Chapter 1: Introduction

1.1 Prologue

Agriculture plays an important role in Botswana, providing food, income, employment and investment opportunities for the majority of the rural population. The sector accounts for 2.8 per cent of Gross Domestic Product (GDP) and employs 30 per cent of the workforce (Botswana College of Agriculture Consult [BCA], 2012; Yaron et al., 2012). Recently, it is estimated that close to 153,000 people (26.5 per cent of the national labour force) are active in the sector; of which 39,300 are paid employees, 91,800 are self-employed on their own farms and 19,500 do unpaid work in family activities (Sigwele & Orlowski, 2015).

Owing to the importance of agriculture in the economy, this study attempts to revisit and examine the performance of the sector from 1979 to 2012. Both parametric and non-parametric approaches are used to obtain and decompose indicators of efficiency and productivity by taking into account inter-regional and environmental differences.

The remaining parts of this chapter provide the relevant background to the study, a statement of the research objectives, research contribution and an outline of the approaches used.

1.2 Background

Agricultural production in Botswana is dualistic in nature, implying that it is composed of commercial and traditional production systems in both livestock and crops. The most dominant production system is traditional farming which mostly operates on communal land and with less market participation and use of modern inputs, whilst commercial farmers own and manage less than 15 per cent of cattle and cultivate less than 10 per cent of agricultural land (Centre for Applied Research [CAR], 2005; Sigwele & Orlowski, 2015). In both production systems livestock production, especially beef cattle, contributes the largest share to agricultural GDP (about 57 per cent) (van Engelen, 2013). Compared to the commercial sector, productivity indicators for the traditional sector are significantly lower and hence it is this sector which is largely responsible for the overall low productivity of the agricultural sector in Botswana (Statistics Botswana, 2008, 2014). As

a result, government efforts aimed at improving agricultural performance have been more focussed on the traditional sector rather than on commercial production and non-traditional sectors such as dairy, horticulture, piggery and poultry (Southern African Development Community [SADC], 2011).

Before the discovery and exploitation of minerals (particularly diamonds) in the 1970s, the government was dependent on agriculture and grants from the British government (Botlhale, 2011). The contribution of the agricultural sector to Botswana's GDP was above 40 per cent at independence in 1966 (Ministry of agriculture [MoA], 1991) and at present this has decreased to 2.8 per cent (Bank of Botswana [BoB], 2014). The decline in agriculture's contribution has been attributed to the growth of other sectors, especially minerals and service sectors (Sigwele & Orlowski, 2015). The decline in agricultural contribution to GDP has also been attributed to low productivity within the sector, which is partly being caused by recurring drought conditions that prevail in many parts of the country and the small scale of farms (Seleka, 1999; Yaron et al, 2012). Additionally, the agricultural sector in Botswana is generally characterised by an undeveloped market infrastructure; poor input delivery technologies; poor access to credit; insufficient knowledge and training for both extension agents and farmers; and a lack of draught power and labour (African Development Bank [AFDB], 1994; Yaron et al, 2012). The decline of agricultural performance over time has led to low returns to capital investment and labour - and hence, subsequently, an increase in rural-urban migration (Sigwele & Orlowski, 2015). One of the possible consequences of low productivity in agriculture is that it is likely to reduce the returns that farmers can earn from their enterprises; this can then lead to reduced farm incomes, which in turn worsens poverty levels (Yaron et al, 2012).

The Government of Botswana (GoB) have, through various government policies, long recognised the importance of improving the performance of the agricultural sector as a strategy to reduce high levels of imports, the abandonment of arable agriculture, rural-urban-migration and poverty, and to enhance the sector's potential in employment creation (Ministry of Finance and Development Planning [MFDP], 2007). Empirical literature shows that increasing agricultural productivity is fundamental for long-term poverty alleviation and overall economic growth in developing countries (Block, 2010;

Bravo-Ureta et al., 2007). Increasing crop output through cultivating more marginal land is a short term supply response mechanism, whilst in the longer term - to sustain growth in food production - total factor productivity must increase (Conradie, Piesse & Thirtle, 2009). Thus, in countries such as Botswana with natural resource (i.e., limited water and arable land etc.) and structural constraints, achievement in future food production may have to rely on improvements in agricultural productivity through efficiency, technological and institutional innovations.

Since independence in 1966, the government has embarked on a series of different policies that have pursued the objectives of; improving food security; diversifying the production base; increasing output and productivity; increasing employment; and providing a secure, productive and sustainable environment for producers (GoB, 2014; MoA, 2014). These policies were designed under successive five year long National Development Plans (NDP) which are based on consultations and comprehensive socio-economic planning (CAR, 2005)[1]. Presently, Botswana is implementing NDP 10, with the next to commence in April 2017 (GoB, 2014). One of the main goals of the current NDP 10 is to increase the productivity of a number of different sectors including agriculture.

In 1991 under NDP 6, the Government of Botswana formulated and implemented the National Agricultural Policy (NAP) with the objective of developing a sustainable agricultural sector (MoA, 2014). This policy was formulated following the poor performance of the agricultural sector in the late 1980s (CAR, 2006; MFDP, 2013). The policy was dominated by farm-level programs such as the Arable Lands Development Program (ALDEP) and the Accelerated Rainfed Arable Program (ARAP). These programs provided free access to capital and operating inputs to farmers to further promote technology adoption and increase productivity (MoA, 2014). ALDEP was devised to assist eligible farmers in rainfed arable agriculture by providing them with draught power, animal drawn implements, fencing materials, water catchment tanks, and fertilisers (Seleka, 2005). ARAP was a non-discriminatory program that assisted farmers

[1] National Development Plans (NDPs) are major statements that outline development strategies, policies, programmes and projects that are to be implemented over a medium term (normally six years) (GoB, 2014; MFDP, 2013).

in rainfed agriculture through the provision of grants for ploughing, input (improved seeds and fertiliser) procurement, water development and fencing.

The success of these programmes in transforming the sector to meet agricultural policy objectives has been minimal for a number of reasons that include; untargeted support services such as extension services, lack of draught power for farming and a lack of sector-wide strategies, which has often led to disruptions caused by some policy interventions (MoA, 2002). This has, over the years, led to the decline in agricultural sector's contribution to the country's GDP (MoA, 2002). The impact of the 1991 policy reform has not been encouraging, since it has not led to any visible transformation of the smallholder agricultural sector at the national level (Seleka, 2005).

The NAP was revised in 2002. This revision included the implementation of the National Master Plan for Agriculture and Dairy Development (NAMPAADD) (a recycled version of ALDEP). This policy sought to improve the performance of the agricultural sector by modernising it through the introduction of improved technologies and efficient use and management of land and water resources and by commercialising it (MoA, 2002). In 2008, the Integrated Support Programme for Arable Agriculture Development (ISPAAD) was introduced "to address the challenges facing arable farmers and inherent low productivity of the arable subsector" (BCA, 2012, p. vii). The objectives of ISPAAD include: to increase grain and horticulture production; promote food security at household and national levels; to commercialise agriculture through mechanisation; to facilitate access to farm inputs and credit and; to improve extension outreach (BCA, 2012). Livestock Management and Infrastructure Development (LIMID) is another major program implemented by the government with the objectives of improving productivity of cattle, small stock and Tswana chickens, improve livestock management and provision of infrastructure. Under this policy scheme, resource-poor farmers receive grants of up to 90 per cent to access small stock and indigenous chicken breeds in order to improve income and security (Sigwele & Orlowski, 2015).

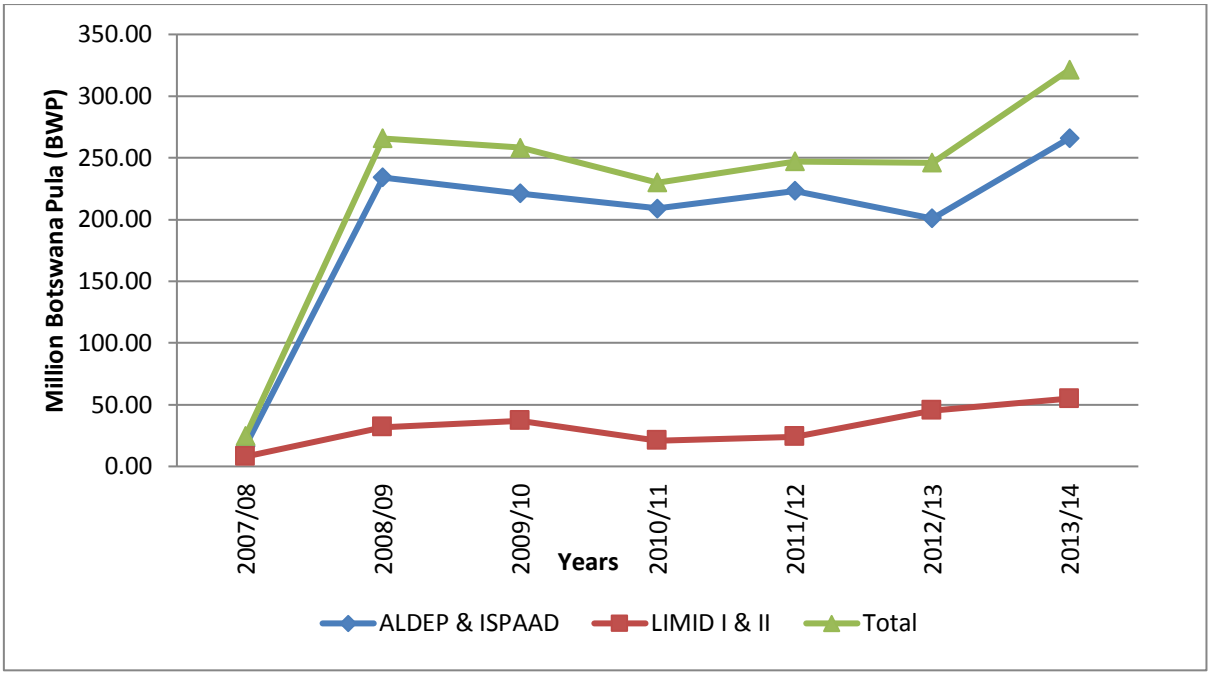

Figure 1.1: Actual Expenditures on Support Schemes, 2007 to 2014[2]

Source: Sigwele & Orlowski (2015)

Figure 1.1 shows the actual expenditures on the major support schemes that the government have undertaken in the ten years from 2007 to 2014. Over the period, ISPAAD consumed the largest share of the expenditure (84 per cent), whilst LIMID was only allocated a 16 per cent share. For the period 2009 to 2013, the two main support schemes absorbed about 20 per cent (P250 million per annum) of the total expenditure of the Ministry of Agriculture. According to Sigwele & Orlowski (2015), in the 2013/14 financial year, the two support schemes made up 70 per cent of total national development expenditure (P266 million for ISPAAD and P56 million on LIMID), which is a significant amount. Public expenditure on agriculture is estimated to be 3 to 4 per cent of annual government expenditure, and which is an amount that is between 40 to 50 per cent of the total of annual agricultural GDP (Fan et al., 2009; Sigwele & Orlowski, 2015).

Despite various policies and programs to improve agricultural performance, output and productivity continue to decline, leading to a progressive increase in food imports (Sigwele & Orlowski, 2015; van Engelen et al., 2013). Since the 1970s total export earnings are positive in the livestock sector, however, the overall trade balance in the food

[2] Exchange rate: USD 1 = BWP 11.012 (March 14, 2016)

sector has been negative (Yaron et al., 2012). For the period 2008 to 2011 national average yield of grain was 320kg/ha against an expected target yield of 1000kg/ha (BCA, 2012). Domestic grain production only satisfied 10 per cent of the national staple grain requirement which led to Botswana importing an average of 300,000 tons of cereal grains per year during the period (BCA, 2012). Imports of food in 2007 amounted to US$1.74 billion against exports of only US$732 million thus resulting in a negative trade balance of US$821 million (SADC, 2011).

1.3 Problem Statement

Agricultural performance in Botswana has continued to decline in the last two decades in spite of the implementation of a variety of policy measures as well as the introduction of new technologies designed to improve that performance. Government expenditure on agricultural schemes since 1980 is estimated to be equivalent in size to about 40 per cent of agricultural GDP, which is well above average for a sub-Saharan African country (Thirtle et al., 2003; Irz & Thirtle, 2004; Fan et al, 2009). Despite such levels of investment, there is evidence that relative to other SSA countries, Botswana has been one of the worst performing countries in terms of productivity (Fuglie & Rada, 2013).

Livestock production systems are the dominant land users, while other types of agricultural production (i.e., crops and horticulture) are generally not suitable to the prevailing environmental conditions in Botswana. However, despite its importance to the economy and the fact that Botswana beef enjoys preferential market access in the European Union (EU), there has been a decline and stagnation in beef exports, to the extent that the country has failed to fulfil its EU beef quota (CAR, 2005; van Engelen et al., 2013). This has been attributed to the mismanagement and inefficient operations of abattoirs, poor beef/cattle marketing arrangements and a failure to raise the productivity of cattle farming operations. Given the relative importance, and the strong linkages of the beef sector to the rural economy, the continued decline of beef productivity may further reduce farm incomes, and is likely to exacerbate rural poverty (van Engelen et al., 2013).

Against this backdrop a fundamental question that naturally arises is: why is the performance of agriculture continuing to decline despite the implementation of such policy measures? Accordingly, this study attempts to shed some light on the following

research questions: (i) why is the performance of agriculture continuing to decline despite the amount of support farmers receive, (ii) what are the main drivers of productivity growth? and, (iii) does agricultural performance differ by agro-ecological regions and farming systems?

Previous studies have attempted to understand the patterns of agricultural productivity and growth in Botswana using various data sets, methods and by studying different sub-sectors (e.g., Irz & Thirtle, 2004; Thirtle, Lusigi, Molefhi, Piesse, & Suhariyanto, 2000; Thirtle, Piesse, Lusigi, & Suhariyanto, 2003). The general conclusion that arises from these studies is that agricultural productivity has been declining. For example, Seleka (1999) examined the performance of traditional arable agriculture for the period 1968 to 1990 and found that although government support to the sector had a positive effect on the welfare of rural households, productivity declined. The study used national level data which fails to account for regional heterogeneity and does not decompose productivity growth into its various components. Measurement of productivity growth at the national level can camouflage significant disparities between high and low productive regions in a country (Rahman, 2007). Decomposition of TFP into different measures can capture the effect of improvements in production technology and investments in research and development (R&D), and in infrastructure such as irrigation, roads and communication (O'Donnell, 2010; Rahman, 2007).

The few other studies that have accounted for regional heterogeneity (e.g., Irz & Thirtle, 2004; Thirtle et al. 2000; Thirtle et al, 2003) exhibit mixed results and are now out of date. The latest database used for total factor productivity (TFP) analysis covered a period up to 1996 and so omits most of the period during which policy reform has been taking place. That is, since the introduction of agricultural policies in the 2000s there is no empirical evidence provided to support the effectiveness of these programs.

1.4 Research Objectives

The objective of this thesis is to contribute to the understanding of agriculture in Botswana and its performance. The study uses productivity measures to assess the performance of the agricultural sector and the drivers of that performance; across different regions and across different production systems, and so which may help in designing appropriate

policies. The Mid-Term Review of National Development Plan 10 (MFDP, 2013) also advocates for the identification of production areas according to their suitability for specific commodities such as crops and livestock in order to ensure optimal productivity of the sector. Thus, the evaluation of differences in performance and production technologies amongst the regions may assist in identifying areas (regions and sub-sectors) with the potential to improve productivity with existing resources and levels of technology.

The specific objectives of this study are to:

i) Revisit and update measures of the productivity of agriculture in Botswana using a current dataset and new approaches;
ii) Investigate whether TFP varies across Botswana's regions, which are characterised by different agro-ecological conditions and levels of economic development;
iii) Examine what are the main sources of efficiency, productivity and output growth in agriculture and explore possible reasons for the decline in productivity;
iv) Undertake an analysis of an important agricultural sub-sector - beef production – in order to re-evaluate its significance;
v) Examine differences in productivity and production technologies between the two beef production systems in Botswana.

1.5 Research Contribution

This thesis contributes to the literature in several ways. Chapter 3 calculates productivity growth using the Färe-Primont index, which allows for decomposition into various measures of efficiency change (technical, scale and mix efficiency) and technical change. Studies in Botswana, as well as in Africa in general, have not taken into account possible inefficiencies that could be attributed to sub-optimal output (input) mix decisions. In simple terms, this is productivity change due to economies of scope rather than scale. Output (input) mix efficiency can be defined as the ability to improve overall productivity by changing the output (input) mix of the farm whilst holding the input (output) set fixed. Measures of TFP which can be more finely decomposed should provide a greater understanding with regard to patterns and sources of growth in the agricultural sector.

Both chapters 3 and 4 attempt to establish the effect of policy reforms on agricultural productivity of Botswana. These analyses provide a timely update on the current state of

agricultural performance and in a wider sense facilitate our understanding of the effectiveness of the expensive support programs that the Government of Botswana has been undertaking. This is an important issue especially from a development economics perspective.

Chapter 5 examines the productivity of extensive beef farms in different regions of Botswana and attempts to explain differences in regional performance in terms of environmental and economic constraints. This study contributes to the literature in terms of extending the empirical application of the stochastic metafrontier (MF) approach to the beef sector. To date, the majority of livestock MF studies have focussed on either the dairy or sheep sectors. This study assesses the performance and technological differences within extensive beef farms across all 26 agricultural districts in Botswana over a nine year period. Such analyses allow policy makers to design policies by taking into consideration the different agro-ecological conditions faced by farmers in Botswana.

Chapter 6, advances the understanding of productivity differences in beef production systems in Botswana using a stochastic production frontier that can simultaneously model for factors that may be associated with the inability of producers to reach their production potential and thus is useful in identifying those aspects of the production process or environment which farmers and/or policy makers might target in order to improve beef production. Another innovative contribution of this chapter is the differentiation by farming system which operate under different land tenure systems. This provides insights into the effects of different land tenure systems upon resource use and productivity. Existing empirical evidence on the relationship between land tenure and agricultural productivity remains mixed (Place, 2009) and some researchers have argued that land tenure policy in Botswana has completely failed to attain its objectives (e.g., Maxwell and Wiebe, 1999). We hope to contribute to this discussion.

Finally, the results generated from this study offer fresh insights to research managers, policymakers and different stakeholders. Various indicators used to assess different drivers of the performance of the agricultural sector across different agricultural districts, agro-ecological regions, production systems and sub-sectors are obtained. Accounting for the presence of different technologies may help policy makers to choose the most suitable

policy measures by identifying those aspects of the production process or environment which farmers and/or policy makers might target in order to improve agricultural production. The productivity of some farmers may need to be improved through efficiency enhancing policies (e.g., through education and extension programs) and others may require improvement through technological progress (e.g., through investment in R&D). Thus, the results of this study have important policy implications for improving the productivity and development of the agricultural sector in Botswana.

1.5 Structure and Approaches

This thesis is divided into seven chapters. The first two chapters provide an introduction to the study and the contextual background information pertaining to the agricultural sector in Botswana. The empirical analyses are structured and presented in self-contained essays delineated by specific objectives, methodological approaches and contributions.

Chapter 2 provides background information on agriculture in Botswana and its contribution to the economy. Some of the relevant policy reforms that were introduced to develop the sector are also discussed. We also briefly review the studies that have been undertaken to assess the performance of the agricultural sector. Some of this background information will be repeated in each individual chapter to provide a contextual background for the empirical analyses being presented.

Chapter 3 attempts to examine and revisit the measurement of agricultural productivity in Botswana using an updated data set and more advanced method of analysis which allows for the decomposition of TFP components. TFP is calculated using the Färe-Primont index which allows for decomposition into various measures of efficiency change (technical, scale and mix efficiency) and technical change.

Chapter 4 examines the sources of efficiency, productivity and output growth in agriculture in Botswana and explores the possible reasons for the decline in productivity. A stochastic distance frontier approach is employed using panel data from six regions for the period 1979 to 2012. The use of non-parametric approaches, such as that used in chapter 3, does not allow us to directly include the environmental variables (such as farm characteristics, policy, and other socio-economic factors) that influence productivity in

the model. In this chapter, to address some of the model deficiencies in chapter 3, a stochastic output distance function and inefficiency effects model is applied. We estimate technical efficiency and the effect of exogenous variables including policy programs and diversification and use regional dummies to account for regional differences.

Chapter 5 examines the technical efficiency of extensive beef farms in different regions of Botswana and attempts to explain differences in regional performance in terms of environmental and economic constraints. Using a panel dataset of 26 agricultural districts (distributed across six agro-ecological regions) for the period 2004 to 2012, technical efficiency indices are estimated using the stochastic production frontier framework. Firstly, standard production frontiers are estimated to obtain measures of efficiency specific to invididual agro-ecological regions. Secondly, a stochastic metafrontier production function is estimated to obtain measures of meta-technological gap ratios (MTR) between these different agro-ecological zones. Measures of technical efficiency can assist policy makers and extension officers in determining the scope of possible improvements to the productive capacity of farmers subject to existing technological constraints. By identifying regions with low levels of technical efficiency and their constraints, strategies could be formulated to improve not only their performance but also the competitiveness of the whole agricultural sector.

Chapter 6 measures the key performance indicators of beef cattle production systems in Botswana. The analysis is divided between traditional and commercial production systems which differ in terms of objectives, land tenure, technology and management practices. The two production systems face varying constraints and different resource endowments and opportunities for growth. We examine whether there are differences in productivity and production technologies between the two beef production systems. To make these comparisons a metafrontier approach is employed that enables us to measure the extent of technology gaps between the two production systems. This will help us answer the question of whether it is indeed the case that traditional beef farms really lag behind their commercial counterparts in terms of productive performance and production technology, as the literature shows. A comparison of the two production systems is of particular relevance to policy makers in Botswana given the ongoing policy efforts that

attempt to develop a more dynamic agricultural sector; where both commercial and traditional farms play a role in agricultural development.

Chapter 7 provides an integrating discussion and draws policy implications from the results of the study. Conclusions and recommendations for future research are also discussed.

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Chapter 2: Overview of Botswana Agriculture

2.1 Introduction

This chapter aims to highlight the features of the agricultural sector in Botswana and so serves as the backdrop to the empirical analyses that are presented in the following chapters. Some of the information presented in this chapter is repeated in each empirical chapter to provide contextual background pertaining to each individual analysis. The chapter is organised as follows: section 2.2 provides an overview of the geography of Botswana; highlighting the climate, soils, and vegetation and describes the six agro-ecological regions in the country. This is followed by a description of the agricultural production and land tenure systems; both commercial and traditional livestock and crop production systems are summarised. The importance of agriculture in the economy is summarised in section 2.4. Section 2.5 discusses the policy environment that agriculture operates within, and this is followed in section 2.6 by a literature review of studies concerned with measuring agricultural performance. The chapter concludes in section 2.7.

2.2 Geography of Botswana

Botswana is a landlocked country situated in Southern Africa with coordinates of 22° South latitude to 24° East longitude. It shares borders with Zambia in the north, Zimbabwe in the northeast, Namibia in the west and north and South Africa in the south and east (Figure 2.1). Botswana has an area of 582,000 square kilometres (approximately the size of France or Kenya) (SADC, 2011). The estimated population is just over 2 million people; and population density is unusually low at around 2.8 persons per square kilometre (Statistics Botswana, 2014). 90 per cent of the population is concentrated in the eastern and southern parts of the country, reflecting the economic opportunities existing there, with most mining, commerce and agricultural activities located in that area (BCA, 2012).

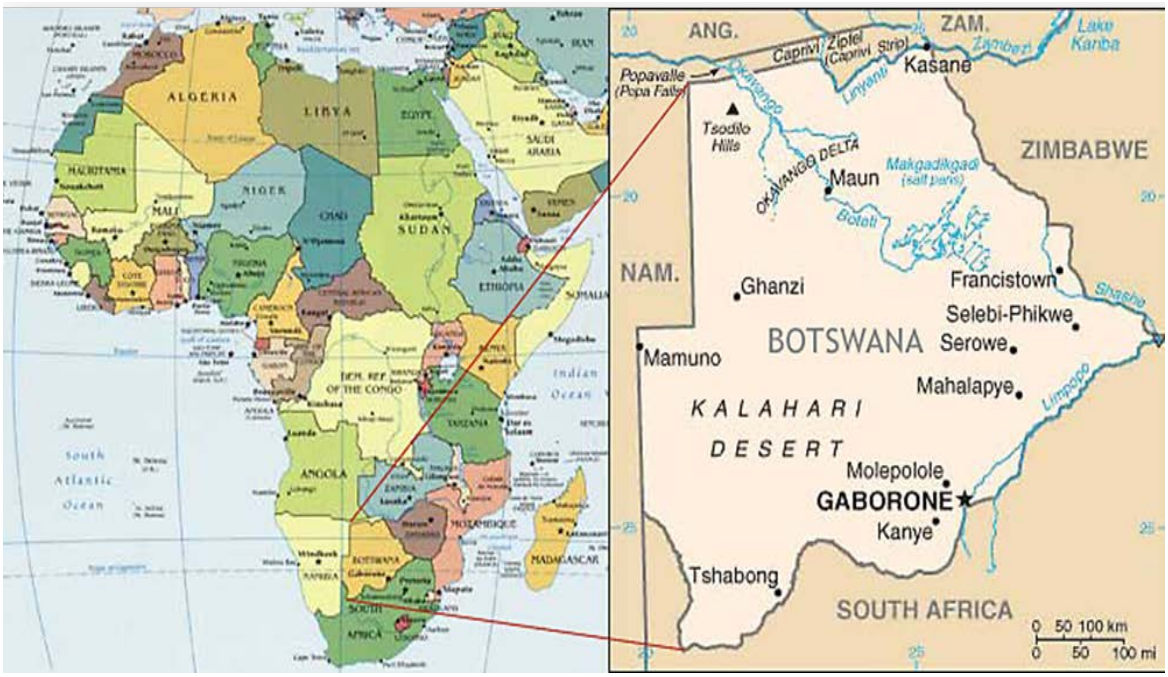

Figure 2.1: Map of Africa and Botswana

Source: Central Intelligence Agency (CIA) website

Botswana is a semi-arid country with average rainfall ranging from 650 mm in the north (Maun region) and 400 to 550mm in the east and south (Francistown, Central, Gaborone and Southern regions). The rainfall is seasonal, occurring mostly in summer months (November to April) (Statistics Botswana, 2013). Temperatures are extreme throughout the year; ranging from 0 degrees celcius to 20 in winter (May to August), and from 12 to 15 degrees celcius to 30 to 40 degrees celcius (September to October) and 25 to 30 degrees celcius during the rainy season (November to April) (Burgess, 2006). Humidity is very low, whilst annual evaporation is about 2000 mm, which exceeds annual precipitation by a factor of 4 to 8 (depending on the location) (Burgess, 2006).

The agricultural sector in Botswana is characterised by cyclic performance mainly due to fluctuating climatic conditions and low productivity (GoB, 1991; Yaron et al., 2012). Most parts of the country are disadvantaged by unfavourable environmental conditions and the performance of different sectors within agriculture is closely related to these conditions (Burgess, 2006; Yaron et al, 2012). A sharp decline in crop output in 2011 coincided with poor rainfall during that season which led to 2012/13 being declared a drought year (BoB, 2012). Similarly, the fluctuating and declining export performance of

the beef industry in Botswana has been associated with climate change phenomena such as droughts, flooding, desertification, and increases in veterinary diseases, pests and insect infestations (Yaron et al, 2012; DEA-CAR, 2007). In the 1980s (1983 to 1987) Botswana experienced one the worst droughts since independence (1966) resulting in approximately 1 million out of 3 million cattle dying (Burgess, 2006).

Several studies have been undertaken to assess the impact of climate change on agricultural production in Botswana (e.g., Batisani & Yarnal, 2010; Chipanshi et al, 2003) and Southern Africa (e.g., Zinyengere et al, 2013). Chipanshi et al (2003) examined the sensitivity of cereal crops (sorghum and maize) to global warming in Botswana. They argued that current levels of rainfed crop production were a small fraction of what could be produced under optimal conditions. The study attributed the production gap to both physical (especially lack of rain) and socioeconomic constraints. Batisani & Yarnal (2010) identified a trend towards decreased rainfall throughout Botswana, which is associated with decreases in the number of rainy days. They concluded that the drying trend and decrease in rainy days are a reflection of climate change projections for Southern Africa. Zinyengere et al (2013) provide a comprehensive review of studies on crop response to climate change in Southern Africa. Their results suggest that the aggregate impacts of climate change on crops in Southern Africa will be negative, with maize yields projected to decline by 18 per cent of the course of the 21st century.

The semi-arid environment in Botswana means that the vast majority of the land is better suited for the livestock sector than it is for arable agriculture (Thirtle et al., 2003). The area under crops varies annually since Botswana is no stranger to drought; in a fact it is a way of life, as it is present in some form, on average, seven out of every ten years, and in three of these seven years it is severe and widespread (Valentine, 1993). Even in good years the total crop area is only around 0.65 per cent of total land area in the country (Burgess, 2006). There is also a large disparity between areas planted and areas harvested in most years, since the harvest depends on rainfall during the growing season (Yaron et al., 2012).

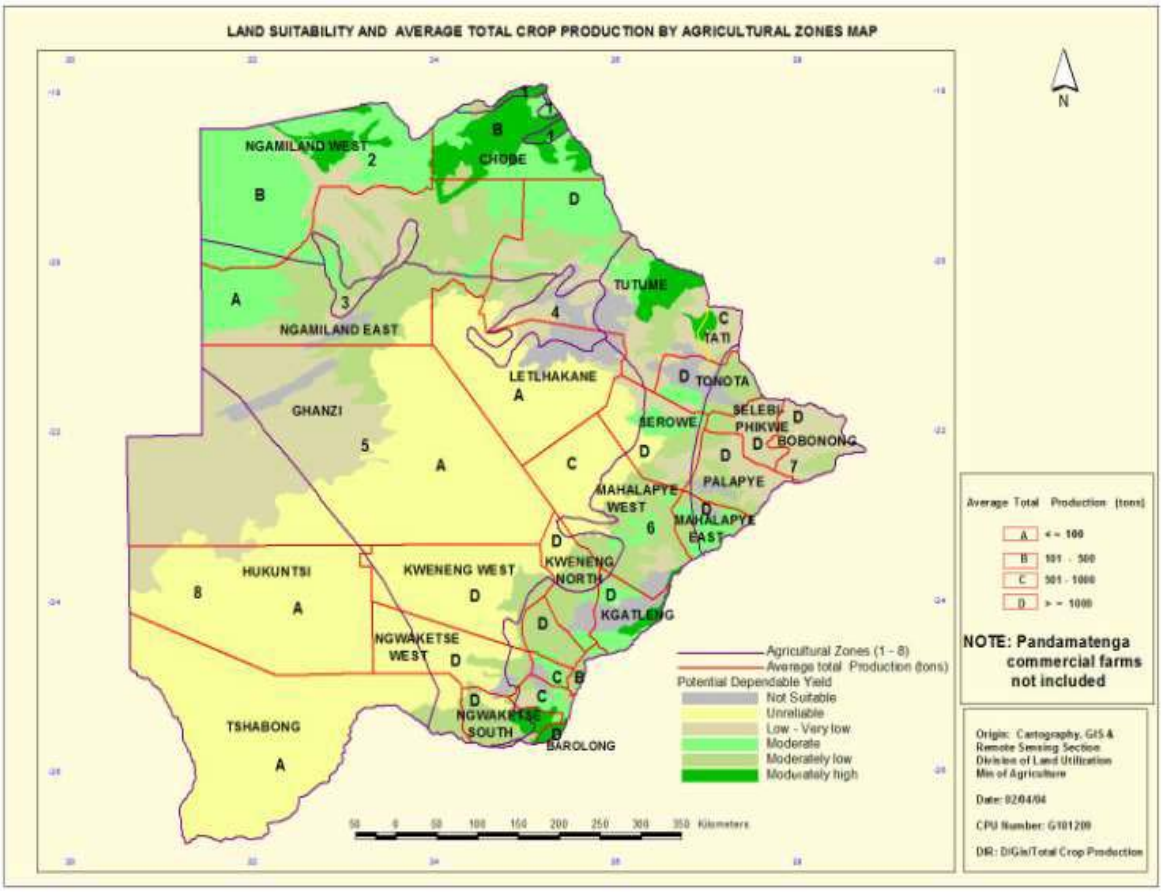

Figure 2.2: Agro-ecological Regions and Suitability in Botswana

Source: van Engelen et al. (2013)

Figure 2.2 shows the agro-ecological regions and crop suitability in Botswana. According to Tacheba and Moyo (1988) and Burgess (2006), the vegetation of Botswana can be generally categorised in three types, hardveld, Kalahari sandveld and Okavango Delta aquatic grassland. The western part of the country (Ghanzi, Hukuntsi and Tsabong agricultural districts) receives low and erratic rainfall (approximately 250 to 400 mm per annum) and is characterised by Kalahari sandveld vegetation, which has low phosphorus content (Burgess, 2006). Due to low and unreliable rainfall there are virtually no perennial rivers and lakes; water is mainly obtained by drilling boreholes. The soils in this region are unreliable for crop production, therefore only livestock production and game ranching are viable agricultural enterprises (DEA-CAR, 2007); cattle being the most dominant livestock followed by goats and small sheep farming (Statistics Botswana, 2014).

The eastern part of the country, which is made up of the Southern, Gaborone, Francistown and Central regions can be generally described as hardveld vegetation with better quality soils, receiving moderately higher rainfall than the western part of the country (Burgess, 2006). The hardveld grasses are generally of a higher nutritive value than those of the Kalahari sandveld (Tacheba & Moyo, 1988). The hardveld has some more fertile soils consisting mainly of sandy loams and loamy sands and generally vegetation contains adequate macro- and micro-elements that meet dietary livestock requirements relative to the sandveld. In these regions crop production systems are closely integrated with livestock production (i.e., animal draught power, manure supply and crop residue as source of animal feed). Chipanshi et al (2003) found that cereal crop production in Botswana varies between the hardveld and sandveld regions. Their results showed that yields declined by 36 per cent in the case of maize and 31 per cent for sorghum in the sandveld, whilst it reduced by 10 per cent for both maize and sorghum in the hardveld region. Also, the growing season tend to be shorter, the average reduction in days being 5 days and 8 days for maize and sorghum in the sandveld region, and 3 and 4 days over the hardveld region.

The northern part (Maun region) of the country receives the highest rainfall (500 to 650mm) in the country and is rich in vegetation (Statistics Botswana, 2013b). However, this region also has the highest density of wildlife and tree species; hence the majority of the region is composed of wildlife management and forest reserves. Human and wildlife conflict is common in this region and this has significant impacts upon subsistence farmers and consequently has implications for food security as problem animals destroy crop fields and kill livestock (Statistics Botswana, 2013b). For decades, Tsetse-fly has been a common problem to the livestock and human population in this region[3]. However, recently it has been successfully eradicated from more than 25,000 square kilometres of the Okavango Delta using aerial spraying (GoB, 2013). This region is also known as the "red zone" where buffalo carrying foot and mouth disease (FMD) reside (van Engelen et al., 2013). Cattle in this region are vaccinated to prevent infection and they cannot be moved to other regions or traded to other countries. Outbreaks of FMD and other transboundary diseases such as Newcastle and CBPP have had major implications for

[3] In humans it is responsible for transmission of trypanosomes which cause sleeping sickness in humans and acts as a constraint to increased livestock production.

rural livelihoods and the economy of Botswana since they both heavily rely upon beef exports to international markets (i.e., the European Union (EU) and South Africa) (Ransom, 2011).

2.3 Agricultural Production and Land Tenure Systems

2.3.1 Crop Production Systems

There are two types of farming systems in the arable sector, traditional and commercial (AFDB, 1994). The most dominant are small traditional farms (numbering some 80,301) with an average size of 5 ha, whilst there are about 114 commercial farms with an average area of 150 ha (Statistics Botswana, 2013a). Both production systems are mainly based on rainfed farming. In the traditional sector farm sizes are highly variable ranging from around 0.5 to 5 ha and are composed of small fields in areas of seasonal floodplains (with black cotton soils) which are mostly located in the Maun region. In these areas farmers plant grains and vegetables in the soil as it retains moisture at shallow depths within the root zone (Burgess, 2006).

Since the majority of the soils in the country are not suitable for arable farming due to deficiencies in plant nutrients and low organic matter content, only cereals, pulses and sunflower are grown, as they are better adapted to the harsh production environment (Seleka, 1991). Sorghum is mostly grown by the commercial sub-sector (predominantly located in the eastern and southern parts of the country) which accounted for 68.9 per cent of output in 2012 (Statistics Botswana, 2014). Sorghum is also an important crop grown by traditional farmers in the hardveld regions; Gaborone, Francistown, Central and Southern. Maize is grown mainly in the Maun region where there is greater rainfall than the rest of the country (Statistics Botswana, 2014) and in Francistown due to ecological adaptation (AFDB, 1994). Although maize is more vulnerable to extreme weather conditions it is popular among the traditional farmers because it is not vulnerable to quelea birds which often cause serious damage in sorghum fields. Beans and pulses are planted as intercrops throughout the country.

The traditional arable sub-sector occupies about 90 per cent of the country's cultivated area and grains contribute about two-thirds of sub-sectoral output (Statistics Botswana, 2014). Figure 2.3 shows the yield per hectare for the main crops grown by traditional crop

farmers for the period 1979 to 2012. The figure indicates that in the 1980s maize and sorghum yields were highest followed by millet and beans/pulses. However, this trend has been reversed since 1993, with millet achieving highest yields followed by sorghum, then beans/pulses. According to Sigwele & Orlowski (2015) the decline in yields of sorghum could be due to high labour demand for bird scaring, thus, farmers prefer crops such as maize which are not susceptible to bird damage. Moreover, "maize gives higher yields and is the preferred crop in good years but sorghum and millet are more drought resistant and dependable in low rainfall times" (CAR, 2005, p.39).

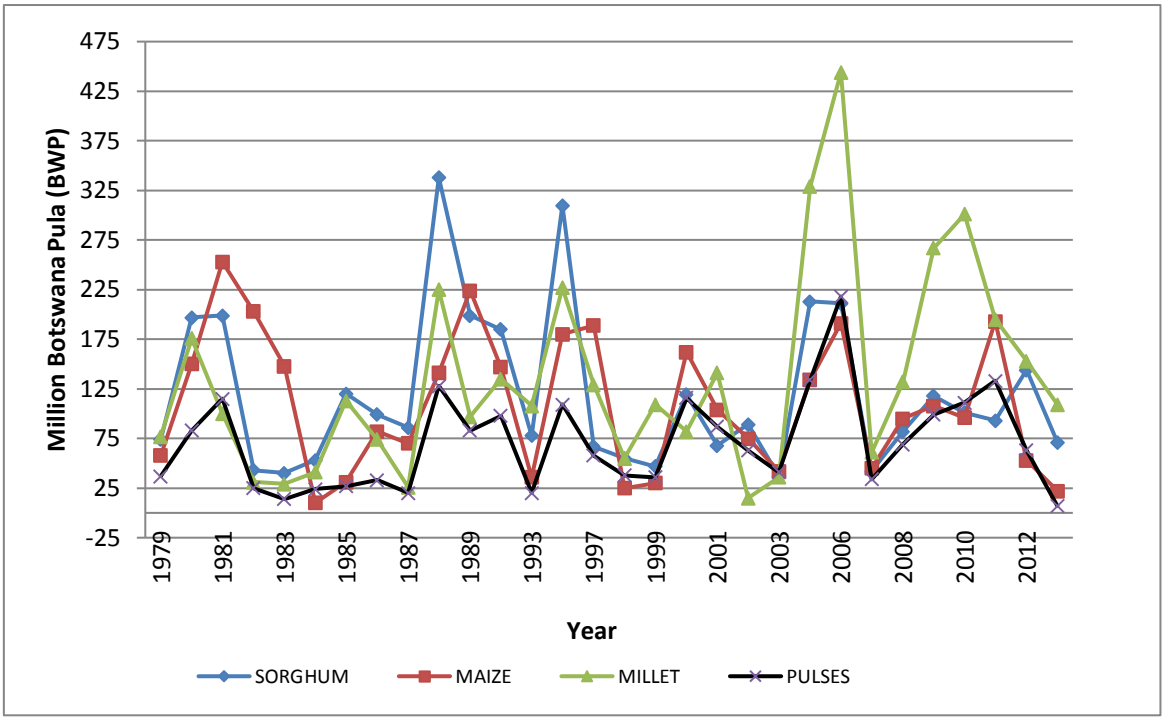

Figure 2.3: Yield per Hectare Planted (Kg/Ha) by Crop for the Traditional Sector (1979-2013)[4]

Source: Statistics Botswana (2015)

2.3.2 Livestock Production Systems

Pastoral land includes virtually all land outside national parks and forest reserves and thus livestock is able to utilise the majority of this rangeland for grazing (CAR, 2005). The livestock sector is dominated by traditional production with output comprised of cattle, sheep, goats, donkeys/mules, horses, pigs, ostriches, chicken and others. However, amongst the majority of households, the most common livestock outputs are cattle, goats

[4] Note that, Data for 1991, 1992 and 1994 are not available, as there was no survey report for those years.

and sheep (Statistics Botswana, 2014). Based on the 2012 Annual Agricultural Statistics data (Statistics Botswana, 2014) the number of cattle per region relative to the other livestock (goats and sheep) was higher in four out of six regions (i.e., Central, Francistown, Maun and Western). In the southern part of the country (Gaborone and Southern) - also the most populated part of the country with better access to infrastructure and services - households tend to keep a similar number of cattle and goats. Sheep rearing is also popular in the Southern, Gaborone and Central regions whilst the other regions have no significant sheep population.

Figure 2.4 shows that over the 34 year period there have been some fluctuations in the livestock population. For example, the 2012 agricultural season (a season of lower than average annual rainfall) (Statistics Botswana, 2013b) recorded a decline in livestock population when compared to 2011. Between the two seasons, cattle population fell by 12 per cent, goats by 7 per cent and sheep by 0.7 per cent. During the 2012 season, the proportion of farms that undertook livestock production was dominated by goat rearing at 69 per cent, followed by cattle at 63 per cent and sheep at only 15 per cent. The popularity of goat rearing is attributed to the fact that they are cheaper to maintain and are more drought resistant when compared to other livestock species (Alexandre & Mandonnet, 2005). Livestock disease outbreaks are a common occurrence in Botswana and they can have devastating effects on performance. During the 1994/95 season there was an outbreak of contagious bovine pleuro pneumonia (CBPP) which resulted in the slaughter of close to 320,000 cattle in the Maun region (CAR, 2005; van Engelen et al., 2013). The other prevalent disease affecting the livestock sector is FMD. Outbreaks are especially frequent in the Maun region of the country where the majority of wildlife areas are located.

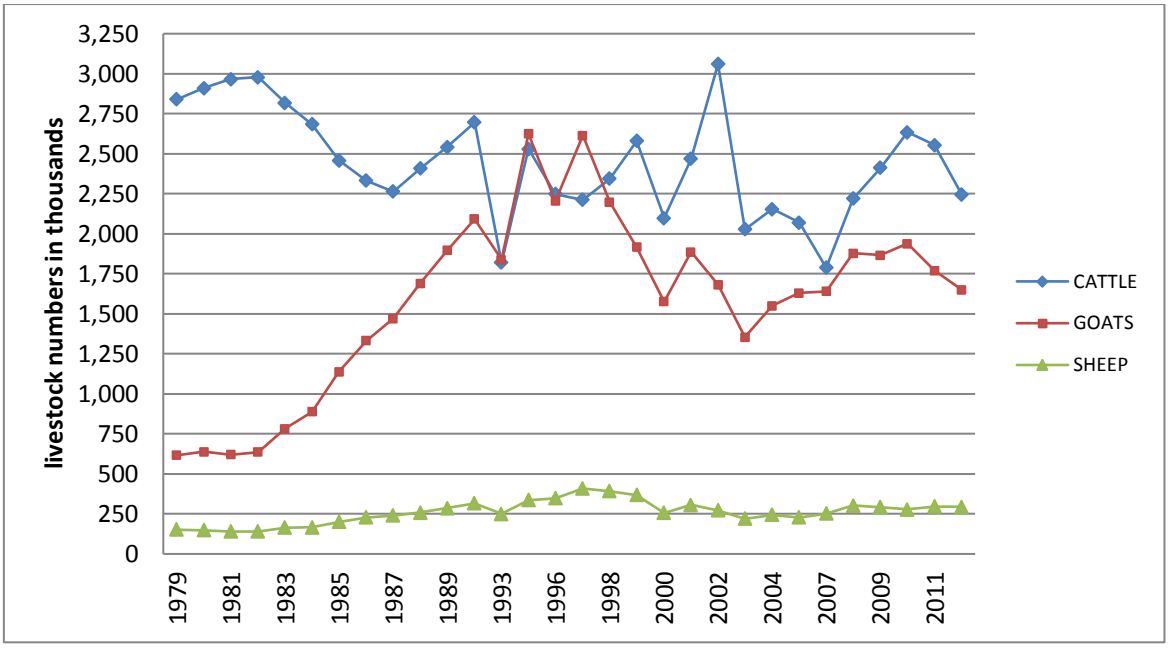

Figure 2.4: Livestock Population Trends, 1979 to 2014

Source: Statistics Botswana (2014)

2.3.3 Land Tenure Systems

There are three types of farm land tenure system in Botswana; communal/tribal, freehold and leasehold land (Cullis & Watson, 2005; Malope & Batisani, 2008). Leasehold land is defined by a lease agreement (normally 50 years, with an option to renew after the lease period) with a government authorisation; land returns to the state after a defined lease period, whilst freehold land is held in perpetuity (Burgess, 2006; Malope & Batisani, 2008). Conversely, under tribal land tenure, tribes are entitled to land for their own use and tribal land, fields and boreholes may be inherited from one generation to another, however, they do not own exclusive rights, the District Land Board can claim it when necessary (Burgess, 2006).

The majority of rural people live on tribal land and have three settlement patterns, cattle post (livestock rearing areas), village (mixed farming) and farmlands (arable production areas). Traditionally, most of the livestock farmers rear their large herds of livestock under the cattle post production system (DEA-CAR, 2007). 'Cattle post' production systems refers to a system that operates on unfenced rangeland where there is a central watering point and which are usually located at large distances from villages and arable crop production areas (Burgess, 2006). Although grazing rights are not exclusive farmers

normally have exclusive rights to water sources. In most parts of the country, individual or syndicates of farmers usually own boreholes which they use to provide pump water to their livestock (Malope & Batisani, 2008). However, in some areas where there is a shallow water table, such as river beds and pans, water is taken from hand dug wells. Although cattle post farmers can be generally described as subsistence oriented, they are also semi-commercial in that they produce for both selling and home consumption (CAR, 2005). 'Village' (grazing and arable production) are systems where small herds of livestock are kept around villages together with small scale crop farming. According to Burgess (2006) this system is commonly practiced in the north, northwest and eastern parts of the country where there are seasonal and perennial rivers. In these areas arable land is fenced and once crops have been harvested livestock are permitted onto the land to feed on crop residues. 'Farmlands', are usually located far away from livestock production areas and in some areas are unfenced (CAR, 2005). These are temporary settlements which farmers usually relocate to from their villages and establish temporary residence during the cropping or rainy season (November to March) for ploughing, sowing, weeding and general upkeep of their crop farms and harvesting. The farmers usually return to their respective villages after harvesting their farms.

The freehold land system involves permanent and exclusive ownership of land by individuals. This makes up about 5 per cent of Botswana's total land area and includes some of the most valuable agricultural land (Malope & Batisani, 2008). Predominantly this land tenure system is utilised by commercial livestock farmers with areas ranging from 1 to 20 ha for small stockholders and from 1,600 ha to 10,000 ha for cattle ranches (Burgess, 2006). Commercial farms are usually fenced; practice rotational grazing, supplementary feeding, controlled breeding, and vaccination (van Engelen et al., 2013). They usually sell directly to the abattoir or cattle are sent to feedlots for finishing and then abattoirs afterwards for slaughter (Burgess, 2006). According to van Engelen et al. (2013, p. 55) the importance of ranching has declined over time; in the 1980s ranches accounted for 30 per cent of the national cattle herd but now account for only 10 per cent. This decline can be mainly attributed to the erosion of the profitability of cattle production (van Engelen et al., 2013). Nevertheless, it has been found in previous studies (Burgess, 2006; van Engelen et al., 2013; Thirtle et al., 2003) that the commercial (ranch) system performs

slightly better than the traditional (communal) in terms of technical productivity indicators.

Table 2.1: GDP Contribution (per cent) of Agricultural Subsectors, Constant Prices

Year	Crops	Livestock	Other	Discrepancy[5]	Total Agriculture
1994	6.1	65.3	29.8	-1.2	100
1995	5.5	62.4	32.1	0.0	100
1996	15.5	57.4	27.5	-0.4	100
1997	7.9	62.0	31.2	-1.1	100
1998	1.8	65.1	33.4	-0.2	100
1999	2.8	55.5	36.3	0.4	100
2000	7.5	62.2	29.6	0.6	100
2001	1.6	68.6	29.7	0.1	100
2002	8.5	60.2	31.1	0.2	100
2003	5.1	64.5	30.2	0.1	100
2004	2.6	71.0	26.9	-0.5	100
2005	6.6	66.7	29.0	-2.2	100
2006	6.3	63.9	32.2	-2.4	100
2007	2.8	63.4	35.8	-2.0	100
2008	6.9	57.6	35.6	-0.1	100
2009	8.0	51.6	40.6	-0.2	100
2010	8.3	57.4	32.8	0.9	100
2011	12.9	43.3	42.7	1.2	100
2012	11.6	46.8	40.6	1.1	100

Source: Sigwele & Orlowski (2015)

2.4 The Role of the Agricultural Sector in the Economy

Table 2.1 presents the contribution to GDP of agricultural sub-sectors for the period 1994 to 2012. The dominant agricultural sector is livestock production which is estimated to have contributed 46.8 per cent to agricultural GDP in 2012. The reason for this dominance is that most livestock produce is sold into the international market (mainly to the EU and South Africa) and hence revenues are greater than that possible for those outputs that are sold into domestic markets. The next most important category is “Other” which is composed of poultry and horticulture enterprises - amongst others. The share of this category has increased from 23 per cent in 1994 to 41 per cent in 2012. The growth of “Other” has contributed to the decline in livestock’s contribution to agricultural GDP from

[5] A statistical discrepancy refers to the adjustments that need to be done to equate the income and expenditure approaches to measuring gross domestic product.

74 per cent in 1994 to 55 per cent in 2011. Traditional crops (i.e., sorghum, maize and millet) contribute less than 10 per cent over most of the period. Beef is the largest livestock enterprise making up an average 46 per cent of the total livestock population. During the period between 1972 and 2009 beef and beef-by-products contributed an average of 10 per cent to total export earnings and were the most consistent and leading source of non-mineral exports (Statistics Botswana, 2010).

Despite the fact that arable agriculture only contributes about 10 per cent to agricultural GDP, government continues to recognise that arable agriculture remains a major source of employment and income for the rural population by continuing to invest in its development. This is because crop production is vital for many poorer people and it is the single most common productive activity among rural households (Irz & Thirtle, 2004; Thirtle et al., 2003). Society in Botswana is very hierarchical in terms of the nature of production relations, and the distribution of resources amongst farmers is also extremely unequal; with almost half of farmers owning no cattle at all, whilst the politically well-connected have accumulated large herds (Thirtle et al., 2003). The proportion of rural households without cattle has increased from 28 per cent in 1980 to 46 per cent in 1999 (Malope and Batisani, 2008). Conversely, ownership of small stock animals (goats and sheep) is more evenly distributed and it is estimated that three out of four households own goats (BCA, 2012). There is a strong link between cattle rearing and arable production and so amongst traditional farmers access to oxen for ploughing is essential (Valentine, 1993). Therefore, both agricultural subsectors are important economically and socially to Botswana.

Since half of the total national population still resides in rural areas and about half of this population largely depends on farming for its income, the government views agriculture as a key component of rural economic growth and development (BCA, 2012). However, in the last 40 years agriculture-led growth has not played as an important role in reducing poverty and transforming the economy of Botswana as have minerals and other sectors. Table 2.2 shows that the contribution that agriculture makes to GDP has continued to decrease over recent decades from an impressive 42.7 per cent at independence (1966) to around only 2.8 per cent in 2012, which makes it one of the least important sectoral contributors to GDP (BoB, 2014). For the period 2009 to 2010, in the wake of the 2008

global economic crisis, this declining trend was slightly reversed as agriculture grew faster than mining (at 34 per cent vs. 22 per cent), resulting in agriculture accounting for 2.9 per cent of GDP in 2010 (van Engelen et al., 2013). According to van Engelen et al. (2013) this growth was driven in part by government support programs. However, for the period 2011 to 2012 agriculture is estimated to have grown by only 6.3 per cent (this is despite that the output was negatively affected by poor rainfall that led to 2012 being declared a partial drought year) and this was following a sharp contraction (-22.4 per cent) in 2011, (BoB, 2014) [6].

Table 2.2: Share of GDP (per cent) by Economic Activity - 1966 to 2012

Economic Sector	1966	1985/86	2008	2009	2010	2011	2012
Agriculture	42.7	5.60	2.50	2.90	2.90	2.50	2.80
Mining & quarrying	0.00	48.9	26.1	13.9	24.5	24.7	19.6
Manufacturing	5.70	3.90	5.60	6.40	5.90	5.80	5.90
Water & electricity	0.60	2.00	0.90	0.40	0.40	0.20	-0.40
Construction	7.80	4.60	4.90	6.20	5.40	6.00	6.80
Trade, hotels and restaurants	9.00	6.30	13.2	15.4	14.0	14.7	15.3
Transport	4.30	2.50	4.04	5.50	4.80	4.90	5.70
Financial & business services	20.1	6.40	12.3	13.4	12.4	12.9	14.4
General government	9.80	12.8	14.4	17.0	14.3	13.8	15.1
Social and personal services	0.00	2.50	5.10	6.40	5.60	5.60	6.20
Adjustment items	0.00	4.40	10.7	12.4	9.70	8.90	8.80
GDP	100	100	100	100	100	100	100

Source: Bank of Botswana (2014) and Statistics Botswana (2010)

The development of mining and the associated emergence of an urban service economy have affected the output growth of agriculture (van Engelen et al., 2013). Figure 2.5 shows that economic sectors other than agriculture experienced growth rates of more than 5 per cent between 1974 and 2012, with Finance and Business Services, Mining, Trade, Hotels and Tourism and Transport and Communication recording the highest rates at 8.5 per cent and above. This sectoral disparity has led to high rural-urban migration (Ortmann & King, 2010). According to van Engelen et al. (2013) the growth of the urban sectors translates

[6] The contraction in mining output in 2012 was mainly due to the weak performance of the diamond sector, caused by lower global demand for rough diamonds (BoB, 2012). The negative output for the water and electricity sector in 2012 was affected by the highly-volatile patterns of domestic electricity production, and associated costs, due to challenges in commissioning of the Morupule B power station (BoB, 2012).

into a rise in absentee-owner management, where farms are left to be run by herd boys with little knowledge and limited resources with which to manage farms. Some economists have argued that improving agricultural productivity and/or income could reduce the incidence of some of the economic problems brought about by rural-urban migration (Ortmann & King, 2010).

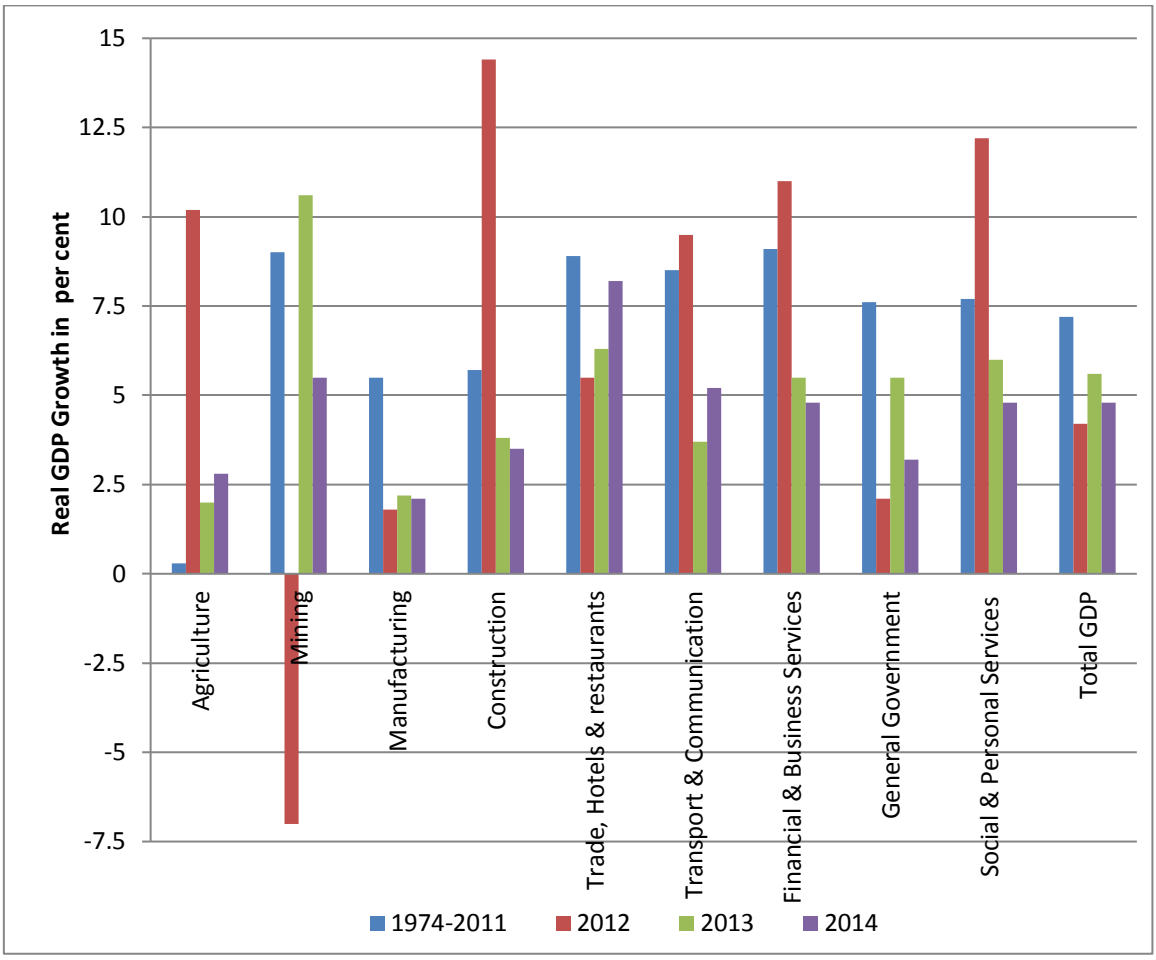

Figure 2.5: Real GDP Growth by Economic Sector (per cent), 1974 to 2014

Source: Bank of Botswana (2014) and Yaron et al (2012)

Statistics Botswana (2008) asserts that, since their discovery in 1970 and subsequent exploitation, diamonds have become the major contributor to government revenues. Diamond mining has meant that Botswana has been one of only a very few countries in the contemporary era that have experienced sustained, rapid economic growth over an extended period (Leith, 2000) (and furthermore, has been virtually the only African country listed amongst this select few). However, Thirtle et al (2003, p.606) state that, "*although the discovery of diamonds has rescued Botswana from its former position as*

one of the poorest countries on earth, mining provides little employment, so the wealth is not shared and the real importance is that [agriculture] is still the main source of income for approximately half the population".

Despite rapid growth of GDP per capita and aggregate poverty declining the fall in poverty has not been accompanied by a decline in inequality (Statistics Botswana, 2011). It is projected that revenues from minerals will no longer grow in the near future, the end of diamond production implies that public funds will not be as readily available as in the past (Basdevant, 2008; Sigwele & Orlowski, 2015). Therefore, it is important that agriculture and other labour-intensive economic activities are considered seriously as viable strategies for alleviating poverty and as a source of economic growth for the majority of the rural population (Basdevant, 2008; Botlhale, 2011). The linkages that agriculture has to the rest of the economy can generate patterns of development that are labour-intensive and favourable for the poor, whereas mining is capital intensive and employs a much smaller proportion of the workforce (MFDP, 2013; Sigwele & Orlowski, 2015).

2.5 The Policy Environment in Agriculture

Over the past four decades, Botswana has established a strong development planning tradition driven by the implementation of successive five year National Development Plans (NDP) and more recently, District Development Plans (CAR, 2005, p. 15). Simultaneously, a range of government policies and support schemes have been introduced to guide, boost and improve growth in different economic sectors (CAR, 2005). Much of the emphasis of these policies and programs are on labour-intensive sectors such as manufacturing and agriculture and comprise a high level of direct involvement aimed at improving productivity (van Engelen et al., 2013) and promoting self-sufficiency in food production (BCA, 2012). Thus, in essence, expenditures on these policies and programs are expected to diversify the economy from one based upon mineral extraction into other sectors (e.g., manufacturing, tourism, agriculture and services) that have the potential to contribute to reduction of poverty and inequality.

Government expenditure on agricultural schemes over the years is estimated to be equivalent in size to about 40 per cent of agricultural GDP, which is well above average

for a sub-Saharan African country (Thirtle et al., 2003; Irz & Thirtle, 2004; Fan et al, 2009). It is estimated that the annual budget of the Ministry of Agriculture has increased almost four-fold between 2006 and 2013, from about BWP105 million in 2006 to BWP209 million in 2008 and reached BWP407 million in 2013 (BCA, 2012; Sigwele & Orlowski, 2015).

Appendix 2.1 provides a summary (in the form of a table) which lists the relevant government policies and support programmes directed towards the agricultural sector that have been initiated in Botswana in recent decades, and which are described in more detail in the following sections.

2.5.1 Policy Reforms & Programs pre-2000

At the macro level, Botswana adopted a National Policy on Agricultural Development (NPAD) in 1991. As noted by CAR (2005) and MoA (2014), the NDAP objectives were to:

- Improve food security at national and household levels;
- Diversify the agricultural production base;
- Increase agricultural output and productivity;
- Increase employment opportunities for the fast growing labour force;
- Provide a secure and productive environment for agricultural producers;
- Develop and conserve scarce land and agricultural resources for future generations.

The following are some of the NDAP measures as summarised by CAR (2005, p. 18):

- Subsidies to be targeted in order to maximise net socio-economic benefits;
- Productivity would be improved through both; improvements in technology, and training of the agricultural labour force;
- Regarding crop production, more attention is to be given to non-conventional crops such as beans/pulses and the grapple plant;
- Need to facilitate the process of agricultural development though research, extension and provision of infrastructure;

- Fencing of grazing land where possible by individuals and communities after taking into account technical, socio-economic and environmental factors;
- Granting of exclusive rights to individuals, groups and communities.

Together with the NDAP the government formulated the National Food Strategy (NFS) which was an attempt to shift from food reliance to food security (MoA, 2014). The general objectives of the NFS were to: achieve a sustainable and broad based recovery in the arable subsector after drought; achieve food security at both household and national levels; ensure at least a minimum acceptable diet necessary for a productive and healthy life for all Botswana by progressively eliminating malnutrition, and; build up and maintain the national capacity to deal with drought and other emergencies (MoA, 2014). The objectives of the two policy strategies were to be achieved through programs such as the Arable Lands Development Programme (ALDEP), the Accelerated Rainfed Arable Programme (ARAP), the Irrigation and Water Development Project, the development of extension services, dairy improvement, the Zambezi Agro-commercial project and other agricultural projects funded under Financial Assistance Policy (FAP) (see, Appendix 2.1 for more details on this programs) (MoA, 2002).

According to BCA (2012) an evaluation of these programs shows that their effect in transforming the agricultural sector has been minimal. For example, it has been revealed that ALDEP did not significantly improve the performance of arable agriculture, whilst, at the same time, the cost of delivering the program was twice the import parity value of cereals (MoA, 2002). There are a number of reasons that have been put forward (BCA, 2012; MoA, 2002) to explain the failure of these programs, these include; untargeted support services - such as extension services, a lack of draught power and a lack of sector-wide strategies which in-turn led to disruptions caused by some policy interventions.

2.5.2 Policy Reforms & Programs since 2000

It is against this background that the Ministry of Agriculture modified its strategies into a revised National Food Policy Strategy (NFPS) in 2002, followed by the introduction of the National Strategy for Poverty Reduction (NSPR) in 2003. Unlike preceding policy strategy these new strategies had the broad-based aims of promoting commodities based

on comparative advantage and the provision of public goods such as infrastructure and research development (MoA, 2014).

One such program designed to achieve these aims is the National Master Plan for Arable Agriculture and Dairy Development (NAMPAAD) established in October 2002. The overall objective of NAMPAAD is to improve the performance of the agricultural sector and ensure economical and sustainable use of the country's natural resources (MOA, 2002). NAMPAAD has three main thrusts; development of large scale, mechanised dry land farming; promotion of irrigated crop production - where feasible (with treated wastewater and other non-portable water sources), and; dairy development (CAR, 2005; MoA, 2002). According to MoA (2002) food security remains the cornerstone of current agricultural policy and NAMPAAD in particular. Although NAMPAAD seems to be a recycled version of the past initiatives such as ALDEP, the MoA (2002, p. 2) note that it differs in that, "*it shifts from the current welfare oriented approach to a business oriented approach*". For example, its specific objectives are; to identify and target high potential production areas and plan their development, and to enable investors with viable agricultural projects to have access to finance from existing financial institutions including the Central Entrepreneurial Enterprise Agency (CEDA) (MoA, 2002).

Another notable program is the Integrated Support Programme for Arable Agricultural Development (ISPAAD) introduced in 2008 to replace ALDEP III and which was designed to address challenges facing arable farmers and the inherent low productivity of the arable sub-sector (MoA, 2014). The primary objectives of this program include: to increase grain production; to promote food security at household and national levels; to commercialise agriculture through mechanisation; to facilitate access to farm inputs and credit, and; to improve extension outreach (MoA, 2008, 2014). In the livestock sector, key support programs have included the introduction of the Livestock Management and Infrastructure Development (LIMID) programme in 1997 and LIMID II in 2010 (MoA, 2010). The objectives of the LIMID program as stated by MoA (2010, p. 2) are to: promote food security through improved productivity of cattle, small stock and Tswana chickens; improve livestock management; improve range resource utilisation and conservation; eradicate poverty, and; provide infrastructure for safe and hygienic processing of poultry meat.

The Mid Term Review of NDP 10 identified some areas of the policy that might help in enhancing the development of the agricultural sector. The strategies to be pursued included: a comprehensive FMD control strategy for better management of the disease, (this included establishing a robust surveillance system and establishment of a FMD control fund); emphasising the use of high yielding varieties for both rainfed and irrigated farming to facilitate improvement of the sector's productivity; and promoting the use of techniques that do not increase moisture loss such as minimum tillage, basin planting and mulching (MFDP, 2013).

At the macro level the introduction of the 10 per cent Value Added Tax (VAT) as a broad-based tax on consumption in 2002 was another important development. Although agricultural products and farming inputs were given special treatment through exemptions or zero rating, it is possible that the new tax policy might have negatively impacted farmers (MoA, 2014). Establishment of CEDA in 2001 and the Local Enterprise Authority (LEA) in 2004 have also extended support to agriculture by providing grants, low interest loans and support services to small, medium, and micro enterprises as well as providing training, market access facilitation, mentoring, business plan development and assistance with technology adaptation and adoption (MoA, 2014). Another significant policy change was the adoption of a crawling band exchange rate mechanism in 2005 which replaced the fixed peg regime and which was aimed at creating export price competitiveness for domestically produced commodities (BoB, 2012).

The other noteworthy development is the support that both the arable and the livestock subsectors receive at the market level through agencies such as the Botswana Agricultural Marketing Board (BAMB) and the Botswana Meat Commission (BMC). A revision of the BMC Act has been considered in recent years by parliament (van Engelen et al., 2013) concerning removing the BMC's monopoly. These efforts suffered a setback after Parliament deferred the billing (Dzimiri, 2014). The Minister of Agriculture has since revealed that efforts to amend the BMC Act to end its monopoly will resume as soon as BMC returns to profitability (Dzimiri, 2014). However, so far there is no indication that this debate has been resumed.

Various observations concerning the implementation and conduct of agricultural policies and support programs in Botswana have been summarised by several studies (e.g. CAR, 2005; van Engelen et al., 2013; MFDP, 2007; MFDP, 2013). Firstly, the policy programs are "one-size-fits-all", that is, they are national, and fail to account for different agro-ecological conditions in the country. Secondly, the support programs are mostly directed towards input provision. CAR (2005) argues that there is no evidence of a linkage between subsidies and agricultural output and some of the subsidies may have had negative effects on efficiency and productivity, implying that the motivation for improving productivity could be lower when farmers obtain subsidies. Thirdly, CAR (2005) also observes that agricultural policies and support programs are not adequately integrated into rural development planning and processes. Furthermore, agricultural policies and programs are not aligned to each other in order to maximise synergy between them (BCA, 2012). Therefore, there is a potential to fully exploit existing synergies to derive maximum benefits out of those initiatives. Fourthly, the revised policies do not significantly differ much from their predecessors. For example, FAP is a recycled and named CEDA; ALDEP was revised and implemented as ISPAAD.

Despite the development and implementation of this array of different policy strategies very little work has been done that evaluates how effective these have been in achieving their stated objectives. This study aims to contribute to this evaluation by measuring productivity, efficiency and growth of the agricultural sector during periods before and after the introduction of these policies.

2.6 Literature Review of Agricultural Productivity and Efficiency in Sub-Saharan Africa

This section provides an overview of the approaches, data used and the major productivity and efficiency scores in the literature of agriculture in SSA. The literature on agricultural productivity and efficiency in sub-Saharan Africa (SSA) has been receiving a lot attention in recent years (e.g., Alene, 2010; Fuglie, Ball, & Wang, 2012; Lusigi & Thirtle, 1997; Thirtle et al., 1995). In estimating productivity growth in the SSA countries, two competing approaches are used, Data Envelopment Analysis (DEA) (e.g., Alene, 2010 and Ni-Pratt & Yu, 2012) and stochastic frontier approach (SFA) (e.g., Avila & Evenson, 2010 and Fuglie & Rada, 2013).

Summarised in Table 2.3 are the findings from several studies that have used various approaches to estimate long-term agricultural TFP growth in SSA region. It is evident that, despite each of these studies employing different methods, there is a similar pattern of agricultural TFP growth for the region as a whole. The studies indicates a slow growth in the 1960s and 1970s, followed by a recovery in the 1980s and subsequent decades, but with long-term TFP growth averaging less than 1 per cent per year since 1961 (e.g., Alene, 2010; Lusigi & Thirtle, 1997; Thirtle et al., 1995). These findings are similar to some of the studies that are summarised by Fuglie, Ball, & Wang (2012) for an African context and Bravo-Ureta et al., (2007) and Coelli & Rao (2005) for world productivity perspective.

On contrary, other studies found exceptional TFP growth rates in African agriculture. For example, Lusigi and Thirtle (1997) estimated a TFP growth rate of 1.27 percent per annum for the period 1961-1991. Similarly, Alene (2010) obtained estimates using a sequential Malmquist method, which shows a growth rate of 1.6 percent per year for the same period, which is an unusually high TFP growth rates as compared to Nin-Pratt & Yu, 2012) who used the same method. Nevertheless, there is a collective evidence (as shown in Table 2.3) that supports the view that SSA agricultural TFP growth has been growing at an average below 1 percent per year.

The empirical studies on the main drivers of TFP growth in Africa provide mixed results with some studies indicating technical change (Alene, 2010) and others efficiency change (Fuglie & Rada, 2013; Lusigi & Thirtle, 1997; Mugera & Ojede, 2013). Lusigi and Thirtle (1997) found that technical change has been the main constraint of achievement of high levels of total factor productivity during the 1961 to 1991 period (Lusigi & Thirtle, 1997). Furthermore, it has been discussed that the recovery during the 1980s may not have been due to technical change, instead may be due to a combination of macroeconomic reforms and improved weather conditions (Fuglie & Rada, 2013; Lusigi & Thirtle, 1997). Indeed, Trueblood & Coggins (2003) found that the productivity gains were consistent with the domestic policy reforms that were implemented during that period. Similarly, Fuglie et al. (2012) found that low productivity has been caused by adverse resource endowments and poor governing institutions and policies which prevents sufficient capital accumulation for agriculture as an engine of economic growth. They placed a greater

explanatory weight on institutional and policy factors over adverse resource endowments, and were optimistic that the structural adjustments (policy reforms) introduced in several countries throughout the 1980s and 1990s would improve agricultural growth. As discussed above, there is evidence that agricultural production in SSA have been affected by distortions to agricultural incentives through both agricultural and non-agricultural policy measures. Thus, it is clear that policy reforms could be one of the most important factors that contribute to agricultural productivity and growth is the region.

Table 2.3: Review of Estimates on Agricultural TFP Growth for Sub-Saharan Africa

Author & Year of Publication	Period	Region/Country	Estimation Method	TFP	EC	TC
Fuglie & Rada, 2013	1985-2008	SSA (47 countries)	SFA	0.92		
		Botswana		-0.14		
		Zimbabwe		0.03		
		Namibia		-1.96		
Mugera & Ojede, 2013	1966-2001	SSA (33 countries)	Bias-Corrected DEA		0.53	
		Botswana			0.67	
		South Africa			0.47	
		Zimbabwe			0.33	
Alene, 2010	1970-2004	SSA (47 countries)	DEA	1.60	-0.20	1.80
		Botswana		0.30	-0.30	0.60
		Namibia		0.10	0.00	0.10
		South Africa		3.80	0.10	3.70
		Zimbabwe		0.8	-1.7	2.6
Avila & Evenson, 2010	1961-2001	SSA (47 countries)	Econometric	1.44		
		Botswana		-0.34		
		Zimbabwe		-0.78		
		Namibia		1.91		
		South Africa		2.96		
Nin-Pratt & Yu, 2012	1994-2003	Southern Africa	DEA	-3.99	-3.99	0.00
		Botswana		-0.50	-1.64	1.14
		Zimbabwe		-0.50	-1.64	1.14
Lusigi & Thirtle , 1997	1961-1991	SSA (47 countries)	DEA	1.27	1.15	0.91
		Botswana		1.35	1.09	1.43
		Namibia		0.00	1.48	0.00
		South Africa		1.34	0.00	1.33
		Zimbabwe		2.00	1	1.15

The productivity gains throughout Africa were far from uniform due to climatological conditions, macroeconomic policies and civil wars. Thus, countries did not perform similarly, for example, Lusigi and Thirtle (1997) found that countries which had been good or average in increasing levels of technical efficiency experienced poor technical change. There was also a large regional disparity in agricultural TFP growth amongst countries in Africa, with west and north African countries (i.e. better soils and good climatic conditions) dominating the frontier and the eastern and southern countries, with poorer conditions (except South Africa and Mauritius, with large commercial sectors) struggled to reach the frontier. Overall, few countries exhibited modest productivity growth (South Africa and Togo), while others showed no or even negative growth in TFP (Botswana, Somalia, etc.). Fuglie and Rada (2013) noticed that, only a few SSA countries appear to have achieved a sustained growth in TFP over the last 50 years whilst several have shown productivity regression. Kenya and Togo are cited as one of countries (other than South Africa) that has sustained a steady long-term growth in agricultural TFP since 1960s. The other countries that entered a sustained agricultural TFP growth path in the 1980s and 1990s are mainly from western Africa (Benin, Ghana, Malawi, Niger, Nigeria), with each country increasing its TFP by at least 40 per cent between 1981 and 2008 (Fuglie and Rada, 2013). These countries are in an area of good physical potential in terms of soil and climate. On contrast, moving into the Sahel, Burkina Faso and Mali have much lower productivities, as do majority of eastern and southern countries (Botswana, Namibia, Lesotho) where rainfall and soils are poorer.

When considering individual countries in Southern Africa (i.e. Botswana, Namibia, Zimbabwe and South Africa) which have similar agro-geographical conditions of semi-arid climate and soils, it is evident that their performance differed over the last three decades (see, Table 2.3). The literature review in Table 2.3 shows that the best performing country among the four countries is South Africa followed by Zimbabwe, Namibia and Botswana. South Africa has one of the most developed agricultural systems (commercial farms) that use modern inputs and technology in Africa, and in addition it has been the benchmark for most of the countries in Africa for many decades. Similarly, Zimbabwe, until the early 2000s (before the macroeconomic issues and civil unrest) it was one of the biggest exporters of agricultural produce in Africa. The TFP growth in Zimbabwe can be explained by adoption of the green revolution which also spread to the communal areas

(Thirtle et al, 1993). The least performing countries, Botswana and Namibia are characterised by low rainfall and unsuitable soils for cropping which makes them only suitable for livestock rearing, hence explaining their slower TFP growth. In the case of Botswana, for the period 1961-1991 Lusigi and Thirtle (1997) shows that it had a TFP growth of 1.3 % which is well above average for Africa (1.2%), however the other studies shows a slower growth since 1990s (e.g. -0.14 for the period 1981-2008 in Fuglie and Rada (2013) and -0.34 for the period 1970 to 2004 in Alene (2010)). These results shows that the productivity performance of Botswana agriculture during the 1980s implied by conventional approach was not sustained in the 1990s and beyond.

Thus, in conclusion there is evidence that agricultural productivity growth has improved in some countries that adopted new technology (South Africa, Kenya & North African countries) or have suitable agro-climatic conditions (West African countries). Whilst is a different story for those countries that have unsuitable climatic conditions (e.g., semi-arid countries such as Botswana, Namibia, Somalia and Sudan). The general picture for the African agriculture is that, technical efficiencies and TFP is affected by agro-ecological factors (which are not subject to decision-makers) such as rainfall and soil quality, market and institutional conditions or armed conflicts, any of which may have worsened over time in some countries and improved in others.

2.7 Review of Studies on Agricultural Performance in Botswana

The previous section provided a summary of the status of and trends in African agricultural productivity and its determinants and regional dimensions. It also attempted to place Botswana's agricultural performance in the regional and continental context. However, since Africa is made up of many countries with diverse agro-ecological and farming systems, it implies that different regions and countries faces different challenges and opportunities for agricultural development. Therefore, it is necessary to have studies that focus on a specific country and/or farming system for better identifications of agricultural interventions that increases productivity and maximise the effects of technological changes on growth. This section attempts to summarise some of the empirical studies of agricultural performance in Botswana. Generally, there are a few empirical studies that have evaluated the performance of agriculture in Botswana (e.g.,

Irz & Thirtle, 2004; Mahabile et al., 2005; Seleka, 1999; Thirtle et al., 2000; Thirtle et al., 2003).

2.7.1 Livestock Sector Performance Studies

Mahabile et al. (2005) applied a Principal Component Analysis and Recursive Regression Model to investigate factors influencing the productivity of livestock in Southern Botswana. They found that: farmers with commercial ranches with larger herds use more agricultural credit than smallholder farmers who rely on open-access grazing to raise cattle; and that herd productivity increases with greater investment in operating inputs and fixed improvements, and is therefore positively and indirectly influenced by secure land tenure (private farms). Therefore, the study concluded that secure land tenure is considered to be the most influential factor in promoting investment in, and productivity of, livestock in developing regions.

Recently, Bahta et al, 2015 applied a stochastic metafrontier approach to cross sectional data collected from three major livestock producing districts (South East, Chobe and Central). The study categorised beef farms according to farm type, namely cattle only farms, cattle and crop farms and mixed farms (i.e., beef, crop and small stock production). The results show that the more diverse the farms are, the more efficient they are. However, these studies have only looked at productivity of specific components of agriculture within specific regions. Thus, they fail to account for both spatial and temporal variations of productivity amongst farmers in Botswana across different agroecological regions and time periods.

2.7.2 Crop Sector Performance Studies

A paper by Seleka (1999) focusses on the arable sector. He used a growth rate and arable sub-sector production models to assess the performance of traditional arable agriculture for the period between 1968 and 1990. He found that cultivated area, output and yields rose by about 27 per cent, 120 per cent and 74 per cent respectively due to the implementation of the ARAP program. The study concluded that the ARAP program was effective in improving rural household food security and welfare (Seleka, 1999). However, the paper argues that the program was unsustainable since it involved phenomenal government expenditures and furthermore that during the post program

period, crop output has fallen as tractor use has no longer been financially viable for the majority of smallholder farmers without the government subsidies supplied by the program (Seleka, 1999). In the 1990-91 and 1991-1992 cropping seasons crop output severely declined as farmers' reduced cultivated area following the termination of the program (Central Statistics Office [CSO], 2006) and the government was forced to reintroduce the policy in modified format as, ARAP-DRAF, in the 1992-1993 cropping season (MOA, 2002). Seleka (1999) concluded that the challenge facing policy makers is to devise new ways of reversing current trends.

2.7.3 Agricultural (Crops and Livestock) Sector Performance Studies

The first study that considered the whole agricultural sector was a study funded by the UK Department for International Development (DFID) (Thirtle et al., 2000). A subsequent paper by Thirtle et al. (2003) applied a Malmquist TFP Index to calculate multi-lateral, multi-factor productivity (MFP) indices for agriculture in the 18 districts and the commercial sector of Botswana from 1981 to 1996. Thirtle et al. (2003) found that MFP grew at an average rate of 1.7 per cent per annum, led by the regions that specialise in livestock (i.e. the Western region in which there is almost no crop production) and the commercial sector (which tends to serve as a benchmark) which grew at well over 3 per cent per annum. This growth was attributed to technological change at 4 per cent per year but was offset by technical efficiency falling at 2.4 per cent per annum; as the commercial sector and the better regions exploited new technologies and infrastructure, whereas the less productive areas fell further behind the best practice frontier (Thirtle et al., 2003). These results reflect the country's comparative advantage in extensive cattle ranching. Because of drought in 1996, efficiency levels for the districts were lower still in all but the three districts in Maun region, which specialises in cattle and has water (Thirtle et al., 2003).

Irz and Thirtle (2004) used the same dataset as Thirtle et al. (2000) and Thirtle et al. (2003) but instead employ a stochastic input distance function approach to investigate dual technological development in Botswana. The paper presents indices of technical change, technical efficiency change and TFP changes, which provide a full account of the way in which agriculture has developed in Botswana. The study finds that the commercial sector was, on average, 6.9 times more efficient than traditional agriculture. The average of the

technology index for the traditional sector is 14.5 and with the biases of technological change taken into account there is technological regression in traditional agriculture of -2.88 per cent per annum, while the commercial sector technology improves at 1.42 per cent per annum (Irz & Thirtle, 2004). Their study shows that the commercial sector experienced stagnation in the first part of the period (1979 to 1991), followed by growth, as the government began major technological support projects. The commercial sector growth rate from 1987 is an impressive 2.7 per cent per annum[7], but for smallholders expensive government support schemes did nothing more than stop the regression of technology and there was no growth (Irz & Thirtle, 2004). They conclude that the impressive commercial sector growth rate is because it is made up of 97 per cent ranching enterprises which are less likely to be affected by prolonged drought and which have benefited from government programs which have concentrated on infrastructure improvements, such as drilling boreholes and improvements in stock and veterinary services (Irz & Thirtle, 2004; Thirtle et al., 2000; Thirtle et al., 2003). The study found that the regions with a reasonable proportion of arable agriculture (Central, Gaborone, Francistown and Southern) do not perform as well as the specialised cattle ranching areas, which is not surprising given their soils and climate.

Overall the empirical literature on the performance of agriculture in Botswana shows that, despite all the efforts by government, agricultural productivity has actually declined over the study period. Irz and Thirtle (2004) and Thirtle et al (2003) concluded that districts (and regions) that are more dependent on crops are more vulnerable to adverse climatic conditions. Similarly, they indicated that the past agricultural policies have not been successful in efficiency terms and have made little contribution to the process of economic development. These policies seem to amount to providing safety nets for the smallholders and ameliorating many of the effects of the harsh and variable climate, but the lack of technological progress in the traditional sector suggests that there is little scope for improving the technologies of the resource poor (Seleka, 1999; Thirtle et al., 2003).

van Engelen et al. (2013) argue that despite considerable investment this has had only a limited impact on the productivity and efficiency of the agricultural sector and that

[7] This is during the same period that most SSA countries adopted new agricultural policies and experienced improvements in productivity over the period 1961 to 1991, with a growth rate of 1.27 per cent per annum (see Lusigi & Thirtle, 1997).

increased food production in the long term will have to come mainly through improvements in production efficiency and appropriate reorganisation of existing agricultural policies. This conclusion is similar to that of O'Donnell (2010, p.527), who argues that, "*in the future if populations continue to grow and natural resource stocks continue to be depleted, growth in agricultural productivity will become increasingly important for maintaining the environment and improving standards of living*". These studies conclude that efficiency is a very important factor for productivity growth, especially in developing countries where resources are meagre and opportunities for developing and adopting better technologies have lately started dwindling (Irz & Thirtle, 2004; Thirtle et al., 2003).

Despite the fact that agricultural performance in Botswana has been previously explored there is a need to conduct further research in this area. Firstly, because previous studies were conducted around ten years ago and many developments have since taken place; such as new government support schemes (e.g., NAMPAAD, ISPAAD and LIMID) and the introduction of new technologies in farming such as tractors. This new study thus provides a timely update on the current state of affairs.

2.8 Conclusion

This chapter presented background information on agriculture in Botswana. It described the country's geography covering climate, soils, vegetation and by describing the six agro-ecological regions. The agricultural production and land tenure systems; both commercial, and traditional livestock and crop production systems are summarised. Some important policy directions implemented by the government in order to improve the performance of the sector are also highlighted. This contextual information about the agriculture sector and a review of previous relevant studies provides the context for the empirical analyses in the subsequent chapters.

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Appendix 2.1: Summary Table of Agricultural Policies and Programmes in Botswana

Major Policy	Programs/Projects	Period	Target Sectors	Overview	Specific Objectives
National Land Policy	Tribal Grazing Land Policy (TGLP)	1975 to 1991	Livestock	The TGLP attempted to create a commercial highly productive livestock sector on leasehold land (tribal land) and to improve the development chances of smaller herds in the remaining communal areas.	1. To control widespread overgrazing by creating leasehold ranches and shifting large cattle owners and their herds out of the already overstocked communal areas. 2. To increase cattle productivity by practicing modern livestock management techniques. 3. To promote social equity and reduce the income gap between the rich and the poor by giving the poor more grazing land.
	TGLP Fencing Component	1991	Livestock	The TGLP programme was modified and expanded to cover all production systems. This programme allowed farmers, where feasible, to fence livestock farming land either as individuals, groups or communities to improve productivity of the livestock subsector and ensure sustainable use of range resources.	
National Policy on Agricultural Development (NPAD), 1991	Services to Livestock Owners in Communal Areas (SLOCA)	1979 to 2006	Livestock	Developed to assist livestock farmers in communal grazing areas. It was terminated and replaced by LIMID in 2006.	1. To provide small grants for livestock farmers and syndicates in communal areas 2. To set up demonstration facilities to provide a base for improved livestock management extension

	Arable Lands Development Programme (ALDEP)	1982 to 2008	Arable agriculture	This was the first major Government support programme to arable agriculture.	1. To improve household and national food security by expanding area planted, yields per hectare and fodder production. 2. To target farmers with less than 40 head of cattle (equivalent) and annual income of less than BWP20,000 and provide them with affordable production techniques such as row planting, fencing and use of donkeys instead of cattle draught power.
	Accelerated Rainfed Arable Programme (ARAP)	1985/86 to 1995/96	Rainfed agriculture	This program was initiated to provide inputs and financial assistance to all farmers (irrespective of their resource endowments) operating under rainfed conditions for ploughing, destumping, fencing, procurement of inputs, weeding and water development.	1. To increase arable production and promote employment creation 2. To provide inputs and financial assistance to all farmers (irrespective of their resource endowments) operating under rainfed conditions for ploughing, destumping, fencing, procurement of inputs, weeding and water development.
	Financial Assistance Policy (FAP)	1982 to 2001	Agribusiness	A grant subsidy scheme that covered a range of industries from agriculture to manufacturing, in which applicants were required to only contribute a small percentage towards the initial capital costs of the project.	1. To assist in diversifying the economy away from dependence on large-scale mining to other industries including agriculture and manufacturing.
	Livestock Water Development Programme (LWDP)	1988 to 2006	Livestock	A program to assist farmers with herds of 60 - 500 cattle and syndicates with a minimum of 60 head.	1. To provide a leasehold (TGLP) and communal farmers with once off funding (40-60%) to drill or equip boreholes in high cost and drought affected areas.

Revised National Policy on Agricultural Development (RNPAD)	National Master Plan for Arable Agriculture and Dairy Development (NAMPAAD)	2002	Rainfed agriculture, irrigated agriculture and dairy farming	A masterplan intended to streamline arable agriculture and dairy development programmes in addressing existing government policy objectives of food security, poverty alleviation and economic empowerment of rural people. Under this programme farmers were encouraged to form clusters so that they could share the costs of connecting to services such as water, electricity and telephone, thereby reducing per units costs.	1. To improve dry-land arable agriculture, irrigated agriculture and dairy farming through development of large scale mechanised dry-land farming, the promotion of irrigated crop production where feasible and the development of dairy. 2. To provide technical guidance and advice to farmers in order to enable and facilitate them to conduct their farming activities in a commercial manner. 3. To develop infrastructure facilities in production areas in the form of tarred and gravel roads and provision of electricity, telecommunications and water to cultivation units and horticultural farms. 4. To establish an insurance fund to cover lost crop and milk production values in years and specific regions declared as eligible for compensation.
	Livestock Management and Infrastructure Development (LIMID)	2007	Animal husbandry and fodder support	This program merged SLOCA and LWDP and covers animal husbandry and fodder support, borehole drilling and purchase, poultry abattoirs, poultry production (Tswana chicken and guinea fowl) and small stock.	1. To promote food security through improved productivity of cattle and small stock. 2. To improve livestock management and improve range resource utilisation and conservation. 3. To eliminate destitution by providing resources for the poor. 4. To provide infrastructure for safe and hygienic processing of poultry products.

	Livestock Management and Infrastructure Development (LIMID) II	2010	Animal husbandry and fodder support	In September 2009 the Ministry of Agriculture reviewed the LIMID programme to determine whether it was realising its objectives and to learn lessons towards improving it. The conclusion from the evaluation was that LIMID was relevant and beneficial to communities as it provided valuable support to farming operations.	
	Integrated Support Programme for Arable Agricultural Development (ISPAAD)	2008	Arable agriculture	To address the challenges facing arable farmers as well as the inherently low productivity of the arable subsector.	1. To increase grain production. 2. To promote food security at the household and national levels. 3. To commercialize agriculture through mechanisation. 4. To facilitate access to farm inputs and credit, and improve extension outreach.
	Central Entrepreneurial Enterprise Agency (CEDA)	2001	Agribusiness	Established to provide financial and technical support for business development with a view to promote viable and sustainable citizen owned businesses.	1. To provide subsidised loans for various sub-sectors within agribusiness in order to enable citizen participation in sustainable agricultural activities.

	Zambezi Integrated Agro-commercial Development Project (ZIACDP)	Under design stage	Commercial arable agriculture	The main aim of the project is to extract water from the Chobe / Zambezi River and to establish a viable commercial agricultural development, which will improve food security, diversify agriculture, and contribute to the country's GDP and create employment.	1. To establish a viable commercial agricultural development, which will improve Botswana's food security, diversify agriculture, meaningfully contribute to the country's GDP and create employment. 2. To increase the area under cultivation using irrigation water from Zambezi river.

Chapter 3: Agricultural Productivity, Efficiency and Growth in a Semi-arid Country: a Case Study of Botswana[8]

Abstract

This paper attempts to examine and revisit the trend in agricultural productivity in Botswana. Using secondary data from six regions of Botswana for the period 1979 to 2012, we estimate components of total factor productivity (TFP) using the Färe-Primont index. Estimates of technical change and changes in technical efficiency, scale efficiency and mix efficiency are obtained. The results show that the annual TFP has gradually declined over the period, which is predominantly due to a decline in technical efficiency and a slight decline in mix efficiency and scale efficiency. The regions with a significant proportion of arable agriculture performed worse than those that specialise in livestock production, thus confirming the comparative advantage of extensive livestock production in semi-arid countries such as Botswana. This study shows how the finer decomposition of TFP into different measures may assist in the identification of the main drivers of productivity and associated policies.

Keywords: Semi-Arid; Botswana; Färe-Primont Index; Total Factor Productivity; Mix Efficiency.

[8] Final published version.
Temoso, O., Villano, R.A. and Hadley, D. (2015). Agricultural productivity, efficiency and growth in a semi-arid country: a case study of Botswana, *African Journal of Agricultural and Resource Economics*, *10*(3), 192-206.

Chapter 4: Sources of Efficiency, Productivity and Output Growth in Botswana Agriculture

Abstract

Over recent years agricultural productivity in Botswana has declined, leading to a progressive increase in food imports. The main objective of this paper is to examine the sources of efficiency, productivity and output growth in agriculture in Botswana and explore the possible reasons for this decline. A stochastic distance frontier approach is employed using panel data from six regions in Botswana for the period, 1979 to 2012. Technical and scale efficiency change are found to be the main sources of productivity growth whilst technical change has been low. Slow growth of technical change reflects the semi-arid production environment; i.e. an environment categorised by poor soils, low and unreliable rainfall and high temperatures, and frequent outbreaks of disease such as foot and mouth (FMD) and contagious bovine pleuro pneumonia (CBPP). The region that achieved the highest total factor productivity (TFP) growth during the study period was the Central region, whilst Maun experienced the least growth. The decomposition of TFP growth into various components provides some useful insights into the role of government support programs in agricultural growth.

Keywords: Botswana, Stochastic Distance Frontier, Output Growth, Total Factor Productivity, Agricultural Policy

JEL Classification: D24, O13, Q18

This chapter has been removed as it is pending publication elsewhere.

Chapter 5: Performance Measurement of Extensive Beef Cattle Farms in Botswana[16]

Abstract

This paper examines the technical efficiency of extensive beef farms in different regions of Botswana and attempts to explain differences in regional performance in terms of environmental and economic constraints. Using a panel dataset of 26 agricultural districts (distributed across six agro-ecological regions) for the period 2004 to 2012, we estimate technical efficiency (TE) indices using a standard stochastic production frontier and meta-technological gap ratios (MTR) with a meta-frontier approach. The study finds that farmers use available technology sub optimally and produce far less than potential output. The average TE indices range from as low as 0.40 for Maun, 0.71 for Western and to 0.79 for the Southern region. The mean MTR also varies substantially across regions; high for Western (0.83), Southern (0.80) and Francistown (0.79) regions and low for the Maun region (0.39). A low MTR for the Maun region is attributed to the re-occurrence of FMD and human and wildlife conflict in this region, restricting the ability of farmers to fully reach their potential output. The results of this study have important implications for policy targeting. The study results allow us to identify the differences in productive performance between beef producers in each region of Botswana, and hence where policies to improve production technologies could be focused.

Keywords: beef production, technical efficiency, stochastic production meta-frontier

JEL Classification Codes: C23, D24, Q12.

[16]Final published version.

Temoso, O., Hadley, D., and Villano, R.A. (2015) Performance measurement of extensive beef cattle farms in Botswana, *Agrekon*, 54 (4), 85-108.

Chapter 6: Evaluating the productivity gap between commercial and traditional beef production systems in Botswana[18]

Abstract

The beef cattle production system in Botswana is dualistic in structure in that it includes both traditional and commercial production systems, which are distinct from one another in terms of objectives, land tenure, technology, and management practices. The purpose of this paper is to measure the key performance indicators of beef cattle production systems in Botswana and explore the drivers of change in those indicators. We examine differences in productivity and production technologies between the two beef production systems. The results show that traditional farms are technically inefficient and that their technology lags behind that of commercial farms. The use of improved breeds, off-take rates and selling to the Botswana Meat Commission (which control the only exporting abattoirs in Botswana) were found to improve technical efficiency in the commercial production system, but only off-take rates had a positive effect on efficiency in the traditional production system. Both farming systems have the potential to overcome technology constraints and achieve the highest attainable productivity level through improvements in; beef cattle technologies, farmer capacity in production and marketing, and the effectiveness of the technology transfer process.

Keywords: Beef production; Productivity; Technical efficiency; stochastic metafrontier; Botswana

[18] Final version accepted for publication.
Temoso, O., Villano, R.A and Hadley, D. (2015) Evaluating the productivity gap between commercial and traditional beef production systems, *Agricultural Systems* (forthcoming).

Chapter 7: Discussion and Policy Implications

7.1 Introduction

This chapter concludes the thesis by summarising the findings of the analysis reported in Chapters 3 to 6, listing the policy implications implied by these findings, noting the limitations of the analysis, suggesting directions for future research and finally, providing some concluding comments.

7.2 Summary of Findings

This study attempts to investigate the patterns of agricultural productivity, efficiency and growth in Botswana using well established and newly developed productivity and efficiency measures. To address the research questions outlined in Chapter 1 the thesis was divided into seven chapters. The first two chapters provide an introduction to the study and the contextual background information pertaining to the agricultural sector in Botswana. The empirical analyses are presented in Chapters 3 to 6 and are structured and presented in four self-contained essays which are delineated by specific objectives, methodological approaches and contributions.

The first objective of this study was to revisit and update measures of the productivity of agriculture in Botswana using a current dataset and new approaches. Using a non-parametric approach, the results show that during the study period TFP declined at 1.35 per cent per annum. Whilst the findings from the parametric approach indicate that TFP growth was very slow at 0.23 per cent at annum for the study period. Thus, overall during the study period agricultural productivity in Botswana has either been minimal, or negative depending on the methodology used. However, when we focus on TFP change for the different sub-periods that coincide with either the implementation of major policy reforms or periods of disease outbreaks or drought both approaches exhibit similar trends. For example, both methodologies detect a large decline in productivity growth that occurred over the sub period 1996 to 2002, possibly due to a combination of drought and the impact of the CBPP disease outbreak. Similarly, both approaches show that the trend in productivity for the period 2002 to 2012 (after the second major period of policy reforms) improved slightly. This implies that the successful restocking of livestock in Botswana and the policies introduced during that period may have contributed to this slight improvement

in agriculture performance but not sufficiently enough to spur a large gain in productivity growth.

The second objective was to investigate whether TFP varies across Botswana's regions, which are characterised by different agro-ecological conditions and levels of economic development. The results from both the non-parametric and parametric approaches show that estimates of TFP growth vary from region to region suggesting that there is a scope for improving productivity by taking a differential regional approach to increasing efficiency. Both approaches show that Botswana's agricultural performance was led by the regions that specialise in livestock production; which is understandable given that soils and climate are generally more suitable for extensive livestock production than they are for arable agriculture.

The third objective was to examine what are the main sources of efficiency, productivity and output growth in agriculture and explore possible reasons for the decline in productivity. The non-parametric approach used in Chapter 3 shows that negative TFP growth was mainly due to declining technical efficiency. In contrast, the parametric approach measures a slow annual growth in TFP which is attributed to growth of scale efficiency and technical change. Thus, the two competing methodologies produce different results in terms of identifying the main components of productivity growth. There are two possible reasons for this. One is that in Chapter 3, we allowed for technological progress but restricted technological regress. In the context of agriculture in Botswana, the most important exogenous variable affecting production is rainfall and therefore an approach that accounts for adverse effects of weather in terms of efficiency decline rather than technical regress is recommended (which is achieved using the methodology undertaken in Chapter 4). The other possible explanation for this is that in Chapter 3 only TFP and its components are estimated, whilst in Chapter 4 the analysis explores both the components and determinants of TFP – insofar as we directly incorporated the variables that determine productivity into the model.

The fourth objective was achieved by undertaking the specific analysis of an important agricultural sub-sector - beef production – in order to re-evaluate its significance. We found that extensive beef farms in different agro-ecological regions in Botswana operate under

different production environments. The results suggest that farmers in the regions with a high metatechnology ratio (Western, Southern and Francistown) have effectively implemented livestock management practices to mitigate the productivity-reducing effects of an unfavourable environment, whilst in a region such as Maun interventions will need to go beyond livestock management practices if productivity is to be improved.

The last objective examined differences in productivity and production technologies between the two beef production systems (commercial and traditional) in Botswana. The results show that, as expected, both productive performance and production technologies are consistently lower in the traditional farming system than on commercial farms. On average, productivity and production technologies have been gradually increasing in both systems, especially for the commercial farms, where productivity grew by 106 per cent between 2004 and 2013, driven mainly by improvements in technical efficiency. Farms located in the Southern region; regardless of whether they are commercial or traditional farms tend to perform better than those from other regions. This is probably associated with their better access to nutritious vegetation and close proximity to Lobatse (which is the main marketing centre for beef export market). Beef farms under freehold land tenure are generally more efficient than those under TGLP land tenure. The use of improved breeds, high off-take rates and selling to the BMC (the only exporting abattoirs in Botswana) was found to improve TE in the commercial production system, however, under the traditional production system only off-take rates were significant.

7.3 Policy Implications

This study offers some useful information to policy makers that may assist them in evaluating the effectiveness of policies, and in the design of appropriate future strategies. The study results allow us to identify differences in productive performance between producers in each region of Botswana and the drivers of those differences, and thus where policies and technologies to improve productivity should be focused.

1. The results of this study shows that ability of farmers to alleviate constraints on agricultural production varies across regions and depend on the nature of the constraints they face. Despite this, current policy programs in Botswana are usually countrywide, and do not fully take account of the existing different agro-ecological conditions (CAR, 2005).

Therefore, in order to improve agricultural performance, technologies and support programs should be made more specifically relevant to local environmental conditions. One possible way to achieve this is through promotion of a community-based breeding approach, whereby instead of building central breeding facilities, genetic choices are taken to farms. This approach explicitly takes account of farmer's needs, views, and decisions, and involves their active participation (ICARDA, 2014). Success of such programs depends on the appropriate consideration of farmers breeding objectives and their infrastructure, and requires their participation and ownership of the process. The strategy is bearing fruits in Ethiopia, where resource poor sheep producers have been empowered to improve the genetic quality and productivity of their livestock (ICARDA, 2014).

2. Our results shows that the best perfoming agricultural regions in Botswana are the livestock specialsing regions. Arable agriculture faces big challenges in terms of availability of suitable soils and water. Reduction of risk remains a major area of potential development. Improvement in; forecasting (e.g., providing farmers with advanced climate and weather information that allows them to plan their activities in order to optimise their outcomes), the prevention, mitigation and recovery from adverse effects of natural disasters; and improving the institutional framework have a high potential to increase agricultural productivity (SADC, 2011). R&D that is oriented towards programs concerned with adaptation and mitigation strategies to cope with climate variability and to increase the adoption of existing technologies may also play an important role (Sigwele & Orlowski, 2015). Greater investment in research that develops drought-resistant varieties, conservation agriculture practices, and other technologies could improve agricultural productivity in rainfed agricultural systems (Haddad et al., 2011; Van Duivenbooden et al., 2000).

3. The results show that both commercial and traditional farming systems have failed to attain their full potential productive capacity. Thus, there is potential to overcome technological constraints and achieve the highest attainable productivity levels through improvements in; beef cattle technologies, farmer capacity in production and marketing, and the effectiveness of the technology transfer process. However, existing extension services are said to be weak and do not match what is required for meaningful development of the industry (MFDP, 2007). The ratio of farmers to each extension agent is too large -

approximately 120 farmers per agent - and only a portion of their responsibilities are assigned to directly advise farmers through training or extension work (Sigwele & Orlowski, 2015). Hence extension services have not been fully effective, leading to slow dissemination of available technologies. Therefore there is need to appoint more livestock-production extension specialists with the objective of widening the scope of the advisory messages given to the farmers. Strengthening and improving the extension-to-farmer ratio may help the delivery of relevant and focussed training programmes and provide technological transfer and advice to farmers in a timely fashion. Moreover, the existing 36 livestock advisory centres (LACs) distributed across the country could play a significant role in the introduction of new technologies and practices (van Engelen et al., 2012). Recently, Sigwele & Orlowski (2015) found that access to mobile phones has partly assisted in communication between farmers and extension staff. Dissemination of information (e.g., weather forecasts, price information, etc.) through mobile and other technology could have a significant future role to play in informing farmers of current market, policy and agricultural technology developments.

4. This study has also attempted to link agricultural performance and policy reforms in Botswana. The summary of the agricultural programs provided in Chapter 2 shows that not all policies are harmonised; for example, NAMPAAD and ISPAAD are both attempting to improve agricultural productivity but there is a mismatch of objectives between the two policies. Moreover, policy reviews are usually conducted individually without recognition of synergies and possible conflicts between different programs. Therefore, macroeconomic and sectoral policy convergence and harmonisation has to be recognised as a prerequisite for accelerated agricultural and rural economic growth. Policy reviews should be conducted as integrated processes that ensure that related policies are properly integrated and harmonised to improve their efficiency and effectiveness. According to ICARDA (2014), "*dryland agricultural systems* [in North Africa and West Asia] *have evolved through an integrated approach that includes the right mix of innovative partnerships, diverse technologies, and appropriate policies*". Countries such as Botswana could learn a lot from such regions.

7.4 Limitations and Directions for Future Research

1. All discussion in this study has involved physical quantities and technical relationships of agricultural production. Due to unavailability of market or price information of production inputs and agricultural outputs, the study focussed on productivity measurement that is determined technologically and ignored those that are caused by market and behavioural conditions such as costs and profits. According to Coelli et al. (2005), if information on prices is available, and an appropriate behavioural assumption such as profit maximisation or cost minimisation is suitable, then performance measures that incorporate this information can be devised. One such measure of productivity that is determined by market conditions (e.g., transactions costs, risk, quantitative restrictions, and incomplete information) is allocative efficiency (Brümmer et al., 2006). Allocative efficiency "*reflects the ability of a firm to use inputs in optimal proportions, given their respective prices and the production technology*" (Coelli et al., 2005, p.51). Improvement in technical efficiency does not necessarily imply farmers are profitable, therefore, a combination of allocative efficiency and technical efficiency would provide a better measure of economic efficiency. Measuring allocative efficiency may give an indication of the effect of market oriented policies which attempt to improve - for example - market access, on farm productivity and profitability. Therefore, there is need for additional methodological and empirical studies to improve our understanding of the different drivers of productivity and profitability in Botswana in order to derive better policy options.

2. This study used district and regional level data which aggregates data from all farms in a given district and then into agro-ecological regions. The aggregation of farm level data inevitably leads to some loss of information. Ideally, the kinds of questions this thesis has been concerned with could be explored in much finer detail if farm-level data observed over a reasonable period of time could be employed.

3. Although attempts were made to account for various farm and regional specific factors and government institutions in the study; farm-specific factors (such as farm size, education and infrastructure) and government institutions (such as extension services and research development) are also significant in determining agricultural productivity. The effects of these variables on agricultural productivity will need to be investigated in future studies.

4. More empirical research needs to be done to investigate productivity and technological differences between the two beef production systems using farm-level data from the same agro-ecological region. Given the availability of such data there is then the potential to identify farmers according to the land tenure system they operate within (i.e., TGLP ranches versus freehold ranches) thus allowing investigation of the relationship between farm size, land tenure and productivity; on which the empirical evidence remains mixed. Results from such investigations may then lead to the better design and implementation of policy aimed at improving the productivity and competitiveness of beef farming in Botswana.

7.5 Overall Conclusion

The different analyses used in the thesis allow for the identification of the different drivers of productivity change in the agricultural sector in Botswana, as well as the measurement of differences in productive performance between districts, regions, sub-sectors and production systems. The main implication that arises from the results of these analyses is that; in order to improve agricultural performance in Botswana, support programs and technologies should be made relevant to local environmental conditions and should focus on targeting high potential areas and sub-sectors.

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