Factors affecting productivity of small-scale sugarcane farmers in Mona and Sonkombo villages

By

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DEDICATION

I dedicate this dissertation to all my friends who have been supportive during my study period at the University of Zululand, KwaDlangezwa.

ORIGINALITYDECLARATION

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I acknowledge that I have read and understood the University's policies and rules applicable to postgraduate research, and I certify that I have, to the best of my knowledge and belief, complied with their requirements.

I attest that I attained an ethical clearance (certificate number UZREC 17110-030PGM 2015/197) and that I have complied with the terms and conditions set out in that certificate.

I further certify that the proposed research is original work, and that the material to be submitted for examination has not been submitted, either in whole or in part, for a degree at this or any other university.

I declare that this research dissertation is the product of my own work and sweat, save for the supervisory guidance received, and I have, to best of my knowledge and belief, complied with the university's plagiarism policy and acknowledged all bases of information in line with normal academic conventions. The document has been subjected to the university's text-matching and or similarity–checking procedures.

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Signed: _____ Date: _____

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ABSTRACT

Sugarcane is regarded as one of the most important crops in South Africa. The sugar industry has a pivotal role to play in the socio-economic development of rural areas. Small-scale sugarcane farmers are faced with various challenges that affect their productivity. The main objective of this study was to determine the factors affecting productivity of small-scale sugarcane farmers. The study was carried out in two selected villages namely, Mona and Sonkombo of Ndwedwe Local Municipality, employing a quantitative research approach. The study systematically randomly selected 100 small-scale sugarcane farmers (50 in each village), drawn from small-scale farmers who delivered cane to Tongaat-Hulett mills. To identify the production challenges faced by small-scale sugarcane farmers in Mona and Sonkombo villages. Descriptive statistics were used to describe the farmers' characteristics and their production challenges.

The study showed that the majority (69%) of the small-scale farmers were female, and a large proportion (67%) was beyond 50 years old of age, and the study also reveals that a greater proportion of respondents (48%) had no formal education. Most of the respondents (88%) indicated that they had access to credit, 80% respondents indicated that they received extension support and about 44% of respondents owned <1ha of land with the average sugarcane production of 50t/ha. The farmers were constrained by production challenges which include crop nutrition challenges such as late and inadequate fertilizer application, about 86% respondents stated that there was late weed control practised six months later after harvesting which likely resulted to low productivity. To determine the factors influencing small-scale sugarcane productivity in Mona and Sonkombo villages, the study used a regression analysis of the amended/hybrid Cobb-Douglas Production Function. The results of the regression analysis reveals that age, level of education, extension support, non-farm income, land size, access to credit and amount of urea applied were found to be positively associated with productivity whereas labour, amount of basal fertilizer and chemicals applied were negatively correlated with productivity of sugarcane. The results suggest that, in order for

small-scale sugarcane farmers to realise higher yields per hectare, they have to apply the optimum amounts of the inputs and at the right time.

Keywords: Amended/hybrid Cobb-Douglas Production Function; Ndwedwe Local Municipality; Productivity; Small-scale farmers; Sugarcane.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

CDPF Cobb-Douglass Production Function

CoGTA Co-operative Governance and Traditional Affairs

DEA Department of Environmental Affairs

ESCC Energy Security and Climate Change

FAO Food and Agricultural Organization

HRS/HA Hours/hectare

IDP Integrated Development Plan Report

Kg/ha Kilogram per hectare

KZN KwaZulu-Natal

KZN DEDT KwaZulu-Natal Department of Economic Development and Tourism SACU

Southern African Customs Unions (SACU

SACGA South African Cane Growers Association

SASA South African Sugar Association

SASMAL South African Sugar Millers Association Limited

SASRI South African Sugar Research Institute

SPSS Statistical Package for Social Scientists

SSE Error Sum of Square

SST Total sum of squares

Stats SA Statistics South Africa

T/HA Tonnes per hectare

THS Tongaat-Hulett

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter introduces and presents the background of the study on factors affecting small-scale sugarcane productivity in Mona and Sonkombo villages in Ndwedwe Local Municipality. Contained in this chapter is a brief background on the study of sugarcane farming worldwide and South Africa in particular. The chapter also presents the problem statement, objectives of the study and hypotheses. The limitations of the study are also presented and discussed in this chapter. The last section of the chapter presents the organisation of the dissertation.

1.2 Background of the study

Sugarcane is regarded as an important crop worldwide due to its massive uses in the day-to-day lives of people as well as its industrial uses aimed at nutritional and economic sustenance (South African Sugar Association, 2011). Sugarcane is also an important industrial crop of subtropical and tropical regions worldwide. According to SASA (2014), about 28.8 million hectares are cultivated with sugarcane in more than 50 countries with a total harvest of about 1.69 billion tonnes in more than 90 countries.

The sugar industry is a diverse industry that combines the agricultural activities of sugarcane cultivation, manufacturing of raw and refined sugar, syrup, and a series of by-products (SASA, 2014). The sugar industry has been reported as an industry with a high focus on the socio-economic development of rural areas by organising rural resources, creating employment, providing a source of income and developing transport and communication networks (Sibiya & Hurly, 2011).

According to Garside and Bell (2007), although there are benefits that can be obtained from sugarcane production, the sugar industry has experienced various challenges encountered by small-scale sugarcane farmers. The challenges include yield decline and farmers decline in numbers to continue with sugarcane as well as low income after harvesting. These coupled with the effects of drought, have affected their productivity and as a result, the industry earnings have gone down over the years.

The small-scale black farmers have particularly been strongly disadvantaged as they lack adaptive strategies. The decline of sugarcane farmers' yields has become a distress for the South African sugar industry (Garside & Bell, 2007). Also the number of small-scale sugarcane farmers has declined precipitately from a peak of around 57 000 farmers in the early 2000s dropped to fewer than 14 000 farmers in 2011 due to unknown factors (Dubb, 2013). Singh *et al.* (2008) state that it is especially small-scale sugarcane farmers whose numbers have declined and this situation can be improved if challenges that reduce their yield could be reduced. Farming on communal land, with its unusual privately-administered regulatory structure, small-scale sugarcane farmers occupy almost 20% of the overall area under cane, yet they are responsible for less than 12% of yearly production from the three producing areas of South Africa.

A preliminary report on a survey conducted in Mauritius and South Africa in 2009 indicated that poor re-plant rates and weeds contributed to reduced yields, and low levels of education contribute to poor crop husbandry practices among small-scale sugarcane farmers (Eweg *et al.*, 2009). Eweg *et al.* (2009) also reported that small-scale sugarcane farmers perceived weeds as the top agronomic constraint.

According to Conlong and Campbell (2010), improving weed management practices amongst small-scale sugarcane farmers in the South African sugar industry needs attention because weeds are assumed as another cause for yield decline. Crop protection practices such as use of herbicides amongst small-scale sugarcane farmers also needs to be addressed.

A high percentage increase in wages paid to farm workers will have a great impact on farmers' net farm income. Secondly, as argued above, there is evidence to suggest that farmers in the pre-law period may have more unproductive labour and the law pressed them to employ fewer skilled workers, working many hours a day.

According to Conlong and Campbell (2010), there are rising input costs for sugarcane production in KwaZulu-Natal, particularly in the planting areas of Ntumeni and Showe, resulting in less profit for farmers. The consequence of the rising input costs has influenced on the performance and the progression of the industry. There is therefore a need for farmers to find areas where the effects of the increased input costs can be reduced.

Mandla, Mnisi and Dlamini (2011) suggest that small-scale farmers have a complex relationship with financial institutions, on which they depend entirely for working capital to support their sugarcane fields. In addition, there are many other factors that explain the decline of production by small-scale farmers in KwaZulu-Natal (Mandla *et al.*, 2011). Other factors may include low productivity, lack of finance, drought, small farm sizes, poor infrastructure, poor education and limited skilled labour (Sibiya & Hurly, 2011).

1.3 Problem statement

The South African sugar industry faces a problem of low productivity by small-scale sugarcane farmers (Dubb, 2013). The areas with low productivity are those areas which may be influenced by the inputs costs, transport costs and poor replant rates which is limiting farmers to commercialise. Although it is known that the number of farmers have decreased because of the resultant low income, it is not known fully what has caused the decrease in productivity which has led to low income and eventually fewer farmers. The farmers with low productivity may be influenced by socio-economic, institutional and environmental factors. The small-scale sugarcane farmers have much higher reliance on government social grants such as old-age pensions and child support grants.

Mandla *et al.* (2011) noted that small-scale sugarcane production has been declining at alarming rate from 57 000 farmers in 2000 to fewer than 14 000 farmers in 2011. According to Dubb (2013), in KwaZulu-Natal, extreme climate events such as drought have been resulting in a rapid decline of sugarcane productivity by small-scale sugarcane farmers because of lack of the adaptation strategies. In contrast, commercial farmers such as Tongaat-Hulett's mill have not suffered from the influence of drought because they have irrigation schemes as one of their adaptive strategies. However, the declining productivity by small-scale sugarcane farmers cannot be attributed to climate change alone but also the poor agronomic practice and other factors (Ntshangase, 2008) which need further investigation.

1.4 Significance of the study

The study helps in understanding the challenges faced by small-scale sugarcane farmers in Mona and Sonkombo villages. The study identifies the factors that limit small-scale farmers'

productivity. It is also very important because it describes and explains the challenges that limit small-scale sugarcane farmers in their production and determines the factors that limit their productivity. The understanding of challenges faced by small-scale sugarcane farmers and the factors that limit their productivity is crucial as it could help both policymakers and the small-scale sugarcane farmers with regard to designing relevant policies and strategies for empowering rural livelihoods, specifically the small-scale sugarcane farmers.

1.5 Objectives of the study

The aim of this study is to determine the factors influencing the productivity of small-scale-sugarcane farmers in Mona and Sonkombo villages of Ndwedwe Local Municipality in the province of KwaZulu-Natal. The specific objectives are to:

(i) Identify and describe the production challenges faced by small-scale sugarcane farmers in Mona and Sonkombo villages.

(ii) Determine the factors influencing small-scale sugarcane productivity in Mona and Sonkombo villages.

(iii) Make recommendations that could assist small-scale sugarcane farmers to enhance their productivity.

1.6 Hypothesis

The study formulates the following hypothesis: small-scale sugarcane productivity in Mona and Sonkombo areas is influenced by socio-economic factors such as age, education level, extension support, farm income and non-farm income and other factors.

1.7 Limitations of the study

The study was limited only to two villages within Ndwedwe Local Municipality and did not cover the entire municipality. The study employed an amended/hybrid Cobb-Douglas Production Function, a functional form of the production function that represents the relationship between the amounts of two or more inputs and the amount of output that is produced by the used inputs. The linear regression model has included various factors but few other variables were excluded after testing its strength as they were found to be weak. Also the analysis in this study did not

capture other factors such as the environmental, cultural and political factors that may influence sugarcane productivity in the study areas.

1.8 Organisation of the dissertation

This dissertation is organised as follows:

Chapter two reviews literature on the importance of sugarcane farming and the factors influencing the productivity of small-scale sugarcane farmers in South Africa and other specific evidence on factors affecting productivity. Chapter three presents and describes the selection of the study sites, the research methodology encompassing the research design and the ethical considerations undertaken. Chapter four presents and discusses the descriptive results of the study. Chapter five presents and discusses the empirical results of the study on the factors influencing the productivity of small-scale sugarcane farmers in Mona and Sonkombo computed from the Cobb-Douglas Production Function. Chapter six presents the summary, conclusions and recommendations of the study as well as direction for future research. The following chapter (chapter two) presents an overview of literature on sugarcane production in South Africa and on the factors affecting productivity of small-scale sugarcane farmers.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents an overview of sugarcane production in South Africa, and provides a description of the sugar industry. The chapter also presents an outline of small-scale sugarcane production in KwaZulu-Natal and highlights production losses incurred by sugarcane farmers in the Amatikulu, Darnall, Eston Felixton Gledow, Maidstone, Noodsberg, Sezela, UMzimkhulu, uMfolozi and Union milling areas of KwaZulu-Natal. The chapter also reviews the contribution made by the sugarcane industry to the South African economy by creating employment providing a source of income, alleviating poverty and contributing to food security. Furthermore, the factors affecting productivity of small-scale sugarcane farmers in South Africa are reviewed and these include environmental factors (drought, soil fertility and soil degradation, socio-economic factors (inputs costs, access to credit, labour availability, land sizes) and institutional support such as extension service delivery.

2.2 An overview of sugarcane production in South Africa

The South African sugar industry is responsible for the production of sugarcane; it produces sugar for both the local and export market. In South Africa, sugar mills are supplied by sugarcane planted in three South African provinces: KwaZulu-Natal, Mpumalanga and the Eastern Cape (Greenwood, 2010). The sugar mills are responsible for the crushing of cane, after which it is sent to Durban for sugarcane refining, then distributed to countries that form part of the Southern African Customs Unions (SACU) for marketing. As members of SACU, the total domestic market is comprised of sales into all SACU countries. The total SACU demand is met by supply from sugar-producing countries of SACU.

Greenwood (2010) states that South African Sugar Association regarded as partnership between local sugarcane farmers and the South African Sugar Millers Association Limited (SASMAL). This joint-venture offers high-quality services of marketing, logistics, research and management in order to add value to the cane-developing and crushing business of the industry. As a result, sugarcane farmers play an important part of the national, world-wide and Southern African Development Community (SADC) committee that formulates policy on the sugar industry. In this way farmers have representation from farm gate with processing as well as marketing.

2.2.1 Gross value of sugar production in South Africa between 2003/04 and 2012/13.

Figure 2.1 indicates that gross value of sugar production started to increase in 2003/04 marketing season, followed by a slight decline in 2004/05 to lower levels of approximately R3 million (South African Cane Growers Association, 2013). A consistent increase in gross value of sugar production from 2005/06 to 2009/10 was due to a significant increase in production of the crop over the same period. The sugarcane's contribution to the gross value of agricultural production increased significantly from 2005/06 to 2009/10 and this was due to a consistent increase in sugarcane producer prices during the aforementioned period. The decline in the contribution of sugar to the gross value of production between 2003/04 and 2004/05 can be attributed to a strong rand against the dollar which had a reducing effect on producer prices of sugar cane. Rainfall across the entire industry was below expectation up to 2004/05 season resulting in the smallest crop since 1995/96. The slight decline in the contribution of sugar to the gross value of sugar production in 2010/11 can be attributed to a strong rand against the dollar which had a reducing effect on producer prices of sugar cane during that period. Figure 2.1 further indicates that the contribution of sugar to the gross value of sugar production in 2011/12 increase consistently to about R5.9 million until a peak was attained in 2012/13 at approximately R6.7 million. The industry is regulated in terms of the Sugar Act and the Sugar Industry Agreement, which are binding on all sugarcane farmers and producers of sugar products.

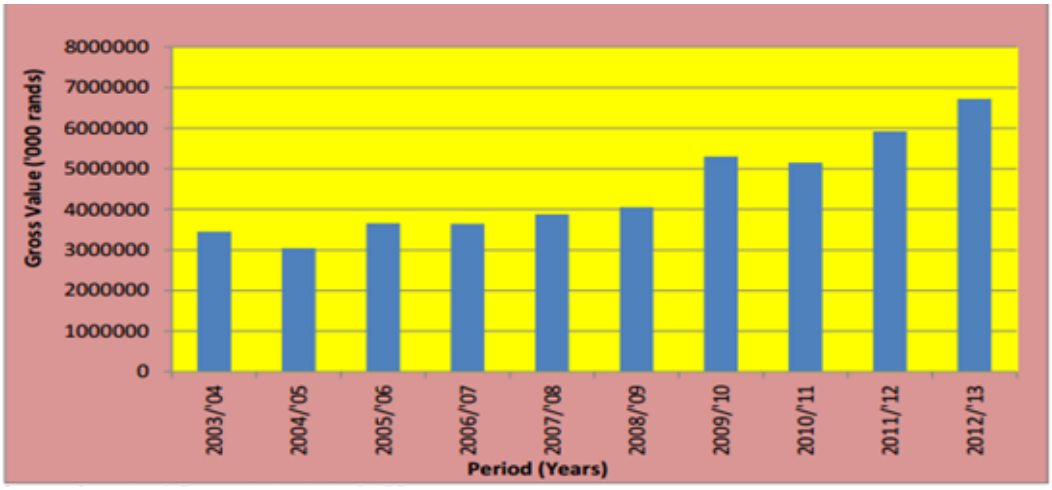

Figure 2.1: Contribution of the sugar industry to the gross value of agricultural production from 2003 to 2013

Source: DAFF (2013)

2.2.2 Total yield (tonnes) of sugarcane harvested in South Africa (not including research stations over the period 2000/01 to 2011/12 seasons.

The total national yield (tonnage) of sugarcane harvested in the period 2000/01 to 2011/12 has decreased considerably and at a rather constant and alarming rate of more than 500 000 tonnes per season (Figure 2.2).

Of concern is especially the period since 2005 when the sugarcane tonnage delivered decreased despite a considerable increase in the nominal Recoverable Value (RV) price paid for delivered sugarcane as well as a smaller but constant increase in the real RV price. Figure 2.2 shows the total South African yield (tonnes) of sugarcane harvested (not including research stations) by considering each milling region's tonnage of sugarcane harvested. From figure 2.2, it is clear that not all the production regions have followed the decreasing production trend suggested by the aggregate industry harvest figures.

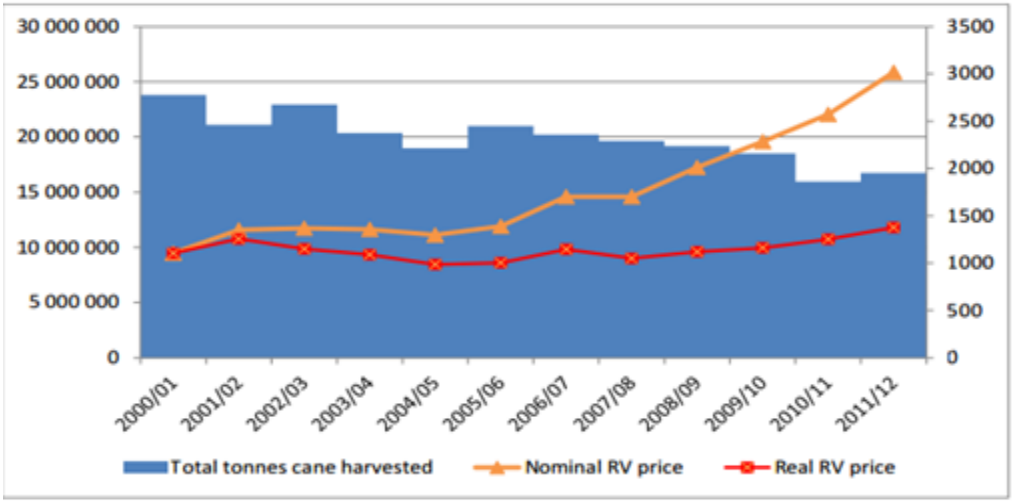

Figure 2.2: Total yield (tonnes) of sugarcane harvested in South Africa (not including research stations) over the period 2000 to 2012

Source: SACGA (2011/12)

2.2.3 Harvest trends in the mill regions where the yield (tonnes) of sugarcane harvested have decreased over the period 2000/01 to 2011/12.

By considering each milling region's yield (tonnage) of sugarcane harvested (Figures 2.2 and 2.3), it is clear that not all the production regions have followed the decreasing production trend suggested by the aggregate industry harvest figures.

Figure 2.3 shows the harvest trends in the mill regions where the yield (tonnes) of sugarcane harvested have decreased over the period 2000 to 2012. Figure 2.3 indicates that production trends in regions where yield of sugarcane harvested and delivered have decreased or remained relatively stable while Figure 2.2 depicts harvest trends in the mill regions where the yield (tonnes) of sugarcane harvested have increased over the period 2000/01 to 2011/12.

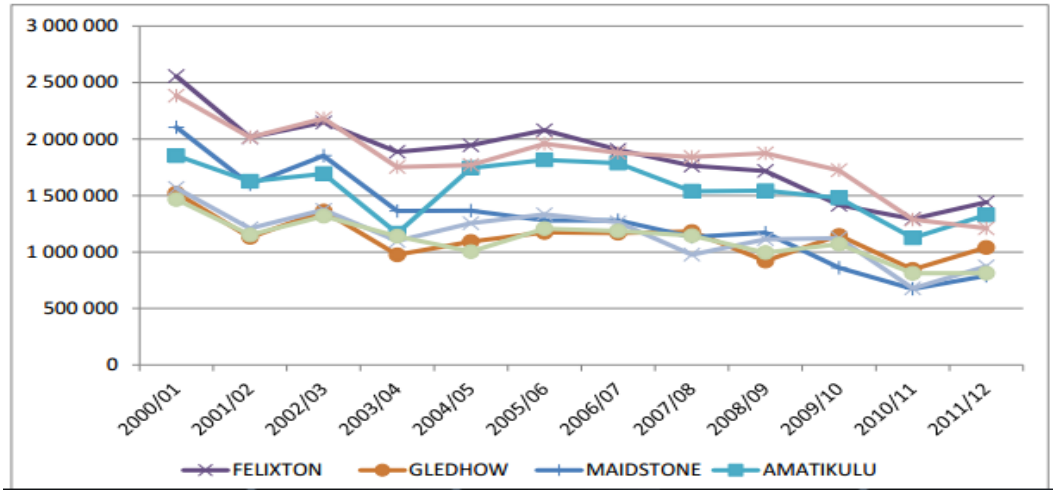

Figure 2.3: Harvest trends in the mill regions where the yield (tonnes) of sugarcane harvested have decreased over the period 2000 to 2012

Source: SACGA (2012)

Figure 2.4 shows production trends in milling areas where production has decreased (tonnes). it is quite apparent that the milling regions where sugarcane production has decreased considerably, are the coastal regions and regions where a large share of the mills' sugarcane are planted at relatively low altitude. Increases and relative sustainment in sugarcane production were attained in mainly the Northern irrigated and the Midland areas.

It has been suggested that one of the indirect objectives of the RV payment system was to decrease the yield (tonnes) of sugarcane delivered relative to the tonnes of sucrose and a decrease in sugarcane tonnage would thus seem in line with expectations. However, Figure 2.4 shows that sucrose deliveries, measured in RV tonnes, for the Northern irrigated and Midlands's mills as well as the Coastal mills have decreased. While the inland mills' Recovery Value deliveries decreased 8463 tonnes per annum on average, the Coastal farmers harvested and delivered on average nearly 55 000 RV tonnes less per season over the eleven-year period.

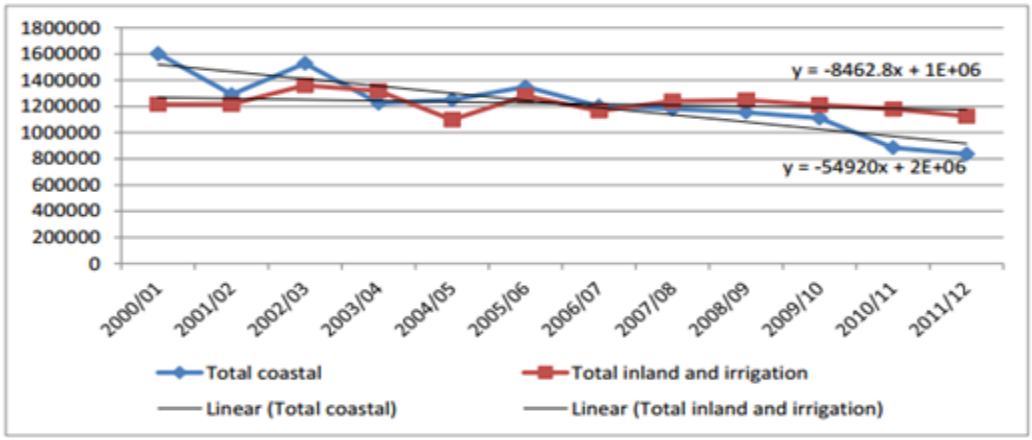

Figure 2.4: Comparison of recoverable value (RV) tonnes harvested for coastal areas versus irrigated areas over the period, 2000/01 to 2011/2012

Source: SACGA (2012)

2.2.4 South African sugar industry sugar sales (in tonnes) over the period 2009 to 2013

Farmers' willingness to plant sugarcane in the sugar industry decreased because of the lowest gross margin received from sugarcane by the year 2009/10 whereby the yield (tonnes) produced were 2 187 542 tonnes with rainfall of 832mm. According to Nxumalo (2013) in 2010/11 sugar sales were showing 1 919 116 tonnes decreased with rainfall of 883mm.

It was further stated by Nxumalo (2013) that in 2012/13 the sugar sales (1 961 031 tonnes) increased with rainfall of 1 224mm this implies that climate has an impact on yield fluctuations. Dubb (2013) states that the contribution of sugarcane to the gross value of agricultural production fluctuated considerably from 2010 to 2012 (see Table 2.1).

Table 2.1: Sugar industry sales (in tonnes) over the period 2009 to 2013

Year	**Sales (Tonnes)**	**Rainfall (mm)**
2009/2010	2 187 542	832
2010/2011	1 919 116	883
2011/2012	1 832 438	886
2012/2013	1 961 031	1224

Source: Adapted from SASA (2013)

2.2.5 An overview of sugarcane production in KwaZulu-Natal

The structure of small-scale sugarcane farming is unlike that found in large-scale profit-making sugarcane farming. Large-scale sugarcane commercial farms are in straight contact with the local farmers' councils, which were established in each mill area to address the concerns of the sugarcane farmers. The small-scale sugarcane farmers operate via different channels: through their representatives, who are established in each mill supply area to represent the interest of the local sugarcane farmers in their locations;

- Through local associations with which small-scale sugarcane farmers and contractors are registered, and
- Through mill-cane committees which are made up of members from several local associations in each mill area. The local association`s responsibility is to set tariff rates for services allocated by contractor committees such harvesting and marketing of sugarcane. Mill-Cane Committee oversees challenges faced by local small-scale sugarcane farmers and re-solves it with the support of local sugarcane farmers` councils of South African Cane Growers' association.

2.2.6 KwaZulu-Natal sugarcane production for the period 1999 to 2009

South African Sugar Association (2014) states that an average sugarcane production from the period 1999/2000 to 2008/2009 has an estimated yield of 66.6 tonnes per hectare produced in KwaZulu-Natal. The period of 2008/2009 harvest diminished from 66.6t/ha to 63.4t/ha, this decline may be the result of climate change. It was further noticed that in 2009 to 2010,

production diminished from 63.4 tonnes per hectare to 61.4 t/ha due to the decrease of land planted with sugarcane from 38 200ha (18.7%) to 31 700ha (16%). The gross value contribution from sugarcane caused farmers to deviate to other crops such as maize in order to support the poor income that was generated from sugarcane (Nxumalo, 2013). Dubb (2013) states that there a drop in the area harvested in the North Coast followed by Zululand. It dropped from 31 000 ha to 16 000 ha of sugarcane land (see Table 2.2).

Table 2.2: KwaZulu-Natal sugar industry sugarcane production for the period 1999 to 2010

Production period	**Decrease in land planted (ha)**	**Decrease in t/ha**
1999/2000-2008/2009	38 000 - 31000	66.6 to 63.4
2009/2010	31 000 -16000	63.46 to 61.4

Source: Adapted from SASA (2010)

2.2.7 Production losses incurred by sugarcane farmers of KwaZulu-Natal from 2013/14 to 2014/15 period and projected losses for the 2015/16 period.

This section presents the production data and percentage losses in KwaZulu-Natal in the 2013/14 to 2014/15 production periods as well as the projected losses for the 2015/16 production period. Table 2.3 shows the percentage decrease in sugarcane production in the 2013/14 period through 2014/15.

It is evident from the data in Table 2.3 that there has been a decline in sugarcane production in some sugarcane-growing areas in KwaZulu-Natal between 2013 and 2015. For example, in Darnall a large decrease of approximately 60% between 2013/14 and 2015/16 is noted, this is assumed to be a result of lack of sufficient adaptive strategies such as irrigation by farmers (see Table 2.3).

Table 2.3: Production losses incurred by sugarcane farmers in KZN between 2013 and 2015 production period and projected losses for the 2015/16 production period

Area	**2013/14 (tonnes sugarcane/hectare/annum)**	**2014/15 (tonnes sugarcane/hectare/annum)**	**Projected 2015/16 (tonnes sugarcane/hectare/annum)**	**% Decrease from 2013/14**
Mfolozi	1 314 245.00	1 137 668.00	1 010 045.00	23
Felixton	1 672 663.00	1 451 752.00	1 050 283.00	37
Amatikulu	1 450 308.00	1 322 902.00	825 000.00	43
Darnall	1 054 931.00	814 991.00	420 000.00	60
Gledow	1 505 853.00	1 257 793.00	933 994.00	38
Maidstone	1 010 359.00	829 612.00	637 513.00	37
Eston	1 542 947.00	1 304 072.00	1 101 716.00	29
Sezela	1 695 409.00	1 395 721.00	1 240 000.00	27
Umzimkhulu	955 738.00	855 503.00	837 184.00	12
Union	970 768.00	830 329.00	591 055.00	39
Noodsberg	1 475 602.00	1 255 353.00	870 935.00	41
Total dry land	1 4648 823.00	1 2455 696.00	9 517 725.00	35

Source: Adapted from South African Cane Growers Association (2015)

2.2.8 Registered small-scale sugarcane farmer numbers who delivered sugarcane for the period 1972 to 2010/11 in KZN

Figure 2.5 shows that the decrease in South African sugarcane farmers' area planted to sugarcane is reflected by the number of small-scale farmers involved with sugarcane production. The number of small-scale sugarcane farmers reached a maximum around 1996/97 and the number of registered sugarcane growers decreased from an estimated 57 000 farmers to less than 30 000 in 2010/11. Farmers who actually delivered sugarcane (which is probably a closer indication of productive small-scale sugarcane farmers) basically halved during the same period from around 30 000 to less than 14 000 farmers and from 2004/05 to 2009/10 (SACGA, 2012).

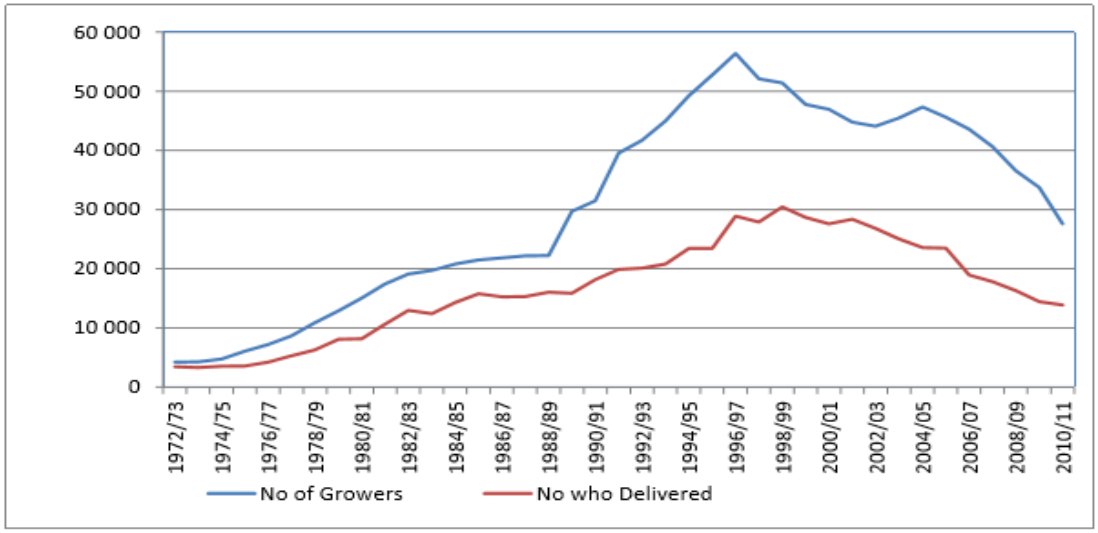

Figure 2.5: Registered small-scale sugarcane farmer numbers who delivered sugarcane for the period 1972 to 2010/11 in KZN

Source: South African Cane Growers Association (2012)

2.2.9 Sugarcane production statistics for Mona and Sonkombo area for the period 2012/13.

The statistics show fluctuations yield (t/ha) under in cultivation in the 2012/13 to 2013/14 period which was 3 005 tonnes to 4 490 tonnes per annum in Mona where there was a 4 085 increase of yield (tonnes) of sugarcane in 2013/2014.

It is indicated in Table 2.4 that there was decrease of yield (tonnes) in 2014/15 which was followed by increase in 2015/16 in Mona and Sonkombo. More decrease of yield (tonnes) happened in 2016/17 because of drought and other challenges (Ingle, 2016) (see Table 4.9). According to Ingle (2016), Tongaat Hulett project manager, the yield fluctuation from 2012/13 to 2016/2017 was a result of climate change with fluctuations in rainfall and temperature. The statement on climate change is supported by the climate statistics (see Table 3.1) in section 3.2.2.2 and Table 3.2 in section 3.2.2.2.2).

Table 2.4: Sugarcane production statistics for Mona and Sonkombo (total deliveries of sugarcane tonnes per hectare produced/annum) for the period 2012 to 2016

Area	**2012/2013 (Yield - tonnes)**	**2013/2014 (Yield - tonnes)**	**2014/2015 (Yield - tonnes)**	**2015/2016 (Yield - tonnes)**	**2016/17 (Yield - tonnes)**
Mona	3005	4 490	3 446	519	44
Sonkombo	685	4 085	3 540	1 291	61
Total	3 690	8 575	6 986	1 810	105

Source: Adapted from SACGA (2014)

2.2.10 The contribution of sugarcane production to the economy of South Africa

This section presents and describes the contribution made by the sugarcane industry to the local economy by creating employment, generating income, alleviating poverty and improving the food security status of small-scale sugarcane farmers.

2.2.10.1 Employment creation

The South African Cane Growers Association (2014) reported that there are approximately 1 550 large-scale farmers and 378 black developing farmers producing 84.69% of the entire sugarcane in KwaZulu-Natal. It was further stated by SACGA (2013) that about 6.72% of the production is from other sugar mill companies with their own sugar estates that produce the sugarcane crop and the remaining 8.4% of sugarcane production is from small-scale sugarcane farmers.

It was noted by SACGA (2013) that the sugar industry employ 77 000 people in sugarcane processing section. The sugar industry also indirectly creates 350 000 jobs in several support industries in three provinces of South Africa where sugarcane is developed and processed, including KwaZulu-Natal. It is further reported by SACGA (2013) that there are approximated 27 580 registered sugarcane farmers and about one million people who rely on the sugar industry for a living.

2.2.10.2 Income generation

The South African Sugar Association (2014) states that sugarcane provides farmers with pay which is ten months after the growing season. Illovo has a definite market to sell sugarcane for its farmers compared to many other crops such as maize and beans which offers income within three to four months of the harvesting period. Illovo, has widespread agricultural and industrial operations in six southern African countries, is the biggest sugar producer (SASA, 2014). Illovo sugar is domestically sold to both household and industrial consumers, with the balance exported to preferential markets in the European Union (EU) and United States of America (USA), and furthermore to other African countries, particularly Zimbabwe. Illovo's small-scale sugarcane farmers also grow crops such as maize, bananas and yams for their own consumption, so as to supplement their income from sugar and ensure their food security (Food and Agricultural Organisation (FAO), 2012).

2.2.10.3 Poverty alleviation

The sugar industry has a number of dependents that are as important as the workers themselves in the sugarcane-planting rural areas of KwaZulu-Natal, Mpumalanga and Eastern Cape (McCarthy, 2008). According to Statistics South Africa (Stats SA) (2012), the sugar industry has financed sugarcane-planting farmers broadly in these rural areas; the totality of dependents on the sugar industry is approximated to be four dependents per employee, adding up to a collective of 400 000 dependents on the sugar industry. The number of four dependents per employee in the sugar industry corresponds with the latest census figures released by Stats SA in 2014. Hickel (2012) states that farm workers continue to earn extremely low wages. Despite a mandated minimum wage of R1 503.90 (185 United states of America Dollar (USD)) a month, a 2004 report by the South African Human Rights Commission documented salaries as low as R60 (8 USD) a month for farm workers.

Sugarcane workers interviewed on large farms and estates earn around the minimum wage. After deductions for rent, protective gear, unemployment insurance, and cut hours, however there is little left, for example the farmer spent R90 on rent and R700 on food and still need to support his family, need to buy clothes, pay school fees, purchase furniture like normal person but in vain (Hickel, 2012).

Hickel (2012) states that there are those working for small-scale farmers generally earns less than R1 000 a month. According to the human right commission documented farm workers' salaries show that farm workers and families remain poor because all money paid by company goes to food and rent, but other expenses are difficult to cover.

According to SACGA (2013), sugarcane production in iLembe District Municipality, especially in the Ndwedwe and Maphumulo Local Municipalities, does not guarantee poverty alleviation because of the production challenges faced by small-scale sugarcane farmers, such as lack of transport, inadequate inputs and high labour costs.

2.2.10.4 Contribution to food security

Illovo's small-scale sugarcane farmers also grow crops such as maize, bananas and yams for their own consumption, so as to ensure their food security (FAO, 2012).

It was stated by SASA (2014) that although sugarcane may be developed on a piece of land which has been used for food production, the income from sugarcane farming can be used to cover domestic needs such as food and agricultural inputs for food crops.

On the other hand, SASA (2014) states that although income from sugarcane production can be used to buy food, due to the high transport costs, the income is poor, leading to food insecurity by small-scale sugarcane farmers of KwaZulu-Natal. It was furthermore noted by SASA (2014) that the distance from Maphumulo Local Municipality to millers in Gledow and Glendale reduces the profits for small-scale sugarcane farmers, resulting in low income to buy food.

2.3 Factors influencing small-scale sugarcane productivity in South Africa

This section presents and discusses the factors likely to influence sugarcane productivity by small-scale sugarcane farmers. These factors include environmental factors and socio-economic factors.

2.3.1 Environmental factors

The major environmental factors which are limiting small-scale sugarcane farming include drought and soils-related factors (Department of Environmental Affairs (DEA), 2010).

2.3.1.1 Drought (variability and climate change)

According to DEA (2010) there is variability in the climatic situation, resulting in bad impacts on water resources and agriculture. Climate change is already being perceived to be increasing, and there are fears that it could result in bad conditions for agriculture (Mashoko, Mbohwa & Kekane, 2009).

Climate change has escalated the water management problems that affect coping strategies such as irrigation because of water shortages (Mashoko *et al*., 2009). Water as a limiting factor as well as a basic need for South Africans, could have major consequences in most sectors of the economy, especially in the agricultural sector (DEA, 2010).

2.3.1.2 Soil fertility and degradation

The degradation of soil has been caused by existing sugarcane systems, mainly the lack of conservation measures, excessive mechanisation leading to compaction, and loss of soil fertility caused by depleting the organic matter in the soil (DEA, 2013). According to Bates *et al.* (2008), soil degradation is mostly associated with the decline in organic soil matter. Secondly, sugarcane production is monoculture. Short-term fallow periods, intensive tillage as well as limited crop rotation contribute to soil degradation in small-scale farms and commercial farms. According to Wenhold (2008), excessive fuel-wood collection, incorrect land use, high population density and overgrazing are the main effects of soil degradation in communal areas.

Soil-fertility and the degradation of soil is a concern in commercial agriculture, leading to nutrient building, especially phosphorus and zinc (Eweg *et al.*, 2009). In some situations, phosphorus has increased up to extreme levels, where it starts to diminish crop yields due to an extraordinary phosphorus fixation percentage. Eweg *et al*. (2009) states that soil type could have an impact on the growth and development of sugarcane. The crop performs well under a variety of soils, but favours well-structured aerated loam and sandy loam soils less than one metre deep. Eweg *et al.* (2009) also reports that sugarcane prospers less on sandy soils due to the fact that nematodes can be populated easily in sandy soils, while in clay soils, root development can be hindered (Bates *et al*., 2008).

2.3.2 Socio-economic factors

The socio-economic factors that influence small-scale sugarcane productivity include the cost of inputs, access to credit, labour availability, land and institutional support.

2.3.2.1 Cost of inputs

Malaza and Myeni (2009) state that the cost of inputs and small-scale sugarcane farmers related to the economies of scale by the feature of environments in which they operate is not having a contact to exploit the savings in bulk buying of agricultural inputs. This offer a chance for the development of combined farming in order to facilitate buying consortiums that will reduce costs of inputs (Malaza & Myeni, 2009). From Figure 2.6, it is clear that labour, fertiliser, and mechanisation (and associated expenses like lubricants and maintenance) and transport (field to mill) are the major sugarcane production expenditures. Interestingly the share of different expenditures has not changed much over the 26-year period, though services (water and electricity) and administration (bookkeeping and audit, office expenses, sugarcane levies and security) have become considerable expenditures (SACGA, 2012).

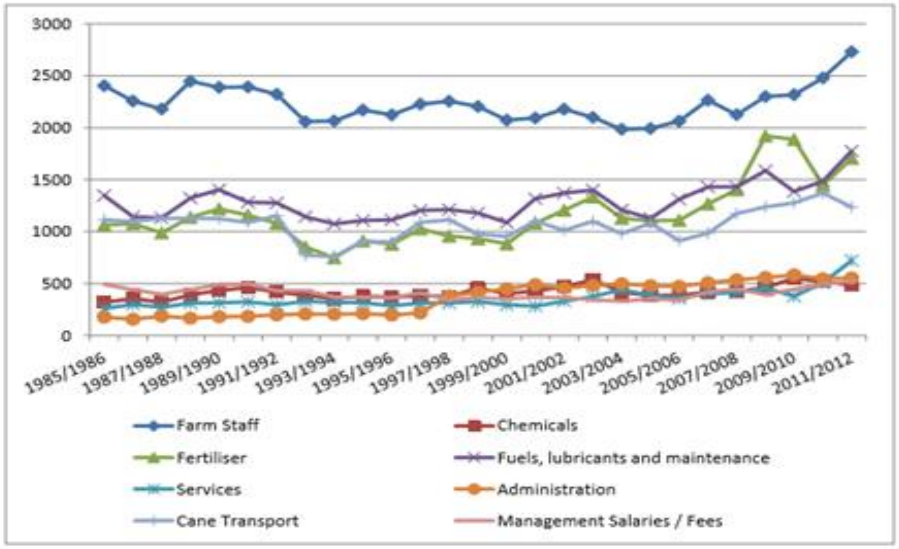

Figure 2.6: Real input expenditure trends per hectare (Rand/hectare) for the period 1985 to 2012

Source: South African Cane Growers Association (2012)

2.3.2.2 Access to credit

Access to credit is important for securing production inputs such as fertilizer, chemicals and labour that is necessary for improving production because it will provide farmers with capital to procure their business costs. The small-scale agricultural sector has been discouraged by the lack of access to financial assistance such as operational loans in order to continue with agricultural production (Sibanda, 2012). Bethel (2008) who found that sugarcane industry has had financial support for more than 50 years currently that holds the deliveries to the mills as security cession. This may have encouraged many to look to agriculture as a way of life, in that it is the only industry that offers new entrant access to financial borrowings, creating a large proportion of land users because of the extent of the land that the farmers own (SASA, 2011).

2.3.2.3 Labour availability

Availability of labour on the farm is increasingly becoming a limiting factor in the sugarcane industry for both commercial and small-scale farmers (SACGA, 2012). Richardson (2010) reported that farmers' productivity is influenced by inputs and labour costs of sugar industry as it results to lower gross margin received by the farmer. The wage bill for harvesting staff accounts for 30.2% of sugar industry profit followed by stable field workers (16.4%) and with general workers which are 14.7% of wages (SASA, 2011). South African Sugar Association (2011) states that the higher proportion of money in the sugar industry is influenced by hired staff where lot of money spent to their payments.

2.3.2.4 Land

According to SASA (2014) many black people were for long side-lined and disqualified to own land and South African land reform policies are trying to correct this imbalance. It was stated by SASA (2010) that there was a company by the name of Inkezo which was facilitating the land restitution processes in South Africa. During this period of land restitution, Inkezo Land Company was integrated into SASA structures after review of its termination (SASA, 2010). The slow movement of land reform, particularly in the land restitution process, continues to influence the sustainability of the cane-growing sector (Harris, 2008). The acquisition of land through land reform will not necessarily translate into an adequate increase in production levels but productivity will be driven by success and returns on efforts applied by the farmer (SASA,

2011). The land restitution projects could only be successful if project is managed through use of mentorship programme which could promote readiness of farmers by means of training from experienced sector or farmer so as to reduce possibility of bare land which is not likely but possible (SASA, 2011). Also the evidence of the dropping of farmer confidence in farming activities explains the loss supply in the sugar industry.

2.3.2.5 Institutional support such as extension support

The necessary link between the South African Sugar Research Institute (SASRI) researchers and farmers is provided by SASRI's extension service through consultation and feedback (SACGA, 2013). It was further emphasized by SACGA (2013) that services offered to the industry embrace specialised advice on growers' problems, soils and leaf analysis through the fertilizers advisory service. The sugarcane quarantine facility in South Africa is based on pest and diseases being operated by SACGA (2013). The quarantine facility provides support to sugarcane farmers to help improve sugarcane production. The lack of this support will lead to poor performance, resulting to low production by the sugarcane farmers. Farmers require farming skills in order to improve agricultural production (Nxumalo, 2013).

2.3.2.6 Other specific evidence about sugarcane production factors affecting sugarcane productivity

Declining small-scale sugarcane yields is a concern for the South African sugar industry (Parsons, 2003; Eweg, Pillay & Travailleur, 2009, Eweg, *et al.*, 2009; Thomson, 2010; Sibiya & Hurly, 2011). Although reduced yields have subjectively been ascribed to a number of factors, no study has been conducted to identify specific crop husbandry or agronomic production constraints as perceived by Small-scale sugarcane farmers A preliminary report on a survey conducted in Mauritius and South Africa (Eweg *et al*. 2009; South African Cane Growers Association , 2011) indicated that poor re-plant rates may contribute to reduced yields, along with low levels of education which contribute to poor crop husbandry practices among small-scale sugarcane farmers (South African Cane growers, 2011). Eweg *et al*. (2009) state, that small-scale sugarcane farmers perceive weeds as the top agronomic constraint that appears to be the first published record of such a perception. In the recent past, there have been numerous publications on improving weed management practices amongst emerging sugarcane farmers

(defined as both Small-Scale Sugarcane farmers and new freehold farmers) in the South African sugar industry, which indicates a recognition of weeds as a major constraint, and a need for research and extension to continue addressing crop protection practices amongst Small-scale sugarcane farmers (Campbell *et al.*, 2009). Smit *et al.* (2010) state that agronomic constraints should therefore be prioritised as an extension topic for the Small-scale sugarcane farmers in the Noodsberg region of the Midlands. This can be achieved by incorporating it into the demonstration plot programme of work which is currently being used for extension in this region (Gillespie *et al.*, 2012). Small-scale sugarcane farmers identified high input costs as an important constraint. This finding is supported by other studies (Armitage *et al.*, 2009; Thomson 2010). According to Eweg *et al*. (2009), high costs of fertilizers may be one of the major constraints on small-scale sugarcane farmers' yields, implying that small-scale sugarcane farmers do not apply enough fertiliser. Since the small-scale sugarcane farmers grow sugarcane in a diversified agricultural system together with other crops and they keep livestock, there is the potential for farmers to be subject to multiple and conflicting messages from extension and support stakeholders involved in these various agricultural enterprises. This has been the case, for example in Lesotho (Molomo, 2012). It is therefore important that extension and support stakeholders in this area communicate effectively with each other, and that good linkages are developed so that the small-scale sugarcane farmers' constraints, such as high input costs and weed control can be addressed effectively (Düvel, 2005).

2.10 Chapter summary

This chapter presents an overview of the sugarcane production in South Africa which pertains to the production of sugar and molasses from sugarcane, used both for local and export markets. It also provides an outline of sugarcane production in KZN, highlighting on the production fluctuations of sugarcane. The contribution of sugarcane production to the economy is also reviewed in this chapter, which includes employment creation, income generation and poverty alleviation. The chapter further reviewed the factors influencing small-scale sugarcane productivity in South Africa such as environmental factors that include drought and soils; socio-economic factors that include cost of inputs, access to credit, labour availability and land sizes; and institutional support such as extension support. The next chapter presents the research methodology of the study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents and describes the selection of the study sites with regard to their geographical aspects such as topography, climate (rainfall and temperature), vegetation, soils and land use. The research design, consisting of the sampling frame, sample size and sampling technique is also presented and discussed. The chapter also presents and discusses the analytical framework employed in the study, an amended/hybrid Cobb-Douglass Production Function and an explanation of the relationship of the dependent variable, which is productivity, to the independent variables. The chapter concludes with the presentation and description of the ethical considerations observed in this study including informed consent and voluntary participation, confidentiality, anonymity, discontinuity, ethics in analysis and reporting, and reporting back to research participants.

3.2 Selection of the study sites

The study was carried out in the Ndwedwe Local Municipality of iLembe District Municipality of KwaZulu-Natal. The selected villages are Mona and Sonkombo. There is a total of five villages planted with sugarcane in the selected local municipality, the other three villages are Ndwedwe Mission, Ntaphuka and Nhlangano. Mona and Sonkombo villages were purposively selected because these villages were in the same local municipality with same weather condition and both villages Mona and Sonkombo have farmers who produce and deliver cane to the same sugar mill.

3.2.1 Description of Ndwedwe Local Municipality

According to the Ndwedwe Local Municipality Integrated Development Plan (IDP) (2014), Ndwedwe is one of the four local authorities that form part of iLembe District Municipality. Ndwedwe Local Municipality lies on the following coordinates: latitude 29°31'0.69", longitude 30°55'36.73". Ndwedwe Local Municipality borders the east of Kwa-Dukuza Local Municipality and the north of Maphumulo Local Municipality (Ndwedwe IDP, 2014/15).

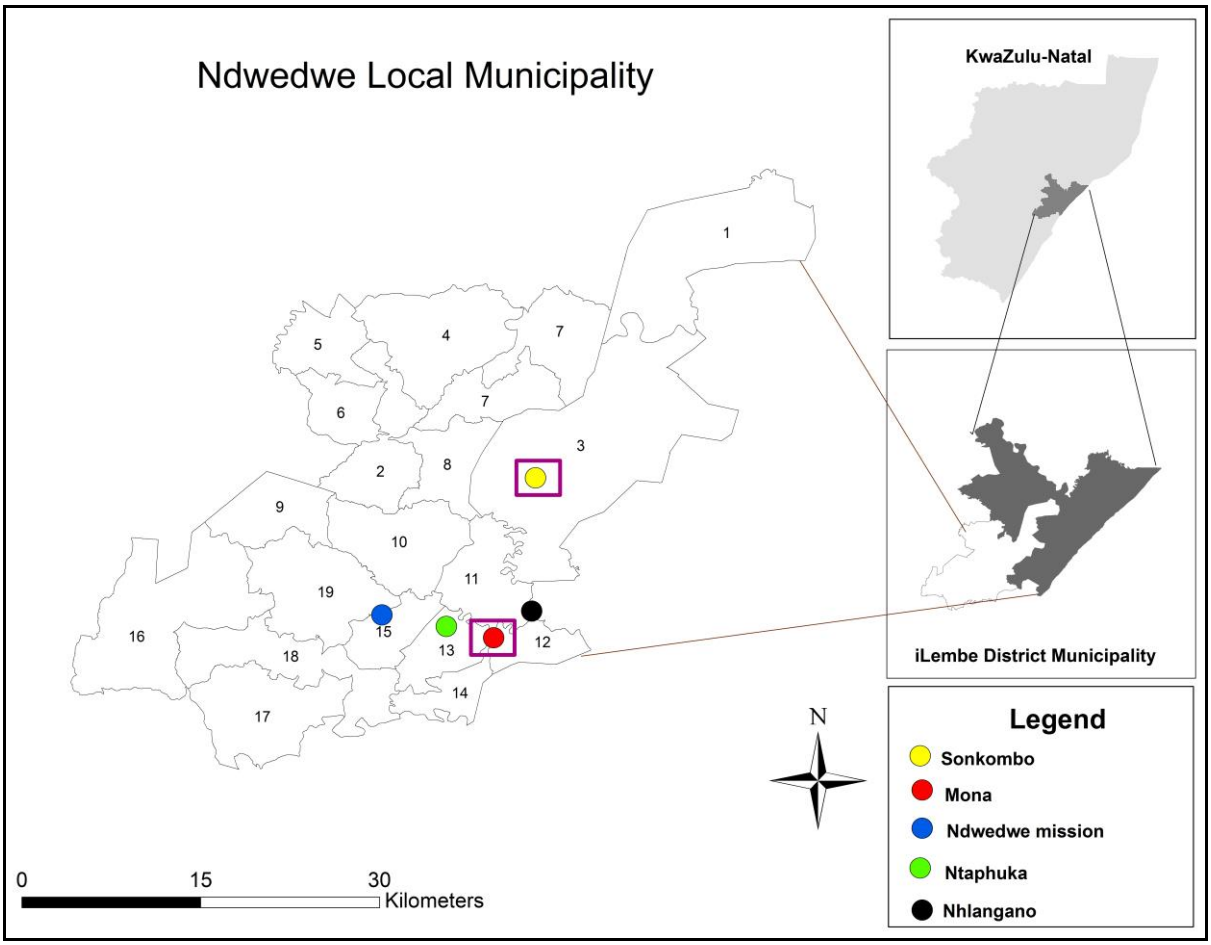

Figure 3.1: Map showing the location of study areas (Mona and Sonkombo) villages in Ndwedwe Local Municipality 2015

Source: University of Zululand Geography Department (2015)

3.2.2 Geophysical aspects

This section presents and describes the geographical aspects of the study areas such as topography, elevation of land and climate (rainfall and temperature distribution), vegetation, soils and land use.

3.2.2.1 Topography

The Ndwedwe IDP (2014) indicates that the future and present situation on the development of the municipality is influenced by the existing topographic conditions. According to the Ndwedwe IDP (2014), the municipality's topography is organised as follows. In the east and

north-east topography is flat to rolling lowland, creating part of the coastal flats. The area, particularly in the western side, is generally steep, uneven and elevated. The area is very steep and has some form of cliffs and escarpments in the western and south-west parts. There is a sequence of incisive river valleys running largely in an east-westerly way, which cross the western part of the municipality in certain parts into a sequence of spurs and valleys.

Though the eastern and north-eastern parts of the area look to be more suitable for commercial farming activities, there are opportunities for linking the current smaller-scale development and deviate agricultural activities in the west which could lead to high agricultural production (Ndwedwe IDP, 2014).

3.2.2.2 Climate

This section presents and describes the climatic aspects of the study areas in terms of rainfall and temperature.

3.2.2.2.1 Rainfall

Table 3.1 shows the average monthly rainfall of Ndwedwe Local Municipality during 2012 and 2013. Rainfall in the Ndwedwe Local Municipality occurs predominantly during the summer months, with some rain in winter. It is also a drought area and frost is recorded in this area. The minimum requirement of rainfall for planting sugarcane is 700mm. Table 3.2 shows the annual total rainfall for the year 2012 which was 1 115mm required for sugarcane production; and in 2013, the total annual rainfall was 923mm, which is above the minimum requirement of 700mm for sugarcane production. According to Ntshangase (2008), the planting season for sugarcane is from September to January, these are summer months with enough rainfall. September usually has more rainfall than all the other planting months. In 2012, September was having high rainfall; but in 2013, September was low in rainfall but October to December were better which were not recommended months by South African Cane Growers Association to plant sugarcane. According to Table 3.1, February has low rainfall; such a month cannot be used to plant sugarcane because sugarcane can be affected by water stress, March is a cold season month so that sugarcane cannot germinate by this season.

Table: 3.1: Average monthly rainfall of Ndwedwe Local Municipality in 2012 and 2013

RAINFALL (mm)	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total**
2012	43	26	167	90	28	22	6	40	263	184	63	183	1115
2013	141	34	121	72	58	32	50	26	38	196	99	56	923

Source: SACGA (2014)

3.2.2.2.2 Temperature

Table 3.2 shows the maximum and minimum monthly temperatures of Ndwedwe Local Municipality for 2013. The wide ranges of processes in agriculture are affected by temperature. Temperature is used as an index of the energy status of the environment. Temperature is the climatic variable in which there is a high degree of confidence that it will increase with global warming. According to the Ndwedwe Local Municipality IDP (2014), Mona and Sonkombo villages are situated in the south part of Ndwedwe Local Municipality, with an optimum temperature for crop growth of 24°C to 30°C. The mean summer temperature for growth in Ndwedwe Local Municipality is 19°C. The mean annual temperature in 2013 was 15.8°C to 20.9°C which is below the optimal temperature for sugarcane growth **(**Ndwedwe Local Municipality IDP ,2014).

Table 3.2: Average monthly temperature of Ndwedwe Local Municipality in 2013

Temp (°C)	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total**
Max 2013	23.4	28.4	27.7	25.4	25	22.7	22.7	24.0	24.8	24.3	26.6	26.6	303.5
Min 2013	20.7	20.2	18.5	15.7	13.5	11.1	12.3	11.2	14.3	15.1	18.0	19.0	923.0

Source: SACGA (2014)

3.2.2.3 Vegetation

Mucina and Rutherford (2006) state that the land is dominated by alien invasive species that have to be removed because they limit agricultural land, especially in Ndwedwe Local Municipality. The trees that are common include peanut butter bush and peanut butter cassia species which can increase flood damage (Mucina & Rutherford, 2006).

According to Mucina and Rutherford (2006), the peanut butter bush and cassia compete with agricultural crops because a lot of water and nutrients of the soils are lost, which affects the survival of indigenous plants and animals.

Peanut butter bush and cassia increase the loss of water from catchments because these alien plants consume a lot of water. They increase the severity of fire burning, resulting in a soil erosion hazard (Mucina & Rutherford, 2006).

According to the ILembe IDP (2013) the area of Ndwedwe is dominated by the royal *Poinciana* family plants. The royal family *Poinciana* tree has other land-use purposes because it can be preserved as a potted sample with sensible pruning and can make an excellent small sample for areas with limited space such as street sides or parking lots.

3.2.2.4 Soils

This section presents and describes the soil physical structure in Ndwedwe Municipality. This section also focuses on the agricultural potential of the soil, with emphasis on Glenrosa soil form which is preferable for sugarcane (Smetak *et al*.,2007).

3.2.2.4.1 Glenrosa soils and Mispah soil form

Ndwedwe Local Municipality consists of Glenrosa and Mispah soils. This means that the Ndwedwe area has high agricultural potential to plant sugarcane. It was stated by Smetak *et al*. (2007) that Glenrosa soils are moderately physically active. The soils are moderately sensitive to erosion. The subsoil is easily affected by erosion and should not be disturbed. Dry land cropping of sugarcane is preferable in Glenrosa soils. These soils are strong-structured, with high clay content subsoil and are not suitable for irrigation. The agricultural potential of the soils is

restricted to grazing and the sustainability of cattle/sheep farming on natural veld of these soils is low.

3.2.2.5 Land use

Much of the area in Ndwedwe Local Municipality has a steep and disorderly landscape, with interior and exterior linking difficult. This makes the servicing of the area relatively costly. The land is only provisionally proper for a sequence of land practices and activities such as small-scale farming of sugarcane, maize and grazing camps. Some of the land is used to build cost-efficient housing because of its structure (Ndwedwe IDP, 2013).

3.2.3 Socio-economic status

This section presents and describes the socio-economic status of the study areas in terms of population and settlements, education, unemployment, and infrastructure and economic activities such as mining, agriculture and tourism.

3.2.3.1 Population and settlements

The Ndwedwe area accommodates a population of about 140 820 people (Ndwedwe IDP, 2014). The overall settlement density of the Ndwedwe Local Municipality is approximately 145 people per km^2 (Ndwedwe IDP, 2014). The area also has traditional authority land and the balance is made up of commercial farm lands situated in the north-east of the municipality.

3.2.3.2 Education

Education is a key determinant to the availability of labour force. An educated population provides the needed skills to produce goods and services in an economy. For this reason, it is imperative to understand the education status of Ndwedwe Local Municipality. The amount of people above the age of 20 years with just primary level of schooling in Ndwedwe declined from 39.4% in 2001 to 22.2% in 2011. People with higher education schooling also declined from 1.7% to 1.3% by 2011 (ILembe IDP, 2013).

According to the ILembe IDP (2013), the number of people with matric level of education increased by almost 22.1%, to 84% in 2011 since from 2001. Likewise, the number of primary education enrolment (aged 6 to 13 years) increased from 87.8% in 2001 to 91.5% in 2011

(ILembe IDP, 2013). The level of education is to be improved if the municipal area is to experience meaningful economic growth and development. An improvement in economic development, increase in job opportunities and an improved living standard could create an atmosphere that may retain the current residents and/or attract new residents to Ndwedwe Local Municipality and stop them from relocating to neighbouring municipalities.

3.2.3.3 Unemployment

Table 3.3 shows the employment profile of Ndwedwe Local Municipality. ILembe IDP (2013) states that Ndwedwe Local Municipality comprises of 39.7% of people who are economically active, while 60.3% are not. Furthermore, out of the people who are economically active, only 33.7% have employment while 66.3% are not employed (ILembe IDP, 2013).

Table 3.3: Employment profile of Ndwedwe Local Municipality

Employment Profile	**Percentage (%)**
Economically active	39.7
Not economically active	60.3
Economically Active sub-division	
Employed	33.7
Unemployed	66.3

Source: ILembe IDP (2013)

3.2.3.4 Infrastructure

This section discusses about transportation infrastructure including numerous provincial tracks that cross the municipality**,** water services such as problems of sanitation, healthcare and hygiene, it also discusses about access to electricity by Ndwedwe Households.

Transportation infrastructure

Ndwedwe IDP (2014) specifies that there are numerous provincial tracks that cross the municipality. Connectivity within the municipality is unfortunately limited, with easier and faster routes positioned outside the municipal area used to reach different areas within the municipality. The main access routes in the municipality, which are also the only tarmac surfaces, include the following: the existing R74 route from Stanger via Ashville to Kranskop. There is another

existing R614 from Tongaat via Qinisani and Bhamshela to Wartburg. Finally, there is the P100 from Verulam to the Ndwedwe villages of Mona, Sonkombo, Ndwedwe mission, Nhlangano, Ntaphuka and Inanda as well (Ndwedwe IDP, 2014). According to Nxumalo (2013), the majority of households in the Ndwedwe area have access to roads within 2,5km or less. This does not indicate the true picture of transport accessibility in the area as many of these roads are poorly maintained, causing vehicle access to the neighbouring areas to be problematic, particularly considering that most roads are gravel and are unsafe during the wet season especial where the slope of the road is steep. The more evenly sloped areas are situated in the western parts of the municipality where commercial agriculture and forestry activities are prominent.

Ntshangase (2008) further states that in the statistical distribution of modes of transport mainly utilized by residents, it is evident that a large portion of the Ndwedwe population (74%) travels mainly by foot because they have no or limited access to affordable public transportation. This also relates to the remoteness of some of the areas as limited road infrastructure which allows taxis and buses to reach these remote areas. The Ndwedwe IDP (2014) mentions that there are well-maintained lower order roads which exist, which is an indication of the poverty levels of the area. With the high dependency on the lower order roads, it is necessary to ensure proper transport infrastructure exist, especially with the view of creating economic growth in the municipality which positively affects all Ndwedwe residents.

Water services

The Ndwedwe IDP (2014) states that the management and implementation of portable water schemes in the Ndwedwe area is regarded as a need for the local people. This also includes problems of sanitation, healthcare and hygiene. The provision of clean water from pipes and incentives of saving water were identified as priority needs for the Ndwedwe community (Nxumalo, 2013).

Access to electricity

The Ndwedwe IDP (2015) states that Ndwedwe census data does not differentiate between population with and without electricity, and it is thus difficult to determine precisely which households are connected to the power network in order to estimate access to electricity. Nxumalo (2013) states that the area is properly serviced with electrical infrastructure. A high

voltage line crosses the municipality area in the east-west direction, from which a number of medium voltage lines provide the opportunity to install reticulation lines all over the municipality area. Municipality wards 1 and 12 had the highest levels of access in 2011 compared to 2001 where wards 1, 3 and 15 had the highest access, with the majority of wards in the municipality having less than 30% access (Ndwedwe IDP, 2015). According to the Ndwedwe IDP, (2015) it is appreciable that the levels of access to electricity have increased in all the wards; and although implementation is slow, there is certainly visible progress. Other municipality wards such as wards 7, 8, 11, 18, as well as 19 require desperate attention, regarding electricity provision. The municipality also facilitates provision of electricity in schools, clinics, and other governmental institutions. The local municipality also coordinates the provision of electricity to homes and schools to enable an efficient learning environment.

3.2.3.5 Economic activities

The municipality is currently lacking a concrete revenue base. There are certain opportunities that have been known relative to the development of King Shaka International Airport and Dube Trade Port. Economic opportunities include mining, agriculture and tourism (Nxumalo, 2013).

3.2.3.5.1 Tourism

The municipality has a poorly developed tourism sector. It, however, has great tourism potential but is hindered by fragmented topographic situations and the lack of funding. The natural environments are in urgent need of attention in the form of rehabilitation, protection and management. The prevailing steep fragmented topographic conditions provide a good environment for attracting tourism to the Ndwedwe area (Ndwedwe IDP, 2013). Also there are a number of tourism initiatives that the municipality has initiated to unlock the tourism potential of the municipal area. These initiatives include the promotion of Nhlangakazi Mountain, which is a significant cultural and religious attraction; Nsuze Battle field, which is significant in the Bhambatha rebellion and has a rich history; Kwaloshe Forest, which is an attractive landscape full of greenery with various indigenous plant species and remedial plants. Kwaloshe Forest surely has the potential to become an eco-tourist attraction that should be connected and utilized as a source of economic expansion and development (Nxumalo, 2013). There is a range of mountains located in the Ndwedwe Local Municipality endowed with natural beauty, which

includes: Ozwathini Mountain; KwaMatabata Mountain; Carmen Mountain; KwaMakalanga Mountain and Goqweni Mountain (Ntshangase, 2008). There is also an Elevation Tourism Centre which depicts the natural scenic beauty of Ndwedwe. The partnership of Ndwedwe Local Municipality with the surrounding communities in developing the Nhlangakazi project whereby Nazareth Baptist Church members assemble for prayer in January on a yearly basis which then become advantageous to tourism within the municipality. The event is very significant for the many tourists who come to witness this spectacular occasion.

3.2.3.5.2 Agriculture

According to the Ndwedwe Local Municipality IDP (2014), there is commercial farming in the north-east and east areas. The rest of Ndwedwe mainly practices subsistence farming. About half (50%) of the municipality is occupied by large-scale farming mainly in the form of sugarcane agriculture. The other half of the municipal area consists of traditional settlements with a restricted number of individuals who are subsistence farmers. Small areas of Ndwedwe are dominated by forest (Ndwedwe IDP, 2013). Furthermore, the municipality also has some community gardens where vegetables and groundnuts are planted. The Ndwedwe IDP (2013) states that there are fruitful pilot projects which have highlighted the need for a combined agro-processing facility that will process condiments such as paprika plants and chillies.

3.3 Research design

The study employed a quantitative research approach. The study explicitly describes the challenges and factors affecting sugarcane productivity by the small-scale sugarcane farmers of Ndwedwe Local Municipality in KwaZulu-Natal. According to Chidoko and Chimwai (2011), a descriptive survey design describes and clarifies the existing achievements, attitudes, behaviours and other characteristics of the group of subjects. The quantitative methods can provide a high level of measurement precision and statistical power. It clearly and precisely specifies both the independent and dependent variables under investigation and eliminates bias of judgment.

3.3.1 Conceptual framework

In order to identify and define variables for the study, the framework presented in Figure 3.2 tries to analytically decompose the factors affecting sugarcane productivity. From Figure 3.2,

socioeconomic and environmental factors and other exogenous factors have any effect on sugarcane productivity which in turn affects farmers' income and profit. This will also affect the amount of foreign exchange earnings for the nations and general wellbeing of the economy.

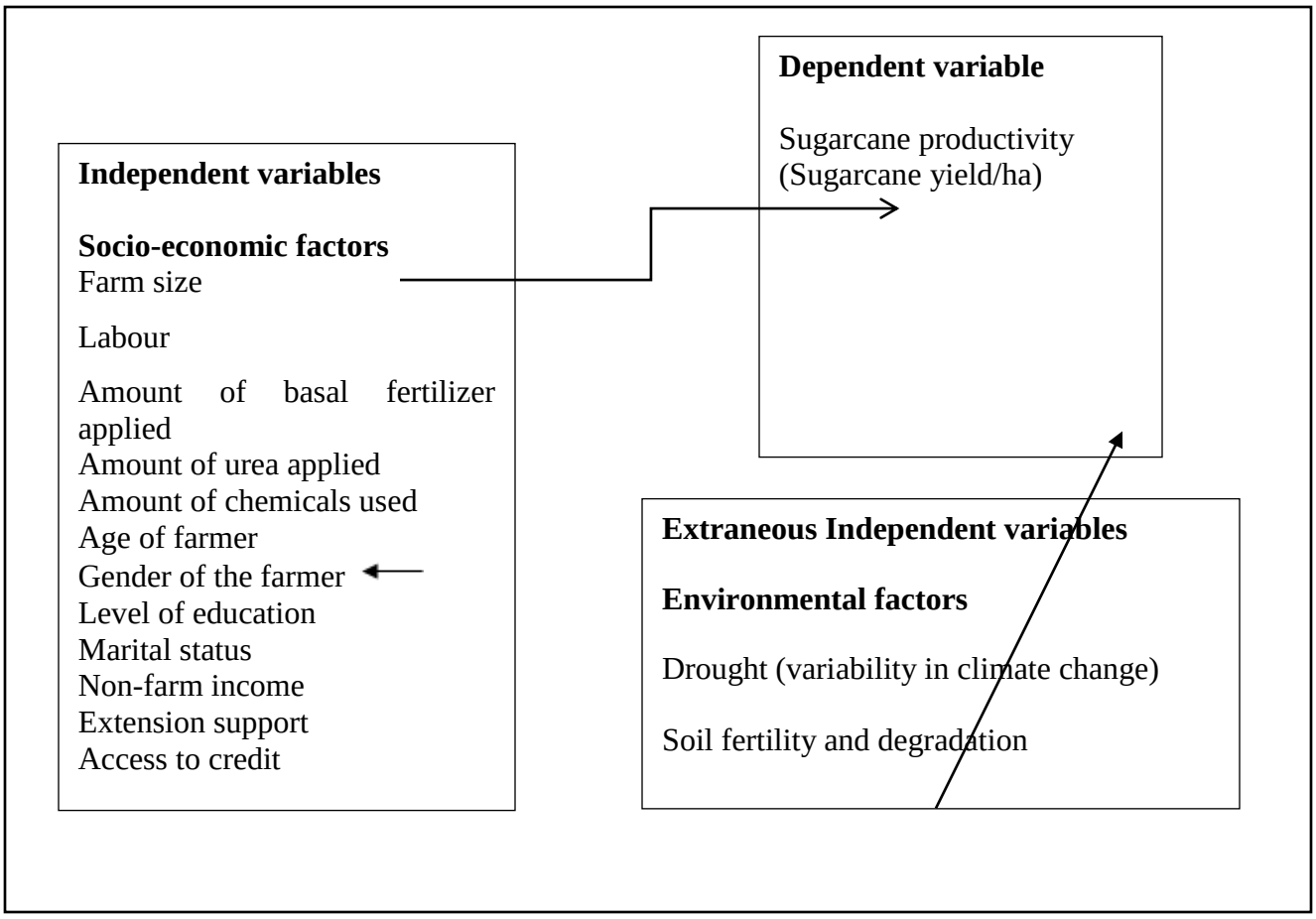

Figure 3.2: Conceptual framework on the factors affecting sugarcane productivity

Source: Adapted from Dindi (2013)

Using literature, the study developed a number of factors likely to affect sugarcane productivity of small-scale sugarcane farmers. Consistent with literature; factors affecting sugarcane productivity production are decomposed as follows; socio-economic factors: such as farm size, labour, amount of basal fertilizer and urea applied, amount of chemicals used, age of the farmer, gender of the farmer, level of education, marital status, non-farm income, extension support and access to credit as well as environmental factors: that include drought (variability in climate change) and soil fertility and degradation. The extraneous environmental factors were however excluded from the model in this study.

3.3.2 Units of analysis

A unit of analysis is a person or object from whom a social researcher collects data. The unit of analysis may also be an individual, family, group, organization or a community (Bless *et al*., 2013). The units of analysis of this study were small-scale sugarcane farmers who delivered sugarcane to the Tongaat-Hulett Mill for crushing in the Ndwedwe Local Municipality under the Ilembe District Municipality of KwaZulu-Natal Province.

3.3.3 Sampling frame

A sampling frame is a complete list of units from which the sample would be drawn (Bless *et al*., 2013). According to Bless *et al.* (2013) the use of the complete and correct sampling frame is the first means of ensuring a representative sample. A complete sampling frame of all the small-scale sugarcane farmers that delivered sugarcane in the mill was obtained from the Tongaat-Hulett office of Nhlangano region in 2014. There were 2000 small-scale sugarcane farmers who planted sugarcane for marketing or crushing in Ndwedwe Local Municipality (Tongaat-Hulett, 2014). The sample size was therefore drawn from this sampling frame.

3.3.4 Sample size and sampling techniques

For the sample to be scientific, it is not only about how many elements should be included for observation. It requires careful thinking about which element should be included and how it is going to be selected for probability sampling (Blanche *et al*., 2006). The study consisted of 100 small-scale sugarcane farmers from the two villages (Mona and Sonkombo) which were chosen purposively for this study since they have identical agro-climatic conditions and sugarcane is the main crop enterprise in these villages out of the five villages in Ndwedwe Local Municipality.

A total sample size of 100 small-scale sugarcane farmers was a reasonable accessible sample in terms of time and cost. This sample size was more than 30, which is adequate to generate statistical analysis (Bless *et al*., 2013). Systematic random sampling was employed, which is a probability sampling method. According Tustin *et al.* (2005) with the simple random sampling, the probability of being selected in the sample is known and equal to all members of the population. In the database of Mona and Sonkombo small-scale sugarcane farmers of 500 members in each village, the researcher selected every fifth member as a respondent. Fifty

farmers were randomly selected from each of the two villages that are in Mona and Sonkombo respectively.

Table 3.4: Study population and sample size

Study site	**Sample size**
Ndwedwe Local Municipality	2 000 (N)
Mona	50
Sonkombo	50
Total sample size	**100 (n)**

Source: Survey data (2015)

3.3.5 Data collection

A questionnaire that was composed of open-ended and close-ended questions was used as a tool for data collection. A questionnaire is used to simplify findings and to understand the phenomenon in its natural context (Bless *et al.,* 2013). The questionnaires were translated from English into the local isiZulu language. The questionnaires were administered to respondents through face-to-face interviews. Chidoko and Chimwai (2011), state that face-to-face administered questionnaires can be conducted with participants that can neither read nor write.

In addition, the existence of the interviewer raises the excellence of the responses as the interviewer can search for more specific answers. The questionnaire captured data on the demographic information, socio-economic characteristics of their respondents, as well as institutional and production factors influencing the productivity of the small-scale sugarcane farmers (Chidoko & Chimwai, 2011).

3.4 Data analysis

Data was encoded in Microsoft Office Excel and then exported to Statistical Package for Social Scientists (SPSS) software, version 20, for analysis. The computer program SPSS that allows one to analyse and describe data was used. The reasons for using SPSS was that editing of data was easier, large data sets could be used, and good looking reports and graphs could be formed. The information was tested for validity using SPSS whereby frequency counts, means and

percentages as descriptive statistic tools were generated. The information was interpreted and presented in the form of graphs and tables.

For the first objective, which is to identify the production challenges faced by small-scale sugar farmers in the study areas, descriptive statistics were applied. Here frequencies and percentages were used. For the second objective, which is to determine the factors influencing the productivity of small-scale sugar cane farmers, an amended or hybrid Cobb-Douglas Production Function (CDPF) was employed.

3.4.1 Cobb-Douglas Production Function

An amended or hybrid CDPF was employed to determine the factors affecting sugarcane productivity in the study areas. In economics, the Cobb-Douglas form of production function is broadly used to describe the association of output to inputs (Hasan, 2008). An amended or hybrid CDPF is a modified or extended CDPF. The amended/hybrid CDPF was used so as to include other factors that the traditional CDPF cannot include such as socioeconomic attributes which are extension support, gender, age and educational level factors of the farmer that also have an influence on productivity.

The CDPF model has been used by a number of similar studies for example Ekbom (1997); Liu and Li (2010); and Baiyegunhi and Arnold (2011). According to Baiyegunhi and Arnold (2011), the production output is determined by the amount of labour involved and the sum of capital devoted.

The selection of CDPF was based on that it does not introduce various econometric estimation problems like heteroscedasticity and multicollinearity and can be handled adequately and easily. The CDPF facilitates computations and has the properties of uniformity and flexibility. The CDPF in its general form is specified as follows.

Equation 1:

$$Y = \beta_0 X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} X_6^{\beta 7} X_7^{\beta 8} X_8^{\beta 9} X_9^{\beta 10} X_{10}^{\beta 11} X_{11} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots e^{\mu}(1)$$

Where;

Y= Productivity (yield/ha)

β_0= Constant

βi = Output elasticities

X_1 = Age of a farmer

X_2 = Gender of a farmer

X_3 = Marital status of a farmer

X_5 = Level of education of the farmer

X_6 = Nonfarm income

X_7 = Extension support

X_8 = Access to credit

X_9 = Farm income

X_{10} = Farm size (ha)

X_{11} = Labour (man days/ha)

X_{12} = Amount of basal fertilizer applied (kg/ha)

X_{13} = Amount of urea applied (kg/ha)

X_{14} = Amount of chemicals applied (litres/ha)

e = error term

Given the growing input prices in the sugarcane industry and management objective to minimize costs, a double-log production function was estimated using the total sugarcane yield (in tonnes per hectare) as a dependent variable in relation to the production inputs. This was used to determine factors affecting small-scale sugarcane productivity.

For ease of interpretation, the amended/hybrid CDPF was linearized so that it could be linear in the parameters and hence easier to estimate (equation 2**):**

$$\ln Y=\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2+\beta_3 \ln X_3 + \beta_4 \ln X_4+\beta_5 \ln X_{5+}\beta_6 \ln X_6 \beta_7 \ln X_7 \ldots\ldots\ldots\ldots\ldots\ldots \mu \quad (2)$$

3.4.1.1 Explanation of variables used in the amended/hybrid CDPF and their expected outcomes

3.4.1.1.1 Dependent variable

3.4.1.1.1.1 Productivity (Y):

Productivity was used in the model as a dependent variable and measured sugarcane yield per hectare (tonnes/ha). Productivity measures the amount of sugarcane yield that small-scale sugarcane farmers produce per hectare. This was measured as a continuous variable.

3.4.1.1.2 Independent/ explanatory variables

Age, gender, marital status, education level, farm income, nonfarm income, extension support, access to credit, farm income, farm size (the area of land devoted to sugarcane, measured in hectares), labour (man days/ha), amount of basal fertilizer applied (kilogram/hectare), amount of urea applied (kilogram/hectare) and amount of chemicals applied (litres/ha), are the explanatory variables that were inputted in the model. Table 3.5 shows the independent/explanatory variables used in the amended/hybrid CDPF and their expected outcomes.

Table 3.5: Independent/explanatory variables used in the amended/hybrid CDPF and their expected outcomes

Variable	**Description and measurement**	**Data type**	**Expected outcome**
Age of a farmer	This is actual number of years for the farmer.	Continuous	-
Gender	Gender/sex of the farmer If Male = 1 ; If female = 0	Dummy	+/-
Marital status	This is being a voluntary partnership or association between the two dominant sexes	Categorical	+

	(male and female) Single = 1 Married = 2; Unmarried =3 Widowed = 4		
Education level	Number of schooling years	Continuous	+
Non-farm income	Total income from non-agricultural sources in South African Rands (ZAR)	Continuous	+
Extension support	This is an extension agent's contact If a farmer had access to extension services for more than 10 days a month = 1; if a farmer receive extension support for less than 10 days a month = 0	Dummy	+
Access to credit	This is the farmers' accessibility to credit If has access = 1; If has no access = 0	Dummy	+
Farm income	Total farm income generated from sugarcane enterprises (ha)	Continuous	+
Farm size	Proportion of farmland in hectares devoted farming land (Area/ha).	Continuous	+/-
Labour	This is amount of labour which is required for the various operations(Average man days/ha).	Continuous	+
Amount of basal fertilizer applied	Amount of basal fertilizer applied during planting of sugarcane (kg/ha).	Continuous	+
Amount of Urea applied	Amount of urea applied for top-dressing (kg/ha).	Continuous	+
Amount of chemicals applied	Amount of chemicals applied in the field (litres/ha)	Continuous	+

Source: Author (2016)

3.4.1.1.2.1 Age of the farmer (X_1)

Age plays a vigorous role in the rejection or selection of new practices and new technology. A person's age is recognized to have great contribution towards personal attitude and such properties adapted to a person's skills and experience over his agri-business life time and help out in right judgement (Asif *et al*., 2005). Farming is not an age specific enterprise, but the survey results of Darroch and Mashatola (2003) on sugarcane growers' perceptions of a graduated mortgage loan repayment scheme to buy farmland in KwaZulu-Natal in South Africa showed that a negative relationship exists between an increase in age and the ability to farm. The older sugarcane farmers are therefore less likely to succeed in increasing RV tonnes (Darroch & Mashatola, 2003). The expected outcome of an ageing farmer is that there is a drop of performance in farming which may result to yield decline.

3.4.1.1.2.2 Gender distribution (X_2)

Gender variable indicates whether the farmer is either male or female and it is a vital in determining to some extent the type and nature of work to be carried out at a given time and in a given society. It is an important variable to be counted with especially as it affects both social and economic activities viz-a-viz, farming. According to FAO (2012), women in rural areas show a vital role in agriculture than men. However, throughout sub-Saharan Africa, profitable cash crops often seem to be male crops and crops for home consumption are perceived to be female crops (FAO, 2012). It has been indicated by FAO (2012) that women sometimes may not be willing to assist in field aspects such as weeding, top dressing because all proceeds are usually directed to males. This reluctant support by women is likely to affect sugarcane productivity because there will be lack of agricultural management in the farm management in the farm because men are lazy when it comes to agricultural management duties. The activity of females is paramount in farming and it is expected that lack of their participation can negatively affect crop performance resulting to a decline in yield.

3.4.1.1.2.3 Marital status (X_3)

This is being a voluntary partnership or association between the two dominant sexes (male and female). The attitude or behaviors of the individual may vary depending on his marital status (Girei 2015). For instance, a married, widow or divorced individual might exhibit arrangement in

decision taking on matters that may be brought before him/her. This might be due to the fact that they are progressive in age and have many years of different experiences in handling different matters and may not be hasty in decision taking. This implies that married couples need stable incomes to support their families so as to meet their social and economic needs; this is likely to improve the productivity. The findings are not in contrast with those of FAO (2012), who found that married farmers tend to be more stable in their farming activities than unmarried farmers. The result is also harmony with those of Mwendera and Chilonda (2013) who suggested that greater the percentage of married farmers help to provide additional labour so that productivity improved.

3.4.1.1.2.4 Level of education (X_4)

This independent variable was measured by the number of schooling years of the small-scale sugarcane farmer. The level of education of the farmers may indicate whether they are able to understand technical information. A positive relationship between education and productivity is expected if people in farming activities are educated. Lindley *et al.* (1996) states that education is one of the fundamental factors that enable a farmer to easily understand basic farm management, financial management, agricultural marketing principles, and the ability to create business networks.

3.4.1.1.2.5 Non-farm income (X_5)

This independent variable represents percentage of total income from non-agricultural sources. It measures the amount of off-farm income the farmers were able to receive. A positive relationship between non-farm income and productivity is expected. A high number of growers derive income from other sources. This makes it clear that growers perceive income from sugarcane farming as supplementary. Sugarcane growing is no longer their main source of income, which might be an indication that other growers might be attracted to other non-farming activities (Nxumalo, 2013). Studies have shown that non-farm income increasingly plays an important role and exhibits an increasing share in agricultural household income (De Janvry *et al.,* 2005). In fact, Ranjan (2006) pointed out that several grounds on the desirability of developing the non-farm sector as a vehicle to reduce rural poverty. Among them are: (i) the growing rural communities cannot be sustained by the agricultural sector alone; (ii) rural

economies are not purely agricultural and most of the rural communities derive their incomes from various sources rather than from agriculture; (iii) avoid rural-urban migration; (iv) reduce the rural-urban economic disparities; (v) reduce rural unemployment since rural industries are usually labour-intensive and hence, expected to absorb more labour; (vi) intensifies linkages between industry and agriculture, and thus support agricultural growth; (vii) reduce income inequality in the rural areas since the lower income group is expected to participate more intensely in non-farm activities.

3.4.1.1.2.6 Extension support (X_6)

Extension support was assumed to positively influence productivity, and similarly, extension support services was set as a dummy variable equal to one if a farmer had access to extension services for more than 10 days a month, and 0 if otherwise (if farmers receive extension support for less than 10 days a month). This variable was measured in terms of the periods of extension support the farmers were able to receive**.** A positive relationship between extension support and productivity is expected. Management, marketing, training and infrastructure capacity are amongst the factors that play an important role in achieving a competitive advantage of any individual or any business entity, including a farming enterprise, irrespective of its size or the number of people involved (Ortmann & King, 2007).

3.4.1.1.2.7 Access to credit (X_7)

Access to credit is important for securing production inputs such as fertilizer, chemicals and labour that is necessary for improving production because it will provide farmers with capital to procure their business costs. The small-scale agricultural sector has been discouraged by the lack of access to financial assistance such as operational loans in order to continue with agricultural production (Sibanda, 2012). The sugarcane industry is fortunate to have had financial support for more than 50 years and currently that holds the deliveries to the mills as security cession (SASA, 2012). This independent variable was measured by assessing whether farmers had access to formal credit or not. Access to credit was set as a dummy variable equal to 1 if yes, and 0 if otherwise. A positive relationship between credit access and productivity was expected.

3.4.1.1.2.8 Farm income (X_8)

According to SACGA (2012) farm size may not influence productivity but productivity may be influenced by the inputs costs, transport costs and poor replant rates resulting farmers to depend more to other income rather than farm income. This is in contrast to most other mill supply areas in the South African sugar industry, as reported by Dubb (2012), where sugarcane yields and production are in decline and the contribution of sugarcane farming to household income is small compared to other income sources. Dubb (2012) also states that in the uMfolozi mill supply area, Small-scale sugarcane farmers had much higher reliance on government social grants such as old-age pensions and child support grants than farm income. By considering each milling region's tonnage of sugarcane harvested it is clear that not all the production regions have followed the decreasing production resulting to low income trend suggested by the aggregate industry harvest. Referring to Figures 2.2 and 2.3 in section 2.2.2 and 2.2.3, the sugarcane farming does play an important role in the farming system and livelihoods of farmers in some areas of KwaZulu-Natal in lowveld areas such as noodsberg mill areas with small farm size. Farming in general, as well as farming of sugarcane specifically is seen as a major livelihood resource by the small-scale sugarcane farmers in Noodsberg (Dubb, 2012). This independent variable was measured in terms of the total farm income from sugarcane enterprises. Farm income was set as a continuous variable. A positive relationship between farm income and productivity was expected.

3.4.1.1.2.9 Farm size (X_9)

For this variable, in the case of small-scale sugarcane farmers, it was assumed that they do not have the supervisory capacity of producing in their farms. Small-scale farmers can only manage small-scale farming provided that they have the proper skills to ensure that the relationship between farm size and productivity is maintained by means of applying the correct amount of inputs which are in accordance with the size of their farms. According to Bezabih and Hadera (2007), correlation between the size of the farm and crop production yield per hectare cannot be pre-determined.

3.4.1.1.2.10 Labour (X_{10})

Sugarcane production is labour intensive and high amount of labour is required for the various operations that take place during the course of the production season. As such in order to produce a good crop, a considerable amount of labour is needed to carry out all the work. A positive relationship between labour and yield per hectare is expected.

Availability of labour on the farm is increasingly becoming a limiting factor in the sugarcane industry for both commercial and small-scale farmers (SACGA, 2012). The high cost of labour may affect the relationship with productivity. Richardson (2010) reported that undesirable influence on productivity is triggered by monthly wages spent on each labour group due to the fact that it is resulting in lower gross margins attained by farmers after harvesting. The wage bill for harvesting staff accounts for 30.2% of sugar industry profit followed by stable field workers (16.4%) and with general workers which are 14.7% of wages in KZN (SASA, 2011). It was stated by SASA (2011) that a higher proportion of money in the sugar industry is influenced by hired staff. Sugarcane production requires more labour for several operations which take place during the process of production. But labourers must have technical know-how on their operations in order for them to be able to produce good quality crops. A substantial total of labourers is desired to do all the work. This amount of labour is required for the various operations. A positive correlation between labour and productivity (yield per hectare) is expected (Li, 2007).

3.4.1.1.2.11 Amount of basal fertilizer applied (X_{11})

A sufficient amount of fertilizer application is imperative for growth of good quality crops (Singh *et al*., 2008). It is important that an adequate amount of fertilizer is applied so that crops should get all the required nutrients to produce a good yield; but fertilizer application has to be based on soil recommendations. This is measured as amount of basal fertilizer applied during planting of sugarcane (kg/ha). A positive association is likely between the amount of fertilizer applied and the yield per hectare provided farmers adhere to soil recommendations (Hussain & Khattak, 2008).

3.4.1.1.2.12 Amount of urea applied (X_{12})

It was stated by SASA (2011) that the top dressing of land, according to the recommended fertilizers requirements, is crucial for the vegetative growth of the sugarcane crop. This independent variable was measured by the amount of urea applied for top-dressing (kg/ha). Application of urea boosts the growth of sugarcane and as such, a positive correlation is expected between the amount of urea applied and sugarcane productivity per hectare.

3.4.1.1.2.13 Amount of chemicals used (X_{13})

Chemicals application is required to protect the crop from pests and diseases and is also a method of weed control such as gramoxone which is post emergence and lasso which is the pre-emergence herbicide chemical. The removal of weeds can lead to the removal of pests and diseases in the field. However, the correct calibration of chemicals must be followed. This variable was measured as an amount of chemicals applied in the field in (litres/ha). Enough and suitable application is imperative to promote a positive association between chemical use and sugarcane yield (Hussain & Khattak, 2008).

3.5 Ethical considerations

The study followed the policies of the university on research procedures, research ethics and preventing acts of plagiarism. The study did not fall into any category that requires special ethical obligations. However, the study followed the ethical research considerations as follows:

3.5.1 Ethical review

Bless *et al.* (2013) states that before a researcher progresses with a particular study he or she should submit a proposal of the intended research to a process of review. The proposal should anticipate what ethical concerns might be raised during the implementation of the project and should explain how these concerns might be raised during the implementation of the project and should also explain how these concerns will be handled. Ethical review is handled differently in different countries and in some African countries the mechanism of ethical review is poorly developed. Ethical review is an important tool by which professional researchers ensure that the ethical standards of work are maintained. It is important that all ethical problems are resolved.

3.5.2 Informed consent and voluntary participation

Participants have a right to know what the research is about, how it will affect them, the risks and benefits of participation, and the fact that they have the right to decline to participate or to discontinue at any time during the process if they choose to do so. Participants of this study were requested to sign an informed consent form, which indicates that the research aims and objectives were explained to them. A copy of the informed consent form must be given to the participants for their own records (Bless *et al.*, 2013).

3.5.3 Confidentiality

According to Ntshangase (2013), in most research as confidentiality is an ethical requirement. Information from participants, chiefly sensitive and personal information, must be secured and not made accessible to anyone other than the researchers. Thus data gathered from participants should, at all periods, be protected. Data collected for this study was kept confidential and not disclosed to parties who were not part of the research.

3.5.4 Anonymity and privacy

The ethic of anonymity is linked with confidentiality. Participants must never be connected immediately by their name or any other identifier. Usually, the researcher assigns a number to a participant's data to ensure that the data remains anonymous. Anonymity should apply at all aspects of the research process, from the first time that the researcher makes contact with a potential research participant to the publication of reports and findings (Nxumalo, 2008). This study adhered to this ethic; no participant names were associated with the findings.

3.5.5 Discontinue

Participants must be given an assurance that they are free to discontinue with participation in the research at any time without being required to provide any explanations. Should a participant choose for any reason that he or she would like to participate in the research then the researcher should accept and respect this decision.

The participant's discontinuation will not stop of the research process from proceeding (Ntshangase, 2013).

3.5.6. Ethics in analysis and reporting

According to Bless *et al.* (2013), researchers are not permitted to alter their data or observations. The misrepresentation of data is very severe wrongdoing. The technical weakness, mistakes, limits of the study, negative findings and methodology must be reported during the reporting process of the research results. The final ethical responsibilities always stay with the researcher. In general, the researcher must always judge in terms of its value to science, the amount of risk its poses to the participants, whether the potential benefits outweigh the risk and whether adequate safeguards have been included to minimize the risks. The researcher adhered to this code of conduct by remaining honest in all aspects of the research.

3.5.7 Reporting back to research participants

It is the duty of the researcher to ensure that the participants are informed of the results of the study. The findings of the study must furthermore be presented to the research participants in a form that is simple and clear to them (Bless *et al*., 2013). It is very important to adhere to this ethic by reporting back findings of a survey to all parties who participated in the research.

3.6 Chapter summary

This chapter presented and described the selection of the study sites, located within the Ndwedwe Local Municipality. The chapter described the study areas with regard to its geographical aspects such as topography, climate (rainfall and temperature), vegetation, soils and land use and the socio-economic status of the study areas with a focus on population, education, unemployment, infrastructure and economic activities (agriculture and tourism). The chapter also described and explained the sample design of the study, focussing on the sampling frame, sample size and sampling technique. The chapter further presented and discussed the analytical framework employed, explaining the Cobb-Douglass Production Function which predicts the economic relationship between the dependent variable (productivity) and the independent variables such as farm size, labour and amount of basal fertilizer, urea and chemical application. The chapter concludes by presenting and describing the ethical considerations undertaken in this study. The following chapter presents and discusses the descriptive results of the study.

CHAPTER FOUR: DESCRIPTIVE RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the descriptive results of the study carried out in the villages of Mona and Sonkombo within the Ndwedwe Local Municipality on the factors affecting the productivity of small-scale sugarcane farmers. The data under analysis were collected from a total of 100 small-scale sugarcane farmers in the study areas. The aim of the chapter is to give the descriptive analysis of the demographic information and farmers' characteristics such as gender, age, marital status, household size, education levels, employment status, income, extension support and access to credit.

The chapter also presents results on production information such as the average sugarcane production per year, land tenure system, land use and the level of sugarcane production for the last growing season in the study areas. The chapter presents and discusses the results on the challenges faced by the small-scale sugarcane farmers in relation with crop nutrition, weed control, harvesting, ratoon management, financial management and other production challenges related to agreements between grower company and the farmer, topography and the soil type. A descriptive analysis of the results creates a better understanding of the variables used in the amended/hybrid CDPF analytical framework used for the estimation of the factors influencing the productivity of the small-scale sugarcane farmers (which include land size labour availability, amount of basal fertilizer, urea and chemical application).

4.2 Demographic information of Mona and Sonkombo small-scale sugarcane farmers in 2015

This section presents the demographic characteristics of the respondents. The demographic information of the farmers was studied with respect to gender, age, and marital status and education levels of the small-scale sugarcane farmers.

4.2.1 Distribution of respondents by gender

Table 4.1 shows distribution of respondents by gender in Mona and Sonkombo for the 2015 period. The respondents were divided according to their gender status to investigate whether gender influences productivity of sugarcane farming. Results show that there were more females

(69%) than males in Mona and Sonkombo sugarcane producing villages (31%).This finding implies that in the areas of Mona and Sonkombo, females dominate in sugarcane production.

The results show that there is majority of females than males in sugarcane production. The findings of survey are in harmony with those of (FAO, 2012) where they found that women in rural areas play more vital role in agriculture than men. However throughout sub-Saharan Africa, profitable cash crops are often perceived to be male crops and crops for home consumption are perceived to be female crops (FAO, 2012).

It was further stated by FAO (2012) that women sometimes may not be willing to help in field aspects related to these crops because all proceeds are directed to males. This disturbs agricultural development because men are not interested in agriculture especially crop production. Ntshangase (2008) states that traditional leaders usually allocate land to men even though most of the land is used by women. This might negatively affect productivity because numbers of studies indicate that women in rural areas play more vital role in agriculture than men.

Table 4.1: Distribution of respondents by gender in Mona and Sonkombo for the 2015 period

Gender	**No. of respondents**	**Percentage (%)**
Male	31	31
Female	69	69
Total	**100**	**100**

Source: Survey data (2015)

4.2.2 Distribution of respondents by age

The age of a farmer is an important aspect in agriculture because it determines the experience that one has in a particular type of farming and also the ability of carrying out the farming activities (Sibanda, 2012). Table 4.2 shows distribution of respondents by age in Mona and Sonkombo areas in 2015**.**

Table 4.2: Distribution of respondents by age in Mona and Sonkombo for the 2015 period

Age (Years)	No. of respondents	Percentage (%)
<20	2	2
21-29	10	10
30-39	1	1
40-49	20	20
>50	67	67
Total	**100**	**100**

Source: Survey data (2015)

Results show that there were (2%) of the respondents under 20 years of age who participated in sugarcane farming; 14% respondents were in the age group of 21-29 years. Those in the 30-39 years of age group made up only 1% of the respondents and those in the age range of 40-49 years' age group constituted 20%. The results confirm that large proportions (67%) of respondents are beyond 50 years of age. Sugarcane farming in the study areas is dominated by elder people and they are considered to be in their inactive age and may not be capable of undertaking economic activities including sugarcane production to adequately cater for their families and possibly others.

According to Balogun *et al. (*2012), inactive age refers to period when farmers cannot carry out the physical rigor required of farm activities. This has implication for agricultural production because farm work requires physical energy and strength. Darroch and Mashatola (2003) indicated that increase of the principal decision makers' age decreases the farmer's ability to improve productivity of sugarcane. Similarly, Antwi and Seahlodi (2011) indicated that a situation like this presents a challenge to the future of agriculture, mostly concerning efficiency and a progression plan for the elderly farmers when they retire from agriculture.

4.2.3 Distribution by marital status

Girei (2015) states that attitude of the individual may vary depending on his marital status. For instance, a married, widow or divorced individual might exhibit arrangement in decision taking on matters that may be brought before him/her. This might be due to the fact that they are

progressive in age and have many years of different experiences in handling different matters and may not be hasty in decision taking.

Table 4.3 shows distribution of respondents by marital status in Mona and Sonkombo for the 2015 period. Results show that a greater proportion (44%) of the interviewed small-scale sugarcane farmers were married, 24% were widowed and those who were not married constituted 32% of the sample. Mwendera and Chilonda (2013) suggested that married farmers help to provide additional family labour, but in case of the study area more labour is provided by contractors (see Table 4.14).

Table 4.3: Marital status of Mona and Sonkombo small-scale sugarcane farmers for the period 2015.

Marital status	**No. of respondents**	**Percentage (%)**
Married	44	44
Unmarried	32	32
Widowed	24	24
Total	**100**	**100**

Source: Survey data (2015)

4.2.4 Distribution of respondents by level of education

Education in agriculture plays a vital role in the improvement of a country's human resource capacity for productivity in all aspect as it is a pre-requisite for social and economic development, in agriculture, both formal and non-formal education are important for the improvement of food security, rural employment and poverty reduction. Formal agricultural education is needed for the production of skilled and semi-skilled manpower to serve the agricultural sector through extension, research, entrepreneurship and improved commerce. Non-formal agricultural education, often provided by both public and private extension services is needed for training of farmers, farm families and workers and for capacity building in a wide range of rural organizations and groups (Lindley *et al.*, 1996). Table 4.4 shows the distribution level of education of the respondents in Mona and Sonkombo for the 2015 period.

Table 4.4: Distribution of respondents by level of education in Mona and Sonkombo for the 2015 period

Education level	No. of respondents	Percentage (%)
None	48	48
Primary	12	12
Secondary	34	34
Tertiary	6	6
Total	**100**	**100**

Source: Survey data (2015)

The highest and lowest education level achieved by the farmer was recorded to determine their ability to interpret information. Results show that 48% of the respondents had no formal education, meaning they never went to school for learning; 12% had attained primary level education, which is the lowest level of formal education and 34% had attained secondary level education. Those that had attained tertiary level education accounted for 6% of the respondents. According to the results, the majority number of respondents is educated with a significant portion of 48% with no formal education, but the majority (52%) had received some formal education although they do not fall in the same level of education. The findings of the survey are not in harmony to the study conducted by Girei (2012) who reported that most of those involved in sugarcane business are of low literacy levels. According to Dick (2001) many poor countries notably in Sub-Saharan Africa have low level of education and improving their education would probably increase agricultural productivity, reduce poverty and improve livelihoods.

4.3 Socio-economic characteristics of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

This section presents and discusses results on the socio-economic characteristics of the interviewed small-scale sugarcane farmers. These include their sources of income such as non-farm income, extension support and access to credit by small-scale sugarcane farmers in the study areas.

4.3.1 Main sources of non-farm income for Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Rural non-farm activities have become an essential component of livelihood strategies among rural households. The reasons for this observed income diversification include declining farm incomes and desire to insure against agricultural production risk (Lanjouw, 1999). Reardon and Berdegué (2006) state that a household is pulled into the rural non-farm activities because returns from non-farm employment are higher and less risky than in agriculture. The economy of rural areas in a developing country is predominantly based on agriculture and other activities related to the agriculture sector. According to Madaki and Adefila (2014) in the rural communities, a number of community members is occupied in non-farm activities in order to enhance economic base. It is universally accepted that when an extreme pressure of population leads to the subsequent addition to labour force, the agricultural sector alone is neither in a position to create additional employment opportunities nor it can provide adequate income to sustain the livelihood of the rural households (Madaki & Adefila, 2014).

It is highlighted that the chief non-farm income generating activities are formal employment, pensions and grants, and businesses such as trading, craft work such as mat weaving. The result of the distribution of the respondents by income according to their capital house non-farm income is captured in Table 4.5. The analysis reveals that the majority of the respondents (62%) indicated that they get income between R500.00 and R1 500.00 from pension and support grants per month, this depicts that majority of respondents have a weak capital base, while 30% had income of between R2 000.00 and R3 000.00 per month and 8% received income from salaries which was greater than R6 000 per month. Table 4.5: shows sources of non-farm income of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period**.** Rural non-farm activities are frequently countercyclical with agriculture and as such might serve as a consumption smoothing or risk insurance method, particularly when the returns to these activities are not highly-correlated with agricultural returns and might also absorb surplus labour during agricultural off-peak periods (Carletto *et al.,* 2007). The finding of this survey is in harmony with that of Dubb (2012) who found that in the uMfolozi mill supply area, small-scale sugarcane farmers put much higher reliance on government social grants such as old-age pensions and child support grants.

Table 4.5: Sources of non-farm income of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Main of Source of Income	Amount (ZAR)	No. of respondents	Percentage (%)
Salaries	2 000.00 – 3 000.00	30	38
Pensions and support grants	<500.00 – 1 500.00	62	62
Business	>6 000.00	8	8
Total		**100**	**100**

Source: Survey data (2015)

4.3.2 Extension support

The extension services serve to facilitate the adoption of technology and practices with better management that inspires accountable and viable land use with best productivity and profitability delivery (SACGA, 2013). Table 4.6 shows the extension services support to respondents in Mona and Sonkombo for the 2015 period. The respondents were asked to indicate how many times per months they received extension support services. Results show that the majority (80%) of the interviewed small-scale sugarcane farmers indicated that they receive extension support services (in an estimated of 10 days/month) (see Table 4.6). The results of Gillespie *et al*. (2012) suggested that due to increased extension activities and involvement of multiple stakeholders with the small-scale sugarcane farmers in the Noodsberg mill supply area, their sugarcane yields and production in this region have been increasing. It was further emphasized by SACGA (2013) that services offered to the industry embrace specialisation advice on growers' problems and soils and leaf analysis through the fertilizers advisory service.

Table 4.6: Extension support of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Frequency of extension visits (number times per months a farmer receives extension support	Number of respondents	Percentage (%)
10days/months	80	20
<10days/months	20	80
Total	**100**	**100**

Source: Survey data (2015)

4.3.3 Access to credit

Credit support is important for securing production inputs such as fertilizer, chemicals and labour which are necessary for improving production because it will provide farmers with capital to procure their business costs. Table 4.7 shows credit support to respondents in Mona and Sonkombo for the 2015 period. The farmers were asked to indicate whether they had received credit for sugarcane development. Results show that the majority (88%) of the interviewed small-scale sugarcane farmers have access to credit support from Umthombo agricultural finance, as well the government support grant, 12% of the interviewed farmers indicated that they had no access to credit. The results show that majority of farmers have good access to financial support so as to develop their sugarcane. The findings of survey are in contrast with that of Sibanda (2012) who found that the small-scale agricultural sector has been discouraged by the lack of access to financial assistance such as loans in order to continue with agricultural production. The findings of the survey are in harmony with that of Bethel (2008) who indicated that the sugarcane industry has had financial support for more than 50 years. The financial support is paid back by the farmer through sugarcane deliveries as per agreement or security cession between farmers and sugar mill to deduct from farmers' proceeds. This may have encouraged many to look to agriculture as a way of life, in that it is the only industry that offers

new entrants access to financial borrowings, creating a large proportion of land users that are different to real farmers because of the extent of the land that the farmers own (SASA, 2011).

Table 4.7: Credit support of Mona and Sonkombo small-scale sugarcane farmer for the 2015 period

Credit support	No. of respondents	Percentage (%)
Has access to credit	88	88
Has no access to credit	12	12
Total	**100**	**100**

Source: Survey data (2015)

4.4 Sugarcane production information

This section presents and discusses sugarcane production, land tenure system, the use of land, the most important challenges facing sugarcane farmers in the study area, planting agreement between the Grower Company and farmers, sugarcane category, topography and soil type. Contained in this section is land position, choice of sugarcane variety, fertilizer decision and practices which includes basal fertilizer and urea, and chemical application. The section also discusses factors influencing decision making in fertilizer use, weed control decision and practices, chemical application, land size and average farm income for sugarcane farmers.

4.4.1 Average sugarcane production in of Mona and Sonkombo small-scale sugarcane farmers

It was stated by SASA (2015) that the estimated SASA standard unit yield (tonnes) to be produced from sugarcane are 90 to 100 tonnes per hectare in dry land areas. Figure 4.1 is showing average sugarcane production (t/ha) of Mona and Sonkombo respondents, for small-scale sugarcane farmers for the 2015 period.

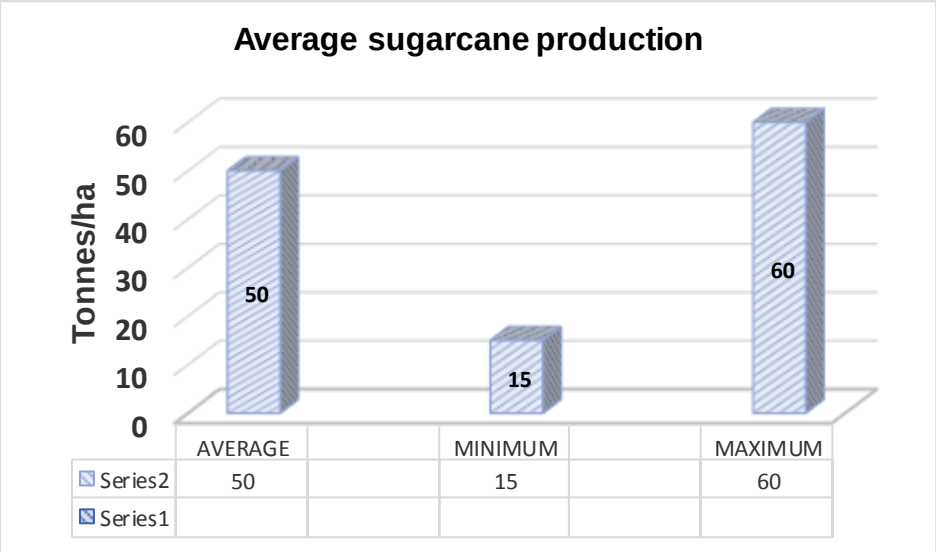

Figure 4.1: Average sugarcane production (t/ha) of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period.

Source: Survey data (2015)

Farmers were asked to indicate average sugarcane production per year in t/ha. Results show that the sugarcane yield per hectare ranged from 15t/ha to 60 t/ha and an average yield of 50t/ha.

There is high difference in terms of production standards between the study area and the sugar industry standards. The findings of the survey are contrary with those of SASA (2015) who stated that production standards of the sugar industry in KwaZulu-Natal ranged from 90-100t/ha and the average being 94t/ha. The results indicate that an estimated average sugarcane yield is lower in Mona and Sonkombo villages, which is much lower than the standards of the sugar industry which may be the result of input costs or climate change. The low yield may result to shortage of money to buy inputs such as fertilizers and chemicals from their retention account controlled by sugar mill of Tongaat-Hulett.

4.4.2 Land tenure system of Mona and Sonkombo small-scale sugarcane farmers

Azam and Khan (2010) state that the land tenure system of small-scale farmers of rural areas does not permit the use of land as a surety if applying for agricultural loans. Figure 4.2 shows the land tenure system of the interviewed small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period.

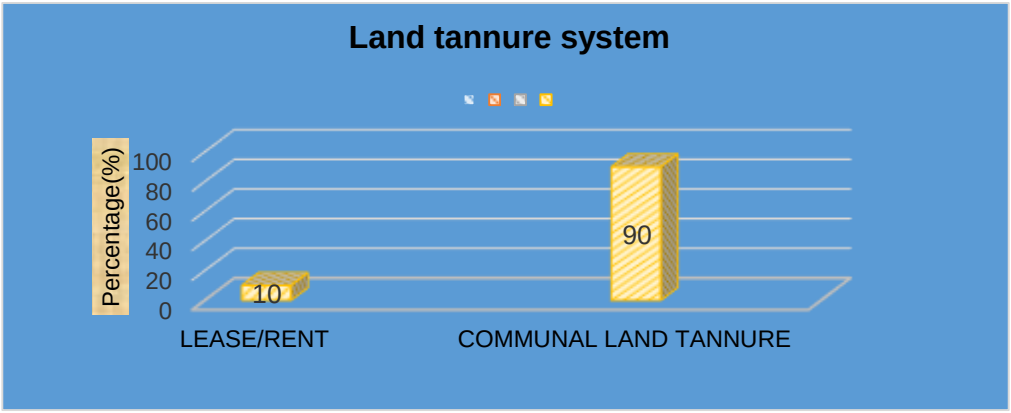

Figure 4.2: Land tenure system of the interviewed small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period

Source: Survey data (2015)

The sugarcane farmers were asked to indicate their land tenure system. The results show that the majority (90%) of the interviewed small-scale sugarcane farmers depend on the communal land tenure system known as permission to occupy (PTO) which prohibits land to be used as collateral. The remaining 10% of farmers indicated that they depend on the rent/lease system.

The findings of the survey are in harmony with those of Azam and Khan (2010) who found that the land tenure system of small-scale farmers in rural areas does not permit farmers to use land as a surety if applying for agricultural credit. The land tenure system in communal land is a problem but in case of sugarcane farmers credit from Umthombo agricultural finance to develop their sugarcane is available.

4.4.3 The use of land

Since the small-scale sugarcane farmers interviewed grow sugarcane in a diversified agricultural system together with other crops and they keep livestock, there is the potential for farmers to be subjected to multiple and conflicting messages from extension and support stakeholders involved in these various agricultural enterprises. This has been the case, for example in Lesotho (Molomo, 2012). Table 4.8 shows the use of land by the interviewed small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period. A total of 60% of the interviewed small-scale sugarcane farmers indicated that they used their land entirely for sugarcane farming, 30%

said that they used their land to farm other crops as well, other than sugarcane, such as maize and beans, and the remaining 10% used land for livestock farming. The farmers produce maize and beans for food purposes. This type of farming is normally practiced by small-scale farmers who are afraid of the risks of monoculture and farmers who lack specialisation in the form of technical skills for sugarcane production. This lack of specialisation may result in the use of old methods which may lead to poor productivity. Small-scale sugarcane farmers` land is more occupied by sugarcane than other commodities such as livestock.

Table 4.8: Type of agricultural enterprises of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Type of agricultural production	**No. of respondents**	**Percentage (%)**
Sugarcane crops	60	60
Other agricultural crops (Maize & beans)	30	30
Livestock	10	10
Total	**100**	**100**

Source: Survey data (2015)

4.4.4 Most important challenges faced by small-scale sugarcane farmers of Mona and Sonkombo

Table 4.9 shows the main challenges indicated by small-scale sugarcane farmers in Mona and Sonkombo areas for the 2015 period. The small-scale sugarcane farmers were asked to indicate the most important challenges they face in sugarcane production. Results show that all (100%) small-scale sugarcane farmers are facing the challenge of high inputs costs, late fertilizers application and less fertilizers applied; delayed weed control; delays in sugarcane transportation

by contractors, high transport costs and inputs costs, old ratoon cane, sugarcane left in the field, and immature sugarcane burning and livestock encroachment before and after harvesting); ratoon management (very late ratoon management after harvest).These challenges may be resulting to poor returns of Mona and Sonkombo small-scale sugarcane farmers. The findings are in harmony with those of Malaza and Myeni (2009) who found that the major determinant of sugarcane productivity is lack of timely and adequate application of inputs through the life cycle of the crop. Lower input use will certainly save costs, but reduce productivity. Malaza and Myeni (2009) identified seed, fertilization, transport costs and ratoon management as the key elements to be managed for efficient production. Hussain & Khattak (2008) state that the use of total fertilizer, pesticides, insecticides, human labour, tractor labour increases sugarcane productivity when it is applied at appropriate time and using the correct dosage in sugarcane fields.

Table 4.9: Main challenges experienced by Mona and Sonkombo small-scale sugarcane for the 2015 period.

Agronomic Practice	**Challenge**	**No. of respondents**	**Percentage (%)**
Crop nutrition	High inputs costs and late and less delivery of inputs farmer	100	100
Weed control	Delay weeding	100	100
Harvesting	High transport costs, immature cane burns , cane left cane, livestock problem	100	100
Ratoon management	Very late	100	100
Selection of seed	Extension officers	100	100
Financial management	Extension officers	100	100

Source: Survey data (2015)

4.4.5 Land and its cultivation

This section discusses planting agreement between the grower company and small-scale sugarcane farmers of Mona and Sonkombo, sugarcane category (plant or ratoon) of Mona and Sonkombo small-scale sugarcane farmers. Contained in this section also is the discussion on topography and soil type.

4.4.5.1 Planting agreement between the grower company and small-scale sugarcane farmer of Mona and Sonkombo

This section presents and discusses land and its cultivation by highlighting the planting agreement between the grower company and the farmer, whether it is a formal or informal agreement. The planting agreement was done through the Operation Vuselela Programme to be achieved via collaborating between the Department of Economic Development and Tourism (DEDT), private sector and the milling company (DEDT, 2015). The agreement is also to extricate rural citizens from poverty and unemployment which is prevalent in most rural areas. Table 4.10 shows the type of planting agreements that exist between the grower company and small-scale sugarcane farmers to plant sugarcane for the 2015 period.

Table 4.10: Planting agreement of Mona and Sonkombo small-scale sugarcane farmers for the period 2015.

Type of agreement	**No. of respondents**	**Percentage (%)**
Formal	98	98
Informal	2	2
Total	**100**	**100**

Source: Survey data (2015)

Results show that the majority (98%) of the interviewed farmers believed that the agreement they had with the miller to produce sugarcane was formal because it had a clear time span and projections to improve the socio-economic standards of sugarcane rural communities. The

remaining 2% believed that the agreement with Tongaat-Hulett was informal because it was not clear to them with regard to the timespan of the agreement. The Department of Economic Development and Tourism (2015) report states that the agreement between farmer and the miller should last for a period of 9.5 years. The findings indicate that most of the farmers knew about the agreement but only a few sugarcane farmers were not familiar with the terms of the agreement. The planting agreement between the miller and the farmer also states that the farmer will be paid according to own size of land which is planted.

4.4.5.2 Sugarcane category (plant or ratoon) of Mona and Sonkombo small-scale sugarcane farmers

A preliminary report on a survey conducted in Mauritius and South Africa by Eweg, Pillay and Travailleur (2009) states that poor re-plant rates may contribute to reduced yields, along with low levels of education which contribute to poor crop husbandry practices among small-scale sugarcane farmers. The right varieties for the climate and soils need to be grown during the planting of new seed. Table 4.11 shows the sugarcane category of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period.

Table 4.11: Sugarcane category of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Sugarcane category	No. of respondents	Percentage (%)
Plant sugarcane	**7**	**7**
Ratoon 1 (R1)	**9**	**9**
Ratoon 3	**30**	**30**
Ratoon >4	**53**	**53**
Do not know	**1**	**1**
Total	**100**	**100**

Source: Survey data (2015)

Farmers were asked about their sugarcane category of their fields. The results show that farmers were having different categories of sugarcane in their fields with the majority (53%) with more

than 4 years old sugarcane. The age of sugarcane can affect yield because the higher the number of ratoon periods the high the demand of inputs used more especially the application of urea (see appendix 3).

4.4.5.3 Topography

Table 4.12 shows the topography of the sugarcane land used by the interviewed small-scale sugarcane farmers for the 2015 period. Results show that the majority (50%) of small-scale sugarcane farmers farmed on flat land, which can have good alluvial material which improve soil fertility if properly managed, 30% worked on undulating slope and 20% on steep slopes which promotes soil erosion. Table 4.12 shows topography of sugarcane land of Mona and Sonkombo small-scale farmers for the period 2015.

Table 4.12: Topography of sugarcane land of Mona and Sonkombo areas as indicated by small-scale farmers for the 2015 period

Topography	**No. of respondents**	**Percentage (%)**
Flat	50	50
Undulating	30	30
Steep slope	20	20
Total	**100**	**100**

Source: Survey data (2015)

The results reveal that farmers were planting on flat land with low erosion and high illuviation and eluviation of nutrients or base status from top layer of soil horizon to the second layer. Rhoades, Eckert and Coleman (2010), supported that production on flat land can be of high value in agricultural productivity provided it has good structured soil. Rhoades *et al*. (2010) state that on undulating and steep slopes, the soils are likely to have low alluvial material with poor nutritive value soils (whether they are sandy or loamy soils, they tend to be unproductive).

4.4.5.4 Soil type

Eweg *et al*. (2009) states that soil type could have an impact on the growth and development of sugarcane. The crop performs well under a variety of soils, but favours well-structured aerated loam and sandy loam soils that are less than one metre deep. Eweg *et al.* (2009) also reports that sugarcane prospers less on sandy soils due to the fact that nematodes can be populated easily in sandy soils, while in clay soils, root development can be hindered (Bates *et al*., 2008).

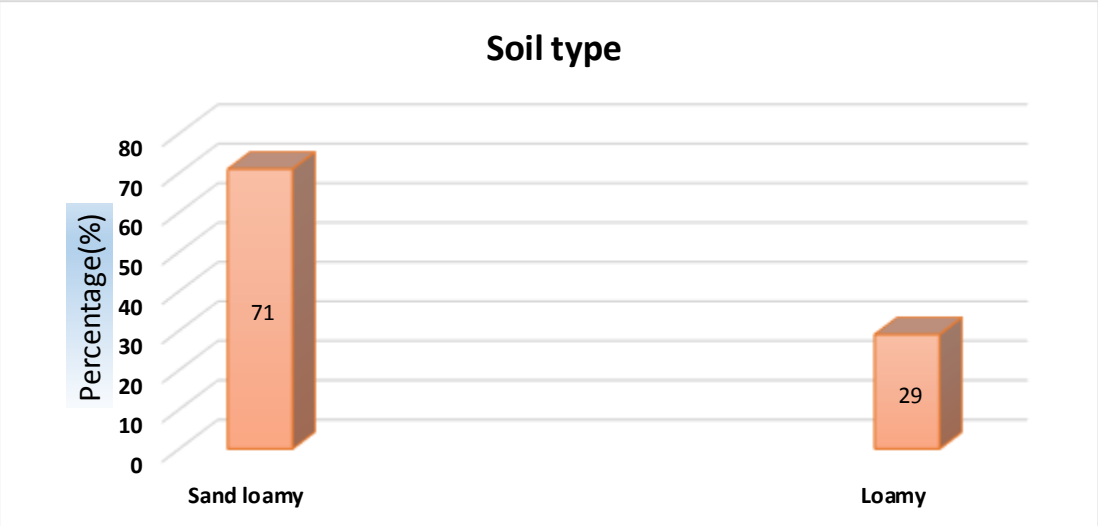

Figure: 4.3: Soil type of Mona and Sonkombo areas as indicated by small-scale farmers for the 2015 period

Source: Survey data (2015)

Figure 4.3 shows soil type in the sugarcane fields of interviewed small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period. Results show that most of the farmers (71%) farmed on sandy loamy soils and the remaining 29% on loamy soils which is suitable for sugarcane production with good soil sample results (see appendix 3). The results of the survey are in harmony with those of SACGA (2011) where it was found that the decline in yield is not caused by the type of soil; it could be caused by other factors such as poor management and high inputs costs.

4.4.6 Labour position of Mona and Sonkombo small-scale sugarcane farmers

Sugarcane production is labour intensive and a high amount of labour is required for the various operations that take place during the course of the production season. As such in order to produce a good crop, a considerable amount of labour is needed to carry out all the work. A positive relationship between labour and yield per hectare is important (Jorgenson, Ho & Samuels, 2014). Table 4.13 illustrates the source of labour among small-scale sugarcane farmers in the study areas for the 2015 period.

Table 4.13: Source of labour for Mona and Sonkombo small-scale farmers for the 2015 period

Labour source **(Land preparation, planting, gab filling, fertilizer and herbicide application, hand weeding and harvesting)**	**No. of respondents**	**Percentage (%)**
Contractors	56	56
Household members	34	34
No response	10	10
Total	**100**	**100**

Source: Survey data (2015)

Results show that the majority (56%) of the small-scale sugarcane farmers relied on contractors in order to do land preparation, planting, gab filling, fertilizer and herbicide application, hand weeding and harvesting of sugarcane. The remaining 34% farmers depend on household members on the same operations, and 10% did not respond to this question. The findings of the survey are in harmony with those of Jorgenson *et al.* (2014), who found that sugarcane production is labour intensive and that high amounts of skilled labourers is necessary for numerous operations during the course of the production. It was stated by SASA (2015) that the industry standards (man days/ha) is 2.5 to do weed control using knapsack sprayer. Table 4.14 shows the average labour man days per hectare by small-scale sugarcane farmers of Mona and Sonkombo for the 2015 period**.** The results show that an average of 2man days/ha are used in

sugarcane fields. The hand on application method was used during the fertilizer application. The knapsack sprayer was used during weed control. The results show that labour on land preparation to planting is averaged at 4 man days/ha with maximum of 8 days which was matching with labour sugar industry standards. The labour which is lower than the estimated standard of 2.5 labour man days/hectare of the sugar industry can harm the weed control programme.

Table 4.14: Average labour man days per hectare of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Variables	**Labour type**	**Average**	**Minimum**	**Maximum**
Land preparation to planting	Contractor	4	2	8
Fertilizer and herbicide application	Household members	2	1.5	3

Source: Survey data (2015)

4.4.7 Choice of sugarcane variety: sugarcane variety and decisions and practices in Mona and Sonkombo

Ogwang (2009) states that plant material is one of the key elements to be managed by farmers for efficient production. Table 4.15 shows the source of planting material for small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period. Respondents were asked to indicate the source of planting material. The results show that the majority (72%) of the farmers used planting material from other growers which was assumed to be properly managed and checked for diseases and the remaining 28% used planting material from their own field. The findings of the survey are in harmony with those of Ogwang (2009) who found that plant material is one of the key elements to be managed for efficient production.

Table 4.15: The source of planting material of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Source of planting material	No. of respondents	Percentage (%)
Receive planting material from other growers	72	72
Receive planting material from own field	28	28
Total	**100**	**100**

Source: Survey data (2015)

4.4.8 Fertilizer use, decision making and practices by the small-scale sugarcane farmers in Mona and Sonkombo

Table 4.16 shows fertilizer use, decision making and practices in Mona and Sonkombo by small-scale sugarcane farmers, during the planting period of 2015. Farmers were questioned on their decision making and practices so as to extract information on the soil tests and fertilizer use. The farmers were asked whether they use soil analysis in their field/s, majorities (70%) indicated that they never used soil analysis but they just plant without using any soil recommendations they continuously use fertilizer that was given to them during the initial sugarcane project. Farmers were asked to indicate when was the last time a soil analysis was done; again majorities (80%) indicated that they had done soil analysis for more than 12 months back before the survey (planting sugarcane period of 2015). The question of "When do you analyse the soils?" Half (50%) of the interviewed small-scale sugarcane farmers indicated that they did soil analysis at planting because it was done during the beginning of the programme of sugarcane. The small-scale sugarcane farmers were also asked to indicate who took the soil samples; the majority (71%) indicated that extension officers from the sugar mill took the soil samples for analysis to calculate fertilizers to be used for planting and topdressing.

Table 4.16: Fertilizer use decision and practices in Mona and Sonkombo small-scale sugarcane farmers, during planting period of for the period 2015.

Soil test and fertilizers decision	**Use of fertilizer and practices**	**No. of respondents**		**Percentage (%)**	
Did you do soil analysis	Never use soil analysis	Yes	No	Yes	No
		30	70	70	30
when was the last time a soil analysis was done?	>12 months	Yes	No	Yes	No
		80	20	80	20
When did you do soil analysis?	At planting	Yes	No	Yes	No
		50	50	50	50
Who take soil samples?	Extension officers	Yes	No	Yes	No
		71	29	71	29
Who explained results of the soil analysis to you?	Extension officer	Yes	No	Yes	No
		86	14	86	14
Did farmer adhere to soil recommendation	doing as recommended by extension officer	Yes	No	Yes	No
		77	23	77	23
When do you apply fertilizer?	wait for extension officer to apply it after the rain	Yes	No	Yes	No
		90	10	90	10
who took decision on fertilizers application	Extension officers	Yes	No	Yes	No
		98	2	98	2

Source: Survey data (2015)

The question on who explains the results to farmers; the majority (86%) indicated that extension officers did explain the results of the soil analysis. The small-scale sugarcane farmers were asked whether they did adhere to soil recommendation and most (77%) of the respondents indicated that they do commit to doing precisely what was recommended by extension officers. The

question when did they apply fertilizers; the response to the question was that 77% wait for extension officer to apply it after the rain. The question who took decision on fertilizers application; the majority (98%) of the small-scale sugarcane farmers revealed that miller extension officers took that decision.

4.**4.8.1 Fertilizer use: fertilizers application rate (kg/ha) by small-scale sugarcane farmers at Mona and Sonkombo**

Armitage, Hurly and Gillitt (2009); Thomson (2010) states that small-scale sugarcane farmers identified high input costs as an important constraint affecting productivity. Table 4.17 shows the amount of fertilizer applied by small-scale sugarcane farmers for the 2015 growing period. Results show that the majority (65%) applied 300kg/ha of fertilizer mixture of 5:1:5 (45) very late after harvesting and the remaining 35% of farmers applied 250kg/ha of fertilizer. According to the industry estimated standards of fertilizer use, 600kg/ha of fertilizer is applied to get good yield per hectare without ignoring soil recommendations. But the results show that the majority of the farmers applied 250kg/ha which is below the estimated standards. According to Eweg (2005), high costs of fertilizers may be one of the major constraints on small-scale sugarcane farmers` yields, implying that small-scale sugarcane farmers do not apply enough fertiliser which is fertilizer mixture 5:1:5 (45). It is, therefore, vital that in order for small-scale sugarcane farmers to realize higher yields per hectare, they have to apply the optimum amounts of the urea straight fertilizer based on the soil sample and at the right time (Baiyegunhi & Arnold, 2011). The soil recommendations report, in sheet 1 of recommendation report, on row four is showing amount of fertilizers 5:1:5 (45) to apply, which is in line with industry standard. The fertilizer recommendation is witnessing amount of fertilizers to be applied in sugarcane field (see the fertilizer recommendation appendix 3). This result suggests that yield decline can be caused by inadequate amount of fertilizer application or by not following the correct recommendations (SACGA, 2011).

Table 4.17: Fertilizers application rates of Mona and Sonkombo small-scale sugarcane farmers for the 2015 period

Fertilizers type	Fertilizer applied for industry standards	Actual basal Fertilizer (kg/ha) Applied	No. of respondents	Percentage (%)
5:1:5	600kg/ha	250kg/ha	35	35
5:1:5	600kg/ha	300kg/ha	65	65

Source: Survey data (2015)

4.4.8.2 Urea use: Urea Application rate (kg/ha) by small-scale sugarcane farmers at Mona and Sonkombo

Small-scale sugarcane farmers also identified high input costs as an important constraint affecting productivity. This finding is supported by other studies such as Armitage, Hurly and Gillitt (2009) and Thomson (2010). Table 4.18 shows the amount of urea application by small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period.

Table 4.18: Urea application rates in Mona and Sonkombo by small-scale sugarcane farmers in 2015 period

Fertilizer Type	Urea application estimated industry standards	Actual Urea (kg/ha) applied	No. of respondents	Percentage (%)
Urea	250kg/ha	250kg/ha	89	89
Urea	250kg/ha	No	11	11

Source: Survey data (2015)

Results show that the majority (89%) of the small-scale sugarcane applied 250kg/ha of urea, in line with industry standards of application rate. The remaining 11% of the small-scale sugarcane farmers indicated that no urea was applied in their fields. The results mean that the small-scale sugarcane farmers were applying adequate amount of top-dressing fertilizer urea as they met

industry standards, but the problem was late arrival of contractors to the farmer with fertilizer to be applied (see Table 4.9). According to Eweg (2005), high costs of urea may be one of the major constraints on small-scale sugarcane farmers` yield, implying that small-scale sugarcane farmers do not apply enough fertiliser such as urea**.** Majority of the farmers (89%) revealed that decision on fertilizer application was taken by miller extension officers. During the time of the study, small-scale sugarcane farmers indicated that sugarcane was harvested by April from the field and contractors arrived to the field for topdressing by October during the rainy season. The contractor arrived during the time when the field was full of weeds and leaves were yellowish with sign of nitrogen shortage. Therefore, even if adequate urea was applied very late, when field is full of weeds, weeds would compete with the sugarcane crop on nutrients absorption. According to the sugar industry estimated standard of urea use is 250kg/ha, on first and second ratoon of sugarcane land in order to produce good sugarcane yield. Baiyegunhi and Arnold (2011) indicate that weed control should be done as soon as its identification in the fields.

4.4.9 Factors influencing fertilizer use and decision making by small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period

The factors that play a vital role in farmers' decisions on fertilizer recommendations in the study area were elicited.

Table 4.19: Description of factors considered when deciding on fertilizer use by small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period

Factors considered deciding on fertilizer use	**No. of respondents**	**Percentage (%)**
Yield gain	78	78
Own experience	75	75
Soil fertility	74	74
Weather (rainfall)	70	70
Knowledge of fertilizer	21	21
Cost of fertilizer	20	20
Capital availability	11	11

Source: Survey data (2015)

The factors that play a vital role in farmers' decisions on fertilizer recommendations in the study area were elicited. The first question posed was 'what factors do you consider when deciding on fertilizer use together with its soil recommendations. The responses were given in sequence and

put into frequency and percentage categories as shown in Table 4.19. The factors considered when deciding on fertilizer use were provided and summarised (Table 4.19).

Among the responses, majority (78%) of the small-scale sugarcane farmers listed their yield gain as an important factor to consider when deciding on fertilizer use and soil recommendations, this can result to correct fertilizer use, but soil recommendation was a first priority to ensure yield gain. This was followed own experience which was indicated by 75% of the sample to consider on fertilizer use and soil recommendation. The soil fertility and weather (rainfall) were recognized as being important by 74% and 70% of the small-scale sugarcane farmers respectively to consider when deciding on the fertilizer use and fertilizer recommendations. Other factors listed include knowledge of fertilizer, cost of fertilizer and capital availability, which play roles in decision making. It is worth noting that both the cost of fertilizer and capital availability are frequently considered in the fertilizer recommendations decision. The sequence of the factors listed may reflect the thinking patterns of the small-scale sugarcane farmers. In general, more important factors to a farmer are identified first.

4.4.10 The weeds control: decision and practice by small-scale sugarcane farmers in Mona and Sonkombo.

The research findings from Dubb (2011) that small-scale sugarcane farmers perceive weeds as the top agronomic constraint appears to be the first published record of such a perception. In the recent past, there have been numerous publications on improving weed management practices amongst small-scale sugarcane farmers. Emerging sugarcane farmers and new freehold growers in the South African sugar industry indicate recognition of weeds as a major constraint and a need for research and extension to continue addressing crop protection practices amongst small-scale sugarcane farmers (Campbell *et al.,* 2009; Smit *et al.,* 2010). Weed management should therefore be prioritized as an extension topic for the small-scale sugarcane farmers in the Noodsberg region of the Midlands North region. This can be achieved by incorporating it into the demonstration plot programme of work which is currently being used for extension in this region (Gillespie *et al.*, 2009; Gillespie *et al.*, 2012). Table 4.20 shows weeds control; decision and practice by small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period. The results show that the majority (97%) of the respondents indicated that weed control was very poor because it was made late; 94% revealed that the chemical control method was applied

although done late; 86% revealed that weed control was done at every stage; 87% show that training type received was calibration of spray.

Table 4.20 weeds control: decision and practices in Mona and Sonkombo small-scale sugarcane farmers for the period 2015

Weed control	Use of decision and practices	No. of respondents	Percentage (%)
Impression on weeding	Very poor	97	97
Method of weeding	Chemical method	94	94
Stage of control	Very late	86	86
Type of training received	Calibration of sprayers	87	87

Source: Survey data (2015)

4.4.11 Chemical application

Hogarth and Allsopp (2000) states that some weeds release compounds that are toxic to sugarcane growth. Herbicides can be useful and economical tools in sugarcane production. Odero (2010) indicated that herbicide application must be incorporated into an overall management plan to obtain their maximum benefit. It is important that sugarcane plants have the initial competitive advantage against weeds. Odero (2010) states that pre-herbicide applications, in conjunction with mechanical cultivation, help to ensure the early season advantage.

Directed or semi-directed post emergence (post) herbicide applications can generally only be effective if the sugarcane is taller than the competing weeds. High application speeds and rough fields can result in poor application uniformity, particularly with banded applications. Speed must be limited if movement of the boom or drop nozzles results in excessive amounts of herbicide actually depositing in the untreated strip.

Broadcast applications are generally less affected by these factors, since nozzle overlap helps ensure uniformity of herbicide placement. Proper timing of herbicide application with respect to the growth stage of the weeds is extremely critical. Table 4.21 shows the chemical application (herbicides) for weed control by small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period.

Table 4.21: Chemical application by small-scale sugarcane farmers of Mona and Sonkombo for the 2015 period

Chemical type	**Chemical industry standards**	**Actual Chemical applied (l/ha)**	**No. of respondents**	**Percentage (%)**
Gramoxone herbicide	400l/ha	400l/ha	34	34
Gramoxone herbicide	400l/ha	300l/ha	66	66

Source: Survey data (2015)

The majority (66%) of the respondents applied 300l/ha of herbicides which is below chemical industry estimated standards. The results again show that the majority (66%) of sugarcane farmers did not apply the recommended amount of herbicide, and another problem was the timing of application which was late, resulting in yield decline. The findings are in harmony with that of Inman-Bamber (2009) who found that poor timing of herbicide application can reduce yield of crop herbicide if applied late. Odero (2010) states that weeds cannot stabilise the growing of sugarcane, it must be controlled earlier at least by pre-emergence herbicides such as the Lasso herbicide as the pre-emergence chemical.

The Results further show that 34% of the respondents applied an estimated 400l/ha of Gramoxone herbicide which is the post-emergence herbicide in order to control weeds. This chemical was applied 6 months late after harvesting which promote vigorous weeds growth. This shows that extension officers wait for the rain before the chemical is delivered to the farmers for

application which really affect chemical effectiveness on weed killing, because this is the time when some weeds resist the control when it is six months old.

4.4.12 Land sizes and average farm income/ha for small-scale sugarcane farmers of Mona and Sonkombo

The results of the studies from three farms conducted by the World Bank (2010); United States Agency for International Development (USAID) (2003) showed convincingly that small individual farms in Moldova achieve higher productivity and efficiency than large corporate farms. The result obtained also in other countries such as Russia and United states were indicating increasing returns to scale for small-scale farmers while large-scale commercial farmers were experiencing decreasing returns to scale (USAID, 2003). For many small-scale sugarcane farmers, sugarcane is a primary livelihood resource, which is in contrast to the findings by Dubb (2012) that in the UMfolozi mill supply area, there is a much higher reliance on government social grants such as old-age pensions and child support grants than income from sugarcane farming as a result of the high costs of inputs as well as poor weeding and replant rates.

Dubb (2012) argue that in Noodsberg mill areas, farmers are achieving good returns out sugarcane productivity. This evidence suggests that land size may not be a contributing factor on yield decline but the decline in yield may be due to the others factors such as costs of inputs, climate change and poor agricultural techniques. Table 4.22 shows proportions of farmer's land sizes in relation to farm income/ha for the 2015 period. The results reveal that 44% of the respondents had <1 ha of land and received farm income of between R84 - R1 300, 34% had land size of 1 - 2ha and received farm income of between R1 300 – R1 600, 22% had land size of 2 - 3ha and received farm income of between R1 600 - R2 500. The findings show that the farm income received increased according to the farming area of land. The farmers were paid according to the size of the land they farm. The results indicated that a large proportion of farmers own small pieces of land to produce sugarcane which is likely to produce low returns. This finding is in contrary to literature that shows that the farmers with small pieces of land received more income than farmers with large pieces of land. According to SACGA (2012) farm size may not influence productivity but productivity may be influenced by the inputs costs,

transport costs and poor replant rates. From Figure 2.6 in section 2.3.2.1, it is clear that labour, fertiliser, mechanisation (and associated expenses like lubricants and maintenance) and transport (field to mill) are the major sugarcane production expenditures from the sugar industry to sugarcane farmers which may be resulting to low income by small-scale sugarcane farmers. Interestingly the share of different expenditures has not changed much over the 26-year period in the sugar industry, though services (water and electricity) and administration (bookkeeping and audit, office expenses, sugarcane levies and security) have become considerable expenditures (SACGA, 2012).

The finding of the survey is in harmony with that of Dubb (2012) who found that in the uMfolozi mill supply areas; small-scale sugarcane farmers have higher reliance on government social grants such as old-age pensions and child support grants, although in Northberg, sugarcane is the major livelihood resource suggesting that their production is this mill area can withstand farm costs.

Table 4.22: Proportions of farmer's land sizes and average sugarcane income/ha for the 2015 period

Average Land size, t/ha and farm income		**No. of respondents**	**Percentage (%)**
< 1 ha	R84 - R1 300	44	44
1 - 2ha	R1 300 - R1 600	34	34
2-3ha	R1 600 - R2 500	22	22
Total		**100**	**100**

Source: Survey data (2015)

4.5 Chapter summary

This chapter presented a descriptive analysis of the findings. Overall, results show that female small-scale sugarcane farmers dominate in Mona and Sonkombo villages. Results reveal that 48% of respondents have non-formal education, while 52% have formal education. The sugarcane farming is a specialized crop which requires frequent evaluation by extension. The

majority (80%) of respondents indicated that they receive extension support more than 10 days a month, while 20% receive extension support less than 10 days a month. The majority (88%) of the interviewed small-scale sugarcane farmers indicated that they had access to credit. Capital is an important aspect in the development of sugarcane production and even of any agricultural enterprise. The findings indicate that the land tenure system in communal land is a problem but in case of sugarcane farmers' credit from Umthombo agricultural finance and department of economic development and tourism to develop their sugarcane is available. The small-scale sugarcane farmers in the study area are not constrained by the land tenure system due to the fact that capital can be sourced from departments and private sectors.

Average sugarcane yield in Mona and Sonkombo ranged from as low as 15 to 60 tonnes/ha with an average of 50 tonnes/ha which is below the estimated sugarcane industry standards. The poor agricultural practices such as late fertilization and chemicals application; delay in weeding; delaying transportation of sugarcane from the field to sugar mills. The sugarcane left lying in fields after harvesting may result in yield decline. These challenges are likely to affect productivity negatively. The following chapter presents and discusses the empirical results computed from the amended/hybrid Cobb-Douglas Production Function to determine the factors influencing the productivity of small-scale sugarcane farmers in the study areas**.**

CHAPTER FIVE: EMPIRICAL RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents and discusses the empirical results of the study. An amended/hybrid Cobb-Douglas Production Function regression was employed to determine the factors influencing the productivity of small-scale sugarcane farmers in Mona and Sonkombo villages.

The amended/hybrid Cobb-Douglas Production Function was formulated and explained in Chapter 3. Within this chapter, the independent (explanatory) variables are tested for their significance and conclusions are drawn based on the results.

Thomson (2010) states that a regression is the relationship between independent variables (X) and a dependent variable (Y). The regression presents the error sum of square (SSE), which is attributable to factors other than the relationship between X and Y. An in-depth explanation is provided for the statistically significant independent variables to predict their influence on the dependent variable. Several measures of variation of Y_i values, the total sum of squares (SST), which is a measure of variation of the Y_i values around their mean is performed. Correlation analysis is carried out to measure the degree of linear association between the explanatory variables used in the regression analysis.

5.2 Factors affecting the productivity of small-scale sugarcane farmers in Mona and Sonkombo (amended/hybrid CDPF analysis)

An amended/hybrid CDPF regression was used which employs an OLS regression to test for the factors that have an influence on the productivity of small-scale sugarcane farmers in the study areas. The dependent variable used in this study is yield regressed against independent variables that include age (number of years), gender, marital status, education level, non-farm income, farm size (the area of cultivated land (ha), extension support, access to credit, labour (man days/ha), farm income, and the amount of agricultural production inputs applied which include basal fertilizer (kg/ha), Urea (kg/ha) and chemicals (herbicides) (l/ha).

5.2.1 Variables excluded from the model

Marital status and gender were found not to be strong in the model during the testing of its validity; the results were less than alpha level 0.05. The regression model was re-run including variables which were fitting in the model and excluding the mentioned weak variables.

5.3 Model fit

A model fit was computed in the regression analysis by determining how well the model fitted the data using the R-Square and Adjusted R-Square coefficients (see Table 5.1). R-Square and Adjusted R-Square measure the "model quality" or the percentage of the results variance that is explained by the model. With regard to this dataset, the R-square (0.631428) shows that the model was fit to explain the variations to the dependent variable. The data accounts for about 63% of the variation of the dependant variable by the explanatory variables. The closer to one (1) the adjusted R-Square, the better the fit of the estimated regression line.

The problem of heteroscedasticity was solved by undertaking robust ordinary least square (OLS) and hence all the explanatory variables were included for the model analysis. The coefficient of adjusted R-Square was 0.585356 this indicates that about 58% of the factors were from the hypothesized explanatory variables (see Table 5.1). Dlamini and Masuku (2011) state that the F-statistic explains the relationship between the dependent and independent variables. According to Table 5.1, the F-statistic is 13.70538 with p-value of 7.06E-15. Since the p-value less than 0.05, the null hypothesis is deemed rejected and it can be concluded that that the parameters are jointly statistically significant (Gujarati & Porter, 2009). This, therefore, implies that there is a significant relationship between sugarcane yield per hectare and the explanatory variables included in the model.

5.4 Results of the amended/hybrid regression analysis on factors affecting the productivity of small-scale sugarcane farmers in Mona and Sonkombo

Table 5.1 presents the empirical results of the regression analysis computed in the amended/hybrid CDPF used to determine the factors affecting the productivity of small-scale sugarcane farmers in the study areas. Results show that the significant factors influencing the productivity of small-scale sugarcane farmers in the study areas included age, education, non-

farm income, extension support, and land size, the amount of basal fertilizer, urea and chemicals applied.

Table 5.1: Factors affecting the productivity of small-scale sugarcane farmers in Mona and Sonkombo for the 2015 period

Variable	**Regression coefficient**	**t-statistic**	**Significance (p-value)**
Age	0.00111***	2.30278	0.0009961
Education level	0.0043469**	2.04478	0.0026339
Non-farm income	0.00004***	3.04478	0.000117
Land size	7.883031**	2.893692	0.041551
Extension support	0.1694**	2.50973	0.0041
Access to credit	0.004815**	3.53649	0.011782
Labour/man-days/ha	0.00000023***	2.82505	0.0000028
Farm income	-0.000216***	-2.0274	0.00031
Amount of fertilizer applied	0.001403**	0.004316	0.00342
Amount of urea applied	0.001403*	2.60067	0.006267
Amount of Chemicals (herbicides) applied	-0.00011***	-2.33064	0.000324
F-statistic	13.70538 (p = 7.06E-15)		
Multiple R	0.794624		
R-square	0.631428		
Adjusted R square	0.585356		

Source: Survey data (2015) ***; **; * Significant at 1%, 5% and 10%

Age: The age variable has influence on the rejection or selection of new practices and modern technology. The coefficient of regression for the age variable was found to be positively related with productivity of small-scale sugarcane farmers with (p-value = 0.0009961) at 1%

significance level. The model predicts that a 1% increase in age is associated with 0.01111% increase in the productivity of sugarcane. A person's age is accepted to have great contribution towards personal attitude and such properties adapted to a person's skills and experience over his farming life time and help out in correct judgement (Asif *et al*., 2005).

Education level: The coefficient of regression for the variable education was positive (0.0043469), and found to be statistically significant at 5% significance level with p-value of 0.026339. (see Table 5.1). The model predicts that a 1% increase in education level is likely to increase productivity of sugarcane by 0.0043469%. The relationship between a farmers' level of education and their respective allocative and productivity shows that farmers with relatively many years of formal schooling can understand agricultural techniques easily (refer to Table 4.4). With better education, it may be argued that, ceteris paribus, a farmer's ability to perceive, interpret and assimilate new farming ideas and technologies is enhanced, leading to an increase in productivity. The findings are consistent with Bravo–Ureta and Pinheiro (1997) who found a positive relationship between farmers' educational level and yield produced per hectare.

Non-farm income: The Regression coefficient for the variable non-farm income was positive related with productivity (with coefficient 0.00004), and found to be statistically significant at 1% significance level with p-value of 0.000117. (see Table 5.1). The model predicts that a 1% increase in non-farm income is likely to increase productivity of sugarcane by (0.00004). This result of the survey is in harmony with that of Dubb (2012) who found that in the uMfolozi mill areas, small-scale sugarcane farmers have higher reliance on government social grants such as old-age pensions and child support grants than farm income. The non-farm income is likely to increase productivity of sugarcane of the Mona and Sonkombo because if non-farm income increases, the more the chances to exercise other development such as buying of more agricultural inputs that would enhance productivity.

Extension support: The variable extension support was statistically significant at 5% significance level (p value = 0.0041) with a regression coefficient of 0.1694. The model predicts that an improvement in extension support would increase sugarcane productivity (see Table 5.1). Farmers must be empowered in order to have self-reliance in their sugarcane farming than waiting for extension officers to promote sustainable development. United States Agency for

International Development (2002) states that extension workers are employed to educate the sugarcane growers to improve farm practices for higher production and also to adopt cost effective production techniques.

Access to credit: The variable access to credit is statistically significant at 5% significance level (p-value = 0.011782) and positively correlated with sugarcane productivity of small-scale sugarcane farmers with a regression co-efficient of 0.004815. The model predicts that an improvement in access to credit is likely to increase the productivity of small-scale sugarcane farming (see Table 5.1) Access to credit facilities to sugarcane farmers is likely to contribute positively to farmers' economic efficiency.

This is in line with a number of studies carried out on the influence of credit access and farmers' economic efficiency (Abdulai *et al.*, 2001; Nchare, 2007). By enabling farmers to overcome liquidity constraints imposed by their limited income, access to credit is expected to enable the timely application of farm inputs, in addition to enabling them to effectively implement farm management decisions, leading, ceteris paribus, to an increase in respective farmers' productive efficiency. This finding is also supported by the descriptive results which showed that access to credit in the study area was not a major challenge, descriptive results showed that 88% of the farmers reported that they had access to credit for sugarcane cultivation (see Table 4.7).

Land size: The variable land size (ha) is statistically significant at 5% significance level (p-value = 0.041551) and positively correlated to sugarcane productivity of small-scale sugarcane farmers with a regression co-efficient of 7.883031. The model predicts that 1% increase in the variable land size will increase the productivity of small-scale sugarcane farming by 7.883031% (see Table 5.1). The land size variable from these results is having a greater influence than all the other factors included in the model because the efficiency of a very small land size can be enhanced by land consolidation, farm operator's education, training, and extension services for expansion and propagation of modern techniques of sugarcane production (Gujarati & Porter (2009). The findings by Dubb (2012) in Noodsberg mill areas further stated that there was an increase of production out of a small size of land. The findings of Dubb (2012) showed that if land was to be increased in Noodsberg mill areas, it would result to increased productivity. The finding of this study is also in harmony with that of Gujarati and Porter (2009) who found that

the increase of land size is expected to increase productivity provided there are no high input costs. However, contrary to this finding, a study by Malaza and Myeni (2009) showed that the area of land cultivated did not significantly increase farm output due to prevalent of inputs and transport costs.

Labour (man-days /ha): The variable labour (man-days/ha) was found to be statistically significant at 1% significance level (p-value =0.000028) and positively correlated with sugarcane productivity with a regression coefficient of 0.0000023. The model predicts that a 1% increase in labour (man-days/ha) will increase sugarcane productivity (t/ha) by 0.000023 (see Table 5.1). This result is in agreement with the expected outcome and also in harmony with findings by Narayan (2004) and Ogwang (2009) who found that labour is positively related to output in sugarcane production.

Farm income: The farm income variable is statistically significant at 1% significant level (p-value = 0.000310) with regression coefficient of -0.000216 showing a negative correlation to productivity. The model estimates that a 1% increase in farm income would be associated with 0.000216% decrease in productivity. This finding is in contrast with the expected outcome. Farm income, is one of the sources of income available to farmers and it is plausible that earnings from the farm can be invested together with off-farm income to compensate for missing or imperfect credit. Therefore, farm income is expected to smoothen consumption of modern inputs and thus increase productivity. The negative correlation of farm income to sugarcane productivity in this case could be due to the lower income offered by Tongaat Hulett as sugarcane payment to the farmers as a result of high production costs and lower returns to scale. The findings of Dubb (2012) in uMfolozi mill areas found that small-scale sugarcane farmers have a higher reliance on government social grants such as old-age pensions and child support grants than farm income suggesting low returns to scale from small-scale sugarcane farming that can also be linked to various challenges by small-scale sugarcane farmers in the study areas.

Amount of basal fertilizer applied: The variable amount of basal fertilizer applied is statistically significant at 5% significance level (p-value = 0.00342) and positively correlated with sugarcane productivity of small-scale sugarcane farming with a regression co-efficient of 0.001403 The model predicts that a 1% increase in the amount of basal fertilizers used is

associated with 0.00143% increase in the productivity of small-scale sugarcane farming. The finding is in harmony with the expected outcome of the study and also to the findings of Khattack (2008) and those of Dlamini and Masuku (2012) who found that the use of fertilizer increases the sugarcane productivity if it is applied according to soil sample requirements. An adequate amount of fertilizer application is vital for the growth of good sugarcane crop (Baiyegunhi & Arnold, 2011). Again Narayan (2004) estimated a sugarcane production model of sugarcane production in Fiji and found that the amount of fertilizer applied had a positive influence on sugarcane productivity.

Amount of urea used: The variable amount of urea applied is statistically significant at 5% significance level (p-value = 0.006267) and positively correlated with sugarcane productivity of small-scale sugarcane farming with a regression co-efficient of 0.001403. The model predicts that a 1% increase in the amount of urea used would be associated with 0.0014% increase in the productivity of small-scale sugarcane farming. This finding is in harmony with the expected outcome of the study and to the findings of Khattack (2008) and those of Dlamini and Masuku (2012) who found that the use of urea increases the sugarcane productivity if it is applied according to soil sample requirements.

Amount of chemicals used: The variable amount of chemicals (herbicides) applied (litres/ha) is statistically significant at 1% significant level (p-value=0.00324) and negatively related with sugarcane productivity of small-scale sugarcane farmers with a regression co-efficient of -0.00011. The model predicts that a 1% increase in the amount of chemicals applied would be associated with a 0.000011% decrease in the productivity of small-scale sugarcane farming. This is contrary with the expected outcome of the study and to the findings of Dlamini and Masuku (2012) who found that the amount of chemicals applied is positively associated to agricultural productivity, provided that proper chemical spray programmes are followed. According to Dlamini *et al.* (2010), chemicals need to be applied to protect the crop from pests and diseases and also as means of weed control. The adequate and timely application is important and hence a positive relationship between chemicals application and sugarcane productivity is expected (Ogwang, 2009). The majority of the small-scale sugarcane farmers (66%) in the study area applied amount of chemicals which were below the industry standards which can bring negative results to productivity (refer to Table 4.21 and section 4.4.11).

5.5 Chapter summary

This chapter presented and discussed the empirical results of the study. The study employed an amended/hybrid regression to estimate the factors influencing the productivity of small-scale sugarcane farmers in the study areas. Yield was used as a proxy for productivity and regressed against explanatory variables that included age, education level, non-farm income, land size cultivated, extension support, access to credit, labour (man-days/ha), farm income and agricultural production inputs which include amount of basal fertilizers, urea, chemicals (herbicides) applied. The amended/hybrid regression analysis reveals that significant predictors of productivity in the study areas were: age, education level, land size cultivated, extension support, access to credit, labour, the amount of basal fertilizers, urea and chemicals applied. Age, education, extension support, land size cultivated, access to credit, amount of fertilizer, amount of urea applied and non-farm income variables were found to be positively correlated with sugarcane productivity whereas, farm income and amount of chemicals applied were negatively correlated with sugarcane productivity.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter draws a summary of the research findings and conclusions based on results of the study and recommendations put forward for the small-scale sugarcane farmers, particularly on improving their productivity.

6.2 Summary

The main aim of the study was to determine the factors affecting the productivity of small-scale sugarcane farmers in Mona and Sonkombo villages. Under this broad objective, the specific objectives were: firstly, to identify the production challenges faced by small-scale sugarcane farmers in Mona and Sonkombo villages, the study relied on descriptive statistics to achieve this objective. Challenges faced by interviewed small-scale sugarcane farmers were both socio-economic and production related challenges.

The farmer's productivity is likely to have positive association with age, non-farm income, land size, access to credit, extension support services, education, fertilizer urea and basal fertilizer, but the amount of chemicals applied and farm income and are likely to be the limiting factors. Small-scale sugarcane farmers were constrained by crop nutrition challenges such as late and less amounts of fertilizer applied because according to the survey results fertilizer was not applied according to industry standards for example, results show that the majority (65%) applied 300kg/ha of fertilizer mixture of 5:1:5 (45) at planting time after harvesting and the remaining 35% of farmers applied 250 kg/ha of fertilizer. The application of 300kg/ha of 5:1:5 (45) instead of 600kg/ha, is mainly done to more than one-year ratoon sugarcane which is the sugarcane harvested for more than one year which require at least an estimated 600kg/ha (see appendix 3).

The majority (66%) of the respondents applied 300l/ha of herbicides which is below the chemical industry estimated standards. The results show that the majority of small-scale sugarcane farmers did not apply the recommended amount of herbicide, and another problem was the timing of chemical application which was done late, resulting in yield decline. According to the survey results on Table 4.21, 66% farmers stated that weed control was done very late; but weed control using chemical application taking place very late approximately after 6 months of cutting sugarcane which is really a poor timing which could result to low

productivity. The majority (70%) of small-scale sugarcane farmers indicated that they never did any soil analysis but they just plant without using any soil recommendations they continuously use fertilizer that was given to them during the initiating of sugarcane project in Mona and Sonkombo villages. (See Table 4.16 on the section 4.4.8).

High inputs costs, high transport costs, late transportation of sugarcane to the sugar mill for crushing, as well as unclear participation of farmers on decision making processes as well as climate change related drought were major challenges faced by small-scale sugarcane farmers which were deemed to affect productivity.

Secondly to determine the factors affecting the productivity of small-scale sugarcane farmers in Mona and Sonkombo villages, the study employed an amended/hybrid CDPF. An amended/hybrid CDPF was chosen for the purpose of data analysis when investigating the factors affecting productivity of small-scale sugarcane farmers in Mona and Sonkombo villages. The selection of the CDPF was based on the notion that it can handle multiple inputs in its generalized form; and in the presence of imperfections in the market, it does not introduce distortions of its own and various econometric estimation problems like serial correlation, heteroscedasticity and multicollinearity and as such can be handled adequately and easily.

The amended/hybrid CDPF results showed that farmer's productivity is likely to have positive association with age, non-farm income, land size, access to credit, extension support services, education, and amount of basal fertilizer and urea applied, but the amount of chemicals applied and farm income factors were found to be negatively associated with sugarcane productivity. The land size appeared to have a greater influence than all the other factors in increasing productivity. This may be because the efficiency of a very small land size can be enhanced by land consolidation, farm operator's education, training, and extension services for expansion and propagation of modern techniques of sugarcane production.

6.3 Conclusion

The study sought to assess the factors affecting small-scale sugarcane productivity. The results suggest that, in order for small-scale sugarcane farmers to realise higher yields per hectare, they have to apply the optimum amounts of the inputs and at the right time. The study reveals that age, education, nonfarm income, land size, extension support, access to credit, amount of basal

fertilizer, amount of urea applied were positively correlated with productivity whereas the amount of chemicals applied and farm income were found to be negatively correlated with sugarcane productivity.

The descriptive results show that small-scale sugarcane farmers had some challenges of late fertilizer chemical application, another factor that can be connected with the observed negative returns. However, the declining productivity by small-scale sugarcane farmers cannot be attributed to production factors alone but also the poor agronomic practices such as high poor fertilizers which could result in reducing yield. Secondly, small-scale sugarcane farmers were constrained by crop nutrition challenges such as late and less fertilizers applied because according to the survey results fertilizer was not applied according to industry standards for example there is an application of 300kg/ha of 5:1:5(45) applied instead of 600kg/ha (see appendix 3). According to survey results on Table 4.17, 65% farmers indicated that weed control was done very late and this could be another challenge resulting to yield decline. Other farmers applied amount which is out of estimated industry standard for example 300l/ha instead of 400l/ha.

According to Malaza and Myeni (2009), it is important that small-scale sugarcane farmers improve their yield and sucrose content in order to maximise income. The major determinant of sugarcane productivity is timely and adequate application of inputs through the life cycle of the crop. Lower input use will certainly save costs, but reduce productivity. It is further argued that the age of ratoon has an inverse relationship with crop yield. If no new sugarcane is planted that implies declining trend in productivity.

In conclusion, age, education level, non-farm income, land size, access to extension, access to credit, labour, and agricultural production inputs such as amount of basal fertilizers, urea, amount and chemicals (herbicides) applied are important in ensuring good sugarcane productivity which could probably result in good returns if good agricultural practices are adhered to; farm income and non-farm income can be a determinant of productivity. Many variables such as farmers` socio-economic characteristics and institutional factors act both in isolation and in combination to influence the sugarcane productivity.

6.4 Recommendations

This section presents recommendations of the study on the proper crop husbandry, allocation of land and access to credit. It also discusses the allocation of inputs, training as well as institutional support to small-scale sugarcane farmers.

Proper crop husbandry: Descriptive results showed that small-scale sugarcane farmers in the study areas realised lower average yields than the estimated standard yields of the sugar industry. Proper crop husbandry post-harvest management such as ratoon management should be improved so that a good crop yield is produced. Farmers need to improve re-plant rates and weed control because farmers perceive weeds as the top agronomic constraint that contributes to reduced yields, along with low levels of education which contribute to poor crop husbandry practices among small-scale sugarcane farmers. Crop protection practices such as use of herbicides amongst small-scale sugarcane farmers also need to be addressed.

Allocation of land: It is recommended that small-scale sugarcane farmers also need to increase the land allocated and ensure good management in order benefit from economies of scale but with support from the local traditional authority by allocating more potential land since the traditional authorities control communal land. The allocation of land will not necessarily translate into an adequate increase in productivity levels, but productivity increase will be driven by success and returns on effort applied by the farmer on good agronomic practices and reducing of input costs.

Allocation of inputs: It is recommended that fertilizer has to be distributed in earlier and recommended quantity to farmers. The agricultural inputs recommended to be applied according to soil testing requirements so as to avoid wastage of inputs applied which can possibly increase production costs.

Training: Farmers' training need to be improved by SASRI to get technical information about the use of good seed sugarcane, chemical use, and pest and diseases control. All the training by SASRI has to be executed working hand in hand with the Department of Agriculture and Rural development, so that all agricultural operations are done in a proper manner in order to deal with mistakes of poor agricultural practices such as delayed planting, hand weeding, chemical weeding, reduced amount of fertilizer and immature sugarcane burning. This training will be

supportive to small-scale farmers because farmers will be cognisant about measures to follow in order to reduce poor agricultural practices.

Institutional support: The government, through the Department of Agriculture, and the private sector should intensify the out-grower extension services by training farmers on excellent agricultural practices. The leading objective of the service of extension is to bring about facilitation to adoption of technology and practices with better management that inspires accountable and viable land use with best productivity and profitability delivery. The extension services offered to the industry embrace specialisation advice on farmers' problems and soils, and leaf analysis through the fertilizer advisory service. The sugarcane quarantine facility in South Africa based on pest and diseases can be continuously operated by the South African Cane Growers Association. The mentorship programme as a pillar of extension service sourced from experienced commercial farmers can be a solution to be applied to small-scale sugarcane farmers so that they can change the poor agricultural practices in order to improve returns from sugarcane productivity.

6.5 Suggestions for future research

This study only focused primarily on the factors affecting small-scale sugarcane farmers in Mona and Sonkombo villages. It has not taken into account influence of political factors including government interventions on project financing and political favours; cultural factors including particular aspects of local culture that the extension agent should be aware of: the farming system, land tenure, inheritance, ceremonies and festivals, and traditional means of communication; and environmental factors including soils and drought which may also have an influence on sugarcane productivity. The area of study has been confined to only one local municipality in KwaZulu-Natal Province of South Africa that is Ndwedwe Local Municipality. It is suggested that a research of this nature be carried out in other local municipalities of the province if the results of the empirical analysis has to be consistent with existing literature.

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APPENDIX 1: QUESTIONNAIRE

DEPARTMENT OF AGRICULTURE, UNIVERSITYOF ZULULAND, KWADLANGEZWA.

Questionnaire on investigation of factors affecting productivity of small-scale sugarcane farmers in Mona and Sonkombo villages in Ndwedwe local Municipality, KwaZulu-Natal.

Interview no….....

Date…….

Village……

Province……

District municipality……...……..

Local municipality……

A. DEMOGRAPHIC INFORMATION

1. Fill in the relevant information and where possible mark with an X or Tick (✓)

A1GENDER		A2 AGE(YEARS)					A3 MARITAL STATUS				A4HOUSEHOLD SIZE			
M	F	<20	21-29	30-39	40-49	> 50	Single	Married	Widowed	Divorced	<3	4-6	> 7	>10
1	O	1	2	3	4	5	1	2	3	4	1	2	3	4

A5. What is the highest educational level the head of the household has completed?

NO FORMAL EDUCATION	PRIMARY SCHOOL ONLY	SECONDARY /HIGH SCHOOL	TERTIARY EDUCATION

1	2	3	4

A6. Please state the source of non-farm income available to your household

SOURCE OF INCOME			PERCENTAGE (%)
Salaries or wages			
Pensions and support grants			
Business			
Total %			

ACCESS TO CREDIT		EXTENSION SUPPORT: How many times per months a farmer receives extension support.	
1=yes	2=no	1=>15days/month	2=<15days/month

B. PRODUCTION INFORMATION

B1. What is your average sugarcane production per year in tonnes per hectare?

…….

B2. Indicate the land tenure system of the land you have access to.

LAND OCCUPATION TYPE	PERCENTAGE (%)
Communal	
Owned	
PTO	
Rent/Lease	

B3. Please indicate how you use your land.

Type of agricultural production	Approximate % of own land used (%)
Sugarcane crops	
Other agricultural crops	
Livestock	

B4. Please indicate your feeling regarding your current level of sugar cane production:

Insufficient for a decent living standard	Just enough for a basic good living standard	Just enough for doing basic improvements in my living standard	Sufficient excess income for doing basic expansions of my operations	Sufficient excess for signify cant sustainable expansion of my operations
1	2	3	4	5

B5. Please provide the most important reason for your answer in Question B4

REASONS THAT ARE CURRENTLY INFLUENCING YIELD	
1	

B6. What do you think are the most important current challenges you face in sugar cane production? (Record the respondent's reasons – open ended question)

ASPECT OF CANE FARMING		
Crop nutrition		
Weed control		
Harvesting practices		
Foundational planting		

Ratoon management		
Pest and disease management		
Selection of base stock / seed cane		
Financial planning and management		

B7. Please complete the following regarding your land and its cultivation.

Cane category (Plant or Ratoon) [3]	
Topography[4]	
Soil Type [5]	
Tons cane/tons sugar/annum	

B8.

[1] Land title	1 = Traditional	2 = Formal Euro	3 = PTO	4 = Legal lease	5 = None	
[3] Cane category	1 = Plant Cane	2 = R1	3 = R2	4 = R3	5 = R4>	6 = DNK
[4] Topography	1 = Flat	2 = Undulating	3 = Slope			
[5]Soil Type	1 = Sandy	2 = Loamy	3 = Sandy loam	4 = Clay	5= Black clay	6=other

B9. Labour: Please complete the following regarding your labour position. Who mostly does the following labour?

Source of labour[1]

Land preparation	
Planting	
Gap filling	
Fertilizer application	
Herbicide application	
Hand weeding	
Harvesting	

B10

[1] Labour source	1 = self	2 = household member	3 = permanent hired labour	4 = part time hired labour	5= contractors

B11 Labour(land prep)	Man days /ha	

Choice of sugar cane variety. Please indicate the following regarding your choice of sugar cane variety decisions and practices.

Who makes the variety decision ?[1]		
Variety		Average Size of land (area/ha) and farm income (ha)
What sugarcane variety do you grow and what area (Ha)?		
How often do you use clean inspected seed cane? [2]		
What is your source of planting material? [3]		
What is the age of the seed cane you usually plant? [4]		

B 12

[1] Who makes decision	1 = self	2 = Milling co	3 = Scheme admin	4 = Extension	5 = Family / Group
[2] Use inspected material	1 = very often	2 = regularly	3 = Sometimes	4 = DNK / Irregularly	5 =never
[3] Source of material	1 = Own field	2 = Local inspected nursery	3 = Sugar estate	4 = Other growers	5= DNK
[4] Age of seed cane	1 = < 10 months.	2 = 11-15 months	3 = > 15 months	4= DNK	

B13. Fertilizer use. Please indicate the following regarding your fertilizer use decisions and practices.

How often do you or another do soil analysis on your fields? [1]	
When was the last time an analysis was done of your soil?[2]	
When do you analyze the soil?[3]	
Who takes soil samples? [4]	
What do you do with the soil analyses?[5]	
Who explains results of soil analysis to you? [6]	
How strict do you adhere to what is recommended to you? [7]	
When do you apply fertilizer?[8]	
Which application method you use to apply fertilizer?[9]	
Who take decision on fertilizer application?[10]	

B14

[1] Do Soil analysis?	1 = every year; 2 = every second year; 3 = less than every second year; 4 = never.
[2] Last time a soil analysis	1 = less than a month ago; 2 = 1 – 3 months ago; 3 = 3 – 6

was done	months ago; 4 = 6 – 12 months ago; 5 = > 12 months ago; 6= never.					
[3] When do you analyse the soil?	1 = At planting only	2 = In Ratoons only	3 = Both	4 = DNK		
[4] Who takes soil samples?	1 = Yourself	2 = Extension officer	3 = Researchers	4 = DNK		
[5] What do you do with the soil analyses?	1 = Use them myself for calculating fertilizer application	2 = Give them to extension officer to calculate fertilizer application	3 = Ask independent scientists / fertilizer salesmen to calculate fertilizer application	4 = Nothing – throw them away	5 = DNK	
[6] Who explains results to you?	1 = Self	2 = Extension officer	3 = Other farmer/agent	4 = No one		
[7] Adhere to recommendations?	1 = I commit to do precisely as recommended	2 = if my circumstances allow I do what I can	3 = also get other opinions and then decide what to do	4 = only sometimes	5 = never	
[8] When do you apply fertilizer?	1 = Immediately after harvest	2 = Before crop is months old	3 = At anytime	4 = DNK	5 = wait for rain	6 = never
[9] Method of application	1 = Tractor	2 = Hand on row	3 = May field	4 = Other/DNK		
[10]Decision to apply	1 = Self	2 = Company or group	3 = Miller	4 = Extension Officer	=independent scientist or salesman	

15

Fertilizers application rate	Kgs /ha	

What Factors do you consider when deciding on fertilizer recommendations?		

16

What Factors do you consider when deciding on fertilizer recommendations?		
Urea application rate	Kgs/ha	

B16. Weed control. Please indicate the following regarding your weed control decisions and practices.

Describe your impression of your own weed control practices.[1]	
What method of weeding do you normally use? [2]	
At what stage do you control your weeds? [3]	
Who normally performs manual weeding practices? [4]	
Who applies herbicides?[4]	
What type of training have? you received in chemical weed control? [9]	

B17

[1] Impression of own practices	Use following scale for farmer assessment: 1 = totally disastrous; 2 = very poor; 3 = of low level; 4 = reasonable level; 5 = very good level.				
[2] Method of weeding	1 = Manual	2 = Chemical	3 = Combination	4 = No weeding	5 = DNK
[3] Stage of control	1 = Before weed germination	2 = When cane < 3 leaves	3 = Cane above knee height	4 = Very late	5 = DNK
[4]Who performs weeding/applies herbicide/ fertilizers	1 = Self	2 = Contractor	3 = labourers	4 = some family member	5 = DNK
[5] Type of training received	1 = Identification of weeds	2 = Maintenance equipment	3 = Choice of herbicides	4 = Calibration of sprayers	5= None

B18

Chemical application	Litres/ha/growing season	

Choice of sugar cane variety. Please indicate the following regarding your choice of sugar cane variety decisions and practices.

Who makes the variety decision ?[1]		
Variety		Size of land (Area /ha)
What sugarcane variety do you grow and what area (Ha)?		
How often do you use clean inspected seed cane? [2]		
What is your source of planting material? [3]		
What is the age of the seed cane you usually plant? [4]		

B 19

[1] Who makes decision	1 = self	2 = Milling co	3 = Scheme admin	4 = Extension	5 = Family / Group
[2] Use inspected material	1 = very often	2 = regularly	3 = Sometimes	4 = DNK / Irregularly	5 =never
[3] Source of material	1 = Own field	2 = Local inspected nursery	3 = Sugar estate	4 = Other growers	5= DNK
[4] Age of seed cane	1 = < 10 months.	2 = 11-15 months	3 = > 15 months	4= DNK	

B20. Fertilizer use. Please indicate the following regarding your fertilizer use decisions and practices.

How often do you or another do soil analysis on your fields? [1]	
When was the last time an analysis was done of your soil?[2]	

When do you analyze the soil?[3]	
Who takes soil samples? [4]	
What do you do with the soil analyses?[5]	
Who explains results of soil analysis to you? [6]	
How strict do you adhere to what is recommended to you? [7]	
When do you apply fertilizer?[8]	
Which application method you use to apply fertilizer?[9]	
Who take decision on fertilizer application?[10]	

B21

[1] Do Soil analysis?	1 = every year; 2 = every second year; 3 = less than every second year; 4 = never.			
[2] Last time a soil analysis was done	1 = less than a month ago; 2 = 1 – 3 months ago; 3 = 3 – 6 months ago; 4 = 6 – 12 months ago; 5 = > 12 months ago; 6= never.			
[3] When do you analyse the soil?	1 = At planting only	2 = In Ratoons only	3 = Both	4 = DNK
[4] Who takes soil samples?	1 = Yourself	2 = Extension officer	3 = Researchers	4 = DNK

[5] What do you do with the soil analyses?	1 = Use them myself for calculating fertilizer application	2 = Give them to extension officer to calculate fertilizer application	3 = Ask independent scientists / fertilizer salesmen to calculate fertilizer application	4 = Nothing – throw them away	5 = DNK

[6] Who explains results to you?	1 = Self	2 = Extension officer	3 = Other farmer/agent	4 = No one

[7] Adhere to recommendations?	1 = I commit to doing precisely as recommended	2 = if my circumstances allow I do what I can	3 = also get other opinions and then decide what to do	4 = only sometimes	5 = never

[8] When do you apply fertilizer?	1 = Immediately after harvest	2 = Before crop is 3 months old	3 = At anytime	4 = DNK	5 = wait for rain	6 = never

[9] Method of application	1 = Tractor	2 = Hand on row	3 = May field	4 = Other/DNK	

[10]Decision to apply	1 = Self	2 = Company or group	3 = Miller	4 = Extension Officer	=independent scientist or salesman

B22

Fertilizers application rate	Kgs /ha	
Urea application rate	Kgs/ha	

B23. Weed control. Please indicate the following regarding your weed control decisions and practices.

Describe your impression of your own weed control practices.[1]	
What method of weeding do you normally use? [2]	
At what stage do you control your weeds? [3]	
Who normally performs manual weeding practices? [4]	
Who applies herbicides?[4]	
What type of training have you received in chemical weed control? [9]	

B24

[1] Impression of own practices	Use following scale for farmer assessment: 1 = totally disastrous; 2 = very poor; 3 = of low level; 4 = reasonable level; 5 = very good level.				
[2] Method of weeding	1 = Manual	2 = Chemical	3 = Combination	4 = No weeding	5 = DNK
[3] Stage of control	1 = Before weed	2 = When cane < 3 leaves	3 = Cane above knee	4 = Very late	5 = DNK

	germination		height		
[4] Who performs weeding/applies herbicide/ fertilizers	1 = Self	2 = Contractor	3 = labourers	4 = some family member	5 = DNK
[5] Type of training received	1 = Identification of weeds	2 = Maintenance equipment	3 = Choice of herbicides	4 = Calibration of sprayers	5= None

B25

Chemical application	Litres/ha/growing season	
manual labour	Man days /ha	

B26. Pests and diseases. Please indicate the following regarding your pest and disease control decisions and practices.

Describe your impression of your own pest and disease control practices[1].	
Why is it important to you to control insect pests? [2]	

B27

[1] Impression of own control measures	Use following scale for farmer assessment: 1 = totally disastrous; 2 = very poor; 3 = of low level; 4 = reasonable level; 5 = very good level.		
[2] why is it important to control pests?	1 = reduce yield losses	2 = prevent further outbreaks	= 1 and 2

END OF QUESTIONNAIRE: THANK YOU FOR YOUR PARTICIPATION

APPENDIX 2: ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF ZULULAND
RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-030)

RESEARCH & INNOVATION
Website: http://www.unizulu.ac.za
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6887
Fax: 035 902 6222
Email: MangeleS@unizulu.ac.za

ETHICAL CLEARANCE CERTIFICATE

Certificate Number	**UZREC 171110-030 PGM 2015/197**							
Project Title	**Factors affecting productivity of small-scale sugarcane farmers of Mona and Sonkombo villages**							
Principal Researcher/ Investigator	NS Zulu							
Supervisor and Co-supervisor	Dr. M Sibanda		Mr. B Tlali					
Department	Agriculture							
Nature of Project	Honours/4th Year		Master's	x	Doctoral		Departmental	

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project proposal and the documents listed on page 2 of this Certificate.

Special conditions: (1) The Principal Researcher must report to the UZREC in the prescribed format, where applicable, annually and at the end of the project, in respect of ethical compliance.
(2) Documents marked "To be submitted" (see page 2) must be presented for ethical clearance before any data collection can commence.

The Researcher may therefore commence with the research as from the date of this Certificate, using the reference number indicated above, but may not conduct any data collection using research instruments that are yet to be approved.

Please note that the UZREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the documents that were presented to the UZREC
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

Classification:

Data collection	Animals	Human Health	Children	Vulnerable pp.	Other
X					
Low Risk		Medium Risk		High Risk	
		X			

The table below indicates which documents the UZREC considered in granting this Certificate and which documents, if any, still require ethical clearance. (Please note that this is not a closed list and should new instruments be developed, these would require approval.)

Documents	Considered	To be submitted	Not required
Faculty Research Ethics Committee recommendation	X		
Animal Research Ethics Committee recommendation			X
Health Research Ethics Committee recommendation			X
Ethical clearance application form	X		
Project registration proposal	X		
Informed consent from participants	X		
Informed consent from parent/guardian			X
Permission for access to sites/information/participants	X		
Permission to use documents/copyright clearance			X
Data collection/survey instrument/questionnaire	X		
Data collection instrument in appropriate language		Only if necessary	
Other data collection instruments		Only if used	

The UZREC retains the right to

- Withdraw or amend this Certificate if
  - Any unethical principles or practices are revealed or suspected
  - Relevant information has been withheld or misrepresented
  - Regulatory changes of whatsoever nature so require
  - The conditions contained in this Certificate have not been adhered to
- Request access to any information or data at any time during the course or after completion of the project

The UZREC wishes the researcher well in conducting the research.

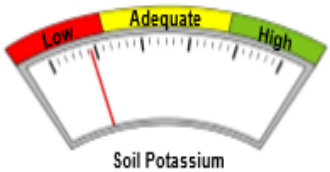
Professor Nokuthula Kunene
Chairperson: University Research Ethics Committee
12 November 2015

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
12 -11- 2015
RESEARCH & INNOVATION OFFICE

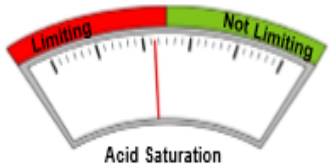
APPENDIX 3: FERTILIZER ADVISORY SERVICE: SOIL ANALYSIS REPORT FOR SMALL-SCALE SUGARCANE FARMERS IN MONA AND SONKOMBO VILLAGES

Exchangeable Acidity (Al+H)	cmol/L	1.32			
Total Cations [2]	cmol/L	4.67			
Acid Saturation	%	28.3	20.0 [6]		Limiting
Exchangeable Sodium % (ESP)	%	3.6	7.0		Not limiting
Ca/Mg (Equivalence ratio)		1.2			Not limiting
Zinc (Zn)	mg/L	5.2	1.5		Adequate
Copper (Cu)	mg/L	2.1	0.8		Adequate
Manganese (Mn)	mg/L	11.7	2.0		Adequate
Iron (Fe)	mg/L	587	3		High
Clay Estimate	%	23			
Organic Matter Estimate	%	2.8			
Nitrogen (N) Category [3]	cat	2			
N Volatilization [4]	%	0.3	10.0 [6]		
Volume Weight	g/mL	1.18			

Soil Phosphorus



Soil Potassium



Acid Saturation

Analysis Notes :

1. P analysis by Truog method if sample pH <= 5.50. If pH > 5.50, Resin method used.
2. Sum of potassium, calcium, magnesium, sodium and (Al+H). In non-saline soils, this is a measure of the effective cation exchange capacity (ECEC).
3. Rating of potential N release from the soil organic matter (1 = low, 4 = high). N recommendations are adjusted according to this rating.
4. Potential N volatilization.
5. Maximum permissible.

LIME AND NUTRIENT RECOMMENDATIONS

Crop	Lime t/ha	Lime Type	N kg/ha	P kg/ha	K kg/ha
Plant	1.5	Dolomitic	80	20	100
Ratoon 1	0.0		120	0	135
Ratoon 2	0.0		120	25	135

POSSIBLE FERTILISER OPTIONS

		Fertiliser	Furrow (kg/ha)	Topdress (kg/ha)
Plant		2-3-4 (30)	200	
	+	1-0-1 (48)		300
	or	MAP(33)	100	
	+	Urea		150
	+	Pot.Chloride		200
Ratoon 1		1-0-1 (48)		500
	or	Urea		250
	+	Pot.Chloride		250
Ratoon 2		5-1-5 (45)		600
	or	MAP(33)		100
	+	Urea		250
	+	Pot.Chloride		250

N.B. The above fertiliser options are approximations based on commonly used products.

Agronomic Comments:

* Lime should be incorporated into the soil 3 to 6 weeks before planting.
* If lime is not incorporated into the soil, urea or urea-based blends should not be used.

FERTILISER ADVISORY SERVICE - SOIL ANALYSIS REPORT

SA Sugarcane Research Institute

Tel: 031 508 7474 / 75 Fax: 031 508 7593 Email: fertiliser.advisory@sugar.org.za

Date Received : 24/07/2014 FAS Lab ID : G S 54657 Report Date : 18/08/2014

CLIENT DETAILS

Grower No. 234221 A
FAS No. 9578

Zandile F Ngogoma
Lower Emona Co op
P O Box 5
Maidstone

Email : keveshen.govender@tongaat.com
Extension Area: North Coast

BILLING DETAILS

Order No:

ADVISOR DETAILS

SYDNEY PILLAY
sydney@profertkzn.co.za

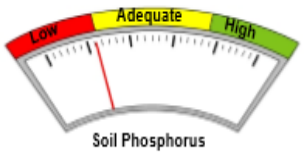
CROP AND FIELD DETAILS

Sample ID or Field Number	1
GPS Coordinates	
Sample Depth	0 to 20 cm
Crop	Plant Cycle
Variety	N31
Is Cane Trashed ?	No
Is Cane Irrigated ?	No
Green Manure Crop Type	None
Green Manure Crop Yield	N/A
Attainable Yield at Harvest	65 tons cane/ha

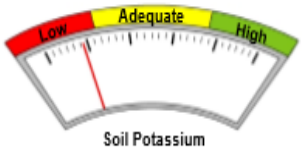
Analysis	Unit	Sample Value	Threshold	Result in kg/ha	Comment
pH (in calcium chloride)		4.09			
Phosphorus (P) (Truog) [1]	mg/L	14.8	15.3	30	Low
Potassium (K)	mg/L	92	125	184	Low
Calcium (Ca)	mg/L	316	300	632	Adequate
Magnesium (Mg)	mg/L	165	50	331	Adequate
Sodium (Na)	mg/L	38			
Exchangeable Acidity (Al+H)	cmol/L	1.32			
Total Cations [2]	cmol/L	4.67			
Acid Saturation	%	28.3	20.0 [6]		Limiting
Exchangeable Sodium % (ESP)	%	3.6	7.0		Not limiting
Ca/Mg (Equivalence ratio)		1.2			Not limiting
Zinc (Zn)	mg/L	5.2	1.5		Adequate
Copper (Cu)	mg/L	2.1	0.8		Adequate
Manganese (Mn)	mg/L	11.7	2.0		Adequate
Iron (Fe)	mg/L	587	3		High
Clay Estimate	%	23			
Organic Matter Estimate	%	2.8			
Nitrogen (N) Category [3]	cat	2			
N Volatilization [4]	%	0.3	10.0 [6]		
Volume Weight	g/mL	1.18			

Note: *Thresholds, Comments and Key Indicators are sample specific and based on the attainable yield indicated on the submission form.*

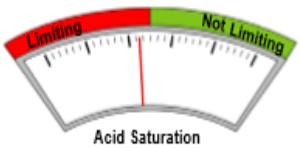
KEY INDICATORS



Soil Phosphorus



Soil Potassium



Acid Saturation