.141	0.083	1.900	0.049
Technology transfer	0.528	0.070	7.123	0.000
R	R-Square			
0.614	0.377			

The significance of both innovation and technology transfer as positive predictors of non-financial agricultural productivity corroborates the findings by other scholars that small-holder farmers in South Africa have in the past exhibited a readiness to adopt new technologies like conservation agriculture, rainwater harvesting and seed varieties that are drought tolerant and early maturing (Gouse, Sengupta, Zambrano & Zepeda, 2016; Senyolo et al., 2017), which contribute to increased financial and non-financial productivity. Hence, this explains the ready connection between technology transfer and non-financial agricultural productivity in South Africa. The comparatively lower impact of innovation on non-financial productivity can be explained by the low innovation capabilities of most agricultural firms in the country due to the prevalence of the innovation chasm in the country (see the National Innovation Plan, 2009; National Development Plan (NDP) 2030).

The regression analysis results, for the Zimbabwe sample, shown in Table 6.22a reveal that technology transfer and innovation jointly explained 21% (R^2=0.210) of the variance in competitiveness. An examination of the contribution of each of the two predictor variables shows that only innovation had a statistically significant (coefficient=0.427, t=4.025, p=0.000) effect on the dependent variable (Competitiveness). The coefficient 0.427 means that every unit change in innovation results in a 0.427 unit change in competitiveness. Technology transfer had a statistically non-significant effect (p=0.607) on competitiveness. The non-significance of technology transfer as a predictor of agricultural competitiveness is surprising given the close positive correlation between the two variables. However, the significant predictive effect of innovation on agricultural competitiveness corroborates previous studies which also proclaim a predictive correlation between agricultural innovation and productivity (Cavallo, Ferrari, Bollani, & Coccia, 2014; Cavallo, Ferrari & Coccia, 2015; Schut, Rodenburg, Klerkx, Kayeke, van Ast, & Bastiaans, 2015).

Table 6.22a: Regression analysis results of innovation and technology transfer predicting competitiveness (Zimbabwe)

Dependent Variable: Competitiveness	Parameter estimates		t-tests	
	Coefficient	Std. Error	T	p-value
Innovation	0.427	0.092	4.025	0.000
Technology transfer	0.055	0.240	0.517	0.607
R=0.459	R-squared=0.210			

The regression analysis results for the South African sample in Table 6.22b highlight that technology transfer and innovation jointly explained 33.8% (R^2=0.338) of the variance in competitiveness. An examination of the contribution of each of the two predictor variables shows that technology transfer had a greater and statistically significant (coefficient=0.475, t=6.270, p=0.023) effect on the dependent variable (Competitiveness). The coefficient 0.475 means that every unit change in technology transfer results in a 0.475 unit change in competitiveness. Although innovation has a statistically significant effect (p=0.000), the coefficient (0.174) suggest a lesser effect than technology transfer. The findings from the South African context collaborate the findings of Kafetzopoulos, Gotzamani and Gkana (2015) and Dunning (2013) which vouch for a tight link between the transfer of agricultural technology and the development of innovations, which increases agricultural competitiveness.

Table 6.22b: Regression analysis results of innovation and technology transfer predicting competitiveness (South Africa)

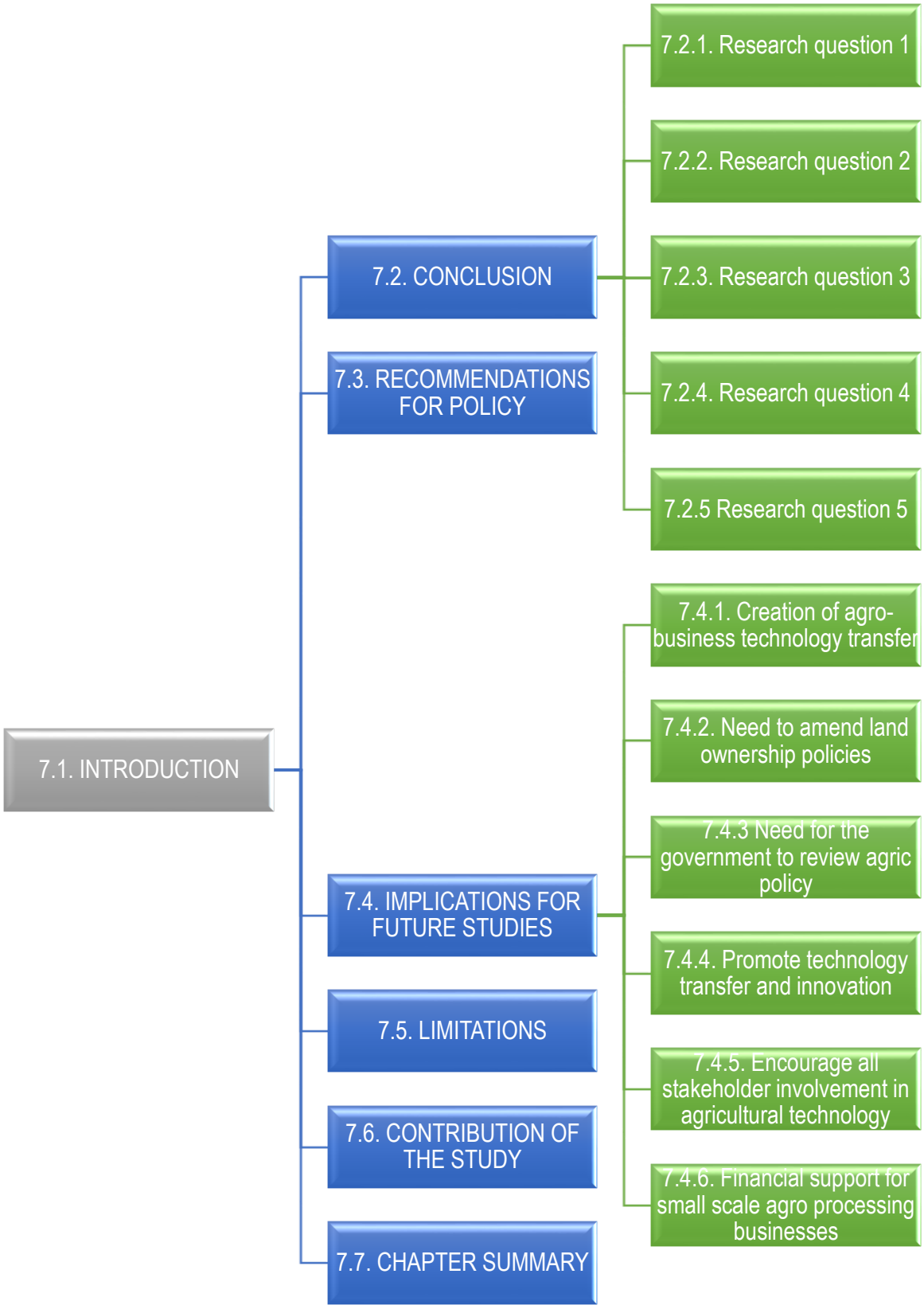
Dependent Variable: Competitiveness	Parameter estimates		t-tests	
	Coefficient	Std. Error	T	p-value
Innovation	0.174	0.080	2.299	0.000
Technology transfer	0.475	0.069	6.270	0.023
R	R-Square			
0.582	0.338			

6.11. Chapter summary

This chapter presented the findings and discussions of the current study. The demographic characteristics of respondents, the statuses of technology transfer and innovation and their effects on financial and non-financial productivity of agro business firms were addressed. In addition, the collective

impact of technology transfer and innovation on the agricultural productivity and competitiveness of agro business firms in Zimbabwe and South Africa was evaluated. The next chapter presents conclusions and recommendations based on these findings.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS



7.1. Introduction

The previous chapter presented findings and discussion of this empirical study, including the various relationships among technology transfer, financial and non-financial productivity, as well as the relationship among financial productivity, non-financial productivity, technology transfer and innovation. Adhering to such a procedure accorded the researcher the opportunity to critique the findings, linking them to extant literature. This created a strong and context-relevant background for a theoretical contribution towards the existing body of knowledge on the subject. This chapter presents the conclusion and recommendations of the study founded on responses to the research objectives and questions. The research questions presented in Chapter 1 were tested in order to draw conclusions and make recommendations.

7.2. Conclusion

The results from the Mashonaland Central province (Zimbabwe) and Free State province (South Africa) samples are linked to the research questions and respective conclusions made.

7.2.1. Research question 1

What is the status and level of productivity of agro-processing firms operating in Mashonaland Central Province (Zimbabwe) and Free State Province (South Africa) regions?

Percentage analyses were performed to address this research question. This procedure was carried out on data relating to the following indicators of the status and level of agricultural productivity: financial productivity, non-financial productivity, output productivity, output per hectare, capacity utilisation per hectare, market productivity (growth) and market productivity (reputation).

The average percentage scores for the Zimbabwean and South African respondents who perceived the financial productivity of their respective firms to have increased were 25.9% and 90.4% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample perceived higher financial productivity in their firms compared to those from the South African sample. Thus, it can be concluded from these results that South African small-scale agro-processing firms experienced higher financial productivity than the Zimbabwean ones.

Furthermore, the average percentage scores for the Zimbabwean and South African respondents who perceived the non-financial productivity of their respective firms to have increased were 29% and 86% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample reported growth in non-financial productivity in their respective firms compared to those from the

South African sample. Thus, it can be concluded from these results that South African small-scale agro-processing firms experienced higher non-financial productivity than the Zimbabwean ones.

Apart from that, the average percentage scores for the Zimbabwean and South African respondents who perceived the output productivity of their respective firms to have increased were 24% and 70% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample perceived increased output productivity in their respective firms compared to those from the South African sample. Thus, it can be concluded that South African small-scale agro-processing firms yielded higher output productivity than the Zimbabwean ones.

In addition, the average percentage scores for the Zimbabwean and South African respondents who perceived the output per hectare of their respective firms to have increased were 29.6% and 57.8% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample perceived growth in output per hectare in their respective firms compared to those from the South African sample. Thus, it can be concluded that South African small-scale agro-processing firms yielded higher output per hectare than the Zimbabwean ones.

Also, the average percentage scores for the Zimbabwean and South African respondents who perceived the capacity utilisation of their respective firms to have increased were 27% and 57% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample reported some improvements in capacity utilisation of their respective firms compared to those from the South African sample. Thus, it can be concluded that South African small-scale agro-processing firms experienced higher capacity utilisation than the Zimbabwean ones.

The average percentage scores for the Zimbabwean and South African respondents who perceived the market productivity (growth) of their respective firms to have increased were 20% and 83% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample reported increased market productivity (growth) in their respective firms compared to those from the South African sample. Thus, it can be concluded that South African small-scale agro-processing firms experienced higher market productivity (growth) than the Zimbabwean ones.

Lastly, the average percentage scores for the Zimbabwean and South African respondents who perceived the market productivity (reputation) of their respective firms to have increased were 20% and 83% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean

sample reported increased market productivity (reputation) in their respective firms compared to those from the South African sample. Thus, it can be concluded from these results that South African small-scale agro-processing firms experienced higher market productivity (reputation) than the Zimbabwean ones.

Based on the preceding, it can be concluded that the overall status and level of productivity of South African small-scale agro-processing firms was comparatively higher than those of Zimbabwean ones.

7.2.2. Research question 2

What is the level of competitiveness and quality of products of agro-processing firms in Mashonaland Central province (Zimbabwe) and Free State province (South Africa)?

To answer this research question, percentage analyses were carried out on the gathered data relating to the following indicators of the level of competitiveness and quality of products of agro-processing firms: general market competitiveness, customer satisfaction, market price competitiveness, market domination, product quality, product promotion and organisational capabilities.

Firstly, the average percentage scores for the Zimbabwean and South African respondents who expressed agreement to the questionnaire items relating to the general market competitiveness of their firms were 29.8% and 75% respectively. These percentage scores revealed that fewer respondents in the Zimbabwean sample reported the general market competitiveness of their respective firms compared to those from the South African sample. Hence, it is inferred from these results that South African small-scale agro-processing firms had higher general market competitiveness than their Zimbabwean counterparts.

Secondly, a greater average percentage of South African than Zimbabwean respondents expressed the sentiment that customers were satisfied with the level of customer service that they received from small agro-processing firms. On average, 90.2% of the South African compared to 37.8% Zimbabwean respondents believed that their customers were satisfied with the service received from small scale agro-processing firms. Therefore, the conclusion is that South African small scale agro-processing firms offered a perceived better level of customer satisfaction than Zimbabwean firms.

Thirdly, the average percentage scores for the Zimbabwean and South African respondents who expressed agreement to the questionnaire items relating to the market price competitiveness of their

respective organisations were 24.5% and 85% respectively. These percentage scores show that fewer respondents in the Zimbabwean sample reported market price competitiveness of their agro-processing products or services compared to those from the South African sample. Therefore, it is observed from these outcomes that agro-processing products and services of South African small-scale agro-processing firms had comparatively superior market price competitiveness than those of Zimbabwean firms.

Fourthly, more South African respondents reported their organisations to be dominant in the market compared to Zimbabwean respondents. On average, 71.2% of the South Africans owner/managers believed their firms were dominant in the market, compared to 23% of Zimbabwean respondents who reported the same. Therefore, the conclusion is that South African small-scale, agro-processing firms were dominant in their respective markets compared to Zimbabwean firms.

Fifth, the analysis of the data on the respondents' perceptions of product quality revealed marked variations between the South African and Zimbabwean samples. An average of 62% of Zimbabwe respondents believed that the overall quality of products offered by their respective firms to be high. This can be contrasted with 91.5% of the South African respondents who believed the same. As a result, it is concluded that the quality of agricultural products produced by South African small-scale agro-processing firms were perceivably of higher quality compared to those produced by Zimbabwean firms of comparable size.

Sixth, the average percentage scores for the Zimbabwean and South African respondents who regarded the promotional activities of their respective firms as effective were 59.5% and 86.5% respectively. These percentage scores demonstrate that fewer respondents from the Zimbabwean sample perceived their firms' promotional activity to be effective when compared to those from the South African sample. Thus, it can be concluded that South African small-scale agro-processing firms conducted more effective promotional activities than Zimbabwean firms.

Lastly, a greater percentage of South African respondents believed their respective firms to be organisationally competitive, compared to the percentage scores for the Zimbabwean respondents. On average, 73.5% of the South African respondents indicated that their respective firms were organisationally competitive. The aforementioned scores can be compared to 49% score for Zimbabwean respondents. Therefore, the conclusion is that South African small-scale agro-processing firms were more organisationally competitive than Zimbabwean firms.

All things considered, it is concluded that the competitiveness of South African small-scale agro-processing firms was higher than those in Zimbabwe.

7.2.3. Research question 3

What is the relationship among technology transfer, financial and non-financial productivity of agribusiness Mashonaland Central Province (Zimbabwe) and Free State Province (South Africa)?

The findings from the study reveal that significant positive correlations of varying strengths were observed among the three variables under study. In the case of Mashonaland Central Province, there was a strong positive correlation between financial productivity and non-financial productivity (r_s=0.771, p < 0.001), while a moderate positive correlation existed between technology transfer and financial productivity (r_s=0.339, p < 0.001) as well as between technology transfer and non-financial productivity (r_s=0.402, p < 0.001).

In the South African sample, there were also strong significant and positive correlations between financial productivity and non-financial productivity (r_s=0.670, p< 0.000) as well as between technology transfer and non-financial productivity (r_s= 0.516, p < 0.000). However, a moderate but positive correlation was observed between financial productivity and technology transfer (r_s = 0.493, p < 0.000). Therefore, the conclusion is that there are significant positive correlations of varying strengths among technology transfer, financial and non-financial productivity.

7.2.4. Research question 4

Which variable between technology transfer and innovation has a greater impact on the productivity of small-scale agro-processing firms in the Mashonaland Central province (Zimbabwe) and Free State province (South Africa)?

The results of the multiple regression analysis indicated that the model encompassing technology transfer and innovation as independent variables and agricultural productivity as the dependent variable revealed mixed results for the two samples. For the Zimbabwean sample, technology transfer and innovation had a non-significant predictive effect on the financial productivity of small agro-processing firms. However, the two independent variables accounted for 9.9% of the variance in non-financial productivity. A closer analysis of the contribution of the two factors revealed that only technology transfer had a statistically significant impact on non-financial productivity.

In the case of the South African sample, technology transfer and innovation explained 23.7% of the variance in the financial productivity of small agro-processing firms. However, only technology transfer had a statistically significant impact on the dependent variable. Collectively, technology transfer and innovation jointly explained 37.7% of the variance in non-financial productivity. However, technology transfer had a greater explanatory effect on the dependent variable than innovation. It can, therefore, be concluded that for the South African sample, technology transfer had a greater impact on financial productivity - while for the Zimbabwean sample, technology transfer had a significant impact on non-financial productivity.

7.2.5. Research question 5

How can the agro-processing production model be constituted to ensure effective and efficient agro-processing business in Mashonaland Central province (Zimbabwe) and Free State province (South Africa) regions? The answer to this question is found in the model that summarises the contribution to this study in Section 7.6. Suffice to say that, the model should comprise the dimensions of the variables (technology transfer, innovation, financial and non-financial productivity) which exhibited positive statistically strong relationships with strong effect sizes in the correlation and regression analysis sections of this study.

7.3. Recommendations for policy and practice

This study sought to determine the status and impact of technology transfer and innovation on the productivity and competitiveness of small-scale agro-processing businesses in Mashonaland Central province in Zimbabwe and Free State province in South Africa. The results of the study revealed the significance of technology transfer in enhancing agricultural output as well as a number of policy challenges that beset the small agri-businesses in the specified study areas. Since agro-businesses empower communities in countering socio-economic challenges, their significance is beyond question. There is, therefore, a definite need for targeted interventions aimed at promoting seamless technology transfer to improve overall agricultural productivity.

7.3.1. Creation of agro-business technology transfer information centres and innovation platforms

In view of the results of the correlations among technology transfer, financial and non-financial productivity, which were positive, statistically significant (with effect sizes ranging from moderate to strong), the further dissemination and transfer of technology in agri-businesses with and across the two countries cannot be taken for granted. The creation of agro business information centres in the two

provinces will contribute towards providing a database of information on new agricultural technologies, new agricultural innovations and knowledge on new ways to improve productivity. In addition, there is a need to create and adopt agriculture innovation platforms to deal with institutional and administrative obstacles to technological transformation in agricultural systems of the regions in the two countries.

7.3.2. Need to amend land ownership policies

The overall status and level of productivity of South African small-scale agro-processing firms was comparatively higher than those of Zimbabwean ones from the perspectives of all dimensions ranging from output productivity, output per hectare, capacity utilisation, market growth, market productivity (reputation), financial productivity and non-financial productivity. Given the reality that the South African economy was under a prolonged economic recession while Zimbabwe was projected to be on an economic recovery path (projected economic growth of 2.8% in 2017 from 0.7% in 2016) due to good rains and greater harvests (World Bank, 2017), it is surprising that Zimbabwean agro-processing firms reported comparatively lower productivity indicators. Perhaps greater capacity utilisation, more integrated agricultural infrastructure and input supply system, and government support backed by an untransformed land tenure system explained this reality for the South African scenario.

While the South African productivity outlook is appealing, it unfolds under a climate of heavy concentration of farming and agro-processing industry along ethnic minority lines, which could be contributing to the stagnancy in the productivity, food security concerns, and concerns by the black majority about the land ownership system in the country. As such, there is a need for a more inclusive land ownership policy that ensures broader participation of various racial groups in agriculture and agro-processing in the country. Following the abolition of apartheid in South Africa, the new government introduced tenure reform, restitution and redistribution to redistribute agricultural land even though the land ownership system remains untransformed in the eyes of the black majority despite the high but stagnant levels of productivity.

In contrast, the agrarian reform and land redistribution programme in Zimbabwe resulted in the issuing of 99-year lease agreements to land holders as opposed to title deeds, itself a failure to transform the inherited settler agricultural systems bequeathed by colonial regimes. Perhaps the difficulty of investing in land could be attributed to a sense of lack of ownership and hence the need to introduce a land ownership system that would render title deeds to land owners to increase their commitment to invest in land and agro-processing activities. Such deeds could also be used as a form of collateral for accessing

loans and other incentives from financial institutions and contribute to increasing the level of investments in agro business firms.

7.3.3. Need for the government to review policy on local agriculture related research and development activities

In view of the positive statistically significant but moderate correlation between technology transfer and financial productivity reported for the two regions in the two countries, it can be argued that there could be a sub-optimal use of technology transfer to drive agricultural productivity, which enhances financial productivity. In view of the central role of agricultural research and development (R&D) in driving technology transfer, there is a need for the South African and Zimbabwean governments to review their policies on research and development (R&D) of research institutes, universities and other agricultural institutions to ensure the scaling up and leveraging of technology transfer to support agricultural productivity to ensure increased financial productivity.

To act as effective agents of technology transfer, research institutes that conduct agricultural and agro-processing research need to be more financially resourced as much as the agro-processing institutions themselves need financial support to drive their activities. Furthermore, small-scale agro-processing firms in both Zimbabwe and South Africa require continuous technological and technical support through research and development to update and extend their technological knowledge base in order for them to effectively adopt and use cutting age agricultural technology. Although technology transfer is an imperative for desirable economic and social development, developing countries under-spend on agricultural research and development, an area key to the development of new technologies or modifying available technologies into appropriate forms needed for agricultural operations and productivity. This partially explains why most technology patents are held in the developed world. So, as Southern African governments increase their investment in agriculture research and development, so does their capacity to develop technological artefacts, tools and equipment needed for the agriculture sector and agro-processing industry.

7.3.4. Promote technology transfer and innovation

In view of the centrality of technology transfer and innovation in predicting financial and non-financial productivity in the South African sample, and the significance of technology transfer in predicting non-financial productivity in the Zimbabwean sample (see section 7.2.4), the Zimbabwean's Industrial Development Corporation and South Africa's Science and Technology department need to adopt a more proactive role in the acquisition, development, dissemination and uptake of technology and innovation by

agro-processing firms through equipping and partnering with their technology transfer agents and spin offs to promote the free movement and acquisition and knowledge to agro-processing firms. In addition, the two governments should provide vital support in the form of financial support and subsidies in the area of technology transfer and innovation.

7.3.5. Encourage all stakeholder involvement in agricultural technology transfer initiatives

Given that a myriad of role-players are involved in different aspects of agriculture technology transfer in both Zimbabwe and South Africa, there is a need for increased participation and involvement by beneficiaries, benefactors and other stakeholders. An all-inclusive approach creates room for trialling of novel innovations and technologies, and the promotion of learning and co-operation among all those concerned. This is significant in two ways. Firstly, stakeholder involvement in the decision-making and processes pertaining to technology transfer initiatives enables buy-in and willingness to accept solutions suggested by technology sources and agents. Secondly, different stakeholders would bring different views to the problem at hand and develop richer standpoints on technologies, which are realistic, adaptable and acceptable in the local contexts.

7.3.6. Financial support for small-scale agro-processing businesses

One of the challenges that small-scale agro-firms in Zimbabwe face, is inadequate financial support to enable the adoption and absorption of technology. In line with this, financial support ranges from financial incentives to support infrastructure development, research institutes and other incentives from banks and other financial institutions. A classic example of such a home country technology transfer support programme is the Canada-Brazil and Southern Cone-Canada Technology Transfer Fund (TTF). The fund assists Canadian organisations that intend to transfer know-how and technology to compatriot organisations in some South American countries. The Canadian International Development Agency (CIDA) oversees the fund and avails financial support to facilitate the effective transfer and adaptation of Canadian technologies in conjunction with local organisations. The fund finances the buying of equipment as well as licencing of specific technology by recipient country firms. It also caters for the training of equipment operators and the upkeep of labourers. Hence, adopting a similar approach in the Zimbabwean and South African context would probably enhance the small agro-firms' adoption of new technology as a bed-rock for improved productivity levels.

7.4. Implications for future studies

This research has presented many questions in need of further investigation. Perhaps a cross-national study involving a larger sample size, with samples selected from other provinces within the two countries, would enhance the generalisability of the research results.

More broadly, research is also needed to determine the other factors that influence the competitiveness and productivity of small-scale agro-processing firms. The chosen determinants of agricultural competitiveness and productivity employed in this study are only a few among a myriad of factors. Future studies need to expand the research horizons by accommodating diverse contributing factors to ascertain the most important predictors of competitiveness and productivity in small agro-businesses.

The study approach adopted for this research was quantitative in nature. Future studies can complement quantitative research with qualitative studies to capture the complex subjective experiences of agro-processing owner/managers on the issues investigated in this study. Dispositions and perceptions of small business owners/managers could be captured to establish whether the findings will be similar or different from the current study's findings.

Furthermore, future research can explore the role of specific agriculture development programmes in promoting agricultural technology transfer and innovation and their subsequent effect on the competitiveness and productivity of small-scale agro-based firms. For instance, in the Zimbabwean case, a starting point would be to investigate the impact of the government-driven command agriculture programme that was launched in 2016.

7.5. Limitations

Finally, a number of important limitations need to be considered. First, the current study adopted a cross-sectional research design in addressing the factors influencing firm competitiveness and productivity of agro-processing firms. Perhaps a longitudinal study could provide a more comprehensive picture of the variations in the dependent variables over the long term compared to a cross sectional design.

Secondly, the study focused on one province from each participating country, which restricts the generalisation of the results. A more inclusive approach can consider several provinces from the participating countries to allow for the generalisation of results within the given countries.

Thirdly, only two variables were used to investigate the agricultural competitiveness and productivity of small agro-based firms in the study. More variables could have been incorporated to gain fuller insight into the key determinants of agricultural competitiveness and productivity.

7.6. Contribution of the study

7.6.1. Theoretical contribution

The technology transfer and innovation scenario in the South African agro-processing industry exhibits a fusion of the Traditional Liberal Theory and Industrial Development Theory. The former is characterised by deliberate cooperation in research and development between the government, research institutes and private industry (e.g. through Agriculture Research Council in South Africa, Agriculture Research Board) to advance technology transfer and productivity (Bozeman, 2000). Other manifestations of Traditional Liberal Theory relate to the South African government's exaltation of the market as an efficient allocator of technology resources - especially promoting private participation in the production and diffusion of agricultural technology and efficient price allocation. In the process, the government creates sufficient favourable conditions for technology investment through deregulation and eliminating unfair competition (e.g. the role of the Competition Commission of South Africa in fair pricing of agricultural technologies, equipment and commodities). The government also strives to eliminate barriers to trade through reduced taxation, promotion of agricultural technology research development and allowing the free-flow of technology among parties in the market (Cecere, 2015).

In the South African case of technology transfer, the Industrial Development Theory is characterised by direct, systematic government interventions through centralised planning to identify and locate specific agricultural areas for technology investment, technology exchange and cooperation, to create the perfect conditions for technology transfer and to correct market imperfections in the agricultural sector. The Department of Science and Technology's Technology Innovation Plan, and the Republic of South Africa's National Development Plan are perfect examples of government intervention. Through interventions such as the Technology Innovation Plan, government departments in collaboration with research institutions and private companies should make decisions on whether to import agricultural capital goods or to locally produce agricultural equipment and agricultural engineering products through transnational corporations' subsidiaries such as Pannar Seed South Africa, Syngenta South Africa and Mahindra South Africa.

The higher levels of agro-processing productivity in the country, the comparatively stronger correlations between technology transfer and productivity, and between innovation and productivity compared to those of Zimbabwe suggest that South Africa has a fairly sophisticated agricultural infrastructure and a

well-developed institutional systems for technology transfer (mainly Multi-National Corporation subsidiaries), which are located and operating in the country.

The innovation scenario for South African agro-processing firms is not sufficiently compatible with Roger's (1962) Diffusion of Innovation theorisation, in which agricultural innovation is created, packaged and disseminated from its source to its consumers (such as agro-processing farmers and businesses). The traditional model of Diffusion of Innovation assumes geographical and psychological proximity between the innovation source (e.g. a region of higher concentration of technology innovation, and readiness and willingness of the technology recipient to adopt the technology innovation) to the technology client/consumers (e.g. region of lower concentration) as technology needs to be transmitted easily from its source to the technology users. In reality, the traditional formulation of the theory seems to negate the role of technology transfer intermediaries (i.e. technology transfer agents) between the technology creator (for instance, multi-national corporations) and the technology consumer (agro-processing firms). In the innovation scenario of agro-processing firms in South Africa, innovation diffusion either unfolds though transnational companies' subsidiaries located in South Africa or in rare cases is imported from developed countries. Domestic production and diffusion of technology innovation contradict Rogers' (1962) theorisation about technology transfer from developed countries to developing countries either through development assistance from World Development bodies, foreign technical cooperation or transfer of actual agricultural technological artefacts, tools and equipment from the host country to the recipient country. The current study reports a high concentration of innovations (e.g. high yielding varieties, agricultural equipment, and irrigation technology) that are designed and transferred within South Africa through innovation intermediaries, and the flourishing technology transfer situation - including the consistently higher correlations between technology transfer and productivity in South African agro-processing firms. This does not match Roger's (1962) postulations about technology mismatches and discontinuities that result in the abandonment of technology transfer by the technology agent upon the end of agricultural projects.

The Zimbabwean case of innovation diffusion somewhat matches Roger's (1962) theoretical narrative. Under the Fast Track Land Reform Programme and Command Agriculture, the Zimbabwean government has harnessed its Look East Policy to intensify the importation of agricultural technology from Chinese companies to support its irrigation systems, agricultural mechanisation schemes involving the acquisition of tractors, machinery and other agricultural equipment. The uptake of innovation and technology transfer (even though comparatively lower to that of South Africa), the positive, statistically significant but moderate to weaker correlations between technology transfer and productivity, and innovation and

productivity, perhaps point to the complexities of adapting Chinese and Malaysian technologies to Zimbabwean agricultural contexts with limited adaptation and contextualisation. This interpretation consummates Rogers' (1962) postulations about local conditions, national social systems and channels of communication shaping the process of diffusion of innovations.

The Traditional Liberal Theory seems to match the Zimbabwe's technology transfer scenario before the 2000 Land reform Programme, which destabilised agricultural production in the country. Up to the mid-1990s, the then Ministry of Agriculture worked closely with agricultural extension officers, university agricultural departments, and research institutes to engage in collaborative research and development initiatives that gave rise to the birth of new agricultural technologies adopted by agri-farmers and agro-processing firms. The hailing of Zimbabwe as the break basket of Southern Africa, manifested in high agricultural productivity, the strong synergies between technology transfer and productivity, and the thriving agricultural innovation and transfers of technology in the country before 2000. The innovation and technology transfer successes revolved around high-yielding varieties, drought-resistant early maturing crop varieties, pest-control chemical and agricultural equipment manufacturing, irrigation systems, conservation agricultural techniques such as gully reclamation, crop rotation, mulching and greenhouse technologies. The collapse of agricultural systems, the attendant growing food insecurity, collapse of research synergies and collaborations between government institutions, parastatals and research institutions after the controversial land reform programme in 2000 all point to the abandonment of Traditional Liberal Theory and the insurrection of Industrial Development Theory in Zimbabwe.

The positive statistically significant moderate to weak correlations between technology transfer and (financial and non-financial) productivity and between innovation and (financial and non-financial) productivity demonstrate that although predictor variables such as technology transfer and innovation are critical to increased productivity, the reality is that agro-processing farmers could be underutilising them as their source of competitiveness and increased productivity. Alternatively, they could be weakly integrating them into their agricultural activities due to weaker financial and technical agricultural support from government.

7.6.2. Practical contribution

The current study is exploratory in nature and spans two countries, a design that has not been used in prior studies conducted on Zimbabwe and South Africa on the same topic. The current findings add to our understanding of the performance of small-scale agricultural enterprises through a novel combination of factors that influence agricultural productivity and competitiveness. Some studies have explored the

relationship between innovation and productivity on the one hand, and agricultural productivity and competitiveness on the other (Lööf, & Heshmati, 2006; Loevinsohn, Sumberg, Diagne, & Whitfield, 2013; Capalbo & Vo, 2015). In addition, others have also examined the relationship between technology transfer and productivity including competitiveness in different economic activities (Dunning, 2013; Cavallo, Ferrari & Coccia, 2015; Gaunand, Hocde, Lemarié, Matt & De Turckheim, 2015). No studies to the researcher's knowledge have explored in one study the association among technology transfer, innovation, competitiveness and productivity among small-scale agro-businesses in developing economies (Zimbabwe and South Africa).

The outcome of the study, which partially proved the predictive effects of technology transfer and innovation on competitiveness and productivity, provided a credible and empirically validated explanatory tool for the performance of small scale agricultural enterprises (SSAEs) in Zimbabwe and South Africa. Based on the empirical findings and the associated conclusions, the study proposed a model for the key determinants of competitiveness and productivity in small-scale agro businesses in Zimbabwe and South Africa. The model is diagrammatically presented in Figure 7.1. Greater understanding of each of the factors influencing the dependent variables will enable the small firms to put more emphasis on those factors that have the greatest and significant effect on competitiveness and productivity as articulated in the findings chapter of this study.

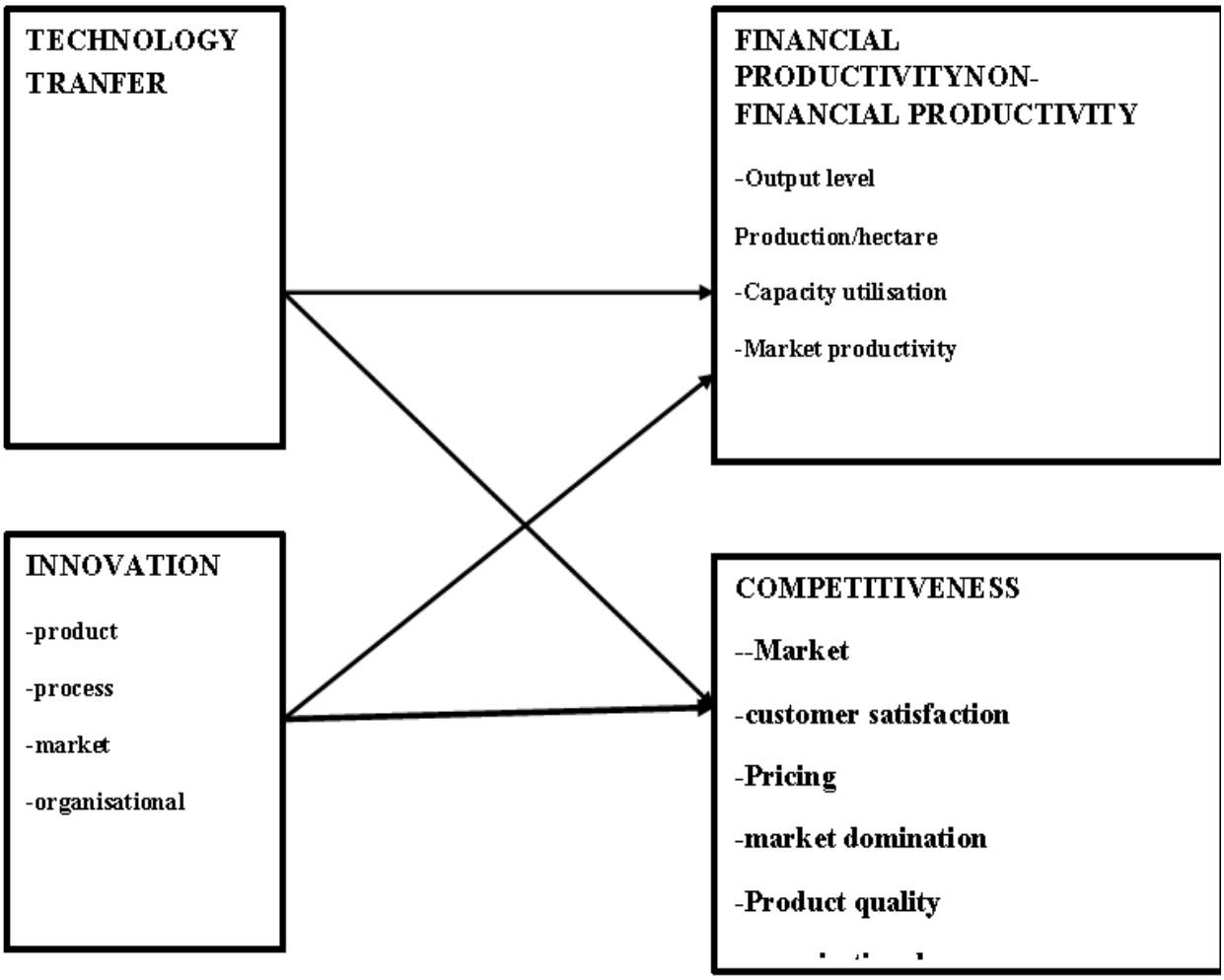


Figure 7.1: Relationship between technology transfer, innovation, productivity and competitiveness

7.7. Chapter summary

This chapter provided a conclusion based on the research findings and then provided recommendations for policy and practice consistent with the conclusions. The expectation is that small agro-based firms in Zimbabwe and South Africa will benefit from these recommendations, leading to better performance and food security in the two countries.

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APPENDIX A

BIOGRAPHY

Mr Justin Gumbochuma (born 19 September 1983) is a Zimbabwean businessman. He graduated with a Bsc Honours in Administration and a Master's in Business Administration from the University of Zimbabwe and National University of Science and Technology. He is a Doctorate candidate at the Central University of Technology, Free State, South Africa. He also worked as a lecturer of strategic management, public finance, public policy, organisational development and as a consultant for Beverley Business School.

His experience include working for United Nations Information Centre, United States of America Embassy in Harare as Inventory consultant (2005-2007). Justin is the Founder and Board Chairman of Credfund Finance, Covenant Finance, Abovelimit Holdings and Industries, Legbead Hiring and Public Private Partnership Institute of Zimbabwe (PPPIZ). Mr G umbochuma served as a consultant of the Government of Zimbabwe for special projects like Indigenization and economic empowerment rollout programme and Command Agriculture and former special government committee member on indigenization and economic empowerment. He also served as a former board member of Youth empowerment Taskforce.

Mr Gumbochuma is also a fellow member of the South Africa Institute of Financial Markets and he holds a postgraduate certificate in Investments and portfolio management from the University of Zimbabwe.

Justin is a devout Christian and a leader of the Seventh Day Adventist and Board member of Adventist Laymen's Services and Industries (ASI) for Zimbabwe and Africa region. He serves as a committee member for ASI programs and projects North America Division (NAD) covering USA and Canada.

APPENDIX B

QUESTIONNAIRE

Section A

Instructions to respondents:

1 Your answers will be kept confidential

2 Please be honest as much as possible in completing this questionnaire.

3 Indicate your response by encircling or ticking the relevant option in the boxes provided

SECTION A

1. Country

Zimbabwe	1	South Africa	2

2. Gender (Representative)

Male	1	Female	2

3 Choose appropriate from 1/2/3/4/5/other.

Age	**1** Below 21 years	**2** Between 21-30 years	**3** Between 31-40 years	**4** Between 41-50 years	**5** Between 51-60 yrs.	61+ yrs.
Ethnic/ Race	**1** White	**2** Coloured	**3** Black	**4** European	**5** Asian	Other Specify……
Years in business	**1** (1-5)	**2** (6-10)	**3** (11-15)	**4** (16-20)	**5** (21-50)	(Over 50)
Employees numbers	**1** (1-10)	**2** (11-20)	**3** (21-50)	**3** (51-100)	**5** (101-200)	(Over 200)
Total assets value(millions USD)	**1** Less 200 000)	**2** 200000-499 999	**3** 500000-999 999	**4** 1000000-4999 999	**5** 5000 000-9 999 999	Over 10 million
Nature of Agro business	**1** Animal Husbandry	**2** Crop production	**3** Horticulture	**4** Manufacturing /agro processing	**5** Sale of agro equipment	6 Marketing of agro equipment/implements Add other specify
Agro business Qualifications	**1** Primary /short courses	**2** High school	**3** Vocational Training course	**4** University 's Bachelor's Degree	**4** Post graduate diploma/degree	Other Specify……

Section B

	STATUS AND LEVEL OF PRODUCTIVITY OF AGRO-PROCESSING FIRMS					
PRODUCTIVITY LEVELS	**Financial productivity questions**					
1.	Please indicate the extent to which the agro-business's financial sales from agricultural products/services increased/decreased over the past 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
2.	Please indicate the extent to which the agro-business's sales from agricultural products/services increased/decreased compared to production costs over the past 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
3.	Please indicate the extent to which the agro-business's total revenue increased/decreased compared to production costs over the past 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
4.	Please indicate the extent to which the agro-business' gross profit increased /decreased over the last 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
5.	Please indicate the extent to which the agro-business' net profit grew/fell over the last 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	

6.	Please indicate the extent to which the agro-business' return on investment (financial returns generated from the business' start-up capital/initial investment) grew/fell over the last 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
7.	Please indicate the extent to which the agro-business' total finances grew/fell over the last 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
PRODUCTIVITY LEVELS	**Non-financial productivity**					
8.	Please indicate the extent to which the agro-business' employment levels grew/fell over the last 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
9.	Please indicate the extent to which the agro-business' market share grew/fell over the last 1-5 years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
PRODUCTIVITY CONT'D	**Output productivity levels**					
10.	Please rate the business' level of agro-processing production over the past 5 years					
	1=very low	2=low	3=moderate	4=high	5=very high	
11.	How would you rate the total revenue from agro-processing production compared to total production costs					
	1=very low	2=low	3=moderate	4=high	5=very high	
12.	How would you rate total outputs (total products/services) compared with total inputs (total raw materials) used in the agro-processing businesses over the past 1-5 years					

	1=very low	2=low	3=moderate	4=high	5=very high	
PRODUCTIVITY CONT'D	**Productivity Output per hectare indications**					
13.	Rate the business' level of productivity in input per hectare					
	1=very low	2=low	3=moderate	4=high	5=very high	
14.	Rate the business' level of productivity in output per hectare					
	1=very low	2=low	3=moderate	4=high	5=very high	
15.	Rate the business' level of productivity in terms of outputs per hectare compared to the input used per hectare					
	1=very low	2=low	3=moderate	4=high	5=very high	
16.	Please rate the business's output per unit cost compared to the input per unit cost					
	1=very low	2=low	3=moderate	4=high	5=very high	
17.	Rate the business' overall level of output in hectares (100 ha)					
	1= very low	2=low	3=moderate	4=high	5=very high	
PRODUCTIVITY CONT'D	**Capacity utilisation Output per hectare indications**					
18.	Rate the level of business' capacity utilisation (i.e. production potential from the exploitation of available resources) currently experienced by the organisation					
	1=very low	2=low	3=moderate	4=high	5=very high	
19.	Rate the level of business' capacity utilisation assisted by agricultural technology					
	1=very low	2=low	3=moderate	4=high	5=very high	
20.	Rate the level of business' capacity utilization assisted by agricultural innovations					
	1=very low	2=low	3=moderate	4=high	5=very high	
21.	Please rate the business' capacity utilization assisted by the use of specialized expatriate labour					
	1=very low	2=low	3=moderate	4=high	5=very high	
22.	Please rate the business' capacity utilization assisted by foreign direct investment					
	1=very low	2=low	3=moderate	4=high	5=very high	
PRODUCTIVITY CONT'D	**Market productivity – Growth**					

23.	Please rate the business' extent of growth/ decline in its share of the domestic market over the last five years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
24.	Please rate the business' extent of growth/ decline in its share of the regional market over the last five years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
25.	Please rate the business' extent of growth/ decline in its share of the international market over the last five years					
	1 Decreased by over 10%	2 Decreased by between 1%-10%	3 No change	3 Increased by 1-10%	4 Increased by over 10%	
	Market productivity – reputation					
26.	Please indicate the extent of reputation of the business' agro-processing products in the domestic market					
	1=very low	2=low	3=moderate	4=high	5=very high	
27.	Please indicate the extent of reputation of the business' agro-processing products in the regional market					
	1=very low	2=low	3=moderate	4=high	5=very high	
28.	Please indicate the business' economies of scale as it relates the international regional market of its products					
	1=very low	2=low	3=moderate	4=high		

AGRICULTURAL COMPETITIVENESS

In the scale provided:

1=strongly agree; 2= disagree; 3=Neutral ; 4=agree; 5=strongly disagree

	Product's Market competitiveness				
	29. The business has established strong agro-processing brands/services in the market compared to its competitors				
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	30. The business' agro-processing products/services has considerable competitive advantage over its over its competitors				

		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	31. The business' agro-processing products or services are easily recognizable in the market compared to those of its competitors					
		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	32. The business ' agro-processing enjoy higher sales in the market compared to those of competitors					
		1 Strongly Disagree	2. Disagree	3 Neutral	4. Agree	5 Strongly agree
	33. The agro-processed products or services have more dominance over those of the organisations competitors					
		1 Strongly Disagree	Disagree	3 Neutral	4 Agree	5 Strongly agree
	Customer satisfaction					
	34. The customers are satisfied with the business' agro-business brands/services compared to that of its competitors					
		1 Strongly Disagree	2 Disagree	3 Neutral	4. Agree	5. Strongly agree
	35. The business' agro-processing products /services are bought by customers ahead of those of competitors					
		1 Strongly Disagree	2. Disagree	3 Neutral	4 Agree	5 Strongly agree
	36. The business' agro-processing products/services are preferred by customers compared to those of competitors					
		1 Strongly Disagree	2. Disagree	3 Neutral	4 Agree	5 Strongly agree
	37. The price of the business' agro-processing products /services are preferred by customers compared to those of its competitors					
		1 Strongly Disagree	2. Disagree	3 Neutral	4 Agree	5 Strongly agree
	38. The business has strong relationship with its customers base compared to its competitors					
		1 Strongly Disagree	2. Disagree	3. Neutral	4. Agree	5 Strongly agree
	Market pricing competitiveness					
	39. My business in agro-processing has developed competitive pricing model					
		1 Strongly Disagree	Disagree	3 Neutral	4 Agree	5 Strongly agree
	40. The agro business has favourable pricing compared with other businesses					

	1 Strongly Disagree	Disagree	3 Neutral	4 Agree	5 Strongly agree	
Business' Market dominance						
41. Please state the business' level of dominance of the domestic market over competitors						
	1 Very low	2 Low	3 Moderate	4 High	5 Very high	
42. Please state the business' level of dominance of its research and development and development (R&D) locally						
	1 Very low	2 Low	3 Moderate	4 High	5 Very high	
43. Please state the business' level of dominance of its research and development and development (R&D) internationally						
	1 Very low	2 Low	3 Moderate	4 High	5 Very high	
44. Please state the business' level of production dominance of agro products and services						
	1 Very low	2 Low	3 Moderate	4 High	5 Very high	
45. Please state the marketing skills dominance of the business' employees						
	1 Very low	2 Low	3 Moderate	4 High	5 Very high	
Product quality						
46. The business develops / produces high quality agro product/services						
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
47. The business have ISO certification of products to meet local quality requirements						
	1 Strongly Disagree	2. Disagree	3 Neutral	4 Agree	5 Strongly agree	
48. The business' products or services meet the international quality standards set by global institutions						
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
49. The business is involved in continuous agro product development and improvement						
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
Promotion strategy						

	50. The business' product promotion help has helped it o to be dominant on the market					
		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	51. The business emphasises effective and unique agro product promotion techniques					
		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	Organisational competitiveness					
	52. The organisation has invested in production capacity that is competent					
		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	53. The business agro business has developed competitive, efficient and effective agro organisational structure					
		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree

Section C

	INNOVATION					
	Product innovation					
	Please state how often the business does the following:					
	54. The business does new agro-processed product/service development					
		1 Never	2 Rarely	3 Sometimes	4 Regularly	5 Always
	55. The business applies innovative agro-processing information on its products or service business					
		1 Never	2 Rarely	3 Sometimes	4 Regularly	5 Always
	56. The business adds new features to existing agro-processing products and services					
		1 Never	2 Rarely	3 Sometimes	4 Regularly	5 Always
	57. The business encourages creation of new agro-processing products and services					
		1 Never	2 Rarely	3 Sometimes	4 Regularly	5 Always
	Process Innovation					
	Please state your extent of agreement/disagreement with the following statements about the business					
	58. The business has established the implementation of new/improved production methods					
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
	59. The business uses new delivery and distribution networks in its agro-processing activities					

		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	60. The business invests in new agro techniques/ equipment/ machinery improve agro-processing activities						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	61. The business uses and applies business process and information techniques to solve agro business challenges						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	62. The business applies key performance indicators in its agro business activities						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	Market innovation **Please state your extent of agreement or disagreement with the following statements**						
	63. The agro-business business introduces marketing strategies regularly						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	64. The business tests its new product designs regularly to address customer needs						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	65. The business employs new product packaging techniques to improve its visibility in the market						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	66. The business involves its market partners when placing new products in the market						
		1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	
	Organisational innovation Please state how often the agro-business does the following:						
	67. The organisation is involved in the adoption of wide scale innovations that affect the functioning of the whole organisation						
		1 Never	2 rarely	3 sometimes	4 frequently	5 Always	
	68. The business encourages new organisational methods and development of new organisational systems						
		1 Never	2 rarely	3 sometimes	4 frequently	5 Always	
	69. The business has invested in organisational best practices and agro-business efficiency						
		1 Never	2 rarely	3 sometimes	4 frequently	5 Always	
	70. The business invests in developing organisational change and operational change at your organisation						
		1 Never	2 rarely	3 sometimes	4 frequently	5 Always	

Section D.

Internal and external technology transfer.

71 Please state the extent to which you agree with the following statements on the business' internal/ external acquisition of technology					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
72. The business encourages the free flow of new agro-processing information within the organisation					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
73. The business emphasizes the use of high-technology ideas, methods and technique in agro business acquired from within the organisation					

	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
74. The business has invested much capital in the use of technology in agro business					
	1. Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
75. The business contributes to the diffusion of agriculture knowhow and knowledge					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
76. The business invest in research and development(R&D) in agro-business					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
77. The business acquires the best available technology outside the organisation					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
78. The external acquisition of agro business technology has increased marketing knowledge in the agro business					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
79. The external acquisition of agro business processing technology has reduced the time to market business products					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent
80. External sourcing of agro business technology has increased the knowledge base of developing new products and techniques					
	1 Not at all	**2** To a least extent	**3** To a less extent	**4** To a moderate extent	**5** To a large extent

Transfer of agro-processing business skills(Sub concept 2) Please state the extent to which you agree/ disagree with the following statements transferring business skills					
81. The agro-business emphasizes the development of new productive agro business methods					
	1. Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
82. The agro-business imparts new agricultural entrepreneurship skills on employees					
	1. Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
83. The agro-business uses agriculture skills development to develop its manpower					
	1. Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
84. The external acquisition of technologies methods has improved efficiency and effectiveness					
	1. Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
85. The acquisition of the best available technology outside the organisation has made the agro-business to focus on capabilities					
	1. Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
86. The external acquisition of agro business technology has increased competitiveness in the agro business					
	1. Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree

Technology transfer of agro-processing business abilities **Please state the extent to which you agree with the following statements the business' agro-processing abilities**					
87. The business employs agro technologies for its enterprise development activities					
	1 Not at all	**2** To a least extent	**3** To a lesser extent	**4** To a moderate extent	To a greater extent
88. The agro business used technology to facilitate marketing activities					

	1 Not at all	**2** To a least extent	**3** To a lesser extent	**4** To a moderate extent	**5** To a greater **e**xtent
89. The agro business employs agriculture technology to develops its planning processes and operations					
	1 Not at all	**2** To a least extent	**3** To a lesser extent	**4** To a moderate extent	**5** To a greater **e**xtent
90. The business uses technology to facilitate the diffusion of technical services					
	1 Not at all	**2** To a least extent	**3** To a lesser extent	**4** To a moderate extent	**5** To a greater **e**xtent
91. The business employs commercialisation techniques and strategies to make farmers more innovative					
	1 Not at all	**2** To a least extent	**3** To a lesser extent	**4** To a moderate extent	**5** To a greater **e**xtent
92. The business uses techniques and strategies to market and distribute agro business products and services					
	1 Not at all	**2** To a least extent	**3** To a lesser extent	**4** To a moderate extent	**5** To a greater extent
Agro-processing technology types: Biotechnology or genetically modification					
Please state the degree to which your organisation uses each of these technologies					
93. The business develops biotechnology products and services					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
94. The business distributes biotechnology products and services					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
95. The business markets some biotechnology products and services					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
96. Agro-processing technology for storage and preservations					
	1 Not at all	2 Rarely	3 To a limited degree	4 To a moderate degree	5 To a large degree
97. Please state the degree which your agro-business uses each of these technologies for storage and preservation of agro-processed products					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
98. The business employees technology in storage					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
99. The agro business use agro-processing technology such as controlled environments for processing its products					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
100. The agro business processing pasteurises and sterilise its products					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
101. The business uses agro-processing technologies equipment to pack preserve its products.					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
102 Transportation and Distribution of agro products					
	1 Not at all	2 Rarely	3 To a limited degree	4 To a moderate degree	5 To a large degree
Please state the degree which your agro-business uses each of these technologies for the transportation and Distribution of agro products					
103. The businesses uses technologies for transportation such as cold chain distribution, transportation by refrigerated cars, planes and boats					

	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
104. Our business uses cold chain distribution to preserve its products					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
105. The business uses refrigerated vehicles (cars/lorries/trucks), planes or boats to transport its agro-processed products. ask the same for its primary raw materials					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
Technology for processing					
106 Please state the extent to which your organisation provides and /uses the following technologies					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
107. Our agro-processing involves the provision and use of freeze –drying					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
108. Our agro-processing involves the provision and use of spray-drying					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
109. Our agro-processing involves the provision and use of micro-wave drying					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
110. Our agro-processing involves the provision and use of frozen-drying					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
111 Our agro-processing involves the provision and use of frozen-grinding					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
112. Our agro-processing involves the provision and use of high-pressure processing					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent
113. Our agro-processing involves the provision and use of membrane-filtration					
	1 Not at all	2 Rarely	3 To a limited extent	4 To a moderate extent	5 To a large extent

THANK YOU!!!

APPENDIX C

PROOF OF LANGUAGE EDITING

13 February 2018

Luna Bergh

55 Jim Fouché Avenue

Universitas, Bloemfontein

To whom it may concern

This is to certify that I language-edited Justin Gumbochuma's thesis electronically via track changes and comments, excluding references and appendices. The author's style was retained and he effected the changes. In this way, both linguistic excellence and the candidate's ownership of his text were ensured.

Sincerely

Luna Bergh

D Litt et Phil

Language and writing specialist