

Efficiency and financial sustainability of sugarcane Farmer Cooperatives in Eswatini

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Abstract

The economy of Eswatini is heavily reliant on the production of sugarcane. However, the 2015 drought, as well as the decision by the European Union (EU) to end the quota system for sugar has had deleterious consequences for the local industry. In Eswatini, sugar imports decreased by 13.5% during the 2016/2017 financial year. Another problem is that a third of Eswatini's sugar output originates from smallholder farmers who have experienced problems with sugarcane productivity in recent years. Therefore, to assist with future investment decisions, there is a need for continued assessment of the financial sustainability of the industry. This is imperative to enhance the productive efficiency of farmers and to improve their welfare. This study assessed the efficiency and operational sustainability of the 114 sugarcane Farmers Cooperatives (FCs) in The Kingdom of Eswatini from 2014 to 2017. The Stochastic Frontier Analysis technique, the Cobb-Douglas and the Translogarithm production functions were used to estimate technical efficiency scores. The results of the study showed that the sugarcane FCs are operationally self-sustainable, with an average technical efficiency of 83.69% (Translog) and 73.01% (Cobb-Douglas). The study identified operational sustainability, and access to grants and loans as significant contributors to improved technical efficiency. On the other hand, factors such as distance to mill, age and membership number were observed to have a negative effect on technical efficiency. Our recommendation is that government policy should focus on implementing caps on certain variables which have decreasing marginal benefit. Policy should also focus on how best to direct funding such that farmers' operating expenses are minimised. This could be done through continual development of cost saving infrastructure to allow farmers to utilise inputs to increase efficiency.

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Glossary of terms

DEA	Data Envelopment Analysis
Eq	Equation
Eswatini	previously known as Swaziland
EU	European Union
FA	Farmers Association
FC	Farmer Cooperative
FCs	Farmers Cooperatives
FSS	Financial Self-Sufficiency
GDP	Gross Domestic Product
Ha	Hectare
KDDP	Komati Downstream Development Project
LUSIP	Lower Usuthu Smallholder Irrigation Project
MFP	Multifactor Productivity
OLS	Ordinary Least Squares
OSS	Operational Self-Sufficiency
PFP	Partial Factor Productivity
RSSC	Royal Swaziland Sugar Corporation Ltd.
SACCOs	Savings and Credit Cooperative Organizations
SACU	Southern African Customs Union
SFA	Stochastic Frontier Analysis
SNL	Swazi National Land
SSA	Sub-Saharan Africa
SWAFCU	Swaziland Farmers' Co-operative Union
TFP	Total- Factor Productivity
VIF	Vuvulane Irrigated Farms

Chapter 1: Introduction

1.1 Background of the study

Agriculture continues to play a key role in the development of Africa. Since Africa has vast, rich and fertile land, agriculture is seen as one of the solutions to unlocking the potential of the continent. The World Bank has emphasised the importance of agriculture in contributing to the eradication of poverty (Terry & Ogg 2017). With the development of Africa being reliant on agriculture, it is imperative to ensure that the sector is productive and efficient.

A burgeoning human population has caused an increasing demand for income and lifestyle changes. Over the next 40 years, agricultural production will need to increase by 60% to meet population needs (OECD 2014). The G20 countries aim to implement public policy that encourages private sector to be more involved in agricultural productivity and economic growth (OECD 2014).

In Africa the focus for many years has been on strengthening the agricultural sector to address issues of poverty. There are arguments for and against a focus on agricultural growth. One long term view acknowledges that, to achieve growth and poverty reduction in Africa, there is a need to decrease reliance on lower-skilled labour. The lower-skilled labour needs to be transformed into higher wage-earning jobs (Collier & Dercon 2014). It has been stated that the difference between successful and unsuccessful countries is the speed in which there is a shift from agricultural labour to modern activities that generate income (McMillan et al. 2014). For the purposes of the study, 'modern activity' includes activities such as construction, mining and manufacturing. McMillan et al. (2014) showed that economic growth can occur when labour and other resources simply move from less productive to more productive activities even if there is no growth within the sector itself. Countries that move out of poverty and develop their economies are those that diversify and move away from being completely dependent on agriculture and other traditional products (McMillan et al. 2014).

Due to globalisation there has been a shift from high-productivity sectors (such as manufacturing) to low-productivity (agriculture) sectors in Latin America and Africa, which is the opposite direction to that experienced by Asia (McMillan et al. 2014). This shift could account for why economic development has been slower in Latin America and Africa. Collier & Dercon (2014) discuss a number of lessons we can learn from the rapidly-developing Asian countries. Firstly, countries should decrease the number of people in agriculture while increasing the urban and coastal population. Secondly, countries should decrease their rural populations and increase populations in urban and coastal areas. Finally, countries should increase labour productivity in the agricultural sector which, in turn will increase overall production.

Farmers that are reliant on subsistence farming are the most vulnerable as they lack the economic resources to respond to a changing climate (Meijer et al. 2015). Decreased soil fertility is reducing crop yield which has also caused a decline per capita food output. This means that Sub-Saharan Africa (SSA) contains the greatest population of undernourished people in the world. Meijer et al. (2015) estimated that 30% of people in the region are undernourished.

The most common problem faced by smallholder farmers in SSA is their poor maintenance of food security, which is exacerbated by low soil fertility, limited resources to make purchases, and the changing rainfall (Whitbread et al. 2010). In the assessment of productivity levels and trends, location is a key factor for consideration. Yields and outputs can be greatly influenced by weather, climate, soils and pest pressures and other location-specific factors (Alston et al. 2010). Climate change is a large threat to rural livelihood and its effects limit the development of smallholder farmers whose agriculture is mainly rain-fed (Nyanga et al. 2011).

It is important for us to consider where financial investment in agriculture is being placed. Most funding strategies have focused on the smallholder farmer in Africa. African agriculture has qualities of consisting of a small group of smallholder farmers supplying most the output with “with low yields, limited commercialization, few signs of rapid productivity growth, and population–land ratios that are not declining” (Collier & Dercon 2014).

The Kingdom of Eswatini, previously known as The Kingdom of Swaziland, is one of the smallest countries in Sub-Saharan Africa, landlocked by South Africa and Mozambique (Berresheim 2015). It is considered to be a lower- to middle-income country, and about 63% of its people live below the national poverty line (Mabuza et al. 2013). Eswatini also has the world’s highest HIV/AIDS prevalence rate. Eswatini’s agriculture sector has been said to support 75% of the population through sugarcane production, citrus fruit, vegetable crops, maize and other cereal crops, cotton, forestry and livestock production (Thompson 2007).

The government of Eswatini is a modern administrative structure. The Kingdom of Eswatini is Africa’s last absolute monarch (Terry & Ogg 2017), as stated in the 2006 constitution. The prime minister is appointed by the King and the structure has cabinet, bicameral parliament and ministries (Terry & Ogg 2017).

Sugarcane plays a significant role in Eswatini’s economy and contributes to 18% of the Gross Domestic Product (GDP). Eswatini is Africa’s fourth largest sugar producer. The current structure of sugar production is 77% large millers and estates, 17% large-growers, 5% medium-growers, and 1% small-growers (Burrow 2016). The sugarcane industry is considered to be a form of rural development in Eswatini. It has resulted in community-driven development which has facilitated the growth of the sugar industry (Terry & Ogg 2017).

The industry has grown to include subsistence and semi-subsistence farmers, through the consolidation of individual farms into commercial sugar farms (Terry & Ogg 2017) which are referred to as Farmer Cooperatives (FCs). This has been possible as a result of the Swazi National Land (SNL) structure which gives Chiefs *kukhonta* (the power to give land to the people in need). Land can also be inherited under this structure (Terry & Ogg 2017). This access to land has resulted in the inclusion of smallholder sugarcane farmers in the commercialisation of land that was under-utilised. This has led to the development of FCs, which has increased throughput for the mills (Dlamini & Masuku 2012). This, in turn, has improved Eswatini's competitiveness in the global market.

In 2014/2015 it was found that sugarcane accounted for 60% of agricultural output and 35% of agricultural wage employment of Eswatini. As stated by Singh et al. (2008), the main concern of sugarcane farmers is to ensure that there is higher sugarcane productivity and high sugar recovery (measured in sucrose levels) as this is expected to result in higher economic return. Malaza and Myeni (2009) mention that smallholder growers need to improve yield and sucrose content in order to maximise income (Dlamini & Masuku 2012).

In economies which are heavily reliant on one product, such as Eswatini and its reliance on sugarcane, assessment of efficiency and financial sustainability is imperative to ensure the eradication of poverty. Eswatini is reliant on the sugar export market offered by the European Union (Richardson-Ngwenya & Richardson 2014). A number of problems persist within the sugarcane industry in Eswatini such as high capital costs and lack of income generated, and this results in loans being taken out to pay dividends (Richardson 2012). Government has been required to alleviate capital pressure through rebates valued at E91 million. Grants for €3.8 continue to go into the sugar industry (Richardson 2012). Eswatini has been most affected by the 2015/2016 drought which has severely impacted the local sugarcane industry. The total area harvested has decreased by 1 265Ha.

Ownership by King and government has driven the sugar industry in Eswatini. The government structures are the biggest contributors to the growth of the industry. However, there is a need for cooperation from the smallholder farmers to further develop the industry and sustain the political legitimacy (Terry & Ogg 2017). Smallholder farmers have merged to form large groups of commercial growers, but Eswatini is still ranked as one of the ten lowest-cost producers of sugarcane in the world (Terry & Ogg 2017).

This study aimed at assessing the efficiency and financial sustainability of the sugarcane farmer cooperatives productivity performance. In an economy that is heavily reliant on sugarcane, ensuring adequate productivity is of utmost importance. The recent drought and changes in European Union (EU) policy have had a huge impact on the sugarcane industry. Therefore, to assist with future investment decisions, there is a need for continued assessment of the financial sustainability of the industry. This is imperative to enhance the productive efficiency of farmers and to improve their welfare.

1.2 Research problem statement

Research has shown that the allocation of inputs has not been optimal in the sugarcane sector (Azam & Khan 2010). The efficient use of inputs is imperative in countries like Eswatini that are highly reliant on sugarcane for the development of smallholder farmers in FCs. Fluctuations in input prices, interest rates and sugar prices have put pressure on the sugar industry to improve productivity and ensure its competitiveness (Malaza & Myeni 2009).

As stated by the CEO of the Eswatini Sugar Association, there is a threat to the “viability and sustainability” of operations due to the decrease in world sugar prices and the strengthening of the South African Rand (to which Lilangeni, Eswatini’s currency, is pegged) (APANews 2017). There has been an increase in production costs, including the cost of electricity and finance. The increased costs have a significant impact on FCs aiming to compete in the sugarcane industry. The CEO also stated that the 2018-2019 forecasts reflect a continual decrease in world market sugar prices due to world market production which currently exceeds consumption (APANews 2017). The main challenges facing the industry are the increasing input prices and the removal of preferential markets (Dlamini et al. 2010). There is, therefore, an urgent need to ensure the efficiency and financial sustainability of the FCs. This study analysed the key input variables of sugarcane cooperatives in Eswatini. To provide guidance on efficient allocation of funds to grow the industry this, in turn, could possibly result in poverty reduction and economic growth.

1.3 Research questions and objectives

Large financial investments, especially from the EU, are being funnelled into the development of the sugarcane industry in Eswatini. However, this sector is not showing the expected growth. Since the economy of Eswatini is highly reliant on this industry, there is a need to understand why there is no growth and how performance can be improved.

This research study explored the following research questions:

- a) What is the level of sugarcane production efficiency by sugarcane Farmer Cooperatives (FCs) in Eswatini?
- b) What is the effect of financial sustainability on the technical efficiency of sugarcane FCs in Eswatini?

The research objectives emanation from the research questions are;

- a) To examine the production efficiency of sugarcane Farmer Cooperatives (FCs) in Eswatini.
- b) To examine the effect of financial sustainability on the technical efficiency of sugarcane FCs in Eswatini.

1.4 Assumptions

The changes in EU policy and the 2015/2016 drought have had deleterious consequences for the sugarcane industry in Eswatini. There is a need for research to expand on previous productivity research conducted by Dlamini and Masuku (2012).

In relation to the input variables used there is a clear assumption that variables have no autocorrelation, multicollinearity and heteroscedasticity (Azam & Khan 2010) making all of them exogenous variables. The neoclassical production function is used in this study and it assumes that firms operate at an optimum level of technical efficiency (Khanna 2006). These assumptions do not hold due to socio-economic constraints, information gaps and non-price factors (Khanna 2006).

1.5 Significance of the research

Sugarcane is a main contributor to Eswatini's economy; therefore, an understanding of the productivity factors and how to improve outputs is imperative to grow the industry. Assessing financial sustainability is important to ensure economic growth of the country. There is a global recognition of the importance of investment into smallholder farmers, but there is a lack of understanding on how best to direct funding to ensure its expected influence on the macro economy. There are many other African countries that are also reliant on a single agricultural product or in the investment of smallholder farmers. Data emerging from Eswatini, as well as changes to policy, could be used to direct changes in other countries.

1.6 Constraints

One of the major limitations of this research relates to the poor accessibility of data. Only secondary data from the Ministry of Economic Planning in Eswatini has been used. This means that our results are based on one set of data which does not necessarily take into account all the input factors that could have an impact on the farmers. Since the study only used secondary data from the Ministry of Economic Planning in Eswatini, it is our recommendation that future studies conduct surveys to determine other factors which may impact farmers.

1.7 Organization of the study

This dissertation comprises five chapters. The current chapter, **Chapter 1**, has introduced the study by providing context and detailing significance and purpose of the research. **Chapter 2** provides a review of pertinent literature, methodology and theory around the assessment of technical efficiency, and also discusses cooperatives. **Chapter 3** details the research methodology and explains the process of data collection and analysis. **Chapter 4** provides a summary of the research findings. Finally, **Chapter 5** provides a discussion of the findings in relation to current literature, as well as recommendations and conclusions.

Chapter 2: Literature review

2.1 Introduction

This section begins with a description of the agriculture sector of Eswatini and the role it plays in the economy. In Africa, continual focus has been placed on the importance of investment in agriculture. Sub-Saharan Africa (SSA) has a number of countries that are highly reliant on agriculture for economic development. This research focuses on a discussion of Eswatini, a country of 1.4 million people and which is mainly reliant on agriculture, specifically sugarcane, for economic sustainability. The chapter provides an overview of the sugarcane industry in Eswatini, its operational sustainability, and the concept of cooperatives in the country. The section then discusses appropriate methods to estimate technical efficiency, and provide a summary of the empirical literature around efficiency of cooperatives.

2.2 Operational sustainability

Kimando, Kihoro and Njogu (2012) referred to sustainability as the ability of an activity to continue into the future using likely resources. When discussing financial sustainability this would be defined as an organisation's "ability to service all of its expenses through generated income" (Nthaga 2017). In order to maintain operational sustainability there must be financial sustainability (Nthaga 2017). Shah (as cited in Kimando, 2012) further suggests that the concept of sustainability includes the ability to mobilise local resources and obtain funds at market rate (Nthaga 2017). Iezza (2010) suggests that there are two levels of sustainability: operational self-sufficiency (OSS) and financial self-sufficiency (FSS).

OSS is determined by the ability of the "institution's operating income to cover its operating expenses, and FSS measures the extent to which the institution's costs are covered by its operating profits" (Nthaga 2017). OSS is determined using the multiple linear regression approach.

Another method to assess the financial sustainability involves focus on Net Revenue (NR). The main contributor to financial sustainability is NR generated to ensure continuity of production. Often, farmers access credit to enhance the resources and market opportunities (Khanal & Regmi 2018). Credit helps farmers gain purchase power for production inputs, and assists them in financing operating expenses and making profitable agricultural investments (Khanal & Regmi 2018).

2.3 Overview of agriculture in Eswatini

The Kingdom of Eswatini is a landlocked country found in SSA, and has a population of just over 1 million people. The economy's Gross Domestic Product (GDP) is 13% agriculture, forestry and mining sectors, 37% manufacturing, and 50% government and other services. Eswatini is a lower to middle income country but the majority of the income is held by the wealthy. This unequal income distribution means that 63% of Eswatini's population lives below the national poverty line (Kristensen 2017).

There are a number of factors which have contributed to the economic challenges in the country, including poor economic growth, high levels of poverty, a high prevalence of people living with HIV (42.6%), and decreasing public resources to address these issues (NationalAdaptationStrategy 2006). The lack of growth and poor provision of social services hinges on the high public services bill, high government expenditure and weak tax collection (European Union 2014). Approximately 70% of Swati people live below the E128-per-month poverty line.

About 55% of the wealth of the country is held by the wealthiest 20% of the population (NationalAdaptationStrategy 2006); 70% of the population are subsistence farmers and 10% of the employment occurs within the agricultural sector.

The aid provided in the 11th European Development Fund (EDF) is guided by aid effectiveness principles, Swaziland's Poverty Reduction Strategy and Action Plan (PRASP) and European Union (EU) Agenda for change (European Union 2014). The majority of the EDF has been designed to focus on the agriculture sector, which is seen to have the largest potential due to the favourable climate and abundant soil in Eswatini (European Union 2014). The EU has chosen to address the issue of food security by addressing institutional, production and marketing factors (European Union 2014).

In Eswatini, a major challenge is that the majority of foreign investment continues to be directed towards agriculture, specifically to the sugarcane industry with the aim of growing the economy. This continued investment was seen in the €134 million received from the EU in the "Aid for Trade" structure. This was allocated to the sugarcane industry even after EU reforms which would lead to decreasing sugar prices (Richardson 2012). The EU reforms decreased the demand for sugar, as the negative impact of sugar on health was highlighted, thus the continual investment into the industry by the EU is questionable.

In an economy where the majority of the population lives in rural areas, smallholder farming is seen as the best vehicle to address poverty. The manufacturing sector accounts for the majority of the GDP at 40%, of which the majority of the manufacturing is from the agricultural products refined in Eswatini (Kristensen 2017). Eswatini is reliant on the success of sugarcane to bring about development as this industry is the main contributor to regions and communities.

Of all commodities in Eswatini, sugar is produced in the greatest quantities (Table 2.1). This highlights the importance of the sugarcane industry for Eswatini's economy. The study is, therefore, vital to provide insight on the performance of the industry. This information, in turn might enhance policy and decision-making for the government. A large contributor to this industry is the smallholder farmers that have formed cooperatives to better participate in the market.

Table 2.1: Eswatini Agriculture Production Volume from 2014-2017

Commodities Produced	Year			
	2014	2015	2016	2017
Sugar (tons)	5,639,193	5,836,553	4,973,571	5,405,151
Cotton (tons)	1,820	873	87	647
Maize (tons)	101,041	81,623	33,460	84,344
Cattle (total slaughters)	50,041	55,842	75,200	47,811
Goats (total formal slaughters)	344	208	325	935
Sheep (total formal slaughters)	76	11	17	587
Eucalyptus(tons)	-	131,430	32,186	31,380
Pine(tons)	-	330,901	344,700	397,500
Citrus (tons)	38,678	38,223	34,314	33,171

Source: Eswatini Economic Planning - Macroeconomic Analysis and Research Unit database (collected from Ministry of Agriculture (MoA) reports)

2.4 Cooperatives in Eswatini

Porter and Scully (1987) define cooperatives as voluntary, closed organizations in which decision-making and risk-bearing are the responsibility of the members, while the manager (acting as an agent) is responsible for decision management. . There are a number economic theories relating to cooperatives, as summarised by Featherstone & Rahman (1996): Enke developed the profit-maximizing solution, Clark developed the price-minimizing or price-maximizing solution which is based on breakeven pricing, and Helmberger and Hoos suggested a situation where the member demand intersects average costs. There is still much debate surrounding the behavioural objective of cooperatives. Some authors, such as Cotterill(1982) and Lopez and Spreen(1985), model the structure of cooperatives around a collective optimizing a single objective, while other authors view cooperatives individuals pursuing their own goals (Featherstone & Rahman 1996).

Porter & Scully (1987, p494) summarise the characteristics of cooperatives which distinguish their structure from other organisations:

- *“Initial investment is divided amongst members based on a formula*
- *Residual value is divided based on a revolving finance system in which one part is based on patronage and the other part to the members with the oldest outstanding shares.*
- *Tax exempt if they earn zero profit*
- *Prohibited from earning capital gains*
- *Implicit restrictions on horizontal mergers and explicit on vertical integration”*

Cooperatives were originally established by farmers to assist with gaining access to markets, balancing market powers and creating a secured and sustainable income (Soboh 2012). The definition of a cooperative in the economics literature is “a (members)user-owned and (members)user-controlled organization that aims to benefit its (members)user” (Soboh 2012).

The members of the cooperative are the owners of farms and thus they determine the mission and strategy (Soboh 2012).

The Ministry of Commerce Industry and Trade in Eswatini define a cooperative as “an autonomous Association of persons united voluntarily to meet their economic, social and cultural needs and aspirations, through a democratically controlled enterprise”. Cooperatives date back to 1931 which is when the first Cooperative Proclamation was introduced. The Cooperatives proclamation was started in 1964 with the objective to promote rural development of indigenous farmers.

Currently, cooperatives are governed by the Cooperative Societies Act No. 5 of 2003. Between 1963 and 1968, agricultural farmers in tobacco, sugarcane, and pineapple were the main groups to register as cooperatives. In March 2000 the National Cooperative Development Policy was introduced as a basis for legislation, to guide stakeholders’ operations and interventions, and to integrate the cooperative movement. As of 31 March 2016, 446 societies have been registered.

Cooperatives in Eswatini are divided into 10 sectors: Savings and Credit Cooperative Organisations (SACCOs), Agriculture, Handicrafts, Consumer, Poultry, Service Providers, Industrial, Dairy, Livestock and Horticulture. The largest sector is made up of SACCOs (47%), and agriculture follows at 33%.

The farming cooperatives are represented by Swaziland Farmers’ Co-operative Union (SWAFCU) which is a body tasked with servicing its members, and lobbying the government, private sector and stakeholders. In 2016 /17, only 55 cooperatives were members of SWAFCU and there are still over 200 cooperatives which still stand alone.

The creation of cooperatives has offered a number of benefits including job creation, income generation, reduction of poverty and exclusion, provision of social protection, and representation in civic engagements (Hlatshwako 2010). Unfortunately, most of the jobs created have gone to men and, in terms of poverty reduction, there has been no significant impact on a national level (Hlatshwako 2010).

There has also been some criticism of cooperatives in Eswatini, and these have been associated with the collapse of the Central Cooperative Union (CCU), incomplete building projects of Savings and Credit Cooperative Organizations (SACCOs) and the failure of Asikhutulisane’s Sentra Supermarket (Hlatshwako 2010). The main challenges with the cooperatives in Eswatini are the lack of good management, lack of effective monitoring from the constituency, poor capacity building, incompetent staff resulting in high turnover, and a lack of accurate record keeping.

With a growing cooperative market in Eswatini, assessment of its impact is imperative to assist with poverty reduction.

As mentioned previously, sugarcane has been one of the larger industries with a growth cooperative structure which has fuelled participation of smallholder farmers.

2.5 Sugar industry in Eswatini

The sugar industry was started in the 1960's through an irrigation project and further supported by the Commonwealth Development Corporation. Most of the expansion occurred in 1968 after independence through the Royal Swazi Sugar Corporation, which is mainly owned by the Royal household. Eswatini's sugar industry is ranked amongst the most efficient in the world using 50 000 Ha of irrigated land to produce more than 650 000 tonnes of sugar per annum (NationalAdaptationStrategy 2006). More recently, growth has occurred through the participation of smallholder farmers in the market due to their access to SNL.

The reasoning behind the expansion of the sugar industry is based on the preferential treatment that the European market has given the sector by absorbing 150 000 tonnes of the sugar production. The challenges of the industry are the appreciation of the currency, decreasing demand for sugar (prices are higher), and the EU reform to the internal sugar market regime, which lowers the prices that Eswatini can obtain, resulting macroeconomic imbalance (NationalAdaptationStrategy 2006).

The EU reform was set to cause a price decline of 36% between 2006 and 2009, which would then stabilise for 10 years (National Adaptation Strategy 2006). The EU has continually been the main investor/donor into the sugar industry and has aimed to improve the industry's competitiveness (Kristensen 2017). Since many Swati people are reliant on sugarcane to keep them from poverty, the investment by the EU keeps the industry functioning. However, this structure also led to the creation of a dependency cycle, which is seen elsewhere in Africa. Investments from the EU mean this region benefits the most. That is, the EU is the first in line to have access to the sugar and also controls the price. This means that the sugar industry is almost entirely controlled by the EU. The EU provides capital for investment, creating demand for the product and then also dictates the price. This leaves Swati people reliant on the EU and the decisions made by the EU have a large impact on the whole industry. The October 2017 EU production quotas resulted in the EU becoming self-sufficient which has had a huge impact on the market. In particular, this has decreased the price offered to buy sugar from Eswatini. Eswatini forms part of the African, Caribbean and Pacific Group (ACP) which has a relationship with the EU. The EU provides a preferential market for sugar and unlimited export to the EU with no payment on import customs. Thus the production quota results in a decreased demand for sugar in the EU.

A third of the sugar output comes from smallholder farmers who have difficulty maintaining productivity. Farmers have had to transition into cooperative farming in order to benefit from economies of scale. This has proven to be difficult for the farmers (Berresheim 2015).

The National Adaptation Strategy was drafted in an attempt to address the fact that support for the sugarcane industry is imperative.

In particular, there is a need for:

“continuous productivity and efficiency improvement”, “viability of smallholder sugarcane farming will be ensured” and “the value of markets will be preserved, and where possible (preferential) market access will be enhanced” (National Adaptation Strategy 2006).

Investment by millers and Government has been put towards developing the smallholder sugarcane industry. As stated in the National Adaptation Strategy, government projects were expected to increase land used to plant sugarcane by 16 000ha over a 5 year period (NationalAdaptationStrategy 2006). The largest portion of agro-processing is in sugarcane-based industries which include sugar mills, distilleries of alcohol from molasses, refined raw sugar and bagasse or cane trash. The strength of the sugarcane industry hinges on its ability to remain competitive through efficient cane production and access to premium markets (NationalAdaptationStrategy 2006).

Exposure to high costs requires firms to restructure existing loans. Without this, smallholder farmers will not see the benefit from the implementation of measures to “improve yields, increase sucrose content and reduce seasonal costs” (NationalAdaptationStrategy 2006). In the current structure, the benefits of any improvements in production efficiency are not realised since the beneficiaries are the owners of the borrowed capital (NationalAdaptationStrategy 2006).

As seen in Table 2.2, the area under cultivation has stayed consistent at approximately 60 000 Ha from 2013 to 2017. Contrary to this, there was a decrease in area harvested and cane yield in 2015/2016 which is connected to the effects of the drought.

The largest decreases in production were seen in 2015/2016 and 2016/2017. The forecasted 2017/2018 figures still show the industry trying to recover slowly. The Kingdom of Eswatini has released the Komati Downstream Development Project (KDDP), Lower Usuthu Smallholder Irrigation Project (LUSIP) and the Vuvulane Irrigated Farms (VIF). These projects have been designed to lower poverty through improving irrigation systems which, in turn, will improve the productivity of farmers in Eswatini.

Table 2.2: Sugarcane Production from 2013-2018 in Eswatini

SEASON	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018*
Area under cultivation (Hectares)	59 586	60 078	61 073	60 757	59 504
Area harvested (Hectares)	56 438	58 138	55 557	56 737	57 570
Increase/Decrease in area harvested	1 910	1 700	-2 581	1 180	833
Cane Production (Tons)	5 639 193	5 836 553	4 973 571	5 405 151	5 985 924
Cane Yield (Tons/Area harvested)	99,99	101,18	89,52	93,6	104
Sucrose Content (% Cane)	14,38	13,95	13,97	14,01	13,95
Sucrose Recovered (% Cane)	12,18	11,91	11,78	12,03	11,94
Sugar Yield from Cane (Tons Cane/Tons Sugar)	8,21	8,39	8,49	8,31	8,38
Sugar Yield from Area (Tons Cane/Area harvested)	12,17	11,96	10,55	11,46	12,41
Sucrose Production (Tons)	810 836	813 966	694 951	757 480	834 889
Sucrose Production (Tons Tel Quel)	686 778	695 408	586 086	650 126	714 652

Source: Swaziland Sugar Association. *Forecast (July2018)

2.6 Cooperative efficiency: Theoretical framework

Neoclassical microeconomic theory highlights that competitiveness in markets creates the necessity for efficiency of firms (Sexton & Iskow 1993). Firms that have monopoly have been found to be both price inefficient, as price exceeds marginal costs, and technical inefficient, as large costs are spent to maintain power in the market (Sexton & Iskow 1993). When assessing the efficiency of cooperatives, Sexton and Iskow (1993) state there are three concepts that need to be considered: Technical efficiency refers to the ability to generate maximum output from set inputs, allocative efficiency refers to the ability to choose a cost minimizing method from a set output, and scale/price efficiency refers to the ability to choose the “correct” level of output (Sexton & Iskow 1993).

Porter and Scully (1987) and Ferrier and Porter (1991) attach the technical inefficiency of cooperatives to the principal-agent problem. This is an economic theory which is defined as “a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent” (William H Meckling & Jensen 1976). This structure may result in a misalignment of focus in which the agent may not act as a good representative of the principal’s agenda. This is apparent in the context of a cooperative because stock is non-transferable, ownership is diffused, and it is difficult to calculate the stock value. This causes poor monitoring of the cooperative by individuals (Sexton & Iskow 1993). This causes the “horizon problem” and scale inefficiency due to a lack of sufficient patronage (Sexton & Iskow 1993).

In contrast to this, efficiency of cooperatives can be created by the cost saving potential due to vertical integration. Klein, Crawford and Alchainstate (as cited in Sexton & Iskow 1993) state that this creates an opportunist environment for trade partners of the cooperative with sunken assets (Sexton & Iskow 1993). This benefit can easily be drowned by excessive costs to set up this opportunity. Staatz (1984) mentioned that the member-customer structure of a cooperative results in easier access to information to improve efficiency.

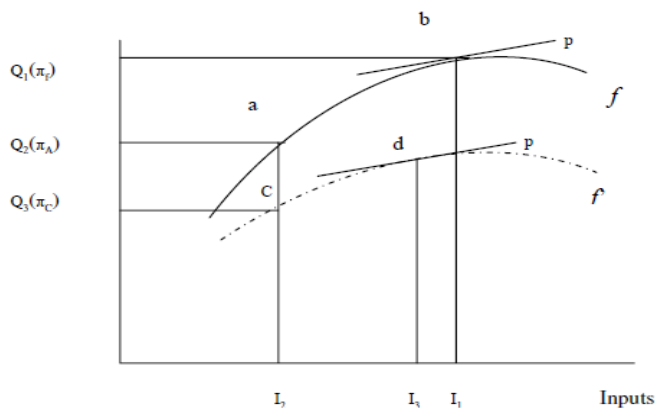
In order to assess the efficiency of cooperatives in the current study, there is first a need to discuss technical efficiency theory.

2.7 Estimation of technical efficiency

Farrell (1957) stated that productive efficiency is made up of both allocation efficiency and technical efficiency. Most often when aiming to improve efficiency, firms make changes to technical efficiency which is optimization of current resource usage rather than allocative efficiency which is recombination of resources (Huang et al. 2013).

A farmer is referred to as technically efficient if they have a higher output using similar input to a counterpart (Khanna 2006). Allocative efficiency is attained by a farmer if marginal cost of input is equal to marginal product of output (Khanna 2006). Both these terms form the foundation for the production frontier which reflects firms using best practice. As seen in Figure 1.1, a firm operating on f is considered to be economically efficient, by being both technically and allocative efficient (Khanna 2006). This would be a representation of the stochastic production function. Point b on the tangent line would be where a firm would be receiving a profit during operations; here the firm is only economically efficient. At point a the firm would still be receiving profits but lower than point b . Firms would often be on f' due to constraints, non-price factors and outdated production (Khanna 2006). When operating at point c , the firm would be allocative and technically inefficient. This production function is the neoclassical production function which displays a firm producing one output using multiple inputs (Khanna 2006).

Figure 1. 1: Production Frontier: Output Oriented



**Kalirajan and Shand,, 1999*

Source: Khanna 2006

Firms can achieve both technical efficiency and allocative efficiency without being economically efficient (Chiromo 2017). Chukwujietal (2006) states that economic efficiency is obtained through a combination of the resources using the least amounts of inputs combined in an aim to generate maximum output (technical efficiency) and the least possible cost to obtain maximum revenue (allocative efficiency).

During production, an accurate frontier will be unknown. Efficiency is measured as a comparison of actual performance and optimal performance using an approximation which is called the “best practice” frontier (Chiromo 2017). Just and Pope (1978) developed the concept that production functions can consist of stochastic elements which are beyond producers’ control as an addition to the classical inputs and outputs.

Due to the inefficient nature of production which can result in farms not operating on the frontier, Farrell (1957) introduced a deterministic measure of technical efficiency. Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) took the study further by including a cross-section of observations which acknowledge the possibility of inefficiency in the frontier. The stochastic production function, which was used for panel data in the current study, was introduced by Pitt and Lee (1981).

Based on neoclassical analysis, it presumes that business activities are driven towards maximising profit or minimizing costs, given set technology, input and output prices (Featherstone & Rahman 1996). To examine the production technology, parametric and nonparametric approaches are used. In the parametric approach, the specific functional form of technology is stated. The factor demand functions from observed data are then derived using a behavioural objective (Featherstone & Rahman 1996). This method accounts for random occurrences when collecting the data and tests the hypotheses (Huang et al. 2013).

The nonparametric approach has no functional form that is specified to represent technology. The first type of the nonparametric approach by Färe, Grosskopf, and Lovell (1985) compares firms to each other in a given year to measure technical, allocative, and/or scale efficiencies. Varian (1984) provided the second nonparametric approach which compares current input-output choices to those made previously.

This method is useful in assessing the consistency of observed data with the theoretic optimizing behaviour (Featherstone & Rahman 1996). This method cannot distinguish the influence of random error and measurement error, and it is subject to extremum (Huang et al. 2013).

The Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) are two of the most widely used techniques to assess efficiency in Economic Theory. DEA is a non-parametric method and the SFA is parametric.

Improving on the traditional DEA, the Bootstrap method of Simar (1998, 2000) “applies repeated self-sampling and deduces empirical distribution of DEA estimators which are consistent with actual values in loose conditions”. The Bootstrap-DEA method results in relative values through comparison of efficiencies of cooperatives with the best practices in industry (Huang et al. 2013). This study used SFA as Coelli (1995) stated that it deals with “stochastic noise and the incorporation of statistical hypothesis tests pertaining to production structure and the degree of efficiency”.

In developing the production frontier, there is a one-stage or two-stage approach. Battese & Coelli (1995) state that the one-stage approach estimates the parameters of the production frontier and efficiency scores and this occurs while controlling the factors which affect distribution of scores across the observations (Maietta & Sena 2010).

The two-stage approach starts with specifying and estimating the stochastic frontier production function, and predicting technical inefficiency effects (Battese & Coelli 1995). The final step in the approach is to specify the regression model for predicted technical inefficiency effects (Battese & Coelli 1995).

Most often, concepts designed to measure efficiency are designed around measuring output relative to measure of input (Alston et al. 2010). There are conceptual issues with this approach due to quality variations, changes in intensity of use, implicit aggregation over time and absent or missing data (Alston et al. 2010). All of these issues affect the output-input approach to measuring efficiency

In measuring efficiency, a certain number of inputs were used to estimate the output. If only one input is accounted for, the concept is called the partial factor production (PFP). Total factor production (TFP) is the opposite theoretical concept in which all the outputs are divided by inputs used to produce (Alston et al. 2010). Most often not all inputs are accounted for; therefore, the multifactor productivity (MFP) is used in a real world context (Alston et al. 2010). Often the data available for measurements is incomplete, inconsistent, inaccurate or inadequate (Alston et al. 2010), which makes the MFP a more realistic theory.

The Cobb-Douglas production function is the main economic tool used to assess productivity in agriculture. The function would most often be structured as follows:

$$Y = F(K, L) \tag{1}$$

$$Y = A \cdot K^\alpha \cdot L^\alpha \tag{2}$$

Equation 1 represents Y as the output produced, which is a function of both capital and labour. These are the most common input variables used to determine output. Equation 2 is an expansion of Equation 1. Here, technology is included as a factor to determine output level. Equation 2 also displays the interaction between input functions to predict what output (Y) would be. This would be the basic form of the function.

This has been explained in more detail in the Methodology, as this is the productivity measure that was used in the current study.

An alternative to the Cobb-Douglas is the Translogarithm (Translog) specification, as stated by Headey, Alauddin, & Rao (2010), which has been found to fit data better. The results of the Translog specification are more flexible in terms of the assumptions of the shape of factor shares and provides information on the interaction or integration effects (Oteng-Abayie 2017). The Translog relaxes restrictions on demand elasticities as well as elasticities of substitution seen in Cobb-Douglas functions (Oteng-Abayie 2017). Translog has been found to be more useful as it shows more information on interactive effects which can be used for policy making (Oteng-Abayie 2017).

Another approach would be the Malmquist TFP index which measures change between data points by calculating the ratio of distance relative to a common technology (Kumar & Anand 2015). This is a multi-input and multi-output approach assessing production technology with no specification of the behavioural objective, such as cost minimization or profit maximization (Fuglie 2012). Kumar and Anand (2015) used the ARIMA method to forecast productivity.

An assessment of 15 smallholder sugarcane growers in the KDDP region, from 2004 to 2011 was done by Dlamini and Masuku (2012). The Cobb-Douglas production function was used which showed that the farm size, labour, basal and topdressing fertilizer had a significant influence on productivity. Hussain and Khattak (2008) found that “the area under sugarcane, total fertilizer used, total pesticides and insecticides used, human labour, tractor labour and total seed cane used” has an effect on production. Based on these observations, the authors suggested that the Ministry of Agriculture and Cooperatives and private sector should intensify out-grower technical services. Furthermore, they suggested that in order to expand, the farmers would need to rely on economies of scale through increased access to land (Dlamini & Masuku 2012).

A stochastic frontier production function was conducted on the Vuvulane scheme and Big bend individual farmers to assess the technical efficiency in the VIF and the non-scheme farmers in Big bend (Dlamini et al. 2010). The stochastic model was chosen due to the fact that agricultural products are exposed to shocks, such as drought. The inputs used in the study were land area under sugarcane, fertilizer, herbicides and labour. The study also used the inefficiency model equation to determine technical efficiency and included socioeconomic, demographic, institutional and non-physical factors as variables. It was suggested that education would assist in improving productivity (Dlamini et al. 2010).

Masuku (2011) assessed the profitability of 124 smallholder sugarcane growers that supply to Simunye, Ubombo and Mhlume. Farmers were affected by their level of experience, change in sucrose quota, yield per ha, sucrose content and the distance of the farm to the mill. The study also found that small-scale farmers who lacked education and would need training and commercialization skills.

The author concluded that there needs to be switch from a commercialisation market to making farming commercially-oriented. Sugarcane can be rejected if farmers do not follow delivery schedules or if they have poor disease control. These issues can, therefore, also hinder productivity. The independent variables in the study included yield per ha, percentage change in growers quota, distance of farm and mill, sucrose content and farming experience (Masuku 2011).

Issues that persist are a lack of good management, no business training and low technical abilities. These can cause delays in obtaining cash to assist productivity as institutions do not trust that they will get their money back (Malaza & Myeni 2009). There is also the issue of increased food prices which is driven by structural change in supply and demand. Food prices can be high due to weather shocks, increases in energy prices, low interest rates and rising income in emerging economies (Binswanger-Mkhize & McCalla 2010).

Most recently the sugarcane industry was exposed to the effects of climate change. Eswatini is a country that is dependent on rain-fed agriculture and labour employment in the sugarcane industry (USAid 2018). Thus the severe drought resulted in decreased production.

A number of studies have assessed the micro-economic impact of the sugarcane industry in Eswatini. Smallholder farmers are mainly using SNL which has been a low contributor to overall GDP. This has been a concern for the government since independence in 1968 (Terry 2007). The majority of the research done shows the need for the smallholder farmers to increase productivity.

Most of the current agricultural investment is being directed to smallholder farms which have great potential for economic growth. Therefore, a study to assess their productivity is important. The research expands on the studies done previously by providing analysis on the smallholder sugarcane growers' efficiency and financial sustainability.

2.8 Empirical literature: Efficiency of farmer cooperatives

A number of studies have been conducted to assess the efficiency of FCs all over the world. This section discusses insights provided by previous literature, and highlights key methodologies and results.

Porter & Scully (1987) highlighted that the efficiency of cooperatives can be ensured through the accurate choice of objectives, and should be measured by equating the marginal benefits with the marginal costs of the cooperative. They also showed that is imperative to assess if the marginal cost of the cooperative is equal to social marginal cost. Using the frontier production function cost these authors analysed efficiency by comparing the property rights structure of proprietary firms and cooperatives. The study showed that forming a cooperative result in a number of costs due to the collective nature of decision-making and responsibility. The costs are seen through efficiency losses, non-optimal factor mix and technical inefficiency caused by the inherent weakness of the structure of property rights.

Sexton & Iskow (1993) found no evidence to support the notion that cooperatives are inefficient in comparison to investor-owned structures. Studies have failed to use theoretical definitions for economic efficiency. It is often difficult to collect data from cooperatives since issues pertaining to the confidentiality of information remain a challenge. As stated by Babb and Boynton (1981) benefits of services such as field service, market information, insurance programs and lobbying are often not considered when cooperatives are criticised. The conclusion is that there are limitations to the argument that cooperatives are inefficient.

Using a sample of 22 ginning cooperatives located in the San Joaquin Valley of California, Caputo & Lynch (1993) tested the hypothesis that a lack of technical efficiency was driven by overall inefficiency. The paper extended the non-parametric methodology “by subjecting the shadow prices of technical efficiency to nonparametric statistical tests” to strengthen the conclusions. Nonparametric methodology has a number of benefits. For example, there is no need for functional forms for the efficiency indices, and no need for distributional assumptions. Furthermore, it is possible to test technical efficiency and it is possible to compute individual gin-specific efficiency indices. One of the limitations is that technology is placed under the assumption that it has constant returns to scale. Furthermore, it assumes that firms have the same input prices in a season. Finally, the methodology has no uncertainty or measurement error (Caputo & Lynch 1993).

Sexton et al. (1989) conducted a study based on duality theory which tested for absolute price inefficiency and relative price inefficiency. Using this methodology, the authors were unable to identify which individuals are inefficient and the source of inefficiency. Final results showed the importance of a sensitivity analysis before making any conclusions or policy recommendations. Based on the study it is suggested that gin cooperatives need training programs to improve technical operations and decision-making processes (Sexton et al. 1989). Obtaining information on whether the technical inefficient cooperatives have risk management strategies in place would solidify the conclusions and recommendations (Caputo & Lynch 1993).

Ferrantino & Ferrier (1995) examined the Indian vacuum-pan sugar industry. The stochastic production frontier method was used to estimate firm-level average technical efficiency for panel data. The study found that efficient firms were smaller and those with access to sweeter cane were less efficient. The findings also suggested that inefficiency can be attributed to the transitory effect of the crushing season in which longer crushing seasons would result in increased efficiency (Ferrantino & Ferrier 1995).

Featherstone & Rahman (1996) conducted an analysis of the optimal behavioural objective (minimum cost and/or maximum profit) of agricultural supply and marketing cooperatives. They used deterministic and stochastic non-parametric tests and firm-level time series data. Data was examined to assess the cost-minimization and profit-maximization hypotheses. None of the cooperatives in the study adhered to the profit-maximization hypothesis when placed under the assumption of constant technology.

The profit-maximizing hypothesis would have been adhered to if the cooperatives were monotonic and if no regressive technical change was considered. In accordance to Clark (1952), all the cooperatives adhered to the cost-minimization hypothesis (Featherstone & Rahman 1996).

Sueyoshi et al. (1998) conducted a study to assess the bilateral performance of Japanese agriculture cooperatives. The DEA was chosen as the method of analysis. To measure the comparative advantage in terms of production and cost analysis, three indices were introduced: comparative production, comparative cost and the comparative cost reduction ratio. The study discussed the management problem facing the cooperatives. Results showed that there is no support of the current strategic assertion that larger operations are more efficient. Thus there is a need for regional integration to improve managerial efficiencies. The paper ended with a suggestion to widen the scope and include more Japanese cooperatives in future studies. This would likely provide more accurate policy recommendations.

Using data from the Great Plains grain marketing and farm supply cooperatives, Ariyaratne et al. (2000) found that large cooperatives are more x-efficient and scale efficient. In particular, the results showed that the cooperatives were 76% x-efficient and 89% scale efficient. The authors offered a number of recommendations. Firstly, there should be a focus on technology. Secondly, high levels of x-efficiency could expand operations. Finally, credit management could reduce overall costs and improve efficiency. Efficiency was found to be significantly correlated to the rate of return assets. Labour was found to be under-utilised, and capital was over-utilised.

Singh et al. (2001), prompted by the increased competition from the private sector dairy plants, conducted a study to measure the cost efficiency at plant level of both cooperative and private sector. Measurements were carried out using both the SFA and DEA on an (incomplete) panel data sample of 13 cooperative plants and 10 private plants. Data was available for the period 1992/93 to 1996/97. Results showed that cooperative plants were more cost efficient but the difference was not statistically significant. The cost efficiency has not changed since market liberalization of India in 1991.

Mosheim (2002) used the DEA to calculate the cost efficiency of the Costa Rican coffee processing sector. Using data from 1988–1989 to 1992–1993, 16 investor-owned firms and 28 cooperative firms were assessed. The following variables were used: organizational type, location, firm size, farm size, competition, time, and a bumper crop dummy. The results showed that cooperatives are no less cost and allocative efficient than investor-owned industries. However, investor-owned industries were less scale efficient. Cooperatives in the Costa Rican coffee industry remain successful. The family-farm based agriculture sector appears to be maintained even under the pressure of competition and liberalization (Mosheim 2002).

In South Africa, Piesse et al. (2005) examined the effects of institutional and organizational change on the efficiency of grain cooperatives. Using the DEA, the study showed that increased competition (caused by deregulation and removal of subsidies) resulted in increased efficiency levels. The initial inefficiencies of cooperatives reflect the economic cost of cooperatives being used as instruments of government policy.

Yamamoto et al. (2006) examined cooperatives in the dairy-farming region of Hokkaido in Japan. They used the nonparametric output-orientated Malmquist indices of TFP and data from the period 1982 – 1991. The study found that the TFP changes were driven by technical progress, not efficiency. Contrary to western cooperatives, Japan has multipurpose agricultural cooperatives which operate simultaneously in business (credit, mutual insurance and purchasing). The final results indicated 0.948 technical efficiency, which shows that there is a 5% margin for improvement regarding the conversion of inputs to outputs. There was no improvement of management performance from increasing business size.

Guzmán et al. (2009) conducted a study on the evolution of the technical efficiency of Spanish and Italian fresh fruits and vegetables producers. The DEA technique was used along with a sample of 81 Italian and 106 Spanish cooperatives. Data was collected for the period of 2001 to 2005. Results found Italian cooperatives to be comparably more able to be technically efficient than Spanish cooperatives, but the latter were more exploitative of economies of scale.

Maietta & Sena (2010) focused on conducting a study in an environment experiencing financial constraints as testing the technical efficiency in this context is imperative. This study involved 63 wine-producing cooperative farmers in Italy. The method of analysis involved the parametric frontier techniques utilising the SFA Translog. The technical efficiency was calculated to be 0.9398. The authors hypothesised that a reduction in external finance should incentivise efficiency to ensure profitability. This hypothesis relies on the presence of initial inefficiency in the production process. This would need to be capitalised on. The final results confirmed the hypothesis. That is, increasing financial pressure can have a positive effect on the efficiency of cooperatives.

Arcas et al. (2011) examined the empirical relationship between size of agricultural cooperatives and performance. This study emerged from the view that the size of cooperatives could be both an advantage and disadvantage. First, size could be an advantage because it facilitates economies of scale and differentiation through innovation. However, it could also be a disadvantage due to structural complexity and reduced flexibility. Using data from 108 fresh fruit and vegetable cooperatives in Spain, as well as the DEA method of analysis, the authors found that size had a positive impact on efficiency. The authors recommended that cooperatives should implement growth strategies to improve efficiency. Soboh (2012) designed a study to measure the performance of cooperatives and investor-owned European dairy processing firms. The focus was to assess the members' strategy for the cooperative and what significance this had on the technical and economic efficiency.

The parametric SFA was used to measure and compare the efficiency and production technology of cooperatives and investor owned firms, while the non-parametric DEA was used to assess the technical efficiency. The results showed that cooperatives, in comparison to investor-owned firms, are less profitable but operationally more efficient, and have higher material costs, lower debt, greater variation in financial indicators, and more productive technology. Their production potential was also used less efficiently. The study showed that the performance of cooperatives cannot be measured as if they are investor-owned as this may result in misleading information (Soboh 2012).

A study by Ahn et al. (2012) was based on the theory that the inefficiency attributed to cooperatives, in comparison to private firms, is related to difficulties in monitoring or poor incentives of cooperatives. Cooperatives in agriculture are sometimes established to attain non-economic political and ideological objectives, which means there is often little focus on achieving economic efficiency. These authors used data from farmers in El Salvador to show that technologies with numerous sequential steps can have large output declines with small shortfalls. For example, the technical efficiency for coffee which has a number of cultivation steps was 0.2491, while the score for maize and sugar which have fewer cultivation steps was 0.3960 and 0.5492, respectively.

Patlolla et al. (2012) conducted a study of 593 Indian sugar factories using data from 1992 to 2007. The Indian government sets a floor price which is bound to private and public firms but not cooperatives, which get rebate profits to members. The paper is structured around the notion that setting a price floor policy results in a disincentive for private and public firms to be technically efficient. The method to assess this notion was the SFA Cobb-Douglas approach. The results showed that cooperatives were the most technically efficient. The solution to address technical inefficiency would be to base price floors on the quality of cane input received at a factory.

Soboh et al. (2014) employed the two parametric production frontiers to assess six major dairy-producing cooperatives in Europe. The aim was to the technical efficiency of cooperatives versus investor-owned firms. The study found that cooperatives had more productive technology and were less efficient than investor-owned firms. They also had less returns to scale on average. Cooperatives were found to perform better in inter-type efficiency. This may be due to physical productivity and market efficiency caused by normalizing outputs and inputs with the same price.

Ma et al. (2018) assessed the impact of agricultural cooperatives membership on the efficiency of apple farmers in China. These authors used the “selectivity-corrected stochastic production frontier model with propensity score matching to address possible self-selection biases stemming from both observable and unobservable factors”. The results showed that cooperatives members’ in comparison to non-members were more technically efficient at a range of 79% to 86%. However, this was based on which biases were controlled. DEA was not applicable to this study due to unpredictable weather which would influence productions.

Mutairi et al. (2018) conducted a technical efficiency and profitability study on 48 Kuwait retail cooperatives. They used the bootstrap DEA and data from the period 2012-2015. The average variable returns to scale profit efficiency was bootstrapped which resulted in a drop of profit efficiency from 84% to 70%. Efficiency is affected by the number of direct and indirect branches. The authors concluded that to increase the profitability, there must be an increase in equity capitalization. Greater control of labour costs would also increase profit efficiency.

Brandano et al. (2018) used data from wine-producing companies in Sardinia from 2004 to 2009. A comparative study was conducted to compare the technical efficiency of cooperatives and conventional firms. The efficiency scores were generated using DEA by regressing “external covariates and ownership type using a pooled truncated maximum likelihood formulation”. As stated by Charnes et al. (1978) the DEA was used instead of the parametric approach because it does not require a specific functional form of the production function, and DEA is flexible technique. To further the research a spatial analysis was conducted to check spatial spill-over which could imply spatial correlation between the DEA efficiency scores. Lastly a post-DEA was regressed to enhance the study. The paper found that cooperatives are less technically efficient and are struggling to adapt to extreme weather fluctuations (Brandano et al. 2018).

2.9 Summary

The literature above shows the importance of agriculture and, specifically, the sugarcane industry in Eswatini. This chapter also reviewed previous literature on the efficiency of cooperatives in different contexts. Continual investment is being directed into Eswatini’s agriculture, specifically the sugarcane industry. To ensure efficient direction of the funds, there is a need to explore the effect of different input factors on sugarcane productivity. The study provided insight into the sugarcane industry in Eswatini, and information to assist with investment decisions in the country. Key data includes observations about the industry’s financial sustainability and efficiency.

Eswatini’s sugarcane industry is reliant on the inclusion of smallholder farmers in cooperative structures. The section highlighted the importance of cooperatives, and discussed the need to provide continual efficiency assessment. Previous studies are often contradictory; that is, there is some conflict in the literature around the most suitable structure of cooperatives.

A trend found was that the SFA and DEA were to assess efficiency in the majority of the literature reviewed. Overall both methodologies appear to be appropriate for assessing technical efficiency. Most previous studies found cooperatives to be less efficient than privately-owned firms.

The study continues with application of the methodology on the data collected from sugarcane farmers in Eswatini providing results on efficiency and financial sustainability of the sector.

Chapter 3: Research methodology

3.1 Introduction

This chapter outlines the method by which the productivity of the smallholder farmers was assessed. The sample was selected from all the sugarcane Farming Cooperatives which had data available for the period 2014-2017. Here we explain the research design and discuss how we measured the efficiency and financial sustainability of the farmers. The Cobb-Douglas and Translog function was used to assess the input variables.

3.2 Research design and sample selection

This study employed secondary data on the production performance of 114 sugarcane Farmer Cooperatives from 2014 to 2017. This time period was chosen so that we could assess the impact of the 2015 drought and changes to the EU policy. The 114 sugarcane FCs represent all FCs with data available over the study period. The data provides information on finance, productivity and cost structures of FCs. The data was originally produced by the National Adaptation Strategy Technical Assistance Business unit. We then requested the data from the Ministry of economic planning and development and were given permission to analyse it for the purposes of this study.

3.2.1 Measuring efficiency: Stochastic Frontier Analysis

As highlighted in the literature review, the two main approaches to examine the efficiency of decision-making units (DMUs) are the parametric and non-parametric techniques. This research adopted the two-step approach on the stochastic frontier analysis (SFA) parametric technique to examine the efficiency of sugar cane FCs.

Under the SFA, the two widely used production functions, the Cobb-Douglas (CBD) and the Translogarithm productions are employed. Under the CBD approach, output of the FCs is expressed as linear function of input units. The Equation (Eq.) is as follows:

$$y_{i,t} = f(x_{i,t}; \beta) e^{v_{i,t} - u_{i,t}} \quad (\text{Eq. 1})$$

where y and x denote output and inputs, respectively; ϵ is the two-sided error term made up of random noise and the inefficiency. The linear specification of the CBD function for the FCs over the study period is defined as:

$$\ln y_{1,t} = \beta_0 + \beta_1 \ln x_{1,t} + \beta_2 \ln x_{2,t} + \beta_3 \ln x_{3,t} + \beta_4 \ln x_{4,t} + \beta_5 \ln x_{5,t} + \beta_6 \ln x_{6,t} + \beta_7 \ln x_{7,t} + \beta_8 \ln x_{8,t} + v_{i,t} - u_{i,t} \quad (\text{Eq. 2})$$

where i and \ln = logarithms to base e ; y = area of sugarcane harvested per ha; x_1 = farm size per ha; x_2 = fertilizer cost per ha; x_3 = electricity cost per ha; x_4 = labour and administration cost per ha; x_5 = chemicals cost per ha; x_6 = repair and maintenance costs per ha; x_7 = haulage cost per ha; x_8 = on farm transportation cost per ha. v is the independently and

identically distributed random noise while, u is the non-negative random technical inefficiency associated with the production process.

In the Translog specification of the production function, FC outputs are defined as a function of inputs variables:

$$\ln y_{i,t} = \beta_0 + \sum_{k=1}^8 \beta_k \ln x_{kit} + \sum_{k=1}^8 \sum_{j=1}^8 \beta_k \ln x_{kit} \ln x_{jit} + v_{i,t} - u_{i,t}. \quad (\text{Eq. 3})$$

A description of the input variables used is as follows:

Farm size (x1): Not all farmers in the cooperative use the total farm for sugarcane. Therefore, size is measured as Ha to display which portion of the total farm size is used for sugarcane. This provides insight on productivity and determines what different correlations exist between the total farm size and the area used for sugarcane production. Such insight may be used to guide future decision-making.

Fertiliser (x2): This cost is the most consistent in the sugarcane farming process as it is a continual expenditure required to ensure that farming occurs. Calculated as Emlangeni/ha, fertiliser costs fluctuate due to inflation and can affect farm productivity. Fertiliser costs cannot be avoided as fertiliser is necessary for operation.

Electricity cost (x3): The recent increasing costs of electricity in the sugarcane industry have a large impact as most equipment requires large amounts of energy. This cost is measured as Emalageni/ha, and there is an expected negative relationship with productivity.

Labour and administration cost (x4): Farmers have chosen to consolidate their farms resulting in Farmer Cooperation that are structured to run as businesses. Thus, labour structures consist of both family and skilled labour. This cost is measured as Emalageni/ha, and there is an expected positive relationship with productivity.

Chemical cost (x5): This cost is consistent in the sugarcane farming process as it is a continual expenditure required to ensure that farming occurs and plants are treated. This is also calculated as Emlangeni/ha. Chemical costs fluctuate with inflation which can affect farm productivity. These costs cannot be avoided as chemicals are necessary for operation.

Repairs and maintenance costs (x6): This cost is consistent in the sugarcane farming process as it is a continual expenditure required to ensure that farming occurs. The cost is calculated as Emlangeni/ha. Maintenance costs are defined as all costs to maintain equipment on the farm. These costs are often reduced through economies of scale. The expectation of the relationship with productivity cannot be determined.

Haulage costs (x7): This cost is a large contributor to productivity because increasing costs paid to transport sugarcane to mills decreases the capital available to sustain the farm and pay other expenses. Haulage costs are mandatory because crop yields must be processed at nearby mills.

On-farm transportation (x8): This is the cost for the transportation of items or products within the farm. This cost is a reflection of all internal transport required to produce sugarcane. This is seen as an operational cost.

The summary statistics of input and output variables are presented in Table 3.1

Table 3.1: Farm and input use characteristics of smallholder sugarcane FCs

		Mean	Std. Dev.	Min	Max	Obs
FARMSIZE_HA	x1	96.17	101.60	0.00	755.00	460
FERTILIZER_HA (E'000)	x2	3186.21	1299.20	471.48	9813.04	404
ELECTRICITY_HA (E'000)	x3	5444.40	2465.74	0.00	14481.68	404
LABOURADMINS_HA (E'000)	x4	4338.93	1705.52	644.64	12442.19	404
CHEMICALS_HA (E'000)	x5	877.16	476.78	64.09	2570.93	404
REPAIRMAIN_HA (E'000)	x6	1458.26	1550.05	0.00	16726.18	404
HAULAGE_HA (E'000)	x7	6356.49	2205.98	1416.64	14439.33	404
ONFARMTRANS_HA (E'000)	x8	1720.11	814.74	0.00	6303.41	404
SUGARCANE HARVESTED_HA	Y	84.70	80.85	0.00	622.21	460

3.2.2 Inefficiency model

The equation for examining the effect financial and FCs level indicators on inefficiency from CBD (3) and Translog (4) production functions is specified as:

$$U_{it} = \alpha_0 + \alpha_1 z1_{i,t} + \alpha_2 z2_{i,t} + \alpha_3 z3_{i,t} + \alpha_4 z4_{i,t} + \alpha_5 z5_{i,t} + \alpha_6 z6_{i,t} + \alpha_7 z7_{i,t} + \alpha_8 z8_{i,t} + \eta_{i,t} \quad (\text{Eq. 4})$$

Where U_{it} is the technical inefficiency estimated from CBD (3) and Translog (4) production functions; $z1$ to $z8$ denotes operational self-sustainability per hectare (OSS_HA); grant per hectare (GRANT_HA); loans per hectare (LOAN_HA); distance to mill in km (MILLDISTANCE); the age of the FC in years (AGE); regional code dummy (REGCODE) defined as 1 for FCs in the Southern region and zero otherwise; area of sugar cane harvested per hectare (SUGARLAND_HA) and total number of members for the FC (MEMBERSHIP). η error term which follows truncated normal distribution.

3.3 Hypotheses development

The first research question stated that the study would assess the level of efficiency of the sugarcane FCs. This question was addressed by using both a Cobb-Douglas and Translog function to run regression analysis on the input variables relative to the area harvested per ha.

Based on these results, commentary on the efficiency was provided using both the results from the Cobb-Douglas and Translog functions to enhance commentary.

To address the second research question which assesses the financial sustainability effect on technical efficiency, the efficiency data was estimated from equations 2 and 3. The theoretical discussions on the effect of the FCs characteristics on the estimated inefficiency terms are discussed in this section:

3.3.1 Operational self-sustainability per hectare (OSS_HA): Operational self-sustainability (OSS) is the ratio used to measure sustainability (Tchakoute-Tchuigoua 2010). Often used to assess Micro-Finance Institutions this ratio is used to measure how well costs can be covered through operating revenue (Hartarska & Nadolnyak 2007). The UNCDF (2002) stated that OSS is one of the tools for measuring financial sustainability. The OSS is based on an institutions operating income to cover operating expenses. OSS in the study is measured as the ratio of total revenues to total operational expenses. The expectation is that if sustainability is to be achieved, there should be a 1:1 ratio between revenue and operating expenses, reflected as 100%. The expectation is that an OSS figure at 100% or above will result in an improvement of technical efficiency. This is caused by the fact that a higher OSS results in revenue that is greater than the operating costs.

3.3.2 Grant per hectare (GRANT_HA): Grants are awarded to farmers in an effort to increase capital and allow farmers to grow investment. Grants, by nature, do not need to be paid back. Their effectiveness has been questioned in a number of studies as they could be creating a dependency mentality amongst farmers. Theoretically, the expectation is that more grants given (showing increased access to capital) should have a positive effect on productivity. Maietta & Sena (2010) provided evidence that financial constraints can improve efficiency. The expectation is that increasing grants will provide more funding for capital expenditure which enhances technical efficiency.

3.3.3 Loans per hectare (LOAN_HA): The loan amount is a reflection of how much debt is still outstanding on each farm. The inclusion of this variable is partly motivated by the prevalence of unpaid loans in the sugarcane industry. Sugarcane farmers in Eswatini have fairly easy access to loans, since the SNL used is considered collateral for the loan. Furthermore, groups of farmers obtain such loans which mean that more people become liable for repayments. This ease of capital gain has resulted in great financial debt amongst many farmers. This is exacerbated by the fact that many loans are used for operational activities such as dividends payment instead of investment into capital. Jensen (1976) stated that financial leverage would have a negative influence on efficiency due to increase in agency costs. Debt has also been said to promote improper allocation of inputs and low efficiency (Featherstone, 1995). The expectation is that increasing loans will provide more funding for capital expenditure which will enhance technical efficiency as long as the loan and interest repayments are managed.

3.3.4 Distance to mill in km (MILLDISTANCE): Linked to the haulage cost, the distance to the mill has an effect on productivity. The hypothesis is that the further a farm is from the mill, the more costs will be directed to transport and this will result in decreased productivity. Distance to mill is measured as kms. The expectation is that the impact of distance to mill in km and haulage costs should be the same on technical efficiency. If there is a difference it may explain an issue with the cost of transport which is independent to the distance. Increased distance to the mill is expected to decrease technical efficiency due to increased travelling costs.

3.3.5 Years since FC was established (AGE): Formation of FCs within the sugarcane industry in Eswatini has been a gradual process. The combination of members to form a FC is driven by the smallholder farmers, and it can take time to ensure that all members within an area are willing to participate. There is an expectation that older, more established FCs will have increased technical efficiency as they have had time to implement rules of management of operations and to ensure adequate corporate governance.

3.3.6 Regional code dummy (REGCODE): The sugar industry in Eswatini is divided into the Southern and Northern region. This separation was designed to organise the sector and is also based on the development of the mills which are also located in the northern and southern regions. Development of infrastructure is also separated in accordance to the north and south separation. In this study, Southern FCs will be represented with the dummy code 1, and Northern FCs will be designated as zero. The expectation is that the region should have no effect on technical efficiency as both regions should have similar infrastructural investment.

3.3.7 Area of sugarcane harvested per hectare (SUGARLAND_HA): This is measured in Ha. Each small-scale farmer has an area of land allocated through the SNL program. Farmers can decide what to use the land for. Most of the farmers have formed associations to increase farm size. This has led to the development of large competitive farms that are managed by skilled personnel. The assumption is that larger farms would be more productive and income-generating. A large area for harvesting is expected to decrease technical efficiency as large pieces of land may be difficult to manage and control.

3.3.8 Total number of members in FC (Membership): Larger FCs have been able to process brand extension and differentiated marketing, while smaller FCs have quicker responses and hold market opportunities making determination of technical efficiency only possible through a quantitative test (Huang et al. 2013). Access to SNL has resulted in farmers forming cooperatives that are more competitive and economically efficient. Each farm hires a board of directors and functions as a company providing dividends and profit to each member. This structure has resulted in larger participation in the industry which means Eswatini is able to compete in the global markets. This variable is measured based on number of people. More people could mean greater farm size which could increase technical efficiency. However, number of people could also have a negative relationship with technical efficiency as they could be more difficult to manage.

3.4 Summary

The methodology implemented is divided into two sections. Firstly, we assessed the efficiency of the sugarcane FCs. Then, using the results, we explored the effect of financial sustainability on technical inefficiency on the FCs. The results of the analysis as described in this chapter are presented in the next chapter.

Chapter 4: Discussion of findings

4.1 Introduction

This chapter provides a summary of the findings obtained from conducting the Cobb-Douglas and Translog functions, the details of which are outlined in Chapter 3. This chapter also provides a reflection on the results of the study.

4.2 Descriptive statistics

Table 4.1 displays the descriptive statistics for operational self-sustainability, grant received, loan received, distance from mill, number of years since Farmer Cooperatives (FCs) were established, regional code, area harvested and number of members.

Table 4.1: Descriptive statistics

	Mean	Median	Std Dev.	Min	Max	Max	N
OSS_HA	1.6548	1.6268	0.3822	0.7081	3.0796	3.0796	404
GRANT_HA	35.7813	27.1804	37.1127	0.0000	125.3539	125.3539	460
LOAN_HA	24.3852	21.9083	16.8375	0.0000	107.9914	107.9914	460
MILLDISTANCE	27.7783	28.0000	15.6465	0.0000	120.0000	120.0000	460
AGE	11.9000	10.0000	7.2137	0.0000	45.0000	45.0000	460
REGCODE	0.6435	1.0000	0.4795	0.0000	1.0000	1.0000	460
SUGARLAND_HA	85.6494	62.6480	81.3039	0.0000	622.2100	622.2100	460
MEMBERSHIP	50.3587	33.5000	59.4687	0.0000	453.0000	453.0000	460

Notes: OSS_HA = Operational self-sustainability per hectare; Grant = Grant received per hectare; LOAN_HA = Loan received per hectare; MILLDISTANCE = Distance from Mill in Km; AGE = Years since FC was established; REGCODE = Regional code equals to 1 for Southern FCs and zero otherwise; SUGARLAND_HA = Area of sugarcane harvested per hectare; MEMBERSHIP = Total number of members in FC. Source: Author's estimate from research data

Operational self-sustainability (OSS) per hectare: This was calculated to be 165% on average, which reflects that the operational income can adequately cover operational expenses. The minimum recommended threshold is 100%; an OSS above this is considered sustainable (Nthaga, 2017). The wide variation, as evidenced by the minimum (70.8%) and maximum (307%) values, reflects large disparities between FCs. A system which allows the underperforming FCs to learn from the FCs with OSS per hectare above 100% could benefit the sugar industry overall.

Financing of FC (grants and loans): There were more grants per hectare (average of 35.78) compared to loans per hectare (average 24.38). This indicates that FCs are heavily reliant on grants as a major source of funding compared to loans. The higher standard deviation for grants per hectare, at 37.11, compared to loans per hectare, at 16.84, reflects higher variability and suggests that there is a higher level of uncertainty with respect to the reliance on grants for the FCs.

Distance from the mill: The average is 27.8 km and the maximum distance is 120km. This reflects the wide range of distances travelled by FCs to deliver cane to the mill. This may influence operational costs.

Age of FC: The average age was calculated to be 11.9 years, with a maximum age of 45 years. This may have implications on the skills and expertise of each FCs and could mean that older FCs might be more efficient.

Average sugarcane harvested per hectare: This variable has the largest standard deviation at 81.30, showing large differences in the ability of different FCs to harvest sugarcane per hectare. The maximum harvest was 622.21 per hectare which reflects the upper capacity of the industry. However, the average was only 85.65. This indicates that there are a great number of farms operating below the upper capacity of 622.21. The farms are decreasing the overall harvesting potential of the industry.

Membership: Due to the self-driven cooperative formation nature of the industry, the standard deviation of this variable (59.47) reflects the diversity in number of members in each FC. On average the number of members in FCs was calculated to be 50.36. The emphasis of corporate governance is imperative to ensure the effective management of FCs with a large number of shareholders. There was one FC with 453 members which could be problematic. It is difficult to gain consensus within such large groups.

4.3 Efficiency results: Cobb-Douglas and Translog functions

The results of the Translog and Cobb Douglas production frontier estimates are presented in Table 4.2.

In the Cobb-Douglas model, the cost of haulage (x_7) is observed to have the greatest effect on technical efficiency with an estimated coefficient of 0.1862 at a 1% significance level. The positive coefficient indicates that an increase in haulage cost would result in increased quantities of sugarcane harvested. The higher haulage cost would mean more products need to be transported, which is a sign of growth in the industry as long as the cost is managed to stay within the financial capacity of the FC. The coefficient for electricity cost (X_3) was -0.0376, which means this variable has the greatest negative effect on total sugarcane harvested. This result shows that an increase in electricity costs decreases the FCs ability to harvest more sugarcane as more finances would need to be directed to covering this cost. The cost of electricity is an exogenous factor beyond the control of the farmers; therefore, it would be ideal if government could implement strategies to maintain the low cost of electricity. This is in keeping with variables x_2 , x_4 and x_5 all of which had negative coefficients. These variables also represent exogenous that FCs have little control over.

Table 4. 2: Results of regression analysis of dependent variables

Dependent Variable: Total Sugarcane Harvested (Ha)					
Translog Function				Cobb-Douglas	
	<i>Coef.</i>	<i>yl</i>	<i>Coef.</i>	<i>Coef.</i>	
Constant	4.2140	x2x4	0.058	Constant	1.2559**
x1	2.0080***	x2x5	0.085**	x1	0.0439***
x2	-0.4560	x2x6	0.027	x2	-0.0063
x3	-2.6300**	x2x7	0.058	x3	-0.0376**
x4	-0.0860	x2x8	-0.047	x4	-0.0055
x5	-0.5340	x3x4	0.033	x5	-0.0262*
x6	-0.2490	x3x5	-0.016	x6	0.0117
x7	2.2570*	x3x6	0.042*	x7	0.1862***
x8	-0.3520	x3x7	-0.017	x8	0.0529***
x1x1	-0.1210***	x3x8	0.109**		
x2x2	0.0160	x4x5	-0.006		
x3x3	0.2360***	x4x6	0.004		
x4x4	-0.0940	x4x7	-0.033		
x5x5	-0.0970***	x4x8	0.081		
x6x6	-0.0030	x5x6	0.011		
x7x7	-0.1770	x5x7	0.054		
x8x8	0.0280	x5x8	0.02		
x1x2x	-0.0580*	x6x7	0.017		
x1x3	0.0660**	x6x8	-0.076**		
x1x4	-0.0500*	x7x8	-0.065		
x1x5	-0.0090	Years			
x1x6	0.0080	2015	0.013		
x1x7	-0.1280***	2016	0.011		
x1x8	0.0000	2017	-0.050**		
x2x3	-0.0900*				
Variance Parameters					
μ	0.1790				0.3173
U_{σ}	-6.235***				-5.3935***
σ_u	0.0440**				0.0674
E (σ_v)	0.2676				0.251164
Farmer cooperatives	114				114
Observations	396				396

Notes: x1 = farmsize_ha; x2 = fertilizer_ha; x3 = electricity_ha; x4 = labouradmins_ha; x5 = chemicals_ha; x6 = repairmain_ha; x7 = haulage_ha; x8 = onfarmtrans_ha; ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source: Author's estimate from research data

It is imperative to keep costs low to ensure that adequate quantities of sugarcane can be harvested. Repairs and maintenance costs, x6, had a coefficient of 0.0117. This cost is often ignored by the farmers because it has long term gains in the sustainability, even though these costs affect profit and dividend gain in the short term. The positive impact of x6 on sugarcane harvested would be a valuable statistic to show the farmers who neglect this cost in an effort to ensure the sustainability of the industry.

The results collected from the Translog function were vastly different from the Cobb-Douglas not in terms of coefficients but in terms of the size of the impact in relation to the sugarcane harvested. For example, the haulage variable had a coefficient of 0.1862 for Cobb-Douglas but was 2.2570 for the Translog. The Translog model could be used to provide a more accurate demonstration of the hectare effect of dependent variable adjustments as it relaxes the elasticities and fits the data more accurately.

In order to assist with policy making, the analysis provided here focused on the interactive and integration results shown in Table 4.2 to reflect correlations between variables that may have not easily been identifiable.

The largest interactive coefficient is x_1x_7 , -0.1280 at a 1% significance level which is a reflection that the interaction of farm-size and the haulage costs has the largest negative impact on sugarcane harvested. Farm-size is a fixed variable that would not be easily adjustable. However, it would be important to keep haulage costs at a minimum to ensure that the quantity of sugarcane harvested does not decrease. The interaction of x_3x_8 at a 1% significance level produced the largest positive coefficient (0.109), and shows that the cost of on farm transport and electricity can increase sugarcane harvested. This would be understandable as revenue spent on these two variables would be a reflection of more sugarcane being transported to mills and electricity being used to operate resulting in a larger harvest. Although having positive effects, this cost would need to be balanced with the revenue generated and operating costs to ensure the financial sustainability of the FC.

Overall the results in Table 4.2 reflect that by increasing certain variables, such as the cost per ha for fertilizer, electricity, labour and administration, chemicals, repair and maintenance, haulage, and on farm transportation will increase the total sugarcane harvested. It could be said that there is an opportunity cost created by increasing these costs.

The coefficient for harvest per year was 0.013, 0.011 and -0.050 for 2015, 2016 and 2017, respectively, which shows that there has been a gradual decrease in sugarcane productivity in recent years as a result of exogenous factors.

Table 4.3 shows a comparison between the two models used to assess efficiency of the Translogarithm and the Cobb-Douglas models.

Table 4. 3: Likelihood-ratio test models

Model	Obs	ll(model)	df	AIC	BIC
TEFF-TRANS	396	326.9528	59	-535.9055	-301.002
TEFF-CBD	396	235.7672	21	-429.5344	-345.925
LR χ^2 (38)	182.37				
Prob > χ^2	0.000				

Notes: Assumption: TEFF-CD nested in TEFF-TRANS: AIC= Akaike's Information Criteria; BIC= Bayesian Information Criteria

Often referred to as the Penalized-likelihood criteria, this information is used to decide which model would be best or decision-making. The AIC and BIC are both used to reflect the measure of fit and penalise complexity of data. The model with the lower AIC and BIC was chosen as the best model. When comparing models based on AIC, the Translog model would be the preferred.

However, when comparing the model based on the BIC, the Cobb-Douglas model would be preferred. The reason for this is possibly due to the fact that the data generated from both models was very similar, as seen in Table 4.2 and Table 4.3. Both models were used to deeper insight when analysing the findings. The likelihood ratio test null hypothesis to find a model that best fits the data has been rejected due to the $182.37 > LR \chi^2 (38)$. This result means that there is no difference in the Translog and Cobb-Douglas model at a 1% significance level. The estimated efficiency scores from the Cobb-Douglas and Translog production functions are presented in Table 4.4.

Table 4.4: Summary of Regional Technical Efficiency

	Northern Region		Southern Region		All Samples	
	TEFF_T RANS	TEFF_ CBD	TEFF_T RANS	TEFF_ CBD	TEFF_T RANS	TEFF_ CBD
Mean	0.8375	0.7326	0.8365	0.7286	0.8369	0.7301
Median	0.8358	0.729	0.8355	0.7261	0.8356	0.7268
Std. Dev	0.0207	0.0328	0.0224	0.0324	0.0217	0.0326
Min	0.7389	0.5909	0.7708	0.6532	0.7389	0.5909
Max	0.9321	0.9353	0.9886	0.9339	0.9886	0.9353
N	146	146	250	250	396	396
2014	0.8387	0.7408	0.8361	0.7313	0.8371	0.735
2015	0.8396	0.7353	0.8346	0.7291	0.8365	0.7315
2016	0.8378	0.7336	0.8368	0.7297	0.8371	0.731
2017	0.8342	0.722	0.8381	0.7249	0.8366	0.7239

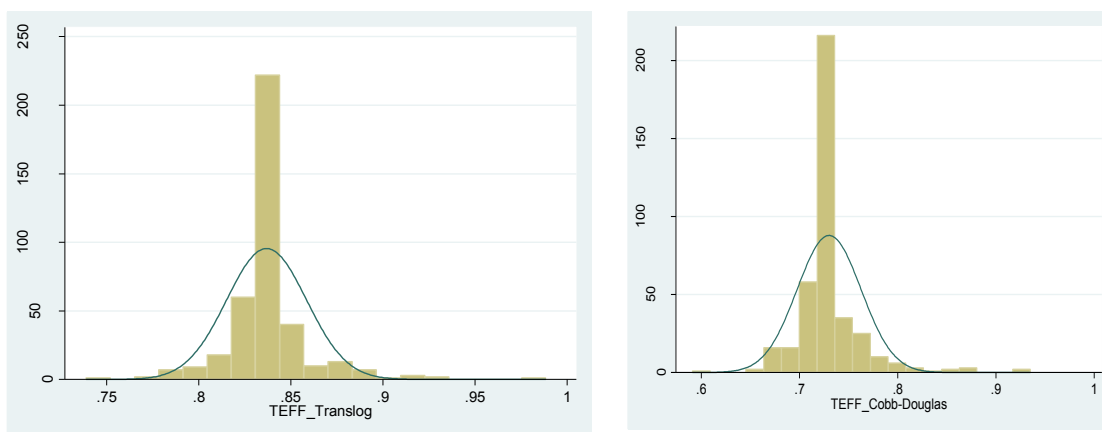
Notes: TEFF_TRANS = Translog Technical Efficiency scores; TEFF_CBD = Cobb-Douglas Technical efficiency scores

Overall, FCs in the Northern region have higher efficiency scores compared to those in the Southern region. Although the Northern Region had only 146 firms' year observations in comparison to the 250 firms' year observations for FCs in the Southern Region, the recent developments of the KDDP and VIF, in the North, may have played a factor in ensuring the technical efficiency of the area. The KDDP and VIF are both irrigation projects that brought about infrastructural development in the North. The FCs were further supported with technical assistance through projects such as RMI out-grower development. Continued funding from the EU has been directed to the Northern Region. This technical assistance has not been provided to the Southern Region. This emphasises that efficiency is not only reliant on infrastructural development - technical assistance is also important.

The expected benefit from economies of scale due to the higher number of FCs in the Southern region is not being realised. There are fewer FCs in the Northern region which displays a higher efficiency level on average than the Southern region. This means that merely increasing the number of FCs in one region may have marginal benefit as there may be limitations to the infrastructure available in the area. This further emphasises that government should limit the number of organisations formed within one area or ensure that continued investment into irrigation projects is provided to assist with capacity building. Based on the results in Table 4.4, the biggest region of concern is the Southern Region which has the largest number of FCs but is the least technically efficient. This has important implications for the industry as a whole.

The histogram plot Figure 1.2 and the Kernel Density plot in Figure 1.3 provide visual representations of technical efficiency.

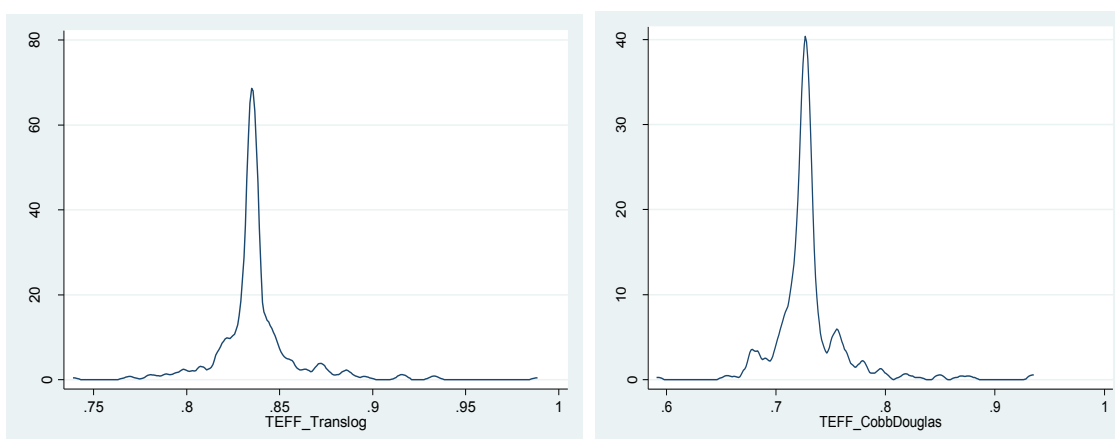
Figure 1. 2: Histogram plot of Technical Efficiency scores



Source: Author's estimate from research data

In Figure 1.2, the histogram plot displays the technical efficiency results of the FCs to be a normally-distributed bell curve. The technical efficiency data obtained using the Translog has a wider spread than the data obtained by the Cobb-Douglas. This means that there is a greater standard deviation in the results obtained from the Translog. The Translog peaks at a mean of 0.8369 while the Cobb-Douglas peaks at 0.7301.

Figure 1. 3: Kernel density plot of Technical Efficiency scores



Source: Author's estimate from research data

In figure 1.3, Kernel smoothing is used to reduce “noise” and improve the visual representation of the histogram distribution. The Kernel density plot depicts a similar result to the Histogram. The highest peak of the density of the technical efficiencies occurs at 0.8369 for the Translog data and at 0.7301 for the Cobb-Douglas data. The Translog results display a smoother density plot on each side of the mean, while the Cobb-Douglas displays sudden spikes in density when moving away from the mean.

4.4 Regression results

The results of the inefficiency model using data from the Translog and CBD techniques are presented in Table 4.5. The estimated coefficients represent the effects of the independent variables on technical inefficiency.

Table 4.5: Summary of dependent variables and technical inefficiency

Dependent Variable: Technical Inefficiency				
	Translog Function		Cobb-Douglas	
	<i>Coef.</i>	<i>Z</i>	<i>Coef.</i>	<i>z</i>
Constant	-1.924 (1.674)	-1.15	1.1932 (1.5219)	0.78
OSS_HA	-5.321*** (0.603)	-8.83	-4.7681*** (0.5523)	-8.63
GRANT_HA	-0.009* (0.005)	-1.91	-0.0073* (0.0041)	-1.78
LOAN_HA	-0.032*** (0.011)	-2.99	-0.0312*** (0.0093)	-3.37
MILLDISTANCE	0.034** (0.013)	2.57	0.0179* (0.0095)	1.89
AGE	1.178*** (0.373)	3.16	0.7031*** (0.2704)	2.6
REGCODE. SOUTH	0.210 (0.407)	0.51	-0.3947 (0.3764)	-1.05
SUGARLAND_HA	-0.003 (0.003)	-0.96	0.0014 (0.0024)	0.58
MEMBERSHIP	1.258*** (0.311)	4.05	0.5980*** (0.1988)	3.01
Wald χ^2 (47/8)	421.86		79.78	
Prob > χ^2	0.000		0.000	
Farmer cooperatives	114		114	
Observations	396		396	

*Notes: OSS_HA = Operational self-sustainability per hectare; Grant = Grant received per hectare; LOAN_HA = Loan received per hectare; MILLDISTANCE = Distance from Mill in Km; AGE = Years since FC was established; REGCODE = Regional code equals to 1 for Southern FCs and zero otherwise; SUGARLAND_HA = Area of sugarcane harvested per hectare; MEMBERSHIP = Total number of members in FC. ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source: Author's estimate from research data*

The coefficient of OSS is negatively related to technical inefficiency at a 1% significance level under both the Translog and CBD specifications. This indicates that operationally sustainable FCs are more efficient.

This result shows that the revenue generated in relation to the operating expenses must be high to improve technical efficiency and ensure the financial sustainability of FCs. The estimated coefficient indicates that OSS has the greatest impact on the technical efficiency of the sugarcane FCs in Eswatini.

The coefficients for grants and loans are both negative and significantly related to technical efficiency. This indicates that an increase in grants and loans per hectare reduces technical inefficiency, which suggests that access to finance is essential to ensure the efficiency of sugarcane FCs. Across both the Translog and CBD efficiency scores, the coefficients of loans (1%) are higher compared to grants (10%). This may be caused by the fact that loans received are requested by the FC. Therefore, the capital received is directed according to the cooperatives needs at a specific time and could be allocated more efficiently. The interest and capital repayment structure of loans could be said to create a discipline effect causing FCs to maximize the usage of the funds. On the other hand, grants given are dependent on the donor. This might lead to reduced responsibility on the FCs part as amounts given could be seen as “free money”. This could decrease the potential of this money to improve technical efficiency. Financial leverage was found to increase transaction costs and cause misallocation of resources (Huang et al. 2013). This creates a necessity for future policy to be directed accordingly. Furthermore, adequate loan capital should be provided to ensure both efficiency and financial sustainability benefits. Mashatola & Darroch (2003) found that high levels of gross turnover relative to loans and access to off-farm income are key determinants of a successful loan repayment (Mashatola & Darroch 2003). Miller & LaDue (1989) found that higher-quality dairy farmer borrowers have higher operating efficiency.

The distance from mill at 0.034 is aligned with expectation. The further away the FC is from the mill the higher cost to transport the sugarcane. This reduces technical efficiency. This result is aligned with a study on the distance of plot from water source which showed a weak negative effect on technical efficiency (Khanna, 2006).

The age coefficient of 1.178 was the most unexpected variable. We assumed that the age of an FC would have a direct relationship with technical efficiency. However, results showed that this relationship was indirect: greater age is related to technical inefficiency. Other studies, which often refer to this variable as “experience in sugarcane farming”, found that greater experience was related to inefficiency (Murali & Prathap 2017).

The SSA CEO mentioned that this relationship is unsurprising for the Eswatini sugarcane industry as a result of the SNL structure of land. FCs have been established for a long time are often presently run by a younger generation which inherited the land from their parents. These individuals do not seem to be as committed to ensuring efficiency. Further qualitative data would need to be collected to expand our understanding of this variable.

As expected, the sugar per hectare variable has a negative relationship with technical efficiency and this could be attributed to economies of scale. The variable is small at -0.003, which could reflect that larger land has decreasing marginal benefit.

As land increases in size, technical efficiency decreases. Khanna (2006) referred to this variable as “area of land cultivated” and found a positive effect on efficiency which contradicts the results of this study.

4.5 Summary

In the chapter we showed that different input variables have varying impact on the technical efficiency. We also showed that either the Cobb-Douglas or the Translog functions could be used for decision making as both functions had similar impact on efficiency. The results showed that the FCs are financially sustainable. In order to ensure the continuation of this, costs must be managed efficiently. The following chapter provides a conclusion and a number of recommendations to assist with investment decisions in this industry.

Chapter 5: Conclusions and recommendations

5.1 Introduction

This final chapter provides a summary of the study conducted, and offers policy recommendations, conclusions, and suggestions for future research.

5.2 Summary and conclusions of the study

As discussed in Chapter 1, sugarcane is the main contributor to Eswatini's economy. Therefore, this study sought to evaluate the industry and provide policy makers with insight regarding how to ensure the industry's sustainability and growth. The literature review provided in Chapter 2 provided insight to support the use of Cobb-Douglas and Translog as the technical efficiency functions of this study. The literature review also provided a discussion of the empirical literature available on other cooperatives. Chapter 3 outlined the research methodology employed for this research, and we described the Cobb-Douglas and Translog functions, as well as all the input variables. Chapter 4 provided a discussion on the findings, and highlighted the importance of 5 key variables: OSS, grants, loans, distance from mill and membership number.

The study assessed the efficiency and financial sustainability of the sugarcane Farmer Cooperatives in Eswatini. Viability and sustainability represent the biggest concerns for stakeholders in the sugarcane industry; therefore, we realised the need to study the input variables to provide insight for future decision-making. The overall objective of this study was to demonstrate the necessity of a continual empirical assessment of products.

The results of the study showed that the sugarcane FCs are operationally self-sustainable, with an average technical efficiency of 83.69% (Translog) and 73.01 % (Cobb-Douglas). The study identified operational sustainability, access to grants and loans to significantly improve technical inefficiency. On the other hand distance to mill, age and membership number were observed to have a negative effect on technical efficiency. Based on the study findings, it appears that the sugarcane industry can be improved through future policy which is designed to create discipline and promote the independence of the FC. Policy must focus on implementing caps on certain variables which have decreasing marginal benefit. Policy should also focus on ensuring how best to direct funding that will minimise operating expenses of farmers. This could be done through continuing to develop cost saving infrastructure to allow farmers to utilise inputs to increase efficiency but not at the detriment of financial sustainability.

5.3 Policy recommendations of the findings

As the sugarcane industry is a main contributor to Eswatini's economy, the focus should be to improve the industry through policy. Policy ensures that change is implemented across the board (that is, it is not optional decision for cooperatives). The use of policy to direct change will guarantee the growth of the industry.

Policy must maintain the sustainability of the farms. Currently an OSS figure of 100% represents a sustainable industry but this could easily be distorted if operating expenses continue to increase in tandem with decreased revenue due to unfavourable export prices. Policy must implement subsidies on operating costs, such as electricity, to maintain sustainability.

In order to manage finance, including grants and loans, policy must focus on dismantling a mentality of dependence amongst FCs. Funding should be provided in a way that ensures FCs are able to operate as independent and self-sufficient firms. Policy must therefore focus on issuing grants indirectly to farmers, such as by subsidising operating costs. Loans provided must then be earned by the FCs, and given with favourable interest terms.

We also recommend the creation of a distance cap between farm and mill to ensure that costs associated with haulage or transport are minimised. Thus policy must be developed to build mills in accordance to distance from farms in the area, not based on regional separation. For example, all farms must have access to a mill within 20km of their farm. As a first step, policy must start by creating infrastructure for more mills. The distance cap can be implemented thereafter.

Implementation of a membership cap on all FCs could be implemented. Limiting the number of farmers in one FC will assist with limiting the negative effects of having a large FC that is inefficient due to the presence of too many shareholders with different strategic approaches.

In the long term, policy needs to create a clear succession plan on all inherited land. This will ensure that only truly committed members of the FC participate in the structure. We recommend that a clear intention of commitment should be signed by the inheritor of the land which demonstrates either their willingness to continue with shareholder responsibilities in the FC or refrain from participation.

Lastly, we recommend the creation of a policy designed around ensuring an equal dispersion of technical assistance amongst all farmers. Policy must be created to ensure that business acumen and training is provided to all FCs. Financial benefits could be provided to FCs that utilise the technical assistance.

5.4 Future directions

The majority of the policy recommendations given above are based on the empirical data and results provided. FCs of different sizes and in different locations may need to implement these policies differently. Further research, possibly involving the collection of qualitative data, is needed to corroborate and enhance the findings of the current study.

Future research should also consider a comparative analysis of FCs in the Northern and Southern regions to determine possible differences in technical efficiencies. This will provide insight into how to transfer effective practices between both regions, and might contribute to the efficient use of investment.

Lastly, it would also be useful to monitor the development, implementation and effects of the policies recommended above. This information could assist government in their efforts to improve the industry.

5.5 Conclusion

The sugarcane industry in Eswatini plays a pivotal role in the economy. Currently the industry is operating efficiently and the farming cooperatives are financially sustainable. It is important to maintain this performance, especially in the context of continual pressure from the European Union's change in policy as well as unpredictable climate change. All input variables which have a large impact on harvesting performance should be constant, or costs should be lowered through policy. The results of this study could provide insight for other countries who wish to explore the technical efficiency and financial sustainability of their own industries. Findings from this study could be useful to inform future investment decisions.

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