FACTORS AFFECTING TECHNICAL EFFICIENCY OF SMALL-SCALE RAISIN PRODUCERS IN EKSTEENSKUIL

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MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

In the

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DECLARATION

I Phofolo Marvin Emmanuel Khaile hereby declare that this dissertation submitted by me for the degree of Master of Science (M.Sc. Agric) Agricultural Economics, at the University of the Free State, is my own independent work and has not previously been submitted by me to any other university. I furthermore cede copyright of the dissertation in favour of the University of the Free State.

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Phofolo Marvin Emmanuel Khaile
Bloemfontein
January 2012

DEDICATION

This work is dedicated to my mother Nomsa Khaile, for the support, motivation and inspiration to persist and remain positive throughout my studies. To my late father Tau Khaile, the legacy you left behind has inspired me and deep in my heart I know you would be proud of my achievements.

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ABSTRACT

Growing per capita income and changing consumption patterns have led commercial retailers to restructure their marketing techniques with the aim of obtaining a greater market share of the consumer's pocket. Retailers have focussed more on bulk procurement and consistent supply of quality produce from a few large food producers. Consequently, small-scale farmers are either excluded from the commercial markets or the few that participate in commercial markets are struggling to meet the stringent requirements from retailers. However, some scholars advise that support is needed for small-scale farmers to participate in commercial markets. FairTrade (FT) is one of the organisations that have provided an opportunity to small-scale farmers in developing countries to participate in commercial markets. Eksteenskuil raisin producers are among the farmers that have been given the opportunity to participate in commercial markets. Despite the support, Eksteenskuil raisin producers are unable to meet market requirements such as stipulated raisin volumes of adequate quality. Hence, this study estimated the level of technical efficiencies and assessed factors affecting efficiencies of Eksteenskuil raisin producers.

The farming operation of Eksteenskuil raisin farmers is divided into two production levels, production and quality. Consequently, a Two-stage Data Envelopment Analysis (DEA) Model was used to understand the level of technical efficiencies in each production level. Due to a small sample size and a large number of independent variables used, degrees of freedom were identified as a problem. A Tobit Principal Component Regression (PCR) was used to reduce the dimensionality of the variables without losing important variables that explain inefficiencies. Primary data was used to obtain technical efficiency estimates and factors hypothesised to influence efficiency. Primary data was obtained through a structured questionnaire and personal interviews. A sample of 28 raisin producers in Eksteenskuil was used. A similar sample of 28 large-scale farmers was also conducted to be used for benchmarking with small-scale farmers.

The empirical results revealed that production efficiencies of small-scale farmers are relatively high although farmers are struggling to increase raisin volumes. When small-scale farmers are benchmarked against each other the mean production efficiency of 81% was estimated. This means that on average small-scale farmers have the potential to operate on the efficient frontier if the mean production efficiency increases by 19 percentage points. On the other hand, the results of a benchmark of both small-scale and large-scale farmers revealed a mean production efficient of 69% and 85% respectively. This implies that small-scale farmers are less efficient relative to large-scale farmers in producing maximum possible raisin volumes with available inputs. Variables that were identified to increase the level of production efficiency are: farmer's age, formal education, farming experience, land tenure, formal credit, record keeping, timely pruning, entrepreneur index, and Middle Island (soil fertility). Thus farmers who are located on the efficient frontier display a number of the variables mentioned above in their characteristics. On the other hand family labour, social capital and area harvested were also hypothesised to either increase or decrease the level of production efficiency. Hence, a positive or negative sign was expected.

Results on the second stage of the two-stage DEA model revealed a mean quality efficiency of 97% for small-scale farmers when benchmarked against each other. The results indicate that small-scale farmers have the potential to increase their mean efficiency by three percentage points to operate on the quality efficient frontier when benchmarked against each other. A benchmark of both small-scale and large-scale raisin producers revealed a mean quality efficiency of 79% and 88% respectively. The scope of variations between the quality efficiency scores of small-scale farmers was recognised to be limited. Due to limited variations, none of the hypothesised variables were found to be significant. Policy implication highlighted from this study is that education and training should be prioritised by policy makers in the study area. Existing support from various stakeholders involved with small-scale farmers in Eksteenskuil should be intensified in order to prevent poverty from becoming an epidemic in the community.

Keywords: Technical efficiency; Production Efficiency; Quality Efficiency; DEA, Tobit PCR, Eksteenskuil; Small-scale farmers; Large-scale farmers; FT; Two-stage DEA; Benchmark.

OPSOMMING

‘n Groei in per kapita inkomste en verandering in verbruikerspatrone het tot gevolg gehad dat kommersiële vervaardigers bemarkingstegnieke moes verander sodat hulle ‘n groter markaandeel kon beding. Verkopers het hoofsaaklik op grootmaat-aankope en ‘n konstante voorraad kwaliteitprodukte vanaf ‘n paar groot voedselprodusente gekonsentreer. Dus word kleinskaalse boere of heeltemal uitgesluit uit die kommersiële mark, of die wat reeds deel is van die mark sukkel om aan die streng vereistes van kleinhandelaars te voldoen. Daar word egter voorgestel dat met meer ondersteuning kleinskaalse boere ‘n beter kans sal staan om suksesvol te wees in kommersiële markte. FairTrade (FT) is een van die organisasies wat kleinskaalse boere in derde wêreldlande ‘n kans gee om in kommersiële markte te kompeteer. Die rosyntjieboere van Eksteenskuil is van die kleinskaalse boere wat die geleentheid gekry het om in die kommersiële mark te kompeteer. Ten spyte van die ondersteuning wat hulle alreeds kry, kan die boere van Eksteenskuil egter nie aan die vereistes soos kwaliteit en hoeveeheid, van kommersiële markte voldoen nie. Die doel van hierdie studie is dus om die tegniese doeltreffendheid en die faktore wat doeltreffendheid van die Eksteenskuil rosyntjie-boer beïnvloed, te bestudeer.

Die boerdery op Eksteenskuil kan in twee produksievlakke verdeel word nl. produksie en kwaliteit. ‘n Two-stage Data Envelopment Analysis (DEA) model is gebruik om die vlak van tegniese doeltreffendheid van elke produksievlak te ontleed. As gevolg van ‘n klein steekproef en die groot aantal onafhanklike veranderlikes wat geïdentifiseer is, was die vryheidsgrade problematies. ‘n Tobit Principal Componenent Regression (PCR) is gebruik om die hoeveelheid veranderlikes te verminder sonder om die belangrike veranderlikes, wat die ondoeltreffendheid bepaal, te verloor. Primêre data is gebruik om die geskatte tegniese doeltreffendheid en die faktore wat die doeltreffendheid beïnvloed te bepaal. Hierdie data is deur gestruktureerde vraelyste en persoonlike onderhoude ingesamel. ‘n Steekproef is gebruik om die 28 kleinskaalse rosyntjie produsente in Eksteenskuil te kies. ‘n Soortgelyke steekproef van 28 kommersiële boere is geneem om ‘n vergelyking te trek met kleinskaalse boere.

Die empiriese resultate het getoon dat produksiedoeltreffendheid van kleinskaalse boere relatief hoog is, alhoewel die boere sukkel om die volume rosyntjies wat geproduseer word, te verhoog. Wanneer kleinskaalse boere met mekaar vergelyk word, was die berekende produksiedoeltreffendheid 81%. Dit beteken dat kleinskaalse boere die potensiaal het om doeltreffend te produseer, mits die berekende doeltreffendheid van produksie vermeerder met 19 persentasiepunte. Die resultate vir kleinskaalse en grootskaalse boere het egter getoon dat die berekende produksie doeltreffendheid tussen 69% en 85% was. Dit impliseer dat kleinskaalse boere nie doeltreffend genoeg is, in vergelyking met grootskaalse boere nie, as dit kom by die produksie van maksimum rosyntjies met die beskikbare insette.

Veranderlikes wat produksiedoeltreffendheid verhoog is: boer se ouderdom, formele onderrig, werksondervinding, eiendomsreg, kredietwaardigheid, rekordhouding, effektiewe besnoeiing, entrepreneurindeks, Middel Eiland (grondvrugbaarheid) en die area wat geoes word. Die boere dus wat op die optimale funksie produseer, toon meer van die veranderlikes wat hierbo gelys word. In teenstelling hiermee, is die hipotese ook gebruik dat familie-arbeid, gemeenskapsbetrokkenheid en die gebied wat verbou word, die vlak van produksiedoeltreffendheid kan verhoog of verlaag. Dus kon'n positiewe of negatiewe teken verwag word.

Die resultate in die tweede deel van die Two-stage DEA model wys 'n kwaliteitsdoeltreffendheid van 97% vir kleinskaalse boere. Die resultate dui aan dat kleinskaalse boere hulle berekende doetreffendheid met drie persentasiepunte moet kan verhoog om op die kwaliteitdoeltreffendheidsgrens te wees. Die beginpunt vir beide kleinskaalse en kommersiële rosyntjie produsente is 'n volhoubare kwaliteit doeltreffendheid tussen 79% en 88% onderskeidelik. Die variasie in kwaliteitsdoeltreffendheid van kleinskaalse boere was beperk. As gevolg van hierdie beperktheid was geen van die gehipotetiseerde veranderlikes in die regressie betekenisvol nie. Deur hierdie studie word dus afgelei dat formele onderrig 'n prioriteit moet wees by beleidformuleerders van hierdie spesifieke studiearea. Die volhoubare ondersteuning van die rolspelers wat betrokke is by die kleinskaalse boere in Eksteenskuil is ook belangrik omdat dit kan voorkom dat armoede problematies vir die gemeenskap word.

Sleutelwoorde: tegniese doeltreffendheid, produksiedoeltreffendheid, doeltreffendheid, volhoubare kwaliteit, kleinskaalse boere, grootskaalse boere, FT, Two-stage DEA, maatstaf.

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LIST OF ACRONYMS

Agric BEE	Agriculture Black Economic Empowerment
FT	Fairtrade
EFA	Eksteenskuil Farmers Association
EAC	Eksteenskuil Agriculture Cooperative
SCI	Social Capital Index
FLO	FairTrade Labelling Organisation
SFA	Stochastic Frontier Analysis
DEA	Data Envelopment Analysis
SAD	South Africa Dried fruits company
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
PCR	Principal Component Regression
NCSS	Number Cruncher Statistical System
DMU	Decision Making Unit
2LT	Two Limit Tobit
PW	Papke-Woolridge
MLE	Maximum Likelihood Estimate
ARC	Agriculture Research Council
OR	Orange River sultanas
CI	Conditional Index
VIF	Variance Inflation Factor
TOL	Tolerance
DOF	Degrees of Freedom
PC	Principal Components
N	Nitrogen

P	Phosphorus
K	Potassium
TRANCAA	Transformation of certain Coloured Rural Areas Act
MBL	Major Baseball League

CHAPTER **1**

INTRODUCTION

1.1 BACKGROUND AND MOTIVATION

The dynamics of food production has evolved during the 20th century and production growth also accelerated. However, consumption patterns over the past two decades has changed more rapidly than production growth in both developed and developing countries (Temu and Temu, 2006; Gaiha and Thapa, 2007; Birthal *et al*., 2005). Among other changes, consumer preferences, growing per capita income, rising formal sector employment opportunities for women, urbanisation and globalisation (such as adoption of western cultures) are amongst the most notable sources of ongoing changes (Van der Meer, 2006). Consequently, marketing techniques have had to restructure in order to keep up with changing consumer preferences. Most of the marketing techniques have taken place at food retail outlets such as supermarkets, grocery or family stores and/or food wholesalers. The procurement strategies of food retailers have favoured large food producers that are able to provide bulk quality goods consistently. The food retailers have grown rapidly to be the most important family food outlets. Their rapid growth has brought widespread concern among development scholars. Scholars have suggested that small-scale farmers are excluded from retailers marketing chains in developing and developed markets.

The concern has been supported by extensive literature in recent years, particularly by Van der Meer (2006), Gaiha and Thapa (2007) and Reardon and Berdeguè (2002). Mixed results have been identified to the exclusion of small-scale farmers in commercial markets. A delayed payment by retailers is identified as a factor that results to farmers being unable to maintain their participation in modern global markets (Rondot *et al*., 2004; Van der Meer, 2006; Brown, 2005). On the other hand, Van der Meer (2006) identifies market failures and policy failure as culprits that place small-scale farmers in a disadvantageous position for sustainable participation. Gaiha and Thapa (2007) analysed the difficulties of smallholders in supplying high value agricultural commodities to supermarkets in selected Asian countries. The authors argue that either the quality or other requirements (e.g. timely delivery of volume and traceability) are too stringent for poor small-scale producers; or small food producers simply lack access to extension, modern inputs and credit (Gaiha and Thapa, 2007). Reardon and Berdeguè (2002) have researched the rapid rise of supermarkets in Latin American countries (i.e. Argentina, Brazil, Chile, Costa Rica, and Mexico). They recognised that procurement practices of Latin American supermarkets and large food processors have a big impact on farmers in the region. Such practices include agreed volumes, packing and packaging, consistency in timely delivery, delayed payment practices, quality and safety standards (Reardon and Berdeguè, 2002). Lu (2006), Moustier *et al*. (2007) and Ruben *et al*. (2007) suggests that such requirements hinder small-scale farmer success towards sustainable participation in mainstream markets. Van der Meer (2006) asserts that without support from retailers or other stakeholders, small-scale farmers are likely to be excluded from participating in mainstream commercial markets.

Fairtrade (FT) organisation has gained increasing interest as a revolutionary certification and labelling initiative, which allows small-scale farmers to participate in global food chains while addressing social and environmental problems worsened by modern global markets (Taylor *et al*., 2005). The organisation has appeared to be a new platform for defining market access and participation in commercial markets by small-scale farmers. Further, FT implements a cluster of trade initiatives that intend to assist small-scale producers in underdeveloped countries and promote sustainability. At the same time FT provides direct support and training to farmers through their legally registered cooperative organisation. According to Béji-Bécheur *et al*. (2008), the FT organisation is a campaigner of stable growth by offering improved trading structures to marginalised producers in developing economies. However, FT requires farmers to meet certain requirements which include environmentally sound farming practices, and stipulated volumes of high quality produce. Some of the requirements are similar to procurement requirements used by food retailers and supermarkets. Even with such requirements, FT continues to grow and operate as a trade platform for small-scale farmers. The growth of FT has had a positive impact on various small farming businesses in developing countries.

Through FT, Eksteenskuil farmers in South Africa are exposed to global markets of the commercial value chain. Eksteenskuil farmers are organised as a co-operative which is called Eksteenskuil Agriculture Co-operative (EAC). It is through the co-operative that the EAC members are the sole provider of raisins to the FT market (Kok, 2009). Thus, FT has become a niche market which allows Eksteenskuil farmers to be the highest paid raisin producers in the world and to be exposed to formal markets (Koch, 2009). Eksteenskuil farmers are currently experiencing the common challenges that small-scale farmers experience; which is low volumes of insufficient quality. The challenge came up as a result of high demand for raisins and farmers being unable to supply required volumes of quality raisins. Therefore, there is a concern that the inability of Eksteenskuil raisin producers to supply the requirements of their niche market may prompt FT to procure from competing raisin suppliers of other nations (i.e. Chile or India). The competition is likely to increase and market share will likely be reduced for Eksteenskuil raisin producers. For EAC members to maintain their market share, raisin volumes along with quality need to increase. Thus, questions are raised on the level of efficiency with which Eksteenskuil small-scale farmers produce their raisins.

The technical efficiency of small-scale farmers is an important area of both research and development of small-scale farmers to operate sustainably in commercial value chains (Mushunje *et al*., 2003). The study of technical efficiency would place attention on the possibility of improving farmer efficiencies without absorbing additional inputs. Failure to improve efficiency will have cumulative consequences for small-scale farmers such as increasing poverty levels and the loss of market position and income. Wollni (2007) argues that inefficiency in agriculture results in failure to take advantage of profits at both farm level and market level. On the other hand, increases in efficiency can be understood to improve farmers' competitiveness and could assist them, confront and deal with the difficult economic conditions caused by the market requirements and uncertainties. Some scholars even emphasise that agricultural productivity has decreased in the last few years due to declining efficiencies. On the other hand, Croppenstedt (2005), Binam *et al*. (2003) and Obwona (2006) highlight that shortfalls in efficiency imply that yield can be improved without involving extra conventional resources and without adopting new technologies. Further, increase in technical efficiency is expected to assist Eksteenskuil farmers to defend their economic status from competitors. Despite threat from competitors, the challenge to Eksteenskuil farmers is also to remain in the preferred supplier list of the purchaser by means of achieving stipulated market requirements by increasing volumes and quality.

1.2 PROBLEM STATEMENT

The major problem facing small-scale farmers in Eksteenskuil is their inability to meet the required volume of quality raisins which in turn threatens their position as sole suppliers of FT raisin in the world. Generally, a lack of understanding pertaining to the factors that hinder the performance of small-scale farmers to achieve both volume and quality exist. Thus, managers and decision makers may provide inappropriate solutions to upholding small-scale farmers in commercial markets such as that of FT.

Various studies have analysed the technical efficiency of agriculture at production level in developing countries. Technical efficiency of production has been approached and analysed in various means by scholars. Amongst several researchers, Ajibefun (2002) applied a stochastic frontier methodology to analyse the determinants of technical efficiency of small-scale farmers in Nigeria. A Maximum Likelihood Estimates was used to estimate the parameters that were likely to influence the level technical efficiency of production. Haji (2006) also estimated the production efficiency of smallholders vegetable dominated mixed farming system in Ethiopia. Technical, allocative and economic efficiencies were estimated by a non-parametric Data Envelopment Analysis (DEA) model and a Tobit model was also fitted to estimate the determinants of technical efficiency. A non-parametric DEA was used by D'Haese *et al*. (2001) to measure the relative efficiency of wool production on farms in the former Transkei. The one-way analysis of variance was adopted to test the determinants of technical efficiency of the farmers. Another production efficiency study was conducted by Mkhabela (2005) with a stochastic frontier production function using a Cobb-Douglas Model. The inefficiency model applied by the researcher was the maximum likelihood method to estimate the determinants of inefficiency. All of the above mentioned studies have only analysed technical efficiency at production level.

Limited research has dedicated interest to technical efficiency of agriculture at marketing level. The few researchers that have estimated marketing efficiency include studies done by Wollni (2007) and Lu (2006). Wollni (2007) measured the productive efficiency of speciality and conventional coffee farmers in Costa Rica. The researcher discovered that the Probit Model highlighted that the probability of participation in speciality markets is influenced by various factors. Lu (2006) applied a two stage non-parametric model to highlight that technical inefficiency could exist at either production or marketing level or both. The adoption of a Tobit Regression Model provided an insight into the factors affecting the production and marketing of vegetable producers' within the vegetable chain marketing channels. Lu (2006) highlighted high transaction costs to be a major factor that affect the technical efficiency of the vegetable marketing chain. Quality of produce is often mentioned in studies but efficiency analysis rarely considers the quality aspects.

1.3 RESEARCH OBJECTIVES

The main objective of this study is to examine the factors affecting technical efficiency of raisin production and quality of produce of Eksteenskuil farmers in the Northern Cape Province of South Africa.

The overall objective will be met by meeting the following specific sub-objectives:

a) The first sub-objective is to quantify the technical efficiencies of small-scale farmers at which inputs are converted to volume of raisins. The quantified technical efficiencies will also be compared to the efficiencies of large-scale raisin producers using a dataset compiled by Jordaan and Grové (2010). Such a comparison will highlight the efficiency gap between small-scale producers and large-scale producers.

b) The second sub-objective is to identify factors that affect the technical efficiency of production of small-scale farmers. A Tobit Principal Component Regression is used with primary data gathered with a structured questionnaire to identify the factors.

c) The procedures employed with sub-objectives one and two are repeated to compare the technical efficiency with which quality output is produced and to identify factors affecting quality of raisin production.

1.4 CHAPTER OUTLINE

The remainder of the thesis is organised into four chapters. Chapter two will address the review of relevant literature on technical efficiencies of farmers which will cover theory, definition, measurement and determinants of efficiency. Chapter three provides an overview of the study area, farmer characteristics, questionnaire design and the methodological framework used in this study. The main objective of Chapter four is to provide the discussion of results. The summary and conclusions made by applying the models and procedures in this study are given in Chapter five. Recommendations for small-scale farm managers, policy implications and further research are also provided in Chapter five.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Chapter two provides a review of relevant literature concerning the technical efficiency of small-scale farmers. In doing so, technical efficiency is defined as a concept that is concerned with a relationship between input and output resources. Further, the relevance of technical efficiency in agriculture is highlighted. The relevance of technical efficiency is discussed from a production and marketing point of view.

Whilst stressing the importance of technical efficiency, measurement techniques are discussed. The discussion of technical efficiency measurement involves three techniques: the Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA) and the Two-stage Data Envelopment Analysis (two-stage DEA). Once measurement techniques are examined, factors affecting technical efficiency of small-scale farming are discussed. Technical efficiency factors provide in-depth understanding of challenges small-scale farmers face. Further, the differences in levels of productivity among farmers are explained by factors affecting their technical efficiency.

The techniques used to estimate factors affecting technical efficiency are discussed. This involves the discussion of the Tobit model and briefly the Ordinary Least Squares (OLS) model. The choice of model applied in this study is motivated by arguments supported by literature and the objectives of the study.

2.2 TECHNICAL EFFICIENCY

2.2.1 PRODUCTION EFFICIENCY

Efficiency has featured in economic debates since the efforts of Koopmans (1951), Debreu (1951), and Farrell (1957). Koopmans (1951) was the first to define efficiency with the analysis of production as an efficient combination of activities. Debreu (1951) added on Koopmans' (1951) work by introducing the first measure of technical efficiency with his paper on coefficient of utilisation. Subsequently, Farrell (1957) made the concept of efficiency famous with his article of the measurement of productive efficiency. It was Farrell's article that made an effort to justify that labour is not the only input that should be used to measure efficiency and this provided a framework for further contributions. Later on, other scholars such as Banker *et al*. (1984), Briec (1997), Halme *et al*. (1999), Kalirajan and Shand (1999), Lovell (1993) and Seiford (1996) improved earlier contributions. Färe *et al*. (1994) notes that the key background to understanding efficiency of production is by considering that the planet has limited resources and decisions must be made regarding the use of those limited resources. Thus, the technical application of scarce resources is critical for the survival of any business. In addressing technical efficiency it should be emphasised that technical efficiency evaluation is impossible if inputs (whether tangible or intangible) are not taken into account.

Technical efficiency is concerned with the relation between resource inputs (in the form of labour, capital or equipment) and outputs (yield, revenue etc) (Palmer and Torgerson, 1999). In essence, technical efficiency is very useful in evaluating value chain performance or multiple production processes (Zhu, 2003 and Zhu, 2002). Aramyan *et al*. (2006) highlight that technical efficiency aims to maximise value added produce in agric-food production chains while minimising the cost absorbed along the production process. Most scholars (i.e. Ogunyinka and Ajibefun, 2004; Den *et al*., 2007; Idiong, 2007; Ojo, 2003; Ngqangweni *et al*., 2001; Hau and von Oppen, 2004; Fan, 1999) regard technical efficiency as a recommendation to improve performance in the agriculture food markets and economic growth. The assessment of technical efficiency can have an output expanding orientation or an input preserving orientation.

The output-orientation is mostly concerned with the maximisation of outputs. Output technical efficiency is a measure of the potential output of a decision making unit (DMU) given that inputs are held constant (Walden and Kirkley, 2000; Den *et al*., 2007; Palmer and Torgerson, 1999 and Nikaido, 2004). This means that with available input resources a farmer should be able to integrate the inputs to achieve maximum yield. If a DMU is below the frontier line in an output-oriented model, it means that it is possible to increase all outputs while using the same level of inputs. A best practice frontier plots out the maximum level of output that could be produced for any given level of input.

An input-oriented technical efficiency model examines the inputs used in the production of any output, and measures whether a DMU is using the minimum inputs necessary to produce a given bundle of outputs (Walden and Kirkley, 2000; Farrell, 1957 and Nikaido, 2004). A DMU is technically inefficient compared to another DMU because much more input is used to produce the same level of output. Input-oriented technical efficiency concentrates on the subject of exploiting available resources at given output.

2.2.2 MARKETING EFFICIENCY

During the last two decades, the world has witnessed a rapid change in consumer preferences and global markets. Growing consumer demand for quality, healthy products, social values, traceability and variety has placed pressure on food producers to adjust their production practices in order to satisfy market requirements. Van der Meer (2006) indicates that the rapidly increasing requirements for food safety and quantities of consistent quality contribute much to the rapid changes of global supply markets. Although the pace and depth of market changes has had mixed results from region to region, the changes in markets has affected both large-scale and small-scale food producers (Fafchamps, Gabre-Madhin and Minten, 2004). The greatest fear is that small-scale farmers are unable to compete efficiently in modern markets with large-scale farmers. Thus, farmers need to consider their farming and marketing practices with the objective to improve their efficiency levels if they want to continue participating in global markets. To address market inefficiencies that small-scale farmers face, the current efficiency levels with which marketing operations are applied need to be examined. However, literature that has addressed market inefficiencies has not succeeded to incorporate the quality aspect. The lack of knowledge in this regard hinders the understanding of market inefficiencies at which the quality crop is produced.

In spite of limited literature, Lu (2006) employed a two-stage model to assess the impact of different transaction costs on marketing chain efficiencies. The first stage determined the technical efficiency of production while the second stage uses the outputs, which are produced as intermediate inputs in the second stage, to quantify the marketing efficiency of producers. The impact of transaction costs was identified to have a great impact on marketing channels used by farmers. The study applied by Lu provided an opportunity for producers to seek out the efficient stage by improving their yields or their revenue. In addition, the analysis also provided knowledge for managers and policy makers to create effective remedies by means of improving weak connections throughout the marketing chain (Lu, 2006). Thus, analysing different subdivisions of production assists in formulating strategies to improve the overall efficiency of the organisation.

The overall efficiency of an industry, however, relies on individual efficiencies of the decision makers that make up the sector. If inefficiencies are identified to exist amongst decision makers', average efficiency of the sector is reduced (Fafchamps, Gabre-Madhin and Minten, 2004). Thus, it is important to develop strategies to move inefficient decision makers from a less efficient level to the efficient frontier. The success of improving overall efficiency levels also depends on farmers undertaking efficient marketing activities, ending with a situation better than when confined to basic production (Abdou, 2007).

2.2.3 Conclusion

Farmers conduct both production and marketing activities on their farm to maximise their profits. The conclusion is that in order to identify specific areas of inefficiency, analyses of different stages are necessary. The literature has shown that the quality of produce is typically not incorporated into marketing efficiency analyses.

2.3 TECHNIQUES FOR MEASURING TECHNICAL EFFICIENCY

Literature provides various procedures for measuring technical efficiency in agriculture. The widely used measurement models which shall be discussed below are Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA) and the Two-Stage DEA Model also known as the Extended DEA. The discussion highlights the differences between the models and motivation for the model used in the study is mentioned.

2.3.1 STOCHASTIC FRONTIER ANALYSIS

The stochastic frontier production function was put forward by Aigner *et al*. (1977) and is one of the most popular models amongst researchers (Cooper *et al*., 2004; Haji, 2006 and Bera and Sharma, 1999). The SFA is a parametric model which adjusts the evaluations to the frontier estimates. The stochastic approach hypotheses the existence of technical inefficiencies of agricultural producers. The model assumes that any variations from the frontier is not only associated with inefficiency but statistical noise is also taken into account (Bravo-Ureta and Pinheiro, 1993). The model is admired for its ability to deal with stochastic noise and allows statistical tests of hypotheses pertaining to the structure and the degree of inefficiency (Coelli *et al*., 2005). To apply the model the functional form of the production function and distribution of the random errors must be specified.

However, critics question the suitability and appropriateness of the SFA. Bardhan *et al*. (1998) discovered two critical concerns with the stochastic approach which are (a) the inability to accommodate multiple variables which can be multiple outputs, and (b) the failure to identify sources of inefficiencies in farm multiple productive operations (Bardhan *et al*., 1998). In addition, the disadvantage of the SFA is that the functional form requires assumptions for technology and a small sample size could lead to biased results (Haji, 2006). Hence, SFA is sensitive to the parametric form selected.

2.3.2 DATA ENVELOPMENT ANALYSIS

The DEA model, initially offered by Charnes *et al*. (1978) based on work done by Farrell (1957), is a non-parametric model. The DEA is a method based on the linear programming algorithm designed to identify appropriate weights for each variable (Giannoccaro *et al*., 2008). The DEA model does not require the specification of a functional form prior to estimation. DEA places emphasis on the efficiency of the individual economic unit (Giannoccaro *et al*., 2008 and D'Haese *et al*., 2001). Hence, the performance of a DMU is calculated relative to all other DMUs in the sample with one restriction that all DMUs be located on or beneath the efficient frontier. During the development of a DEA, it was recognised that there is a need to calculate the efficiency of complex business activities similar to bank branches, and government public services (Popović and Martić, 2005). Thus, the DEA model achieves the evaluations by computing various performance processes (inputs and outputs) in a single integrated model and also identifies a reference level (frontier) for which continuous improvement is weighed against.

The DEA model varies from regression approaches in three other ways: (a) it is in a deterministic form, (b) it is focussed on an individual observation at a time instead of averages over all observations and (c) it also has abilities to identify and estimate inefficiencies in each input and output for the specific DMU (Bardhan *et al*., 1998). On the other hand, the DEA is able to handle multiple inputs and outputs simultaneously which gives it an added advantage over the measurement models.

Because DEA is deterministic and directs all the variations from the frontiers to inefficiencies, it is likely to be sensitive to measurement errors or noises in the data (Haji, 2006). Additionally, the DEA handles each DMU as a black box by taking into consideration only the inputs employed and outputs created by each DMU (Sexton and Lewis, 2003). The black box approach is often preferable and adequate for overall efficiency of the DMU. Zhu (2003) describes with an example that the ordinary DEA black box approach fails to correctly identify areas that may show signs of inefficiencies. An approach of this nature gives no insight concerning the exact locations of inefficiency and as a result managers are unable to provide appropriate managerial remedies to assist DMU's to improve their organisational performance.

2.3.3 Two-Stage Data Envelopment Analysis

To overcome the black box approach problem, an extension of a DEA model is recommended. The extended DEA model is described by two inter-linking sub-DMUs, where each DMU is represented as two sub-DMUs connected in sequence. As shown in Figure 2.1, the sub-DMU-1 in stage one uses inputs to generate intermediate products. The intermediate products proceed as inputs into stage two of sub-DMU-2, which uses them to produce the DMUs outputs. The purpose of the two-stage DEA model is to estimate the relative efficiencies of each DMU and each of its sub-DMUs and also identify the locations of inefficiencies (Lu, 2006).

Figure 2.1: A two-stage DEA model

(Sexton and Lewis, 2003)

A two-stage model is practical when managers choose to focus on the sub-divisions of the operation as part of an economical or purely reactive strategy (Rouatt, 2003). An evaluation of farm operations with a two-stage DEA model provides the basis to understand farm operations as inter-connected components, and alerts managers with critical performance constraints through identifying the best practice operations (Zhu, 2003; Zhu, 2002).

Extensive application of the two-stage DEA in literature is associated with financial institutions (i.e. Popović and Martić, 2005; Rouatt, 2003) and sports economics (i.e. Sexton and Lewis, 2003; Lewis *et al*., 2007). Sexton and Lewis (2003) and Lewis *et al*. (2007) employed the two-stage DEA to identify inefficiencies in Major League Baseball (MBL). They confirmed that the two-stage model distinguishes inefficiency in the first stage from that of the second stage and allows team managers to target the inefficient stage of the team’s performance. The two-stage procedure has proven to be valuable for management, policy and processing problems, particularly in the service and economic sectors (Barr *et al*., 1999). Further, the two-stage technique provides researchers and managers the ability to appreciate a business in better depth by allowing a simultaneous evaluation on two components with various variables that influence organisational performance. Ultimately, managers and policymakers can employ the two-stage DEA as an informative technique to understand the activities of sectors and markets in the fast transforming global economy.

2.3.4 DISCUSSION AND CONCLUSION

SFA, DEA and two-stage DEA models are acknowledged as important in research related to efficiency for various reasons. The ability of the SFA to deal with stochastic noise continues to be the key strength in technical efficiency studies. The fact that the SFA is unable to accommodate multiple outputs is a concern. In addition, small sample size could result to unreliable results with the SFA. Thus, the SFA may be unsuitable in studies that may suffer from small sample sizes. Due to the disadvantages of the SFA, the DEA is often considered. The DEA is viewed to be effective in various complex organisations without specifying assumptions on the distribution of the error term. Literature has shown that the DEA model has been applied to many different industries, ranging from the financial sector to public institutions. Its wide ranging application highlights its flexibility to any industry.

The DEA is generally used to analyse overall efficiency, hence it does not allow for a distinction between inefficiencies at both production and marketing levels. Another major challenge with the DEA is that it is known to be sensitive to random errors because it does not account for noise in the data. An alternative to the black-box approach is the two-stage DEA. The two-stage DEA present an in-depth understanding of farm efficiency by breaking down the operational levels of the farm. Therefore, the two-stage model is able to identify areas that are likely to cause inefficiency in the overall organisation. It is concluded that the two-stage DEA is a suitable model in this study due to the complexity of the operation of raisin farming. Further, based on the objectives of the study the two-stage DEA appears more suitable to understanding the decision making process of a DMU at production and marketing levels.

2.4 FACTORS AFFECTING TECHNICAL EFFICIENCY

Once technical efficiencies are quantified using the suitable model for measuring technical efficiency, it is vital to understand the factors that cause some decision makers to be more technically efficient than others. In this section various inefficiency factors that are identified by literature will be discussed along with their effect on technical efficiency.

2.4.1 HUMAN CAPITAL

Among many factors, human capital factors such as age, education, farming experience and gender have always been at the centre of technical efficiency studies. The inclusion of human capital variables in technical efficiency studies highlights the importance of the variables in determining efficiencies of decision makers. Wollni (2007) found that farm experience has the potential to improve technical efficiency of coffee production, while an older farmer was found to be inefficient. In this instance experience may be associated with the knowledge of the crop and age may not necessary imply the know how in crop production. Ogunyinka and Ajibefun (2003) found education to be significant and showed signs to increase technical efficiency for Nigerian crop farmers. Begum *et al*. (2009) also concluded that the level of technical efficiency for commercial poultry producers may increase by improving management efficiency through training and education. Dolisca and Jolly (2008) found farmers ages, literacy among farmers and gender reduced the levels of technical efficiency of Haitian potato and bean farmers. Farmers (i.e. older) were most likely to be men and illiterate and therefore more likely to be inefficient. The gender variable highlighted that male farmers were found to be inefficient because of the argument that women are more likely to be members of a local group and therefore more knowledgeable than men in terms of credit procedures, pest management and new cultivation techniques. Conradie *et al*. (2006) acknowledge that farmer’s age and education variables were found to reduce technical efficiency. Such results are explained by the fact that old farmers who also had more years of education bought the vineyards as an attractive retirement lifestyle. Hence, they are less efficient in farming.

2.4.2 CREDIT, OFF-FARM INCOME AND LAND TENURE

Small-scale farmers are generally known to experience constraints in sourcing credit to meet day to day farming activities. Various studies have estimated the credit variable to be important in explaining farm technical inefficiencies. Binam *et al*. (2004) identified access to credit to be a major factor that affects the technical efficiency of farmers. The authors found that access to credit is likely to enhance the technical efficiency for decision makers as they would be able to buy inputs and pay labour timely. On the other hand, the off-farm activity variable is also suggested to explain farm efficiencies by scholars.

Haji (2006) evaluated technical, allocative and economic efficiencies on small-scale farmers' vegetable-dominated farming systems of Ethiopia with a Tobit regression. He discovered that off-farm income improves technical efficiency because of secondary effects it has on farm operations. Wollni (2007) also argues that off-farm activities improved technical efficiency because farmers were likely to have networks to access information and financial resources to overcome liquidity constraints and thus buy inputs on time. On the other hand, Speelman *et al*. (2007) identified that having a title deed is likely to improve technical efficiency efficient compared to those not having direct ownership of land. Land ownership carries secondary effects similar to credit access. The title deed could be used as security to source credit for farming activities and having a title deed provides comfort in doing long term investments on the land.

2.4.3 MEMBERSHIP OF ASSOCIATION AND EXTENSION SERVICES

Co-operative membership is generally expected to provide members with relevant information and also allow farmers to reduce their transaction costs through affordable access to inputs. Binam *et al*. (2004) identified membership to a farmer association to affect the technical efficiency level of farmers. The authors also noticed that non-members also benefitted. The argument was that sharing of information on farming practises at association level tends to filter to other non-association members (Binam *et al*., 2004). However, it can also be argued that improving the flow of information to a decision maker does not necessarily result in the decision maker acting on it. A financially constrained farmer may be familiar with improved cultivars, fertilisers and other necessary inputs but they are unable to access them. Hence, Dolisca and Jolly (2008) highlight that extension services have little influence on farmers' decision making because they address the problem of asymmetry of information without providing farmers the necessary resources such as finance. Ogunyinka and Ajibefun (2003) and Haji (2006) also found that extension visits did not increase technical efficiency with the reason similar to the one highlighted by Dolisca and Jolly (2008).

2.4.4 RECORD KEEPING AND MANAGERIAL SKILLS

Wollni (2007) found record keeping as having a positive influence on technical efficiency indicating that farmers that keep records are likely to be using historic information to plan ahead. Dolisca and Jolly (2008) also suggest that skills of the farmer may be the key factor in explaining farm technical efficiency. Lu (2006) also highlighted that managerial skills addresses knowledge gaps on producers market experiences and information with the aim of reducing technical inefficiencies. Management skills are observed through decisions made and planning ahead in the interest of the business. The importance of management skills is highlighted in literature because of the expectation that good management knowledge and acumen is likely to result in sound management decision being undertaken.

2.4.5 Productivity of Resources

Conradie *et al.* (2006) quantified technical efficiency of commercial farmers in South Africa. Results showed that the percentages of young vines which are non-bearing vines were found to increase inefficiency and this is so because inputs are used on vines that are still unproductive. However, a prospering farmer was regarded as reinvesting in the land and is likely to show signs of inefficiency at the moment but in future the farmer is likely to be more efficient.

Soil fertility is another variable that is acknowledged to affect the technical efficiency of production. Binam *et al*. (2004) and Wollni (2007) proved that the better the soil quality on which the farm is located the more likely the farmer will be technical efficient. The impact of soil quality on farm efficiencies is due to differences in agro-ecological environment (Wollni, 2007). The quality of the soil and the application of appropriate chemicals in the soil are important factors that are likely to provide positive spin-off on technical efficiency.

The impact of family labour on technical efficiency is understood through the economies of size (Wollni, 2007; Haji, 2006 and Speelman *et al*., 2007). Thus, technical inefficiency is realised when family labour is employed beyond optimal levels of production. That means with limited land, labour is sometimes employed beyond the size of what the land can accommodate, which decreases the productivity of labour. On the other hand, large farm area is likely to increase technical efficiency levels of decision makers compared to smaller farms as a result of economies of scale.

2.4.6 Conclusion

Studies have highlighted various factors that may hinder or improve technical efficiencies of decision makers. It is concluded that human capital, factors that influence access to credit directly or indirectly, information, managerial skills and the productivity of resources are important factors that could contribute towards explaining low efficiencies. On the other hand, human capital variables such as age and education should be treated with caution since a negative relationship between farming experience and age and education and therefore technical efficiency may exist if farmers took up farming at a later stage in their career. Thus, the hypothesized influence of age and education should be done with proper knowledge of the characteristics of the study sample. Cognisance should be taken of the variables discussed above to ensure that their measurements are included in the questionnaire.

2.5 IDENTIFYING FACTORS AFFECTING TECHNICAL EFFICIENCY

As it will be defined in Equation (4) the DEA score falls between the interval zero and one ($0<\theta^k<1$), making the dependent variable a bounded dependent variable. A bounded dependent variable is also described as censored. A suitable technique available to measure censored variables is the Tobit regression model. The Tobit model is often preferred due to the censored nature of the DEA distribution scores between zero and one. Researchers who have used a Tobit to identify factors affecting technical efficiency include Begum *et al*. (2009), Ogunyinka and Ajibefun (2004), Lu (2006), Masterson (2007), Bravo-Ureta *et al*. (2007), Fethi *et al.* (2002) and Vestergaard *et al*. (2002).

Begum *et al*. (2009) used a Tobit regression on poultry farms to explain some of the variations among farmers. Lu (2006) employed a Tobit model on a vegetable marketing chain to estimate the level on efficiencies among vegetable farmers. Lu (2006) suggests that the Tobit model offers a way, from transaction costs point of view, to improve technical efficiency at particular stage in the supply chains. Masterson (2007) adopts a Tobit to assess the relationship between farm size and productivity and emphasizing that the Tobit analysis applies maximum likelihood estimation to dependent variables that are censored. Ogunyinka and Ajibefun (2004) highlight that the Tobit analysis does not only give explanation to the value of the dependent variable, but also the size of the non-limit (i.e. value of technical inefficiency). Bravo-Ureta *et al*. (2007), Fethi *et al.* (2002) and Vestergaard *et al*. (2002) rationale for using Tobit is that DEA scores are bounded with an upper limit of one and the Tobit can account for the censoring of the dependent variable.

However, some researchers (i.e. Hoff, 2007) have suggested that the Tobit model is miss-specified. Hence, McDonald (2009) highlights the OLS to be a regression technique that can effectively substitute the Tobit as a model to explain inefficiency outcomes. The OLS is regarded as a correctly specified model because it is unbiased and consistent (McDonald, 2009). However, the disadvantage of the OLS is that with small sample size, the accuracy of inefficiency results could be doubted. Therefore, given the characteristics of the DEA sores used in this analysis the OLS technique is inappropriate from a methodological point of view.

Literature has shown that the Tobit model is the most appropriate to explain the technical inefficiencies associated with DEA efficiency score despite the fact that some scholars argued against the censorship of DEA scores. An added benefit of using the Tobit model is that it performs well with small sample sizes. The conclusion is that the Tobit model is an appropriate regression model for explaining the technical inefficiencies of farmers in this study.

2.6 IMPLICATIONS FOR THE RESEARCH

For Eksteenskuil, the importance of producing enough volumes of required quality is imperative when addressing today's market requirements. Therefore, the implications of this research will assist Eksteenskuil farmers to attend to potential challenges that hinder their successful participation in commercial markets. On the other hand, this study will provide better understanding of organisational performance and farmers seeking for the efficient stage are able to know which area of their farming operation is causing inefficiencies. The use of the two-stage DEA model has been widely recognised as one of the most effective ways for identifying the locations of organisational efficiency. For countries with small-scale farmers like South Africa, there is dire need to support farmers to continue producing food efficiently through improved primary production practices and value added activities to take advantage of better prices. Thus, this study intends to emphasise on the importance of production and marketing activities for Eksteenskuil farmers with the aim of maximising profits.

The quantification of efficiencies at different interlinking stages is predicted to provide more insight into the decision making process of each farmer. On the other hand, the decision maker will be able to improve his overall efficiency by paying attention to an area that demonstrates signs of low efficiencies. The implications for decision makers that work as a co-operative, is that each decision maker is able to recognise that individual efficiencies need to improve in order to increase overall efficiency of the co-operative. Individual efficiencies can improve once the factors are identified and farming activities adjust towards the improvement of overall efficiency levels. Moreover, factors that increase the levels of efficiency in each stage of the farming operation are easily identified when each stage is quantified independently.

Factors that literature recognise as having a positive impact on technical efficiency comprise of farming experience, formal education, access to credit, off-farm income, membership of association, record keeping, tenure security and soil quality. The impact of the above mentioned factors is understood to be significant in determining the overall functioning and performance of the farm. The quantification of factors that hinder the performance of small-scale raisin farmers is expected to reveal the inner workings of the farming operation. Thus, challenges that small-scale farmers experience in maximising volumes of adequate quality will be better understood by both managers and policy makers. However, factors that are recognised to move decision makers away from the efficient frontier should also be controlled by ensuring that they are minimised or eliminated where possible.

CHAPTER 3
DATA AND PROCEDURES

3.1 INTRODUCTION

The purpose of this chapter is to discuss the data that was used in the study and the procedure followed to address the main objective and sub-objectives of this study. The following section begins with the research area. Under the research area the history of Eksteenskuil is discussed with information obtained from Mr. Kok (Chairman of Eksteenskuil Agriculture Cooperative - 2009), the demographics and the current agricultural practices are also discussed. Discussion on collection of data begins with the process followed during the design of the questionnaire. Thereafter the sampling procedure and survey is discussed. Based on the information obtained with the questionnaire, the profile of respondents used in this study is discussed followed by data limitations.

The procedure section discusses the process followed to analyse the data to achieve the research objectives. The procedure section begins with the quantification of technical efficiency. Followed by the identification of factors that affect technical efficiency with emphasis on model specification, hypothesised variables and estimation problems. The principal component regression (PCR) is discussed with emphasis on the theory and application of the PCR technique.

3.2 RESEARCH AREA AND DATA

3.2.1 RESEARCH AREA

3.2.1.1 History of Eksteenskuil

The Eksteenskuil farming community is a previously disadvantaged community according to the South African land reform context. The community is found in Eksteenskuil, west of Keimoes in Northern Cape Province. The area was first inhabited by black farmers in the 1920s.The land was generally barren and not economically viable at the time. Because of no alternative source of income, the farmers at the time transformed the area into productive agricultural land. During the 1950s, as a result of government policies and support towards large scale commercial farming, white commercial farmers were settled. Thereafter mechanisation was adopted as the method of land cultivation. Before the settlement of commercial farmers, the area consisted of 200 farm plots. During the 1970s plots were consolidated to 147 plots but less than 147 commercial farmers farmed. Vineyards were established in the 1970s and at the same time people were migrating away from farming to urban areas.

In the late 1980s government initiated a transfer of land to the initial inhabitants of the land. Additionally a government policy (then known as the Transformation of Certain Coloured Rural Areas Act (TRANCAA)) was passed, with the primary objective to differentiate between waste land and remainder land. Some of the remainder land is currently occupied by farmers but with no title deeds, while some of the land is not occupied or utilised at all. In the advent of democracy, new government adopted new land related policies. During the beginning of the 21st century, the Minister of Agriculture approached independent consultants to determine how the remainder land should be disposed. The consultants reached the conclusion that the land be allocated to the community. Regardless of the consultants conclusion the land is still held by the legal trust of the Minister. Hence, the communities are unable to carry out long term investments on land and have no collateral to obtain financing to buy inputs timely and to finance daily farming activities.

Literature highlights that farmers operating in small-scale in terms of their land operations should work as a group to lower input and other farm related costs. Consequently, Eksteenskuil farmers realised their common challenges which led to the formation of Eksteenskuil Farmers Association (EFA). On the other hand, in 2005 Eksteenskuil farmers were introduced to Fair Trade (FT) which has allowed farmers to take home better incomes and to improve their standard of living with the social premium that FT provides. Since EFA was registered as a non-profit organisation, obtaining finance under EFA was impossible and the association was replaced by Eksteenskuil Agriculture Co-operative (EAC), as a registered legal entity in December 2006. Furthermore, FT was also the driving force for the formation of EAC which is tasked to direct benefits to members.

3.2.1.2 Geographical setting of the Eksteenskuil region

The Eksteenskuil region is situated in the Northern Cape Province of South Africa. The region is located in the north western part of the province (see Figure 3.1). Generally the province is arid and experiences little rainfall which is measured below 200 millimetres (mm) per annum (Weather SA, 2009). The nearest town servicing Eksteenskuil farmers is Keimoes which is approximately 10 kilometres away, while Upington is the largest metropolis found 53 kilometres North of Eksteenskuil (SA Explorer, 2009). Since Eksteenskuil is located close to Upington, the weather station reports a similar weather for both areas. Hence, the region experiences temperatures varying between 30^0C and 40^0C. Winter temperatures also vary with day temperatures peaking at 25^0C, while night temperatures average between 4^0C and 10^0C (Weather SA, 2009). Further, the region is in close proximity to the Kalahari Desert and humidity is extremely low but in summer humidity can vary. Summer humidity varies due to the region being located along the banks of the Orange River (SA Explorer, 2009).

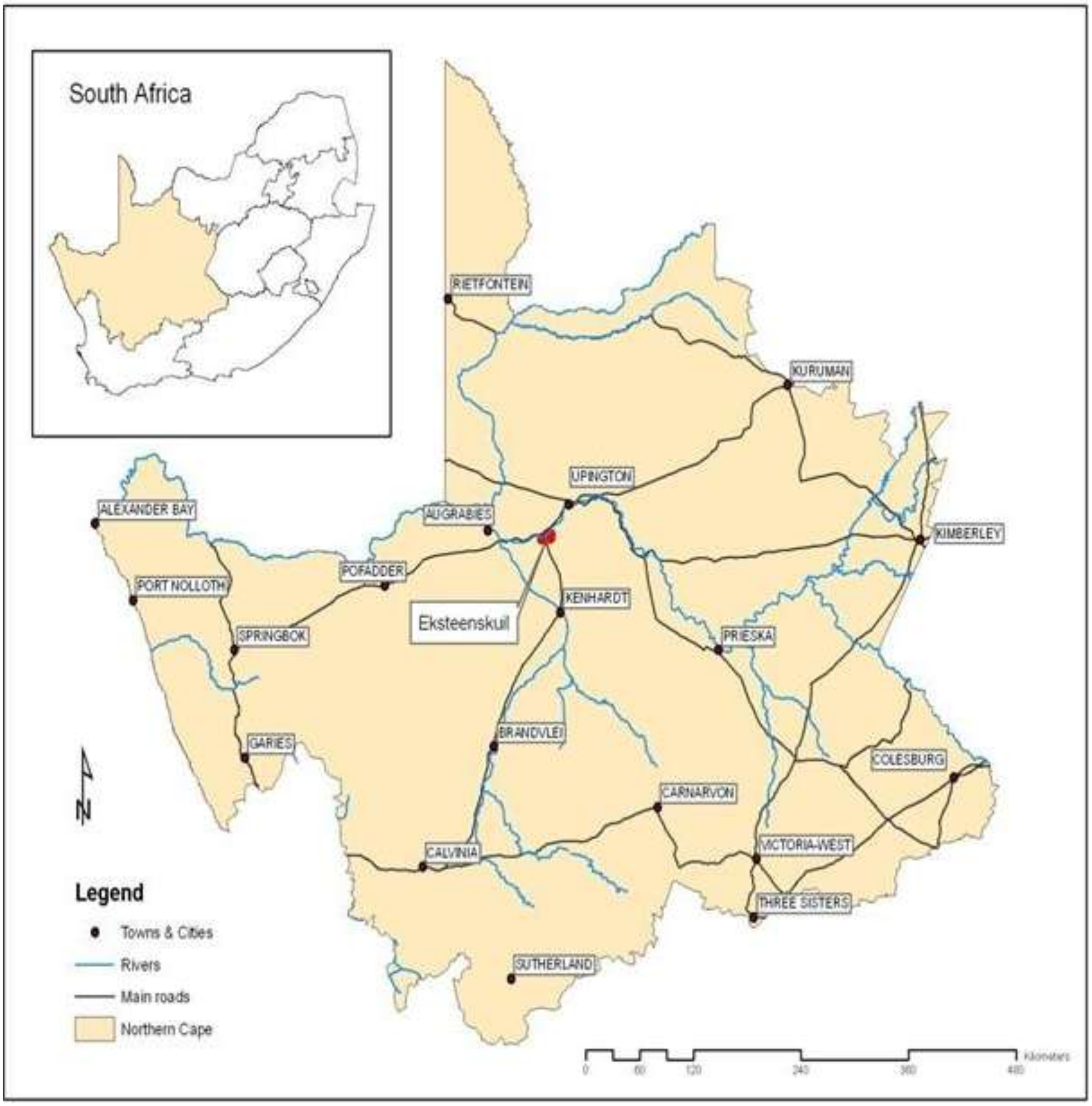

Figure 3.1: Eksteenskuil in Northern Cape Province

The economy of the region depends very much on farming with viticulture crops. Current agriculture practices of EAC farmers comprises of: (i) livestock for family consumption and manure, (ii) lucerne is produced as feed for domestic livestock and some is sold to the nearby feedlot and (iii) grape production is for raisins, wine, juice and table grape production. The niche markets the farmers currently utilise has provided the Eksteenskuil farmers with valuable social premium for community development. The FT market has given the Eksteenskuil community an opportunity to increase their production capacity through the expansion of farming operations. The infrastructure is poor and as such there is no road linking North Island directly to the South Island (not shown in Figure 3.1). Middle Island does not serve as a bridge to the adjacent Islands. Travelling is challenging because farmers have to travel around to get to each island. Currently, the total farm land of Eksteenskuil consists of approximately 2,000 hectares (ha) on three main islands and only 600 ha is arable land.

3.2.1.3 Current Agricultural Practices

The previous section provided a departure point into understanding the current set-up with emphasis on current raisin production practices and marketing as sources of income and livelihood development. The next section describes the current practices and technologies that farmers employ in their raisin production and marketing practices.

3.2.1.3.1 Production practices

Raisin farmers in the Eksteenskuil region employ numerous inputs to produce raisins. However, raisins are not the initial crop that is being produced but grapes. Since grapes are a perennial crop, preparations on vineyards immediately after harvest are necessary to ensure a good yield and quality crop. The need to technically employ various inputs to achieve greater volumes of good quality raisins requires greater effort and commitment from farmers. To ensure good quality grapes farmers perform certain activities such as leaf management and timely pruning to mention a few. Inputs are obtained from farming outlets in the nearby town by the co-operative. The inputs bought by the co-operative are sold to the members at affordable prices. Alternatively, Eksteenskuil farmers can buy inputs directly from input suppliers in town. As required by FT the co-operative accounts for the safe storage of chemicals used by its members. The use of sophisticated farming technologies is not popular among EAC raisin producers. Flood irrigation is the main technology employed to irrigate crops such as lucerne and vineyards.

The success of Eksteenskuil raisin producers is associated with support they receive from various stakeholders for their production activities. Such support is provided by South African dried fruit company (SAD), EAC, FT and Agriculture Research Council (ARC) at the production level. In brief, SAD and ARC provide information and advice on vine management while EAC and FT outsource consultants to provide training and skills development. In spite of the support, the farmers still need to abide by certain regulations such as labour laws, water act and other international trade agreements and standards. Further, Fair Trade Labelling Organisation (FLO) certifies farmers and their co-operative for compliance. The way the farmers conduct their business is very much determined by regulations, resources provided by stakeholders and what the market requires. In general, a combination of the support and regulations defines the set-up of the production practice of Eksteenskuil farmers.

3.2.1.3.2 Marketing practice

After grapes are harvested decisions need to be made with regard to the proportion of grapes to be dried into raisins and how much will be sold as fresh grapes to the wine cellar. Commonly almost all grapes are dried into three raisin varieties namely: Thompsons, Golden's and Orange River sultanas (OR). All three types of raisins are produced from Sultana cultivar. Most EAC raisin farmers' sun-dry their grapes to produce Thompsons and Golden raisin variety. Currently none of the raisin producers produce ORs. The decision to produce the Golden raisin variety is usually based on market demand. Consequently, after the grapes have been dried into raisins they are delivered to the processor which grades and buys the raisins from the farmers. Raisins of each raisin variety are graded into three grades namely choice, standard and industrial grades. Grading of raisins is based on the sugar content of the raisins. The premium grade is choice grade due to its high sugar contents and receives a higher price compared to the other grades.

EAC members use one marketing channel in terms of processing, packaging, exporting and traceability. The farmers outsource SAD's resources to fulfil FT market requirements. In essence, SAD has developed to be a strategic partner with EAC, although there is no formal agreement in place. SAD and FT also provide technical assistance towards producing good quality raisins based on market requirements. The institutional arrangement of marketing for EAC is quite sophisticated in the sense that only FT certified raisin producers have exclusive participation to FT market. Hence, a small-scale farmer in Eksteenskuil has an opportunity to participate in the FT market through the EAC membership. The EAC membership allows collective production that assists the farmer to supply a bulk produce to the FT market.

3.2.2 QUESTIONNAIRE DESIGN

A comprehensive approach was employed throughout the development of the questionnaire. Personal meetings were conducted and stakeholder opinion and suggestions were taken into account. A literature review was conducted from different schools of thought. However the focus was eventually scaled down to technical efficiency of production and quality. Literature, in essence, provided a background understanding of management practices concerning raisin production and quality. Groundwork began with one on one discussion with the chairman of the Eksteenskuil Agriculture Cooperative. During the discussions the chairman described the history and current setting of Eksteenskuil farmers which has been earlier discussed in this chapter. Further, the chairman explained the value chain of raisins with respect to EAC and he also identified different stakeholders involved in the EAC raisin value chain. For the duration of the discussion, issues and problems that hinder the smooth functioning of the EAC were identified. However, discussions were not limited to the chairman.

The provincial Department of Agriculture allocated an extension officer to the Eksteenskuil farmers to provide necessary public services. At the time when the questionnaires were completed the extension officer had retired, but discussions with him were undertaken to obtain background information about the previous support and operation of Eksteenskuil farmers. Although retired, the former extension officer now operates as a commercial farmer and that allowed discussions to also focus on regional farm concerns, farming techniques, and technology related to the raisin farming from both a former government employee and a commercial farmer perspective. In addition, discussions with other commercial farmers' in the region provided broader issues that concern the raisin industry.

Further on, discussions were conducted with SAD representatives. Detailed information about the raisin industry and the role of SAD in Eksteenskuil was obtained. Moreover, traceability of Eksteenskuil raisins at the SAD factory was witnessed during the walk around. Thereafter, discussions with all EAC board members were held to highlight the importance and purpose of the study and its expected implications to the area. The discussion was helpful in the creation of the relationship with the board members of EAC. A meeting with the international quality manager, another representative from SAD was organised of which the discussion helped with the compilation of the questionnaire. In addition, primary information obtained during discussions was compiled together with information from literature to develop a structured questionnaire.

A pilot survey was conducted on four randomly selected EAC farmers and a senior agricultural economist of SAD was asked to provide input to the questionnaire. During the pilot survey, the respondents were also given an opportunity to be critical about the questionnaire and provide constructive comments. The purpose of the pilot survey was to test the correctness and suitability of the questionnaire to collect data. Thereafter, the questionnaire was corrected and a complete structured questionnaire was then used to collect primary data for this study. Data obtained from the sampled farmers in Eksteenskuil consisted of socio-economic, tenure structure, production activity, marketing behaviour, product quality control, social capital and entrepreneurial characteristic variables. The questionnaire used in this study is provided in Appendix A.

3.2.3 SAMPLING PROCEDURE AND SURVEY

The EAC consists of approximately 60 raisin producers located in three different groups of islands. All farmers were contacted to participate in the study. Consultations with the chairman and board members of the co-operative took place to find the suitable location where interviews could be held. The hall at the EAC offices was used as the central location for North and Middle islands. Farmers at the South island were interviewed at the islands community hall. Since all farmers deliver to one processor under the co-operative name, the co-operative receives the list of farmers from SAD with volumes delivered and grades obtained. Therefore, the output data of delivered volumes and grades obtained was obtained from the co-operative. Furthermore, prices obtained by farmers at the time of delivery were also obtained from the co-operative.

The fieldwork was conducted from the 17th to the 23rd of June 2009. Four junior researchers and two senior researchers were requested to assists to interview respondents. The respondents came willingly to the interviewing area and transport was provided to farmers to get to the interviewing hall. Since data was obtained during the pruning period interviews were flexible for respondents in order to avoid disruptions in critical farming activities. The interviews went smoothly since most of the respondents have been involved in surveys before and it was explained to the farmers that once the study is complete feedback and opinions would be provided.

3.2.4 PROFILE OF RESPONDENTS

From the survey conducted, a total of 43 respondents were obtained. A common characteristic among small-scale farmers in developing countries is that they tend to have relatively small land sizes. However, the ecological setting and geographic location will always set the farmers apart from farmers elsewhere. Though the scale on which they farm is small, Eksteenskuil farmers still manage to produce enough for their livelihood, however not enough for the market. Characteristics of respondents varied a lot as shown in Table 3.1. Human capital characteristics such as farmer's age, formal education and farming experience were measured in years. The only non-human capital characteristic, farm size, was measured in hectares.

The mean age of farmers included in the study is relatively high at 50 years, while the maximum age is 72 years. The standard deviation highlights that the age of farmers is spread out over a large range (11 years). During the interviews farmers highlighted a concern that farming in the region does not attract enough young entrants. Educational level is a concern with some farmers having zero formal education. On the other hand, the average educational level of Eksteenskuil farmers is nine meaning that most farmers barely have matric education. The experience in farming shows great variation indicating great differences in farming experience for the sampled farmers. Further, only one farmer was identified to have recently entered into raisin production with only one year experience, while most farmers have extensive experience of more than 19 years on average. Common with small-scale farmers in developing countries, land sizes are generally small. Eksteenskuil farmers also farm on small areas with one hectare as the minimum and they farm with different activities on the available area. However, there were exceptions with only about two farmers farming on 27 hectares while 7 hectares was the mean farm size.

Table 3.1: Profile of survey participants (n=28)

	Farmers age (years)	Formal education (years)	Farming experience (years)	Farm size (hectare)
Mean	50	9	19	7
Standard deviation	11	4	11	6
Minimum	24	0	1	1
Maximum	72	17	41	27

3.2.5 DATA LIMITATIONS

Studies commonly emphasise that small-scale farmers seldom keep comprehensive records and Eksteenskuil is no exception. Only 28 questionnaires were justified to be analysed in the study. Questionnaires that were discarded were because of incomplete information. It is acknowledged that this study may suffer from limitations related to the small sample size that qualified to be used in this study. In addition, the accuracy of data depended on farmer's ability to recall earlier seasons information or records. Efforts to minimise such limitations were carried out by calling farmers if inconsistency was identified when capturing data.

3.3 PROCEDURES

3.3.1 QUANTIFYING TECHNICAL EFFICIENCY

Various researchers have quantified technical efficiency in varied economic and non-economic environments using the DEA. The DEA is the most applied model to measure technical efficiency in the field of operational research. The literature review highlighted several limitations of the DEA model in addressing research problems and objectives similar to this study. Armbruster (1987) called for the need to develop new conceptual models to quantify the complex setting of today's production and marketing processes. Hence, scholars have identified a two-stage DEA value chain model as an appropriate technique to quantify today's multiple operational processes.

Based on the nature of the research problem objectives, the two-stage DEA model was identified as a suitable model. The two-stage model is appropriate because farm operations of the selected study area are complex. The two-stage DEA model employed by Lu (2006) is currently the only known applied procedure in the agriculture field that successfully demonstrates the efficiency of food producers at multiple production stages.

In the next section, the model specification of both production and quality efficiency is discussed. Thereafter, efficiency variables used in the estimation model are discussed.

3.3.1.1 Production and Quality Model Specification

This study evaluates efficiency of a multiple-stage production process using both an input orientation and variable returns to scale in the production stage of the production process, as demonstrated by Lu (2006). The input-oriented technical efficiency model examines the inputs used, and measures whether a DMU is using the minimum inputs necessary to produce a given bundle of outputs. For the production stage sub-DMU at DMU j variables returns to scale are assumed:

$$\begin{aligned}
&Min\ \theta_{j0}\\
&subject\quad to\\
&\sum_{j=1}^{J}\lambda_j x_{ij} \le x_{ij0}\theta_{j0}; && i=1.........I\\
&\sum_{j=1}^{J}\lambda_j y_{ej} \ge y_{ej0}; && e=1..........E\\
&\sum_{j=1}^{J}\lambda_j = 1 && && (1)\\
&\lambda_j \ge 0; && j=1............J
\end{aligned}$$

Thus, $j=1,..........,J$ indicates the group of DMUs and j_0 represents the current DMU. Where x_{ij} (input vector) is the level of input i consumed by DMU j, y_{ej} (output vector) is the level of the intermediate output e produced by DMU j and λ_j indicates non-negative weights or intensity variable defining frontier points. In the production stage, DMU j consumes inputs x_{ij} to produce y_{ej} as the level of the intermediate output e. These in turn are inputs to the quality stage of sub-DMU, which are used to produce final output w. For the quality stage, an output-oriented technical efficiency model is applied and variables returns to scale are assumed. The output-oriented technical efficiency model examines the output produced, and measures whether a DMU is producing maximum output from a given bundle of inputs.

$$\begin{aligned}
&Max\ p_w q^*_{wj0}\\
&subject\ to\\
&\sum_{j=1}^{J} y_{ej0} \ge \lambda_j y_{ej}; && e=1.................E\\
&\sum_{j=1}^{J}\lambda_j q_{wj} \ge q^*_{wj0}; && w=1................W\\
&\sum_{j=1}^{J}\lambda_j = 1 && && (2)\\
&\lambda_j \ge 0 && j=1..................J
\end{aligned}$$

Where all notations used as previously defined, except for q_{wj} which represents the final quantity of output w produced by DMU j, and q^*_{wj0} is the revenue-maximisation vector of output quantities (which is calculated by the DEA program) for the j^{th} farm given the output prices p_w. In the quality stage, DMU j consumes inputs y_{ej} from the production stage to produce final output q_{wj} which eventually is expressed as the maximisation of revenue based on given output prices p_w.Since output prices p_w are known, Coelli *et al*. (2005) indicates that total revenue efficiency (RE) of the j-th farm is calculated as:

$$RE = \frac{p_w q_{wj0}}{p_w q^*_{wj}} \qquad (3)$$

Therefore, RE is the ratio of observed revenue to maximum potential revenue. Observed revenue of DMU $j0$ is represented by $p_w q_{wj0}$. The observed revenue is determined by the multiplication of a given price p_w with observed quantity q_{wj0}. Potential revenue is represented by $p_w q^*_{wj}$. The potential revenue is determined by the multiplication of a given price p_w with revenue-maximising quantity q^*_{wj} achieved by j^{th} farm. The efficiency of each DMU is weighed relative to all other DMUs in the sample with one limitation that all DMUs be positioned on or below the production efficient frontier (Haji, 2006). It should be emphasised that RE is used as an index for quality efficiency because all farmers in Eksteenskuil receive the same product price. The quality of raisins produced tends to differ among farmers. Hence, farmers should maximise the production of high quality raisins that fetches a better price to maximise overall revenue.

3.3.1.2 Variables used in Efficiency Estimation

The variables used in estimating technical efficiency for the production stage were based on their importance in producing raisins. In spite of poor record keeping by small-scale raisin farmers, critical information was obtained to estimate the production function for efficiency approximation. Nonetheless, Capèau and Dercon (2005) indicate that the first problem researchers' face is how to convert locally measured information into standardised measures. According to Denison (1961), comparisons are practical when inputs are standardised. Table 3.2 shows the standardised units used to allow meaningful comparisons. The input variables used were:

- **Raisins**

The output quantity used in efficiency analysis was the total volume of raisins delivered to the processor. The output data was reliable as it described the true reflection of raisin volumes produced. Since farmers have different land sizes, it was acknowledged that for meaningful comparison amongst farmers the measurement unit would be kilogram per hectare (kg/ha).

- **Nitrogen** (N), **Phosphorus** (P) and **Potassium** (K)

The inputs that were identified as critical to the growth of vines were the fertiliser contents mainly N, P and K. The importance of the N content is because it improves vegetative growth to sustain normal plant growth and provides a deep green colour which the vineyard leaves require. The P content is known to hasten maturity, improve fruit quality, supports root growth and may even increase disease resistance (KZN-Agri, 2006). Vines generally require water to survive and the K content was recognised as a relevant nutrient that acts as a catalyst in the water economy of vines. Further, K reduces tendency to wilt, and may reduce susceptibility to diseases and improve the quality of grapes (KZN-Agri, 2006).

- **Water**

The importance of water to the economy of the study area cannot be exaggerated. Due to the ecological setting of the area, water acts as a key driver to agriculture production and subsequently stimulates economic growth. The best measure of water that could be obtained for the research was the number of irrigations per season.

- **Labour**

Raisin production is generally labour intensive amongst crop enterprises. Although new technology has been introduced in developed nations, labour use still remains an important factor for raisin production. For this study labour includes seasonal, full-time and family labour. Depending on the information available to researchers, the unit of measurement for labour is sometimes argued over. Denison (1961) states that labour input is comparable over time when measured in average number of persons employed and the total number of hours worked. However, some researchers' measure labour in man-days since farmers are able to recall days worked rather than hours. Eksteenskuil farmers could only recall days worked for each type of labour. Therefore measurement was in terms of man-day per hectare. Table 3.2 summarises the inputs and output used in efficiency analysis.

Table 3.2: Descriptive statistics on outputs and inputs used to quantify production efficiency

	Unit	Average	Standard Deviation	Minimum	Maximum
Volume Raisins	kg/ha	1,674	965	405	3,995
Nitrogen (N)	kg/ha	35	33	3	127
Phosphorus (P)	kg/ha	11	11	1	54
Potassium (K)	kg/ha	18	17	1	88
Water	No of irrig/ season	19	6	6	36
Labour	Man-days/ha	519	548	101	2,230

The above mentioned inputs were utilised in the production stage of technical efficiency estimation. For the quality stage, quality efficiency estimation is quite complex. Reason being, both raisin volumes of each variety and total revenue need to be quantified. However, it was possible because the non-parametric approach is able to handle multiple inputs and outputs.

Table 3.3: Descriptive statistics on outputs and inputs used to quantify quality efficiency

Crop	Category	Unit	Average	Standard Deviation	Minimum	Maximum
Golden raisin	**Input**	kg	7,926	4,711	741	13,186
Choice grade	Intermediate Output	kg	7,226	4,206	697	11,649
Standard grade	Intermediate Output	kg	633	638	44	1,537
Industrial grade	Intermediate Output	kg	485	95	418	553
Choice Revenue	Final Output	R	131,868	76,759	12,712	212,592
Standard Revenue	Final Output	R	3,798	3,826	267	9,223
Industrial Revenue	Final Output	R	971	190	836	1,106
Thompson raisin	**Input**	kg	3,622	3,934	373	19,618
Choice grade	Intermediate Output	kg	3,134	3,484	325	17,737
Standard grade	Intermediate Output	kg	454	553	46	1,881
Industrial grade	Intermediate Output	kg	387	347	81	985
Choice Revenue	Final Output	R	40,742	45,291	4,219	230,575
Standard Revenue	Final Output	R	2,268	2,766	230	9,407
Industrial Revenue	Final Output	R	775	694	163	1,969

It should be recalled that after grapes are harvested the decision maker decides to either produce Thompson or Golden raisins or both. Therefore, the raisins (Thompson and Golden) were used as inputs. Since both raisin varieties are subject to grading, grades of each variety were used as intermediate outputs for quality (revenue) efficiency estimation. However, the objective of the farmer is to maximise revenue through quality raisins. The prices of each grade were obtained to estimate efficiency in terms of quality (revenue). The volumes of raisins were measured in kilogram and revenue in Rands. Table 3.3 shows a descriptive summary of inputs and output used in efficiency approximation for the quality stage.

3.3.2 IDENTIFYING FACTORS AFFECTING TECHNICAL EFFICIENCY

3.3.2.1 Regression Model Specification

The Tobit regression was used to analyse the data and the magnitude of inefficiencies. Speelman *et al*. (2007) propose the use of a Tobit model since the efficiency parameters range between [0; 1] and are regarded as censored variables. The Tobit regression was thus used to account for the censoring of the dependent variable (Lu, 2006). The Tobit was employed to assess factors causing low efficiencies in both stages of the analysis. Speelman *et al*. (2007), Lu (2006) and Haji (2006) specify the Tobit as:

$$\begin{aligned} \theta^{k^*} &= \beta_0 + \beta_1 z_1 + \beta_2 z_2 + ...\beta_d z_d + u \\ &= Z\beta + u \end{aligned}$$

Subject to (4)

$$\begin{aligned} \theta^{k^*} &= \theta^k if\ 0 \langle \theta^k \langle 1 \\ &= 0 if\ \theta^k \langle 0 \\ &= 1\ if\ \theta^k \rangle 1 \end{aligned}$$

Where θ^k is the DEA efficiency index (technical efficiency score) used as the dependent variable while β are the coefficients to be estimated and Z is a vector of independent variables related to attributes of the sampled farmers used in the analysis (Speelman *et al*., 2007).

3.3.2.2 Hypothesised Independent Variables

3.3.2.2.1 Production Efficiency

Factors that are hypothesised to influence farmers' efficiency are regressed against the efficiency score to identify the extent to which each variable influences the technical efficiency of the farmer. Literature has identified many factors that influence the technical efficiency of decision makers. For this study, variables were selected on their relevance to Eksteenskuil setting and importance to raisin production.

Table 3.4 shows a summary of variables that were selected for analysis along with their expected sign and measurement index. A positive sign for a variable indicates an increase in efficiency due to an increase in the value of the variable, while a negative sign indicates a decrease in efficiency due to an increase in the value of the variable. Human capital variables are commonly assessed in technical efficiency literature. However, Conradie *et al*. (2006) indicates that human capital variables are known to give unexpected results especially age. However, age was expected to be positive because of the expectation that older farmers regard farming as the primary activity while younger farmers regard farming as a secondary income source. Studies conducted by Ogunyinka and Ajibefun (2003), Dolisca and Jolly (2008) and Begum *et al*. (2009) hypothesise formal education to have a positive influence on technical efficiency of small-scale farmers. Thus, it was hypothesised that formal education would have a positive impact on Eksteenskuil farmers. Farming experience often assists in understanding the dynamics of the environment and the farming business as farming experience is knowledge accumulated over a period of years. Therefore, farming experience was hypothesised to improve technical efficiency and a positive sign is expected. The expectation of a positive sign is adopted from Wollni (2007), who hypothesised that a more experienced farmer is likely to perform better in his farming business.

A farmer who receives off-farm income is often expected to be more resilient and able to cope with farm financial difficulties because off-farm income is able to finance farm activities. Further, labourers are paid timely while inputs are bought on time with off-farm income. Hence, off-farm income was hypothesised to have a positive influence on technical efficiency of Eksteenskuil farmers. The positive hypothesis is in line with Wollni (2007) and Haji (2006) who also hypothesised off-farm income to contribute positively to the technical efficiency of farmers. Land tenure is one of the critical factors identified to constrain the growth of Eksteenskuil farmers. Studies also highlight tenure insecurity as a concern for farmers in developing countries because long-term investments in improvements to land are likely to be dampened. Speelman *et al*. (2007) hypothesised tenure security to have a positive sign and to enhance farmer efficiency. Moreover, while gathering background information about Eksteenskuil, land tenure was identified as a constraining factor in not only obtaining formal credit but also in enhancing fixed improvements on land. Thus, in this study secure land tenure is expected to have a positive influence on Eksteenskuil farmers. Access to credit is highlighted by literature as a factor that has a huge influence on technical efficiency. Binam *et al*. (2004) hypothesised access to credit to have a positive influence on farmers' efficiencies. Thus, access to both formal and informal credit was also hypothesised to be positive and improve technical efficiency.

Table 3.4: Variables used to explain technical efficiency in the production stage

Variable	Measurement index	Expected Sign
Farmers age	Number of years	+
Formal education	Number of years	+
Farming experience	Number of years	+
Off-farm income	As a percentage of total income	+
Land tenure	1=Have title deeds; 0=Have no title deeds	+
Young vines	As a percentage of total vines	-
Old vines	As a percentage of total vines	-
Formal credit	1=Yes; 0=No	+
Informal credit	1=Yes; 0=No	+
Poor labour health	Likert type scale of 1-5	-
Record keeping	Likert type scale of 1-5	+
Family labour	As a percentage of total labour	+/-
Timely and sufficient irrigation	Likert type scale of 1-7	+
Remove weeds	Likert type scale of 1-7	+
Timely pruning	Likert type scale of 1-7	+
Prevent soil compaction	Likert type scale of 1-7	+
Same pruning team	Likert type scale of 1-7	+
Entrepreneur index	Index 1-50	+
Middle Island	1=Yes; 0=No	+
Social Capital index	Index 1-50	+/-
Area harvested	Hectares of land	+

The inclusion of young vines (less than 5 years) and old vines (older than 25 years) in the study was based on discussions with some of the farmers in the region. During discussions stakeholders suggested that young vines are unproductive while the productivity of old vines are decreasing. Conradie *et al*. (2006) also identified farmers with a large proportion of young vines to be inefficient. Hence, the hypothesis is both young and old vines will likely have a negative sign and reduce technical efficiency of farmers.

The inclusion of poor labour health (less poor or more poor) in the analysis was motivated by discussions held with farmers in the region. Poor labour health was highlighted as a concern to productivity. Hence, a negative sign was hypothesised to reduce technical efficiency of raisin production. Family labour is a crucial input to small-scale farmer productivity. Family labour is often expected to enhance the technical efficiency of small-scale farmers because the high cost on hired labour is saved (i.e. Wollni, 2007 and Masterson, 2007). In this study, family labour is hypothesised to either have a negative or a positive sign. Some of the youth in Eksteenskuil were observed to be less keen to continue farming. If a small-scale farmer uses a large proportion of the family relative to total labour, it is likely that some of the family labour employed may be less motivated and subsequently reduce the farm efficiency level. However, the small proportion of family labour involved in faming may be more motivated and keen on taking farming as a career. Hence, a negative or a positive sign is hypothesised. Moreover, Mr. Kok (2009) indicated that they will be providing a bursary to students in the community that intend to pursue agriculture as a career. Land area generally describes economies of scale. The implication would be that farmers with bigger farms or with expansion plans will have cost advantages over small farms. A producer’s average cost per unit decreases as the scale of output is improved. Thus a positive sign is hypothesised. Better technical efficiency is expected from a farmer with a large productive farm compared to a farmer with a small productive land.

Management characteristics were identified as critical factors influencing farmers’ efficiency during discussions with farmers. Management variables included were record keeping, timely and sufficient irrigation, removal of weeds, preventing soil compaction, employing the same pruning team from the past production season and soil quality. The inclusion of management variables is because vineyards are generally management intensive. The expectation is that good management skills results in higher efficiency scores. Therefore, a positive sign was hypothesised for all the management variables. Record keeping is another managerial input that indicates sound planning by the business manager. A positive sign was expected for record keeping in accordance with Wollni (2007). Soil quality is also regarded as a management variable. However, soil quality was not physically tested but farmers did highlight that middle island is more fertile compared to South and North islands. Thus a positive sign was hypothesised for farmers farming in the Middle island. Binam *et al*. (2004) also highlights that farmers with good soil fertility are likely to be more technical efficient.

This study was privileged to take place at the same time with a study conducted by Jordaan and Grové (2010). As a result, social capital and entrepreneurial index were obtained from a working paper by Jordaan and Grové. Social capital means the involvement in social associations or gatherings. Binam *et al*. (2004) mentions that farmer associations are a good platform for farmers because ideas and information are shared within these platforms. However, non-farm associations could lead to low efficiency because farming activities are given less focus. Thus, social capital was hypothesised to have a negative or positive influence on technical efficiency depending on which the type of social capital the respondent is involved. The Entrepreneurial index explains the entrepreneurial expertise of the manager. Entrepreneur index was hypothesised to have a positive impact on technical efficiency because a manager with entrepreneurial expertise is expected to make sound business decisions compared to a manager lacking entrepreneurial knowledge. For more information on the calculation of the social capital and entrepreneurial indexes see Jordaan and Grové (2010).

3.3.2.2.2 Quality Efficiency

Table 3.5 presents a summary of variables that were selected for the estimation of quality inefficiencies, along with their expected sign and measurement index. In quantifying quality efficiency, most hypothesised variables were recognised to be very much related to management qualities. Since the quality of raisins explains 100% of the revenue the farmer obtains, it is acknowledged that quality is determined by management qualities and activities that the farmer performs before raisins are graded by the processor. Management activities include, the new harvesting team, leaf management, delayed block harvesting, timely pruning, eliminate damaged and contaminated grapes, turning over raisins when drying, avoid over stacking when drying, cleanliness of drying trays, oversee all activities during harvesting, cover raisins when raining, timely pruning and timely irrigation. According to Klonsky and Tourte (1997), management practices vary depending upon management skills, available technology and yearly conditions. All management variables are expected to have a positive sign and improve quality efficiency except new harvesting team.

It was hypothesised that the new harvesting team variable would be negative because of high labour demand and labour shortage during the harvesting period. Thus, the probability of obtaining the same team utilised in the previous season is unlikely. A farmer is expected to employ a new team of harvesters and more supervision would be required resulting in reduced efficiency.

A hypothesis was generated that a farmer who is less social in the community, is likely to feel uncomfortable to borrow someone else's test kit for maturity testing. Thus, an interaction between social capital index and using someone else's maturity test kit is hypothesised to be negative because for a farmer who is less social is likely to be reserved and less inclined to borrow someone else's test kit and is thus less efficient. The interaction between the social capital index and using own maturity test kit was hypothesised to have positive sign because using own test kit and being less social would likely improve technical efficiency.

Table 3.5: Variables used to explain revenue efficiency in the quality stage

Variable	Measurement index	Expected Sign
New harvesting team	Scale of 1-7	-
Leaf management for exposure to sunlight	Scale of 1-7	+
Delayed block harvesting	Scale of 1-7	+
Eliminate damaged and contaminated grapes	Scale of 1-7	+
Oversee all activities during and post harvesting	Scale of 1-7	+
Cleanliness of drying trays	Scale of 1-7	+
Avoid over stacking when drying	Scale of 1-7	+
Turning over raisins when drying	Scale of 1-7	+
Cover raisins when raining	Scale of 1-7	+
Social Capital Index * Testing sugar content with own test kit (SCI_Mtest5)	Interaction between discrete (1=own a sugar test kit; 0= used other method) and SCI	+
Timely pruning	Scale of 1-7	+
Timely irrigation	Scale of 1-7	+
Entrepreneur index	Index 1-50	+
Social Capita Index * Testing sugar content with someone's test kit (SCI_Mtest3_4)	Interaction between discrete (1=use someone's test kit; 0= used other method) and SCI	-
Area harvested	Hectares of land	+
Family labour	As a percentage of total labour	+/-

The rationale for the inclusion of family labour is the same as that of production efficiency. Committed family labour relative to total labour expected to make certain that all processes and activities are carried out properly to ensure a good raisin quality is delivered to the processor. Committed family labour can also motivate and supervise hired labour compared to less committed family labour. Thus, a negative or positive sign is expected. The entrepreneurial variable was hypothesised to have a positive impact on quality efficiency because of the same reasoning mentioned at production efficiency. Land area was hypothesised to have a positive influence on quality efficiency because the larger the area that need to be harvested the more likely the farmer will be involved on the farm to ensure all necessary activities are carried out carefully to ensure production of good quality raisins. In the next section problems with regression estimation are discussed.

3.3.2.3 Regression estimation problems

Typical regression estimation problems are due to correlated variables (multi-collinearity) or a small sample size with too many independent variables (degrees of freedom problems). Multi-collinearity is a high degree of correlation or relationship among several independent variables. Such relationship occurs when some of the independent variables measure the same variable. The first effort to fit Equation 4 using maximum likelihood procedure proved to be unsuccessful in both stages of the analysis. Inconsistency to parameter results was suspected to be due to multi-collinearity. Another concern was a degree of freedom which is discussed later in the Chapter.

3.3.2.3.1 Multicollinearity

Gujarati (1988) indicates that eigenvalues and the conditional index can be used to diagnose multi-collinearity. On the other hand, Lin (2008), O'Brien (2007), Adnan *et al*. (2006) and Ranjit (2006) suggests three widely used criteria to detect multi-collinearity, namely: (i) variance inflation factor, (ii) tolerance (TOL) and (iii) correlation matrix of independent variables. Each of the above mentioned methods to detect multi-collinearity is discussed in short.

- **Eigenvalues and Condition Index**

Therefore, the eigenvalues results were obtained from the Number Cruncher Statistical System (NCSS) (see Appendix B1 and B2 for full results). To test for the existence of multi-collinearity, a condition number g was derived as:

$$g = \frac{Maximum\,eigenvalue}{Minimum\,eigenvalue} \tag{5}$$

$$and\ the\ condition\ index\ (CI)\ defined\ as:$$

$$CI = \sqrt{\frac{Maximum\,eigenvalue}{Minimum\,eigenvalue}} = \sqrt{g} \tag{6}$$

The value of g was found to be equal to 129 and 99 for the production and quality stage respectively, indicating that multi-collinearity exists but is not a serious problem. The rule of thumb is: if g ranges between 100 and 1,000 there is evidence of moderate to strong multi-collinearity and above 1,000 would imply serious multi-collinearity (Gujarati, 1988 and Ranjit, 2006). On the other hand, the value of condition index was found at $\sqrt{g} = 11$ and $\sqrt{g} = 10$ for the production and quality stage respectively. According to Gujarati (1988) and Ranjit (2006) if the $CI = \sqrt{g}$ is found between 10 and 30, there is evidence of moderate to strong multi-collinearity. From the eigenvalue and conditional index technique it is confirmed that multi-collinearity is not a serious problem.

- **Variance Inflation Factor and Tolerance**

The variance inflation factor (VIF) and tolerance were applied to test the existence of multi-collinearity with NCSS. The VIF found in this study for the production stage was 8.1 and tolerance value of 0.123 and at the quality stage a VIF of 8.537 and tolerance value of 0.117 was found. The rule of thumb regarding the presence of multi-collinearity varies amongst researchers with Adnan *et al*. (2006) highlighting that there is no formal cut-off value for verifying the presence of multi-collinearity. However, O'Brien (2007), Lin (2008) and Ranjit (2006) indicate that the commonly used guideline is any VIF exceeding 10 is an indication of multi-collinearity. VIF values as low as 5 and 4 have also been employed as rules of thumb (Ranjit, 2006 and O'Brien, 2007). However, Lin (2008) suggests that a tolerance value less that 0.1 signifies the existence of multi-collinearity. The absence of multi-collinearity is realised when the tolerance value is close to one. The rule of thumb used in this study is for VIF is 10 and for tolerance, 0.1. Based on the VIF and tolerance results found in this study, multi-collinearity does not appear to be a problem.

- **Correlation Matrix**

A correlation matrix was calculated on all hypothesised independent variables. The highest correlation found in the matrix was 0.771 and 0.798 for the production and quality stage respectively. According to Bagheri and Midi (2009) a correlation coefficient exceeding 0.9 shows signs of multi-collinearity. In a case where there are more than two independent variables, multi-collinearity can also be present when the correlation coefficient is less than 0.9 (Bagheri and Midi, 2009). From the results of the diagnostics, multi-collinearity was acknowledged as minimal. Based on the norms and the results obtained from the analysis multi-collinearity is not seen as a major problem. In the next section the degrees of freedom problem is discussed.

3.3.2.3.2 Degrees of Freedom

In this study, out of 28 respondents 21 and 16 independent variables were hypothesised to influence the efficiencies of decision makers at production and quality level respectively. The rule of thumb that is at least two observations need to be present for every explanatory variable included. Therefore, degrees of freedom (DOF) were acknowledged as a problem. However, with many estimated parameters and small sample size the researcher may be prompted to leave out some of the parameters leading to biased results. The elimination of parameters could also lead to the exclusion of important information.

According to De Mol, Giannone and Reichlin (2006) the OLS regression model is not appropriate to solve DOF problems because it is unable to reduce parameters and keep important information simultaneously. Since the OLS is unable to address DOF problems, Principal Component Regression (PCR) technique was adopted to solve DOF problems. PCR is a data analysis tool that is usually used to reduce the dimensionality (number of variables) of a large number of interrelated variables, while retaining as much of the information (variation) as possible. Thus, problems associated with degrees of freedom would be managed and poor forecast would be avoided.

PCR offers not only the opportunity to discover the most significant directions among data and to get rid of noise directions, it also offers new filtered information in an orthogonal or even orthonormal basis (Pfisterer, 2006). This new set of information is known as eigenvectors and eigenvalues. Because of orthogonality the eigenvectors are uncorrelated, and the basic vectors corresponding to the maximum variance can be extracted without distracting the analysis in other directions (Pfisterer, 2006). The success of the PCR technique to solve DOF problems requires the following characteristics to be maintained: (i) the eigenvectors are orthogonal and orthonormal and (ii) the eigenvalues are always real and non-negative.

3.3.3 PRINCIPAL COMPONENT REGRESSION

In this section, the theoretical application of the PCR is discussed. The discussion of the theoretical application begins with the transformation of the variables into standardised variables. Thereafter, the estimation of principal components (PCs) is discussed followed by the regression of PCs on the dependent variable. In the last part, explanatory variables are estimated within the PCs. After the theoretical application, the practical application of the PCR is discussed. Under the application of the PCR, the discussion begins with determining the PCs, followed by the significance of the PC's. Thereafter, individual hypothesised variables are calculated based on the PCs.

3.3.3.1 Theory

The theoretical application of the PCR entails the explanation of the mathematical notation of the technique. The departure point in conducting a PCR is by transforming original independent variables into standard variables. The independent variables were standardised as follows:

$$a_i^s = (a_i - \bar{a}_i) / s_{a_i} \qquad (7)$$

a_i^s is the i^{th} standardised independent variable under consideration, a_i is the i^{th} explanatory variable, $\bar{a}_i$ is the mean of the independent variable concerned, and s_{a_i} represents the standard deviation of the i^{th} independent variable. The standardised independent variables are required for the computation of principal components which will be used in the regression analysis. Since the methodology is conducted in a Tobit framework, the dependent variable d is not transformed to a standardised dependent variable d^s because the Tobit only takes censored variables $[0;1]$.

3.3.3.1.1 Estimating Principal Components

The following step of the PCR is to calculate eigenvectors that will be used to construct the principal components (PC). The criterion to select components which will eventually be included in the regression model is based on eigenvalues greater than one, a method referred to as "Kaiser-Gutman Rule" (Fekedulegn *et al*., 2002). Severe multi-collinearity is indicated by very small eigenvalues (Liu *et al*., 2003). Thus components with very small eigenvalues are excluded from further analysis.

The eigenvalues and eigenvectors are calculated from original independent variables with NCSS. The correlation matrix C using both standardised and un-standardised variables were used to calculate eigenvalues $\Phi_1, \Phi_2, \ldots\ldots, \Phi_k$ and equivalent eigenvectors v_j using Equation 8 and 9 respectively:

$$\left|C - \Phi I\right| = 0, \left|C - \Phi_j I\right| v_j = 0 \quad (8)$$

Further, eigenvectors are organised to provide matrix shown in Equation 9, V is acknowledged to be orthonormal as its columns acts in accordance with the conditions $v_i' v_i = 1$ and $v_j' v_i = 0$ for $i \neq j$:

$$V = \begin{bmatrix} v_{11} & v_{12} & . & . & . & v_{1k} \\ v_{21} & v_{22} & . & . & . & v_{2k} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ v_{k1} & v_{k2} & . & . & . & v_{kk} \end{bmatrix} \quad (9)$$

The important step in this section is the extraction of components. As earlier discussed the extraction criteria used in this study was within the common rule of selecting principal components with eigenvalues greater than one. Components with the smallest eigenvalues were disregarded, despite Magingxa's (2006) concern about the cut-off value of one as a selection criterion. The concern arises from the possibility that if the largest eigenvalue is close to one, then useful variables might be eliminated.

3.3.3.1.2 Regression with Principal Components

The principal components scores denoted by Σ is calculated by matrix multiplication of eigenvalues obtained from Equation 9 with the standardised variables obtained from Equation 7. Therefore, Equation 10 describes the principal components scores Σ as follows:

$$\Sigma = A^s V \tag{10}$$

A^s is the $n \times k$ matrix of standardised variables initially calculated in Equation 7 and V is eigenvector matrix as explained by Equation 9. The component scores Σ are calculated in a matrix multiplication product form with a dimension of k components equal to k variables. Recalling Equation 4, the estimation of the components is regressed against the original dependent variable θ^k (which is equal to Ψ) of which Equation 4 is reformulated into Equation 11:

$$\Psi = \beta_0^s + A^s V \beta^s + \varepsilon \tag{11}$$

Where β_0^s and β^s are estimated by the Tobit Regression Model, and are standardised coefficients for the constant and the independent variables respectively. Since, the eigenvectors are orthogonal to one another as defined by the eigenvector matrix V where $VV' = I$, according to Fekedulegn *et al*. (2002) the original Equation 4 or to be more precise Equation 11 can be reformulated in the form:

$$\Psi = \beta_0^s + A^s VV' \beta^s + \varepsilon \tag{12}$$

or

$$\Psi = \beta_o^s + \Sigma\rho + \varepsilon \tag{13}$$

Where $A^s V = \Sigma$ and $V'\beta^s = \rho$. As described by Magingxa (2006), Σ is the $n\, x\, l$ matrix of retained components, V is a $k\, x\, l$ matrix of eigenvectors equivalent to the l retained components, and A^s are the standardised dependent variables. ρ is $l\, x\, l$ vector of new coefficients associated with l components. Magingxa (2006) and Fekedulegn *et al*. (2002) describe standard errors of the estimated coefficients ρ as symbolized by a $l\, x 1$ vector calculated in the form:

$$Var(\hat{\rho}) = \hat{\delta}^2 (\Sigma^{'}\Sigma)^{-1} = \hat{\delta}\, diag(\Phi_1^{-1}, \Phi_2^{-1}, ..., \Phi_l^{-1}) \tag{14}$$

Where $\hat{\delta}^2$ is the variance of the residuals determined in Equation 12. The elimination of components is carried out in accordance with the procedure proposed by Fekedulegn *et al*. (2002). The elimination of some principal components does not change the magnitude of the variance. However, the elimination of one or more components will eventually reduce the total variance in the prediction model and consequently results in a better prediction model (Draper and Smith, 1981 and Myers, 1986). The elimination of the component(s) can be done based on its significance from the regression results (Magingxa, 2006). Presume that r principal components are eliminated due to the insignificance, then Equation 13 can be reformulated to use $k - r$ components.

$$\Psi = \beta_0^s + \Sigma_{k-r}\rho_{k-r} + \varepsilon^0 \qquad (15)$$

The ^{0} symbol on ε^0 is used to differentiate it from ε determined in Equation 13, since they are not identical (Fekedulegn *et al*., 2002). The residuals differ because the vectors of coefficients have been reduced to $k-r$ components.

3.3.3.1.3 Identifying the significance of individual explanatory variables within the Principal Components

The advantage of a PCR is that all hypothesised independent variables can be manually calculated. The retained components are transformed back into the original independent standardised variables in the following manner:

$$b_{pc}^s = V_{k-r}\hat{\rho}_{k-r}$$

$$\begin{bmatrix} b_{1,pc}^s \\ b_{2,pc}^s \\ \cdot \\ \cdot \\ \cdot \\ b_{k,pc}^s \end{bmatrix} = \begin{bmatrix} v_{11} & v_{1l} & \cdot & \cdot & \cdot & \cdot & \cdot & v_{1l} \\ v_{21} & v_{22} & \cdot & \cdot & \cdot & \cdot & \cdot & v_{2l} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ v_{k1} & v_{k2} & \cdot & \cdot & \cdot & \cdot & \cdot & v_{kl} \end{bmatrix} * \begin{bmatrix} \hat{\rho}_1 \\ \hat{\rho}_2 \\ \cdot \\ \cdot \\ \cdot \\ \hat{\rho}_l \end{bmatrix} \qquad (16)$$

Where V_{k-r} is the matrix of eigenvectors for with retained principal components. $\hat{\rho}_{k-r}$ is a vector of coefficients (apart from the intercept) estimated in Equation 15, and b_{pc}^s is a vector of coefficients (apart from the intercept) of the parameters in vector β^s estimated in Equation 11. Further, in line with Magingxa (2006) and Fekedulegn *et al*. (2002), variance of the principal component estimators in the form of standardised variables is calculated by:

$$Var(b_{pc}^s) = \upsilon_l^s K^S \qquad (17)$$

Where υ_l^s indicates the squares of the eigenvector elements of V_l^s in Equation 9, and K^S indicates the squares of the elements of the matrix of standard errors of the coefficient matrix ρ in Equation 15. The equivalent standard errors for the estimators of principal components of standardised variables are specified by:

$$s.e.(b_{pc}^{s}) = Var(b_{pc}^{s})]^{\frac{1}{2}} \tag{18}$$

In same context as Fekedulegn *et al*. (2002) and Magingxa (2006), standardised variables b_{pc}^{s} are transformed back to natural un-standardised variables $b_{j,pc}$ of A_i. The results of the mentioned procedure are given by:

$$b_{i,pc} = \frac{b_{i,pc}^{s}}{1/S_{ai}}, \qquad i = 1, 2, \ldots\ldots\ldots, k \tag{19}$$

and

$$b_{0,pc} = b_{o,pc}^{s} - \frac{b_{1,pc}^{s}\bar{a}_1}{S_{a1}} - \frac{b_{2,pc}^{s}\bar{a}_2}{S_{a2}} - \ldots\ldots\ldots\ldots - \frac{b_{k,pc}^{s}\bar{a}_k}{S_{ak}} \tag{20}$$

Where s_{ai} is the standard deviation of the i^{th} original variable A_i and $b_{o,pc}^{s}, b_{1,pc}^{s}, b_{2,pc}^{s}, \ldots, b_{k,pc}^{s}$ are coefficients of the standardised variables. Since the original un-standardised dependent variable (efficiency score) is used in the Tobit model when estimating principal components significance, it follows that the natural un-standardised variables $b_{i,pc}$ can be correctly calculated when the standard deviation s_{ai} is calculated by $1/S_{ai}$ as shown in Equation 19. In the following section the practical application of the PCR is discussed.

3.3.3.2 Application of the Principal Component Regression

3.3.3.2.1 Determining the Principal Components

The application of the PCR is the same for both technical efficiencies at production and quality stages. In quantifying the hypothesised variables, original hypothesised data was standardised. The standardisation follows the procedure indicated in Equation 7. To confirm if variables are indeed standardised, a mean of zero and a standard deviation of one are obtained from the standardised variables. Thereafter, the standardised data was imported into the NCSS to obtain eigenvalues and eigenvectors. Eigenvectors are required in the computation of the PCs. When computing the eigenvalues and eigenvectors, an un-rotated procedure of components was selected. The selection of un-rotated method was motivated by the fact that components were not the primary objective to be explained or interpreted and Liu *et al*. (2003) demonstrates that credible results can be obtained without performing the rotation method. Furthermore, the NCSS manual highlights that though rotated components simplify the interpretation of the factor variables, variable signs can be different from that predicted. When components are rotated the variance is also not evenly spread among the factors.

The principal components were calculated through a matrix multiplication between standardised variables and eigenvectors. Thus, uncorrelated PCs were manually calculated using Equation 11. A correlation matrix was used to confirm that the PCs were uncorrelated. The uncorrelated components are important to the estimation of the original hypothesised variables. Before the regression analysis was conducted, inclusion of PCs into the regression model was based on the exclusion criteria. A method earlier discussed under the theoretical procedure referred to as "Kaiser-Gutman Rule" was applied in the selection of PCs. Table 3.6 shows the eigenvalues of the components selected for the regression at the production stage.

Table 3.6: Eigenvalues for production efficiency regression model

Principal Components	Eigen value	Percentage of variation
PC_1	4.564168	21.73
PC_2	2.645806	12.60
PC_3	2.441287	11.63
PC_4	1.878127	8.94
PC_5	1.758874	8.38
PC_6	1.243117	5.92
PC_7	1.201390	5.72
Total	**15.732769**	**74.92**

The total variability explained by the seven selected components was 74.92%, while 25.08% variation is explained by the eliminated components. Table 3.7 shows the eigenvalues for the components selected for the regression analysis at the quality stage.

Table 3.7: Eigenvalues for quality efficiency regression model

Principal Components	Eigen value	Percentage of variation
PC_1	5.447424	34.05
PC_2	2.838243	17.74
PC_3	1.590629	9.94
PC_4	1.289587	8.06
PC_5	1.107320	6.92
PC_6	1.003446	6.27
Total	**13.276649**	**82.98**

For the quality stage, the selected PCs explained 82.98% of the total variation, while 17.02% variation is explained by the eliminated components (Note: eigenvectors and squared elements of eigenvectors of the corresponding eigenvalues for both Table 3.6 and 3.7 can be found in Appendix C1 and C2 and Appendix C3 and C4 respectively).

3.3.3.2.2 Determining the significance of Principal Components

In determining the significance of the PCs, a Tobit model was estimated, with the PC variables. Two Tobit models were fitted; one to determine the factors that affect technical efficiency in the production stage, and the other to determine the factors that affect revenue efficiency in the quality stage. The results of the regression analysis of the production stage are shown in Table 3.8.

Table 3.8: Significant PCs for the Production stage

Variable	Coefficient β^s	Standard Error	T-ratio	Probability
Constant	0.946116	0.053246	17.77	0.0000***
ZPC1	-0.08139	0.024152	-3.37	0.0008***
ZPC2	0.159495	0.037573	4.25	0.0000***
ZPC3	-0.01321	0.028056	-0.58	0.5612
ZPC4	-0.09927	0.031355	-3.17	0.0015***
ZPC5	-0.01211	0.029444	-0.41	0.6809
ZPC6	0.051256	0.038627	1.33	0.1845
ZPC7	0.141323	0.044717	3.16	0.0016***
R^2 – DECOMP based fit measure				0.581212

***1%

From the result shown in Table 3.8 it can be seen that four components are highly significant at one percent levels, excluding the constant. The objective is not to interpret the significance of components; hence results in Table 3.8 will not be discussed. However, the R^2 - DECOMP fit measure of the Tobit model is explained to understand if the components indeed fit the Tobit analysis. In Tobit models a fit measure is suitable to be used as a alternative for the OLS R^2, because DECOMP fit measure mimic OLS R^2 and converge to it as censoring probability goes to zero (Speelman *et al*., 2007). According to Greene (2002) the R^2 - DECOMP based fit measure is calculated as the variation of the predicted mean relative to the observed mean divided by the sum of the numerator and model residual variation. There value of R^2 - DECOMP fit measure is generally between zero and one. There higher the value the better the goodness-of-fit. Markova and Reilly (2007) estimated an R^2 - DECOMP fit measure as low as 0.23 and still concluded the goodness-of-fit measure as satisfactory by the standards of the cross-sectional models. On the other hand, Hartwich *et al*. (2007) estimated an R^2 - DECOMP fit measure of 0.60 of the Tobit model. The goodness-of-fit was regarded as a very comfortable level of overall fit. Therefore, the R^2 - DECOMP fit measure of 0.58 seen in Table 3.8 is high enough to show no lack of fit for the data set. The same procedure applied in production stage was applied to determine the significant PC's for the quality stage. Results for the quality stage regression are shown in Table 3.9.

Table 3.9: Significant PCs for the Quality stage

Variable	Coefficient β^s	Standard Error	T-ratio	Probability
Constant	0.986133	0.009553	103.23	0.0000***
ZPC1	-0.002581	0.004238	-0.609	0.5426
ZPC2	-0.014185	0.010107	-1.403	0.1605
ZPC3	0.006527	0.006767	0.965	0.3348
ZPC4	-0.016784	0.008285	-2.026	0.0428**
ZPC5	-0.000983	0.007911	-0.124	0.9011
ZPC6	-0.002555	0.007950	-0.321	0.7479
R^2 – DECOMP based fit measure				0.510681

*****1%; **5%**

Although only one component is significant, the interpretation of the components is not essential as the final results are of most importance. However, the R^2 - DECOMP fit measure of 0.51 indicate that the fit is satisfactory. Magingxa (2006), Adnan *et al*. (2006) and Fekedulegn *et al*. (2002) highlighted that the new set of variables (component scores) are orthogonal meaning they are uncorrelated. Thus the results obtained do not have any symptoms of multi-collinearity or degrees of freedom problem.

3.3.3.2.3 Estimating the Significance of Individual Variables from the Retained PC's

The ability of the PCR technique to allow all hypothesised independent variables to be estimated provides an added benefit to the researcher. This is accomplished with the Tobit regression results obtained with Equation 15. Using Equation 15 the β^s coefficients and the standard errors squared for significant components were extracted from the Tobit results. Equation 16 was used to transform the retained PCs into standardised hypothesised variables. The application of Equation 16 was done by computing a matrix of eigenvectors with estimated coefficients of the retained principal components. The outcome from the matrix multiplication of Equation 16 is the standardised b^s of independent variables.

Thereafter, eigenvectors were transformed into squares of eigenvector elements. The standardised variance corresponding to the standardised b^s was calculated using Equation 17. A matrix multiplication of squares of eigenvector elements and squares of elements of the standard errors corresponding to significant PCs resulted in a standardised variance for the standard variables. The standard errors for standardised variables were obtained by calculating the square root of the standardised variance. The standardised variables do not provide the final results of the hypothesised variables. Therefore, standardised variables are further transformed to original un-standardised variables. Un-standardised coefficients were obtained through the division of standardised b^s with the standard deviation of the original independent variables as shown by Equation 19. The calculation of un-standardised standard errors also applies Equation 19 by dividing standardised standard errors with the standard deviation of the original independent variables.

To obtain the significance of the hypothesised un-standardised variables, the T-statistics was calculated by dividing un-standardised beta coefficients with its corresponding standard errors. Thereafter, the probability of significance was calculated with the Microsoft Excel T-distribution formula. Thus, with the PCR technique it was possible to determine the significance of the variables within the PCs. The next chapter discusses the results which were obtained through the PCR regression. Chapter 4 not only illustrates the results obtained with a PCR procedure but also illustrates the technical efficiency of small-scale farmers alongside the efficiency of large-scale commercial farmers.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

Chapter four covers the results obtained from the analyses. The chapter is divided into two main sections. The first section is devoted to analyses concerned with the production of raisins while the second section is devoted to analyses concerning the quality of raisins. Each main section is again divided into a section that covers the results from estimating the technical efficiency of farmers and a section that identifies the determinants of inefficiencies. The sections on the technical efficiencies also include results of commercial large-scale producers for comparison. The results for the large-scale producers were calculated using a dataset compiled by Jordaan and Grové (2010). However, the factors affecting technical efficiency of large scale producers is beyond the scope of this research.

4.2 RAISIN PRODUCTION EFFICIENCY ANALYSES

4.2.1 PRODUCTION EFFICIENCY SCORES

4.2.1.1 Production efficiencies of small-scale and large-scale farmers

The aim of this section is to present and discuss the distribution of the production efficiency estimates obtained from the first stage of the two-stage DEA model. Table 4.1 shows the summary statistics of the calculated efficiency scores of small-scale raisin producers in Eksteenskuil and large-scale farmers producing raisins in the vicinity of Eksteenskuil. Important to note is that the results were obtained through separate analysis of the two groups of farmers and therefore the two groups could not be compared relative to each other.

Table 4.1 shows that the predicted production efficiencies for small-scale farmers range from 33% to 100% with a mean of 81%. The mean production efficiency of 81% indicates that on average, the respondents are able to obtain only 81% of potential output from a given mix of production inputs. Hence, there is a potential for small-scale raisin producers to improve their average efficiency by about 19 percentage points by employing existing farm resources better and adopting improved technology and techniques. The mean of large-scale farmers is 85% and is slightly larger than the small-scale farmers. The results further show that the deviation from the mean is slightly less for the large-scale farmers.

Table 4.1: Summary statistics of production efficiency scores of small-scale and large-scale raisin producers

Farmers	Mean	Standard Deviation	Minimum	Maximum
Small-scale farmers	0.81	0.22	0.33	1.00
Large-scale farmers	0.85	0.19	0.44	1.00

Figure 4.1 illustrates the production efficiency of small-scale farmers benchmarked against each other and large-scale farmers also benchmarked against each other. Small-scale farmers are represented by the dashed line, while the solid line represents large-scale commercial farmers. Beginning with small-scale farmers, Figure 4.1 shows that there is a large gap between the levels of production efficiency. The cumulative probability distribution between small-scale farmers shows that 43% (1-0.57) of raisin farmers are on the efficiency frontier, while the remaining 57% of farmers is found below the efficient frontier. Thus, only 43% of respondents are regarded as technical efficient in raisin production and the remaining 57% is regarded as being less technically efficient. The results indicate that most small-scale decision makers are not technically applying their inputs efficiently to produce the given output.

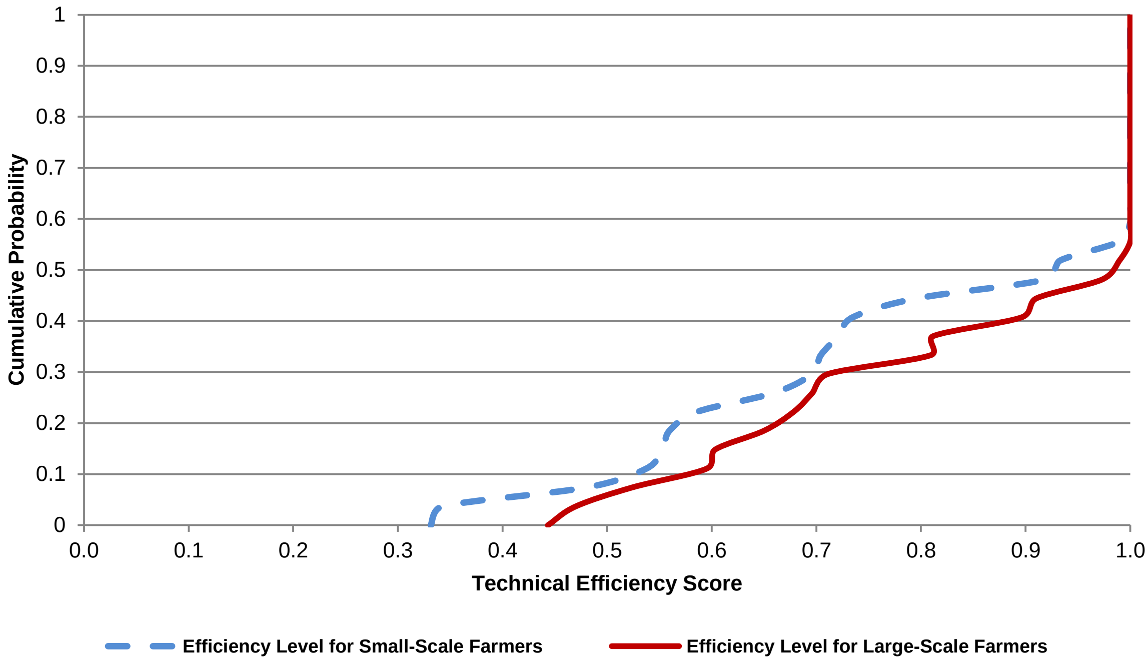

Figure 4.1: Production efficiencies of small-scale and large-scale farmers

On the other hand, a gap is also seen between the levels of production efficiency among large-scale farmers. The cumulative probability distribution between large-scale farmers shows that approximately 45% (1-0.55) of respondents are on the frontier, while approximately 55% of respondents are found below the efficient frontier. This means that 45% of respondents are technical efficient in raisin production and 55% of the respondents are less efficient in employing their inputs.

Similar to small-scale farmers, most of large-scale farmers are not technically employing their inputs efficiently to produce given output. The interesting aspect about the efficiency level of large-scale farmers is the distribution of efficiency scores which highlights that low efficiency exists. Since both large-scale and small-scale farmers were benchmarked separately from each other, the two farming groups cannot be compared against each other. Hence, a comparison requires both samples of large-scale and small-scale farmers to be combined to benchmark small-scale and large-scale relative to each other. The benchmarking of both small-scale and large-scale could assist in understanding the technical efficiency levels of raisin farmers in the region.

4.2.1.2 Comparison of production efficiencies between small-scale and large-scale farmers

Table 4.2 provide the summary statistics of the production efficiency scores when small-scale and large-scale farmers are benchmarked relative to each other.

Table 4.2: Summary statistics of combined production efficiency scores

Farmers	Mean	Standard Deviation	Minimum	Maximum
Small-scale farmers	0.69	0.25	0.28	1.00
Large-scale farmers	0.85	0.19	0.43	1.00

The predicted technical efficiencies for small-scale farmers range from 28% to 100% with a mean of 69%. On the other hand, the technical efficiencies of large-scale farmers show an average of 85% and a range from 43% to 100%. The indication is that large-scale farmers are more technically efficient in applying their inputs to produce a given bundle of output compared to small-scale farmers. Therefore, small-scale famers have a potential to improve their efficiencies by about 31 percentage points on average to operate on the efficient frontier. While large-scale farmers have a potential to increase their efficiencies by about 15 percentage points on average to operate on the efficient frontier.

Figure 4.2 illustrates the technical efficiencies of the combined sample of both small-scale and large-scale farmers in the Eksteenskuil area. The variations in technical efficiencies of raisin production are clearly visible in small-scale farmers when compared with large-scale farmers. The cumulative probability distribution of small-scale farmers shows that 86% of respondents are below the efficient frontier and 14% (1-0.86) of respondents are found on the efficient frontier. On the other hand, the cumulative probability distribution of large-scale farmers shows that 46% (1-0.54) of respondents are on the efficient frontier and 54% of respondents are found below the efficient frontier. Therefore, the benchmarking of both small-scale and large-scale farmers simultaneously highlighted low efficiencies in raisin production amongst small-scale farmers.

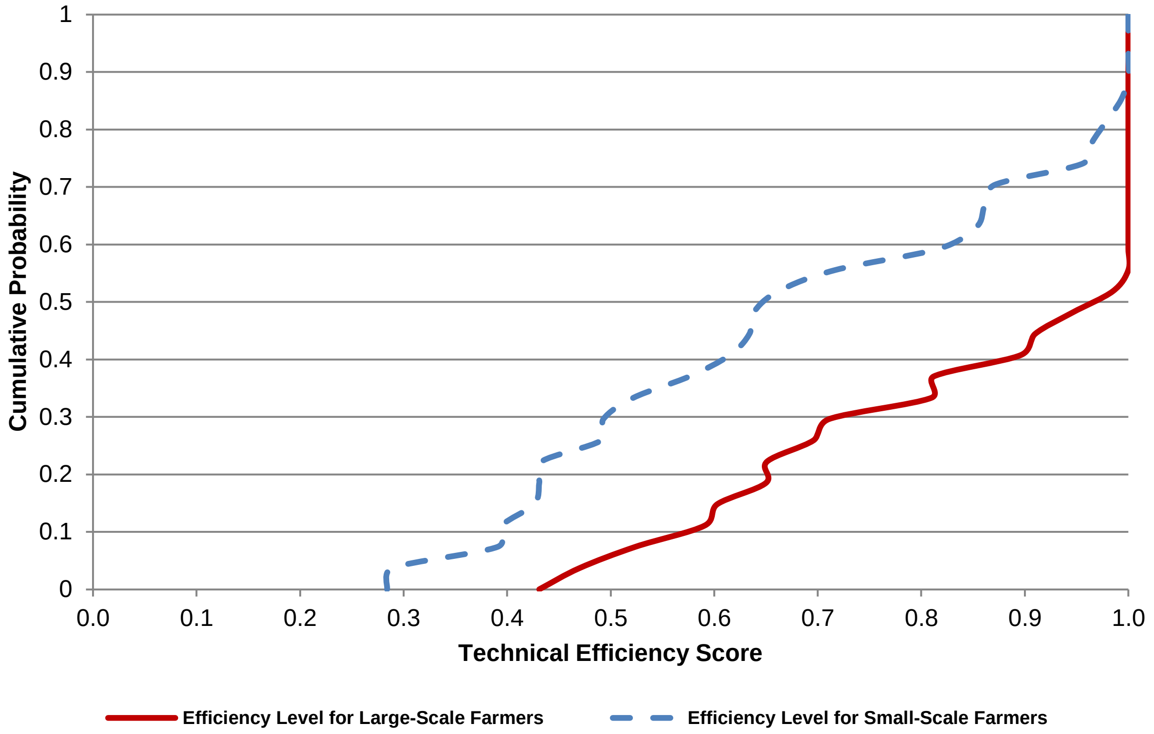

Figure 4.2: Benchmarking production efficiency of small-scale and large-scale farmers

A benchmarking analysis for both small-scale and large-scale farmers revealed a clear representation of raisin production efficiencies of the Eksteenskuil region. According to Fleming *et al*. (2006) the benchmarking approach puts forward a way to expand the proportion of farmers who can gain from benchmarking. Wynne *et al*. (2008) highlight that conducting a benchmark analysis may be an effective technique, because best-practice producers are often the best reference for action plan improvement for less efficient decision makers. However, the beneficial element of benchmarking is that it not only illustrates the overall technical efficiency for the region but it also creates a meaningful comparison of farm efficiency across many raisin producers in a benchmarking sample (Fleming *et al*., 2006). Further, less efficient farmers can improve their efficiency through observing not only other small-scale peers but also the production practices of large-scale farmers, whose technical efficiency is on the frontier.

4.2.2 DETERMINANTS OF RAISIN PRODUCTION

Analysis of the hypothesised variables of the efficiency model highlights the influence of the variables on technical efficiency in the study area. One of the sub-objectives is to identify factors that affect the technical efficiency of production of small-scale farmers. Hence, hypothesised variables are only regressed against the technical efficiency score of small-scale farmers. Table 4.3 provides the estimated coefficients and their significance resulting from applying the Tobit PCR procedure. Most of the estimated regression coefficients were found to be statistically significant. The significant variables confirmed their relative importance in raisin production in Eksteenskuil.

Table 4.3: Determinants of Production Efficiency in Raisin Production

	Coefficient (β)	Standard Error	T-ratio	Probabilities
Farmers age	0.004	0.001	3.356	0.015**
Formal education	0.009	0.002	5.022	0.002***
Farming experience	0.007	0.001	4.907	0.003***
Off-farm income	-0.001	0.001	-1.920	0.103
Land tenure	0.183	0.042	4.369	0.005***
Young vines	-0.156	0.065	-2.415	0.052*
Old vines	-0.235	0.073	-3.245	0.018***
Formal credit	0.161	0.025	6.583	0.001***
Informal credit	0.023	0.043	0.525	0.618
Labour health	0.011	0.011	1.002	0.355
Record keeping	0.025	0.008	2.985	0.024**
Family labour	-0.256	0.064	-3.997	0.007***
Timely and sufficient irrigation	0.003	0.006	0.575	0.586
Remove weeds	0.006	0.006	0.895	0.405
Timely pruning	0.028	0.006	4.807	0.003***
Prevent soil compaction	0.008	0.008	1.045	0.336
Same pruning team	-0.007	0.005	-1.420	0.205
Entrepreneur index	0.003	0.001	2.922	0.027**
Middle Island	0.127	0.055	2.327	0.059*
Social Capital index	-0.003	0.001	-2.158	0.074*
Area harvested	0.038	0.007	5.518	0.001***

***=1%, **=5% & *=10%

The negative sign on hypothesised parameters in the technical efficiency model implies that associated variable decreases efficiency, meaning it has a negative impact on technical efficiency as a result it decreases productivity level. A positive sign indicates that the reverse holds.

The first three variables in Table 4.3 that are associated with human capital significantly increase the technical efficiency at production level. The variables are farmers' age, formal education and farming experience which are significant at 5%, 1%, and 1% respectively. According to Conradie *et al*. (2006), age and education commonly give unusual results. In their study both age and education were found to reduce technical efficiency. However, in this study these variables increase technical efficiency significantly. Formal education is identified to have an positive impact on technical efficiency of production and the conclusion follows the results observed from studies conducted by Ogunyinka and Ajibefun (2003), Dolisca and Jolly (2008) and Begum *et al*. (2009). The researchers highlight that illiterate farmers tend to be inefficient compared to farmers with many years of formal education. Formal education as a managerial input meant that a farmer with more years of formal education would be expected to make good sound management decisions. With regard to farming experience the results obtained are in accordance with a technical efficiency study done by Wollni (2007). The researcher concluded that the longer the years of farm experience the better the efficiency of the decision maker. Better technical efficiency attainment is a result of trial and error that has been practised over the years. It is therefore safe to highlight that with more experience regarding raisin production, the more likely that the farmer will be technical efficient.

Since the study was done on a perennial crop, the productivity of the grapevines was taken into account. The age of the vines were used as proxies for productivity. Both young and old vines were identified to negatively influence efficiency at 10% and 1% significance level respectively. A credible explanation is that young vines (< 5 years) consume tangible and intangible input resources and technical efficiency is seriously affected as inputs are utilized on vines that are not as yet productive. Thus, there is normally an expectation that farms that are heavily involved in the establishment phase may appear to be less efficient (Conradie *et al*., 2006). On the other hand, the older vines (> 25 years) become less productive as they get older. In addition farmers that had a large proportion of old vines were also expected to be inefficient. The explanation is that old vines have reached their productive life and need to be replaced.

Credit is extremely important for small-scale farmers around the world. Generally, farm business like any other business needs cash/credit to maintain itself and small farmers commonly fall short in this respect. Binam *et al*. (2004) identified farmers having access to credit to be performing better because credit allows farm managers to buy inputs timely and also finance cash flow transactions at critical times. Though Binam *et al*. (2004) did not specify the form of credit which farmers' access, in this study formal and informal credit were analysed separately. Formal credit was found to be highly significant at 1% significance level and likely to have a positive influence on productivity. The possible explanation to the positive and high significance level on formal credit is that farmers who have secure land tenure were likely to obtain formal credit. Thus, it is not surprising that land tenure was found to positively influence on technical efficiency at a 1% significance level. Formal credit assists farmers to fund business activities with available cash at any given moment. Therefore, small farmers are able to remain afloat and are also able to continue to support their families.

Scholars highlight the importance of record keeping for management and planning purposes. Its importance arises from the idea that farm records represent the sound management and planning skills. Record keeping was found to positively influence technical efficiency at a 5% level of significance. In Eksteenskuil, farmers who were identified to keep records were as a result likely to be technically more efficient. A farmer that keeps his or her financials and other farm activity records is more likely to be efficient because the farmer can easily refer to his or her records for planning and for credit application. Wollni (2007) also came to the same conclusion that record keeping indeed improves farmers' efficiencies and has a positive influence on technical efficiency.

Literature has highlighted family labour to be important for small-scale farmers. Further, theory also mentions that the use of family labour is likely to have a positive influence on technical efficiency. The argument put forward is that family labour tends to require less supervision and is more encouraged compared to hired labour and as a result should be extra productive and efficient (Masterson, 2007). Therefore, Haji (2006), and Masterson (2007) expected family labour relative to hired labour to improve farmers efficiency due to less supervision required. Both researchers found that family labour reduced technical efficiency, which was opposite to their expectations. In this study, the use of a larger proportion family labour relative to hired labour was also found to negatively influence technical efficiency at a 1% significant level. A plausible explanation to the negative influence is that family labour is not productive on the farm because of lack of interest in farming. The negative impact of family labour on technical efficiency is in line with the results obtained by Masterson (2007), Wollni (2007) and Haji (2006). The high average age of the study sample involved in farming could also explain the lack of interest in farming by the young generation.

Among other management factors, pruning vines in good time is extremely important. According to Martin, Davis and Mason (2008) pruning is done to determine the quantity and quality of fruiting wood. In the same context, premature or overdue pruning will definitely affect the fruiting quantity. Early flowering that might be caused by early pruning may expose the vine to late cold which negatively affects production. Timely pruning was found to influence efficiency positively at a 1% significance level. The importance of timely pruning cannot be overemphasised, as it is evident that farmers' who prune vines on time stand a better chance to achieve better raisin volumes. In addition, the vineyard long term quality is ensured through better pruning management and resulting to improved farmer efficiency.

In a business environment, entrepreneur skills are required. Farming like any other business requires an entrepreneurship driven purpose. What this means is that profit is the end result that keeps the farmer in the business. The results indicate that the entrepreneurship variable was positively significant at 5%. It was expected that farmers that possessed entrepreneurship skills were in a position to be technical efficient. Entrepreneurship is a skill or knowledge that can be taught. It is necessary that decision makers either learn from entrepreneurial affluent farmers or the EAC can assist with sourcing learning material and/or contracting consultants. The sourcing is in line with FT objective which highlights that co-operatives registered to FT should be committed to promote farmer and community development for the long term development of the community (FLO, 2002 and FLO, 2007). Entrepreneurship learning's should be seen by farmers as a long term investment that will empower him/her with better business knowledge towards business planning and decisions.

During the discussions about the background of the region it was mentioned that the middle island has better soil fertility, however evidence of that was never physically tested. In spite of the physical testing, the middle island was used a proxy for soil quality. The results showed farmers farming on the middle island had significantly (p<10%) higher levels of efficiency. The implication is that farmers farming on the middle island are likely to perform well due to soil fertility. Farmers farming on other islands are encouraged to improve the soil fertility of their current farming plots. The results are in line with Binam *et al*. (2004) who also indicates that the better the soil quality on which the farm is located the more likely the farmer will be technical efficient. It is quite important for raisin farmers to look after their soil because vines are a perennial crop and a long term investment such as maintaining the soil is crucial for future crop returns.

In this study the social capital index compiled by Jordaan and Grové (2010) was included as a potential factor affecting the efficiency of production. According to the analysis the social capital was identified to be significant at 10% significance level. A possible justification for the negative sign is that when developing the index, productive and unproductive social practices were combined into one index. Binam *et al*. (2004) and most other researchers point out that being involved in a farmer association or group is beneficial as it allows farmers to come together and share ideas and information. The importance of associations to a farmer is linked to a likelihood of learning more about best practice relevant to his/her enterprise. Farmers who tend to frequently socialise unnecessarily or involved in non-farming associations may lose sight of his/her farming functions. The importance of giving the farming enterprise undivided attention and also getting involved in productive social capital cannot be overemphasised in this instance.

The size of the land indicates the full utilisation of the existing potential of the farm. Moreover, large farmers in terms of scale are expected to intensify their supervision. Large farms were associated with less social capital and therefore were able to attend to farming requirements. Small-scale farmers farming at a larger scale than other farmers were also likely have an entrepreneurial drive which persuades them to invest in expansion and/or re-establishment. As a result, area under production significantly improved efficiency at a 1% significance level. Farmers with larger area under crops are expected to pay more attention on managing their farms and less on unproductive social activities. Hence, farmers with large area were likely to be more efficient.

4.3 RAISIN QUALITY ANALYSIS

4.3.1 QUALITY EFFICIENCY SCORES

4.3.1.1 Quality efficiencies of small-scale and large-scale farmers

The main purpose of this section is to discuss and highlight the distribution of the quality efficiency estimates obtained from the second stage of the two-stage DEA model. Table 4.4 shows the summary statistics of the estimated quality efficiency levels. The summary statistics distinguish between the quality efficiencies of small-scale farmers benchmarked against each other and large-scale farmers benchmarked against each other.

Table 4.4: Summary statistics of quality efficiency scores of small-scale and large-scale raisin producers

Farmers	Mean	Standard Deviation	Minimum	Maximum
Small-scale farmers	0.97	0.03	0.87	1.00
Large-scale farmers	0.89	0.11	0.69	1.00

The predicted quality efficiencies show that the small-scale farmers are on average highly efficient in producing quality produce with a mean of 97% when they are benchmarked against each other. The mean indicates that for the entire EAC farmers to be on the efficient frontier, the average quality efficiency of EAC farmers can only improve by three percentage points when benchmarked against each other. The quality efficiency scores of small-scale farmers range from 87% to 100%. The efficiency scores highlight that most farmers are likely to be operating on the frontier because the deviation from the mean is three percentage points. Large-scale farmers are also observed to be highly quality efficient with a mean of 89% when compared relatively to each other. Large-scale farmers have the potential to increase their efficiency by 11 percentage points on average, if all the farmers aim to be on the efficient frontier. The quality efficiency levels of large-scale farmers range from 69% to 100%. The results highlight that there are decision makers that show signs of low efficiencies but the variation is minimal because the standard deviation is low.

Figure 4.3 shows the quality efficiency of small-scale farmers benchmarked against each other and large-scale farmers also benchmarked against each other. The distribution of quality efficiencies among small-scale decision makers shows that most decision makers are close to the efficient frontier. The cumulative probability distribution of small-scale farmers' efficiency scores highlights that 36% (1-0.64) of decision makers are on the efficient frontier, while the remaining farmers is found below the efficient frontier. Therefore, only 36% of respondents are regarded as efficient in producing adequate raisin quality when compared to each other and the remaining 64% is regarded as less efficient. Although the variation in the efficiency scores is minimal, there is potential for less efficient decision makers to improve their raisin quality efficiency levels. In view of the variation in quality efficiency, the variation is limited and it is likely that estimated variables will be insignificant.

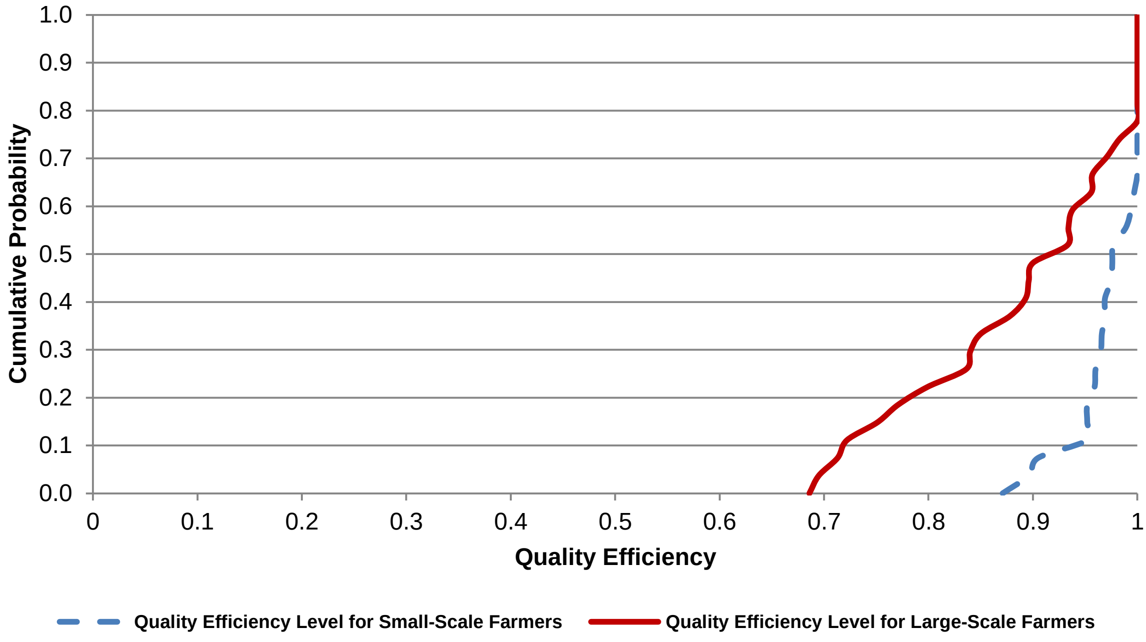

Figure 4.3: Quality efficiencies of small-scale and large-scale farmers

Several large-scale farmers are seen as less efficient in raisin quality when benchmarked against each other. The cumulative probability distribution of large-scale farmers shows that 25% (1-0.75) farmers are on the efficient frontier. Therefore, 75% of farmers are found below the efficient frontier. The quality efficiencies of large-scale farmers show considerable more variation in their efficiency to produce quality produce. Therefore, less efficient decision makers have the opportunity to review their farm practices to increase raisin quality.

Figure 4.3 does not allow a comparison of the two groups of farmers because the benchmarking was done separately on the two groups. Thus, the quality efficiency level of the region cannot be confirmed with results from Table 4.4 and Figure 4.3. The next section will discuss the benchmarking of both small-scale and large-scale farmers in the region.

4.3.1.2 Comparison of Quality efficiencies between small-scale and large-scale farmers

The summary statistics of the estimated quality efficiency scores when small-scale farmers and large-scale farmers are benchmarked against each other is shown in Table 4.5. The benchmarking analysis assisted in understanding the quality efficiency levels of small-scale farmers relative to large-scale farmers.

Results from Table 4.5 shows that small-scale farmers are less efficient when compared to large-scale farmers. A mean of 79% indicates that less efficient decision makers have a potential to improve the efficiency levels by 21 percentage points on average, in order to be on the quality efficient frontier with other efficient decision makers. On the other hand, large-scale farmers have the potential to improve their level of efficiencies in raisin quality by 12 percentage points. Therefore, the level of efficiencies between the two farming groups clearly differs and small-scale farmers could use large-scale farmers as their peers for best practice. The standard deviation for small-scale farmers is 8% and 11% for large-scale farmers which indicate that the variation is recognised to be fairly limited. The efficiencies of raisin quality for small-scale farmers range from 65% to 100% while that of large-scale farmers vary from 69% to 100%.

Table 4.5: The benchmark summary of Quality efficiency scores

Farmers	Mean	Standard Deviation	Minimum	Maximum
Small-scale farmers	0.79	0.08	0.65	1.00
Large-scale farmers	0.88	0.11	0.69	1.00

Figure 4.4 illustrates that the distribution of quality efficiency of small-scale raisin farmers vary to a great extent from that of large-scale raisin producers. The benchmarking of decision makers in the Eksteenskuil region shows several small-scale farmers falling below the efficient frontier. The cumulative probability distribution for small-scale farmers shows that approximately 99% of respondents are below the efficient frontier while only 1% of respondents are found on the efficient frontier. On the other hand, the cumulative probability distribution shows that approximately 19% (1-0.81) of large-scale farmers are on the efficient frontier, while 81% is found below the efficient frontier. The efficiency scores of the large-scale producers are furthest to the right indicating that they are more efficient. The area between the graphs shows the difference in quality efficiency which is substantial. However, the difference is less when compared to the production efficiencies.

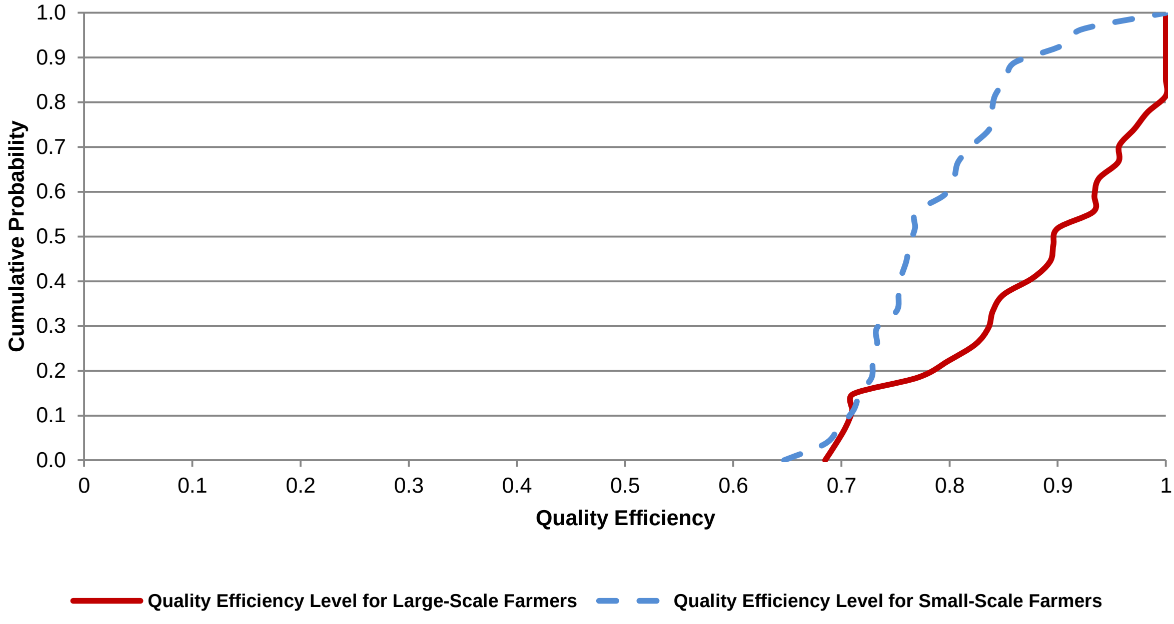

Figure 4.4: Benchmarking of small-scale and large scale-farmers

4.3.2 DETERMINANTS OF RAISIN QUALITY

The hypothesised independent variables were regressed against the quality efficiency scores of the small-scale producers. Results from the analysis showed that for quality efficiency determinants, there were no significant factors that were identified to hinder performance of small-scale farmers. Hence, no factors are explained. The non-significance of variables does not imply that variables have no influence on efficiencies of raisin quality. However, insignificance of the variables is attributed to little variation in the efficiency scores of small-scale producers. The limited variation of efficiency scores is also likely to be attributed to the use of a single marketing channel for processing, packaging, exporting and traceability.

4.4 CONCLUSION

The conclusion is that in Eksteenskuil's raisin production, low technical efficiencies have been identified to exist in the production level. As far as production efficiency is concerned, the production practices of Eksteenskuil raisin producers are not aligned with the increase raisin volumes. This is confirmed by the low average production efficiency of 69% compared to 85% of large-scale farmers. On the other hand, the average quality efficiency of small-scale farmers was found to be nine percent lower compared from that of large-scale farmers. Hence, there is evidence to suggest that farm practices of small-scale farmers with regard to raisin quality are similar to large-scale farmers. It should be recalled that approximately 35% of the survey responses were excluded from the econometric analysis because of poor record keeping. Considering that better farmers may be expected to be more likely to keep good farm records, it is acknowledged that the sample included in the econometric analysis may be biased. Moreover, the cumulative distributions of small-scale farmers' production and quality efficiency scores are likely to over-state the average efficiencies of the population of EAC members. In spite of the possibility that the sample is likely to be biased, the recognition of low average production efficiency scores compared to quality efficiency scores has highlighted the failure of EAC members to meet market demand. Moreover, the locations of low efficiencies have also provided a clear direction for managerial solutions and approach. Managers and policy makers are able to exhaust their energies in specific low efficient areas of farming.

Various factors were estimated to affect the level of efficiencies of raisin production. Factors that are acknowledged to increase the level of production efficiency of raisin production are farmer's age, formal education, farming experience, land tenure, formal credit, record keeping, timely pruning, entrepreneur index, Middle Island and area harvested. The study suggests strengthening of policies that will enhance production efficiency through effective education, entrepreneurial up skilling, secure tenure and farmers' access to credit as well as incentives to increase area under vines and fertilisation of the soil with environmentally friendly products. Such policies and incentives will give the necessary momentum to upwardly move the frontier of raisin production in Eksteenskuil from the current position.

On the other hand, farmers who plan accordingly when it's time to prune the vines and use records for proper farm planning are likely to operate on the efficient frontier. Due to the low level of education, farmers should to be trained with regard to record keeping and the importance of planning for the next season needs to be highlighted. Training could be provided by qualified government extension officer or consultants can be outsourced by the cooperative on behalf of the members.

The high average quality efficiency score found amongst small-scale farmers provides sufficient evidence to point out that managerial remedy and policies should redirect their resources away from quality enhancing strategies towards the intensification in raisin production. This would not only enable farmers to meet market demand but would also allow Eksteenskuil farmers to protect their market share in the FT market.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

5.1.1 BACKGROUND AND MOTIVATION

The advancement in technological development during the 20th century has had a strong influence on agricultural production. Consequently, consumer health and lifestyles along with spending patterns have changed rapidly (Gaiha and Thapa, 2007; Birthal *et al*., 2005). Due to changing lifestyles, marketing approaches have had to adapt to the transforming system. Changing consumer lifestyles and marketing techniques have created pressure on small-scale food producers to meet market standards. Concerns have been raised by some researchers about the impact of modern consumption and marketing patterns on small-scale farmers.

Van der Meer (2006), Gaiha and Thapa (2007) and Reardon and Berdeguè (2002) are among the scholars that have highlighted the plight of small-scale farmers in participating in modern markets. Gaiha and Thapa (2007) argue that quality, delivery of volumes and traceability are too inflexible for poor small-scale producers. If small-scale farmers do not receive support, their role in food production could diminish and poverty would most likely spiral out of control. Thus, FT has provided a market that is able to promote the participation of small farmers in global markets. FT has also provided indirect support and training to farmers through their legally registered co-operative organisation.

FT support has also benefited Eksteenskuil farmers in the Northern Cape Province of South Africa. Eksteenskuil farmers are currently the only small-scale raisin producers that have had the opportunity to be exposed to the FT global market (Koch, 2009). The FT market also requires volumes of adequate quality to satisfy market demand. Consequently, small-scale farmers are unable to meet the market requirements such as providing sufficient volumes of required quality. For Eksteenskuil farmers to remain participating in the FT market, raisin volumes together with required quality need to increase. The inability of Eksteenskuil farmers to produce sufficient volumes of good quality raisins is troubling when evaluating their level of efficiency. The role of efficiency in agricultural production has been researched for many years (Mushunje *et al*., 2003; Ajibefun, 2002; Haji, 2006 and D'Haese *et al*., 2001). Scholars even put emphasis on decreasing agricultural productivity for the last few years due to declining efficiencies. Therefore, if low efficiencies are not attended to, Eksteenskuil farmers will be unable to maintain their economic status as a FT provider. Moreover, FT has started looking for other small-scale raisin farmers in Chile and India to supply to the FT market. In spite of threat from competitors, Eksteenskuil farmers have to remain in the FT supplier list by ensuring volumes of adequate quality is increased.

5.1.2 PROBLEM STATEMENT AND OBJECTIVES

The major problem facing small-scale farmers in Eksteenskuil is their inability to meet the required volume of adequate quality raisins which in turn threatens their position as sole suppliers of FT raisin in the world. Generally, a lack of understanding pertaining to the factors that hinder the performance of small-scale farmers to achieve both volume and quality exist. Thus, managers and decision makers may provide inappropriate solutions to the upholding small-scale farmers in commercial markets such as that of FT.

Many studies have analysed the efficiency of agriculture production in developing countries (Ajibefun, 2002; Haji, 2006; Wollni, 2007; Croppenstedt, 2005; D'Haese *et al*., 2001; Mkhabela, 2005; Idiong, 2007; Binam *et al*., 2003), while Wollni (2007) and Lu (2006) are among the few researchers that have given marketing efficiency attention. Ajibefun (2002) used a stochastic frontier model to examine the factors affecting the technical efficiency of small-scale farmers in Nigeria. Maximum likelihood estimation was used to estimate the parameters that were hypothesised to affect the level technical efficiency of production. Haji (2006) evaluated the efficiency of smallholders' vegetable farmers. A Data Envelopment Analysis (DEA) model and a Tobit Regression Model were fitted to estimate the levels of efficiency and determine factors affecting technical efficiency respectively. D'Haese *et al*. (2001) also used a DEA to measure the relative efficiency of wool production on farms. The one-way analysis of variance was used to evaluate the determinants of technical inefficiencies. All of the above mentioned studies have only analysed the technical efficiency at production level. Although some research has been done on marketing efficiency, the analysis of quality efficiency is rarely considered.

The main objective of this study is to assess the factors affecting technical efficiency of raisin production and quality of produce of Eksteenskuil farmers. The first sub-objective contribute to meeting the overall objective by quantifying the technical efficiencies with which small-scale farmers convert inputs to volume of raisins produced. The technical efficiencies of small-scale farmers are also compared with that of large-scale raisin producers using a dataset compiled by Jordaan and Grové (2010). A Tobit Principal Component Regression is employed to achieve the second objective which is to identify factors affecting the technical efficiency of production of small-scale farmers. The same analyses were conducted to estimate and compare the quality efficiency levels of small-scale farmers and to identify factors affecting quality efficiency.

5.2 LITERATURE REVIEW

The main condition to understanding technical efficiency of production is by acknowledging that the globe has scarce resources and choices have to be made concerning the utilisation of those scarce resources (Färe *et al*., 1994). The estimation of technical efficiency is recognised to be impractical if input resources are not incorporated into the analysis. According to Palmer and Torgerson (1999) technical efficiency is concerned with the relation between resource inputs and outputs. Technical efficiency estimation can follow two different forms, namely output-orientation or input-orientation. The output-orientation measures the potential output achieved by the decision maker when all inputs are held constant (Walden and Kirkley, 2000 and Den *et al*., 2007). On the other hand, Farrell (1957) and Nikaido (2004) indicate that the input -orientation measures the ability of the decision maker to utilise the least inputs to achieve a given output. The estimation of technical efficiency does not end with production. Due to increasing vertical integration in agriculture and farmers failing to meet market requirement, efficiency at marketing level has drawn attention to researchers. Farmers have engaged in adding value in order to maximise consumer purchasing power. Abdou (2007) highlights that taking advantage of higher prices is possible if marketing operations such marketing better quality, grading, packing, processing, transport and storage are integrated into the business operation. However, the failure of small-sale farmers to meet some of the market requirements raises concerns about the level of efficiencies with which they operate. To address the challenges faced by small-scale farmers at improving their marketing efficiencies, appropriate approaches need to be formulated. Literature that aims to understand market inefficiencies has failed to address the quality aspects of the crop.

Two popular models that have been well documented in research to estimate technical efficiency are DEA and the Stochastic Frontier Analysis (SFA) models. The two techniques use different approaches to evaluate technical efficiency. The SFA assumes that any variations from the frontier are not only related with inefficiency but statistical noise is also taken into account (Bravo-Ureta and Pinheiro, 1993). According to Coelli *et al*. (2005) the model is popular for its ability to deal with stochastic noise and allows statistical tests of hypothesis relating to the structure and the degree of inefficiency. On the other hand, the DEA is a method based on the linear programming designed to identify appropriate weights for each variable (Giannoccaro *et al*., 2008). Thus, the performance of each DMU is estimated relative to all other DMUs in the sample with one limitation that all DMUs be placed on or below the efficiency frontier. However, both techniques suffer from weaknesses. The SFA is criticised for its inability to accommodate multiple outputs when estimating technical efficiency. The DEA is also known to direct all the variations from the frontiers to inefficiencies, and it is likely to be sensitive to measurement errors or noise in the data (Haji, 2006). In complex business structures the DEA might fail to identify the exact locations of inefficiencies. Lewis *et al*. (2007); Lu (2006) and Sexton and Lewis (2003) proposed the use of a two-stage DEA model consisting of two interlinked stages where the outputs from the first stage are used as inputs in the second stage. Lu (2006) highlights that the function of the two-stage DEA model is to assess the relative efficiencies of each DMU and each of its sub DMUs and also to identify the locations of inefficiencies. Thus, the two-stage model is suitable for businesses that have more than one production stage because locations of inefficiencies are specifically identified. The study will use the two-stage DEA for its ability to provide more insight into the multiple-production operations of the business. Moreover, the two-stage DEA appears more suitable in understanding the multiple-input to multiple-output production process. The objective of the study thus will be better addressed with the two-stage DEA.

There are various studies that have assessed the technical efficiency of small-scale farmers in developing countries. Studies that have addressed technical efficiency of small-scale agriculture in developing countries include: Wollni (2007), Ogunyinka and Ajibefun (2003), Begum *et al*. (2009), Dolisca and Jolly (2008), Binam *et al*. (2004), Haji (2006), Wollni (2007), Lu (2006) and Speelman *et al*. (2007). Researchers have identified a wide range of factors influencing crop management practices of small-farmers in developing countries. Human capital factors, off-farm activities, farmer association, family labour, farm size, soil fertility, land tenure, access to credit and managerial skills are among the important factors identified by research to influence the level of efficiencies of small-scale farmers.

The estimation of factors affecting efficiency is assessed with various methods. Commonly used models are the Tobit and the OLS. The Tobit regression is most appropriate when the dependent variable is restricted from below and above. Various scholars recommend the use of the Tobit because of the censorship of the dependent variable. The Tobit model has been used in studies as the natural preference for regressing DEA efficiency scores. However, studies by Hoff (2007) and McDonald (2009) suggest that the Tobit may be miss-specified. According to McDonald (2009) the OLS technique may even substitute the Tobit as a technique to explain efficiency results. Given on the nature of DEA and the characteristics of this study, the Tobit regression is appropriate to explain efficiency outcomes.

5.3 DATA AND PROCEDURES

5.3.1 RESEARCH AREA AND DATA

The research was conducted at Eksteenskuil which is situated in the Northern Cape Province of South Africa. The climate is conducive to the production of grape vines which constitute the most important crop produced in the area. Other notable agricultural production activities comprise of livestock and lucerne. Most of the farmers produce raisins which are exported through the FT initiative if quality permits. The success of Eksteenskuil farmers is attributed to the support they receive from South African dried fruit company (SAD), Eksteenskuil Agricultural Cooperative (EAC), FT and the Agriculture Research Council (ARC) regarding their farming practises and marketing.

A structured questionnaire was developed to gather information regarding the socio-economic characteristics of the farmers, their levels of production, input use and possible factors that might influence the efficiency of production and the quality of the raisins. The development of the questionnaire was inclusive in the sense that discussions took place with EAC board members and all stakeholders involved with Eksteenskuil farmers. Most of the raisin farmers are members of EAC and it was decided to include all 60 members of the EAC in the sample. Forty three members agreed to partake in the survey which yielded 28 usable questionnaires. The survey was conducted by means of personal interviews. Some of the characteristics of respondents reflect the common qualities that are associated with small-scale farmers. Such characteristics include low average level of education and small average size of farming land.

5.3.2 PROCEDURES

The study uses the two-stage DEA to estimate the technical efficiency of production and quality. An input and an output oriented model were used to quantify the levels of efficiency at production and quality stages respectively. Next, a Tobit model was used to determine the significance of hypothesised factors influencing efficiency of production and quality. The Tobit model was used because it is an appropriate econometric model for dependent variables that are censored (Lu, 2006). The study hypothesised 21 independent variables to have an influence on the level of efficiency at production level for raisin farmers. The independent variables comprise of farmers age, formal education, farming experience, off-farm income, land tenure, young vines, old vines, formal credit, informal credit, labour health, record keeping, family labour, timely and sufficient irrigation, remove weeds, timely pruning, prevent soil compaction, same pruning team, entrepreneur index, middle Island, social capital index and area harvested.

The variation in revenue is 100% explained by the proportions of quality raisins as farmers receive standardised prices for different quality raisins. All choice grade raisins are exported through the same channel (FT) while raisins of a lesser quality are all sold to the same channel (secondary processors). Therefore, two inputs from the production stage were used in the quality stage, which are Thompson and Golden raisins. Each of the two products are eventually graded into three grades namely, choice, industrial and standard grade. The three grades are intermediate outputs within the quality stage. Since prices are given for each grade, revenue could be calculated. There are 16 variables that were hypothesised to explain inefficiency variations at quality level. The variables comprise of same harvesting team, leaf management for exposure to sunlight, delayed block harvesting, eliminate damage and contaminated grapes, oversee all activities during and post harvesting, cleanliness of drying trays, avoid over stacking when drying, turning over raisins when drying, cover raisins when raining, interaction between social capital index and testing sugar content with own test kit, timely pruning, timely interaction between irrigation, social capital index and testing sugar content with someone's test kit, area harvested and family labour.

Due to the large number of hypothesised independent variables relative to the sample size of 28 respondents, potential regression estimation problems were identified. Multi-collinearity and Degrees of Freedom (DOF) were suspected to be the cause of estimation problems. Four techniques were used to detect multi-collinearity, which are the eigenvalues, conditional index, VIF, tolerance and correlation matrix. Based on the results of the four techniques and rules of thumb used in literature, multi-collinearity did not emerge to be a hindrance. However, DOF emerged as a problem and the PCR was used to address the problem of DOF because it can reduce the dimensionality of independent variables without losing important information. The PCR was used within the Tobit regression framework at production and quality stages.

The procedure for the PCR follows the following steps. Firstly, original independent variables were transformed into standardised variables which were later used to calculate PCs to be included in the regression model. Thereafter, original independent variables were subjected to PCA in order to reduce the dimensionality of the variables into a few uncorrelated PCs. The Tobit regression was conducted with seven PCs and six PCs at production and quality stages respectively to determine the PCs that significantly influence the level of technical efficiency. The results of the model indicate that four PCs were significant in production stage and one PC in quality stage. Significant PCs were made use to calculate the individual variables enclosed in each PC. Thereafter, estimated coefficients, variance, standard errors, t-ratios and probabilities of each variable were calculated to determine the levels of variable significance when hypothesised variables are regressed on technical efficiency at the production and quality stage.

5.4 RESULTS

5.4.1 PRODUCTION EFFICIENCY ANALYSIS

5.4.1.1 Production efficiency scores

The two-stage DEA model results revealed that the average production efficiency of small-scale farmers is relatively high when benchmarked against each other. The average efficiency of small-scale famers was estimated at 81% when benchmarked against each other. Although the mean appears high but the gap between the lowest (33%) and the highest (100%) efficiency score highlights that production practices differ among small-scale decision makers. The mean of 81% indicates that small-scale farmers have the potential improve their average level of production efficiency by about 19 percentage points through efficient utilization of available resources. On the other hand, average production efficiency of large-scale farmers was found to be relatively high at 85%. The minimum technical efficiency realised by the commercial farmers is higher than that of the small-scale farmers, and the standard deviation of the efficiency scores is also smaller. Both of these findings contribute to a higher average technical efficiency score of commercial farmers. Large-scale farmers have the potential to operate on the efficiency frontier if the average efficiency increases by approximately 15 percentage points.

A benchmark of small-scale farmers and large-scale farmers against each other revealed that small-scale farmer show signs of considerable low efficiencies. The average efficiency of small-scale farmers was estimated at 69% compared to 85% of large-scale farmers. The combined benchmarking of both farming groups highlights the severity of low efficiencies amongst small-scale farmers. For less efficient small-scale farmers to operate on the frontier, the average efficiency of small-scale farmers should increase by 31 percentage points. However, from this benchmarking analysis it is noted that the production practices of small-scale farmers require an adjustment towards strategies that increase raisin volumes.

5.4.1.2 Determinants of production efficiency

Determinants of production efficiency describe the reasons why some decision makers operate on the efficient frontier, while others are found below the efficient frontier. Variables that were found to be significant and having a positive sign indicate that they improve the level of efficiencies of decision makers. On the other hand, variables that were found to be significant and carrying a negative sign suggest that they reduce the level of efficiencies of farmers. Variables that were identified to be insignificant are not necessarily unimportant in raisin production but it may suggest that not enough variation was found for them to justify their influence in production efficiency of raisin production.

Various unrelated factors were identified as significant and to have a positive influence on the efficiency levels of raisin production. Farmer's age, formal education, farming experience, secure land tenure, formal credit, record keeping, timely pruning, entrepreneur index, Middle Island and area harvested are factors that improve the level of production efficiency amongst small-scale farmers. Factors such as record keeping, timely pruning, entrepreneur index, Middle Island and area harvested are more within the control of the client. The opportunity for inefficient decision makers to operate on the efficient frontier is possible if each decision maker concentrates on factors within his control. On the other hand, variables that were identified to reduce the efficiency levels of raisin production among farmers are young and old vines, family labour and social capital index. Therefore, the effect of such variables on raisin production should either be reduced or eliminated if possible. For family labour, it may be critical that the farmer creates an environment that allows family members to feel unobligated to work on the farm.

5.4.2 QUALITY EFFICIENCY ANALYSIS

5.4.2.1 Quality efficiency scores

The second stage of the two-stage DEA revealed high average quality efficiency scores for both small-scale farmers and large-scale decision makers. The benchmark analysis of small-scale farmers was calculated as 97% and the quality efficiency score ranges between 87 and 100 percentage points. The indication of a high average quality efficiency score is that most decision makers are likely to be found near or on the efficient frontier line. Further, the gap between the efficient and less efficient decision makers is small indicating that variations are minimal. The quality efficiency of small-scale farmers is understood to be complemented by appropriate management activities that ensure a higher quality raisin is produced. Large-scale farmers were also identified with a high average quality efficiency score of 89%. The least efficient decision maker amongst large-scale farmers has a quality efficiency score of 69%. Therefore, there are indications that low quality efficiencies among large-scale farmers exists.

The combined benchmark analysis of both small-scale and large-scale farmers provided a better picture concerning the quality efficiency of Eksteenskuil farmers. The average quality efficiency of 79% and 88% for small-scale and large-scale raisin producers highlights that there is a scope for other farmers to improve their efficiency level. On the other hand, the relatively high average quality efficiency score for both farming groups might also indicate that farmers are not experiencing extreme negative distraction and challenges in producing good quality raisins. In addition, results reveal that variations in quality efficiency are minimal compared to production efficiency.

5.4.2.2 Determinants of quality efficiency

Quality efficiency results reveal little variation in the quality efficiency levels of the farmers. Thus, the regression model could not find any of the estimated variables to be significant. The non-significance of variables suggests that variations are not sufficient to justify the significance of the estimated variables. Moreover, the results indicate that quality efficiency is not the major cause of inefficiencies for raisin farmers in Eksteenskuil. On the other hand, the single marketing channel used by small-scale farmers is likely to be the cause of limited variations in quality efficiency while large-scale farmers use different marketing channels for their raisins.

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5.5 CONCLUSION

The inability of Eksteenskuil farmers to supply the required raisin volume of adequate quality was verified through the adoption of the two-stage model which identified serious managerial inefficiencies amongst Eksteenskuil raisin producers. The results of this study highlight that low technical efficiencies are associated more with maximisation of raisin volumes and not necessarily with raisin quality. The combined benchmarking of small-scale and large-scale farmers against each other revealed a rational picture about the efficiencies of the area compared to benchmarking of small-scale and large-scale farmers separate from each other. The study also revealed that overall average efficiencies of Eksteenskuil farmers can only increase if farmers realise that their individual efficiencies should increase in order to maintain their participation in the FT market. Thus, there is a need for less efficient small-scale raisin producers to review their production practices with intention to meet raisin demand in the FT market. Furthermore if low efficiencies are not addressed urgently, household income would be lost and poverty will increase for the Eksteenskuil community.

The conclusion is that low efficiencies at production level should be addressed through the promotion of acquiring formal education, secure land tenure which will eventually influence access to formal credit, record keeping, timely pruning, acquiring entrepreneur knowledge, looking after the soil through soil fertilisation and expanding land under vineyards for raisin production. The promotion of the above mentioned factors is recognised as the role of both farm managers and government. The government is expected to provide title deeds that would secure the tenure of farmers and subsequently allow farmers to obtain credit and invest in the land. The remaining factors are more in the hands of the farm manager. However, it is acknowledged that farmer's age, farming experience improves the efficiency level but the factors are beyond the farmer's control. The fact that none of the estimated variables were found to affect the efficiencies of raisin quality may be attributed to variations that were acknowledged to be too little.

The findings of this study recognise that the two-stage DEA model is a valuable tool that is able to identify the existence of inefficiencies in a multiple production analysis. The two-stage model demonstrated a greater insight into the locations of organisational inefficiencies. Further, the analysis also provides an opportunity to decision makers searching for the efficient stage to improve their raisin volumes or revenue. The two-stage DEA model also provides managers and policy makers an opportunity to develop strategies that will move less efficient decisions towards the efficient frontier.

5.6 RECOMMENDATIONS, POLICY IMPLICATIONS AND IMPLICATIONS FOR FURTHER RESEARCH

Policy implications drawn from the result include the acceleration of secure land tenure by responsible government department to legitimate owners of the land. Once tenure is secured, it is anticipated that sourcing credit will become simpler and farmers will be keen on undertaking long term investment in the land. Further, education and training should be given attention by government when developing and designing agricultural development strategies. Education and training empower farmers with knowledge and skills to operate in a different way that enhances their performance.

The existing support from FT and other stakeholders is understood to have sustained Eksteenskuil farmers to continue participating in commercial markets. On the other hand, stakeholder support is recommended to continue because it provides Eksteenskuil farmers an opportunity to develop themselves without seeking donation or hand-outs. The inability of Eksteenskuil farmers to supply required raisin volumes of adequate quality to the FT market can be addressed if managerial remedies are directed towards the increase in yields. Thus, Eksteenskuil farmers need to reassess their production practices and work collectively with efficient farmers with the intention of protecting their niche market.

For further research, the impact of FT on Eksteenskuil farmers was not entirely explored. The scope exists to conduct a study that would specifically pay attention to the role that FT plays. FT was understood to be playing a huge role in Eksteenskuil and their model would be valuable if it could be replicated to other developing agri-businesses in the country. In addition, this study did not attempt to estimate different types of social capital. Differentiating between productive and unproductive social capital would perhaps have provided a more accurate impact of social capital on technical efficiency.

Social capital is among the most ignored source of development for small-scale farmers. Social capital acts as the culture of the community that an outsider may find it difficult to understand. However, research scope in this regard exists and such knowledge would be valuable in understanding the dynamics of the area for development intervention. Further, research may be necessary to get a better understanding of the impact of a single marketing channel to quality efficiency variations as this would provide an understanding of quality efficiencies among Eksteenskuil farmers.

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APPENDIX A: QUESTIONNAIRE

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INSTRUCTION: TO BE COMPLETED BY THE RESEARCHER ON BEHALF OF THE PRINCIPAL DECISION MAKER ON THE FARM. INFORMATION WILL BE STRICTLY CONFIDENTIAL

Respondent number ____________ Date of interview ____________

Interviewer number ____-____

1 Socio economic questions

1.1 Age ____-____ years

1.2 Years of formal education (Matric = 12 years)? ____-____ years

1.3 Years in farming ____-____ years

1.4 How far is your farm from the market? ____-____ km

1.5 If farmer is from Eksteenskuil, on which island is the farm?

North Island	1
Middle Island	2
South Island	3

1.6 Please indicate the proportion of your **total** income (farm + off-farm) coming from the following activities:

Income generating activities	**%**
Off-farm economic activities	
Raisin production	
Wine/juice production	
Table grapes	
Crop rotation	
Livestock	
Other	
	100%

2 Land ownership and tenure

2.1 Which of the following best describes your form of land ownership or tenure?

1	I own my land and have title deeds or a land letter from government
2	I own my land and lease **additional** land from another farmer
3	I lease my land from another farmer who does have title deeds
4	I lease my land from government waiting for the transfer of title deeds to me
5	Other (please specify) ______________________________

If 4, would you be willing to sell or lease all or part of your land once you receive the title deeds?

	Yes	**No**
Sell	1	0
Lease	1	0

2.2 Would you like to expand the size of the land you are currently cultivating?

Yes	**No**
1	0

3 Production activities

3.1 Please complete the following table with regard to the size of your farm (own + lease) and the scale of your **raisin** production activities.

	Total farm size (ha)	Total area used for raisin production (ha)		Area harvested (ha)	
		Sultana	Merbein	Sultana	Merbein
2008/9					

3.2 **As at 2008/9**, what size (in ha) of your total established vineyards is:

Between 0 and 4 years old? ________

Between 5 and 10 years old? ________

Between 11 and 24 years old? ________

Older than 25 years? ________

3.3 Please complete the following table with regard to production during the previous seasons.

		Volume delivered (kg)	Choice grade		Standard grade		Industrial grade	
			%	Price	%	Price	%	Price
2008/9	Thompson							
	Golden							
	OR							

3.4 Please indicate which of the following extraordinary activities took place during the past seasons that negatively affected your yield.

Season	None	Hail	Extreme cold at blooming stage	Other
2008/9	0	1	**2**	3

3.5 Please indicate which of the following actors in the value chain normally provide you with advice and/or assistance with regard to raisin production

Actor	No	Yes	Organisation
Input suppliers	0	1	
Buyers	0	1	
Government	0	1	
Other farmers	0	1	
Cooperative	0	1	
Research institutes	0	1	
Private consultants	0	1	

- If you have received assistance/training, please indicate on a scale from 1 to 5 the level to which you agree with the following statements:

Statement	Strongly disagree		Neutral		Strongly agree
I attend **all** of the training sessions that are held in the region.	1	2	3	4	5
I **fully** understand the advice and/or training I receive from the above organisations.	1	2	3	4	5
I implement **all** the advice I receive from the above organisations	1	2	3	4	5

3.6 Please indicate what type of irrigation technology you use for **raisin** production.

Flood irrigation	1
Drip irrigation	2
Other	3

3.7 Please indicate whether you use manual or mechanic labour when performing the following activities

Activity	Manual	Mechanic	
		I borrow/lease the implement	I own the implement
Weeding	0	1	2
Applying pesticide	0	1	2
Pruning/Harvesting	0	1	2

3.8 Do you have access to the following sources of credit?

	YES	NO
Formal (Formal lending institutions)	1	0
Informal (i.e. Family and friends)	1	0

If **NO**, please indicate the level to which the following factors prevent you from having access to credit

Factor preventing access to credit	**Not at all**				**Main reason**
I do not have title deeds of my land and thus I do not have the required collateral	1	2	3	4	5
I do not have a credit record at credit providers	1	2	3	4	5
I do not have family members with sufficient surplus money to fund me	1	2	3	4	5
Other	1	2	3	4	5

3.9 Please indicate on a scale from 1 to 5 the level to which you agree with the following statements:

Statement	**Strongly disagree**		**Neutral**		**Strongly agree**
In general the road network in the region is of a good quality	1	2	3	4	5
In general the water distribution network is in a good condition	1	2	3	4	5
In general the infrastructure at the input suppliers is of good quality	1	2	3	4	5
In general the infrastructure at the market is of good quality	1	2	3	4	5
In general water quality constrains my performance	1	2	3	4	5

3.10 Please indicate the amount of the respective inputs you've used for your 2008/9 **raisin** crop and how much you spent on the respective inputs.

Items		Amount **(per ha)**	Amount **(total)**	Amount spent
Fertilizer (granular) (specify NPK +concentration)		kg	kg	R
Fertilizer ((liquid) (Specify NPK + conc.))		l	l	R
Kraal manure (specify type & unit)				R
Semi-organic fertilizer (specify NPK +conc.)		kg	kg	R
Pesticide		l	l	R
Water (Sultana)		irr	irr	R
Water (Merbein)		irr	irr	
Labour: Full time		#	#	R
		days	days	
Labour: Seasonal	Pruning		#	R
			days	
	Harvesting		#	R
			days	
Number of family members providing family labour for the production of raisins (older than 15 years)		#	#	R
		days	days	
Fuel (used specifically for raisin production)		l	l	R
Leaf feed		kg	kg	R
Number of times you weed (manual/mechanic/ chemical) per year		#	#	R

3.11 What was your total cost (variable +fixed) for raisin production during the 2008/9 season? R ________

3.12 In your opinion, did you apply a sufficient amount of inputs to obtain an optimal yield?

Yes	No

Reasons	**Not at all**				**Main reason**
Input costs are too high	1	2	3	4	5
I don't have sufficient cash flow by the time I need to apply the inputs	1	2	3	4	5

3.13 On a scale from 1 - 5 please indicate the level to which you agree with the following statement (1 = not at all; 5 = 100%)

Statement	Not at all				100%
During the past year my farm workers visited the doctor **much more** compared to previous years	1	2	3	4	5

4 Marketing behaviour

The following questions relate to the marketing of **raisins**

4.1 Which marketing channel best describes the channel within which you participate?

Farmer --- Processor --- Retail --- Consumer	1
Farmer --- Transporter (middle man) --- Processor --- Retail --- Consumer	2
Farmer --- Processor --- **Fairtrade** --- Retail --- Consumer	3

4.2

Which of the following statements best describes the Fairtrade initiative (choose only one of the available alternatives)?	
Everybody gets treated equally and in a fair manner	1
Previously marginalised producers get a better price	2
Emerging farmers get the same price and treatment as commercial farmers	3

4.3 Please indicate the level to which the following reasons influence your decision to participate in the specific channel as mentioned in 4.1?

Reasons	Not at all				Main reason
I obtain higher prices	1	2	3	4	5
I incur lower marketing costs	1	2	3	4	5
I obtain more market information	1	2	3	4	5
It is more convenient than other alternatives	1	2	3	4	5
It is the only available marketing channel that I can use	1	2	3	4	5
The specific channel is less risky than the other	1	2	3	4	5
Other (Specify)	1	2	3	4	5

4.4 Please indicate which of the following best describes the way you deliver your raisins to your buyer, and the cost of transporting raisins.

Means of transporting raisins to buyer	
I transport my raisins to the buyer with my own truck	1
I pay someone else to transport my raisins to the buyer	2
The buyer comes to my farm to collect my raisins	3

4.5 What proportion of your total raisin crop did you sell to the following buyer(s). State only the percentage at the specific buyer to which you've sold.

Carpe diem	Fruits du Sud	Kalahari Raisins	Redsun raisins	SAD	TRC	Other (Specify):			
									100%

If you sold your raisins to SAD, did you participate in the risk sharing scheme?

Yes	No
1	0

4.6 Please indicate on a scale from 1-5 the level to which you are able to influence the price you receive for your raisins through negotiation (1=not at all; 5=100%)

Not at all				100%
1	2	3	4	5

4.7 Please indicate the level to which the following reasons influence your decision to sell your raisins to the specific processor

Reasons	**Not at all**				**Main reason**
I obtain higher prices	1	2	3	4	5
I have a long term relationship with the specific processor so I feel loyal towards them	1	2	3	4	5
I obtain more market information from the specific processor compared to other	1	2	3	4	5
They come and collect my raisins from my farm	1	2	3	4	5
I can negotiate with the specific processor for a better price for my raisins	1	2	3	4	5
Other (Specify)	1	2	3	4	5

4.8 Do you have a preferred processor to which to like to sell your raisins?

Yes	No
1	0

If YES, please indicate the level to which the following reasons will convince you to sell your raisins to another processor.

Reasons	**Not at all**				**Main reason**
If the price of the other processor is higher than the current price I can receive	1	2	3	4	5
If the other processor provides more information/assistance/training	1	2	3	4	5
If the other processor is willing to collect my raisins from my farm	1	2	3	4	5
If the trust relationship between my preferred processor and myself is compromised	1	2	3	4	5
If the other processor is willing to negotiate for a better price for my raisins	1	2	3	4	5
If the other processor will grade my raisins a larger percentage choice grade	1	2	3	4	5
Other (Specify)	1	2	3	4	5

4.9 In your opinion, which of the processing companies has got the most power in the market?

Carpe diem	Fruits du Sud	Kalahari Raisins	Redsun raisins	SAD	TRC
1	2	3	4	5	6

4.10 Where do you get your price information?

Other farmers	1
Buyers (via sms/telephone call)	2
Buyers (you visit them for price information)	3
Other: ____________________	4

4.11 How many buyers do you consult before you sell your raisins?

1	2	3	4	5	>5

How long did it take you to determine which buyer to sell to?

<1h	1-2h	2-3h	>3h

How many transactions do you engage with buyers (i.e. How many loads do you deliver)?

<3	4-6	7-9	10-12	13-15	>15

4.12 Which of the following best describes your relationship with your buyer:

No formal agreement	0
Short term relationship	1
Long term relationship	2

4.13 If you do have a formal agreement with your buyer, do you write down what you agreed upon

Yes	No
1	0

If YES, what are the main specifications of the written agreement?

Price	1
Price and volume	2
Price, volume and quality	3
Price and quality	4
Volume	5
Volume and quality	6

4.14

Please answer **YES** or **NO** to the following questions	**YES**	**NO**
Do you plan to have future transactions with your current buyer?	1	0
Have you ever experienced delayed payment from buyer?	1	0
Do you receive financial support/credit from buyer?	1	0
Have you ever had conflicts with the buyer?	1	0
Do you always know current raisin prices?	1	0
Do you own vehicle/implements that are **specifically** used for raisins production and/or transporting raisins to the market?	1	0
Have you invested in storage facilities for raisins?	1	0
Have you invested in packaging facilities for raisins?	1	0
Have you invested in processing facilities for raisins (trays, mats)?	1	0
Do you agree that the buyer withhold important information?	1	0
Do you sometimes tend to withhold information from buyers?	1	0

- If important information was withheld, it would most likely be about:

Withheld information	**By buyer**	**By You**
prices	1	1
chemicals used	2	2
quality (true reflection of my grade, etc.)	3	3
volumes	4	4
what other farmers are doing / are not doing	5	5
market demand	6	6
other:	7	7

4.15 On a scale from 1 to 5 please indicate the level to which you agree with the following statements

	Not at all				Agree 100%
I am willing to cooperate with other farmers to **buy inputs**	1	2	3	4	5
I am willing to cooperate with other farmers to **sell my raisins**	1	2	3	4	5
I am willing to work with other farmers to process raisins in order to **add value** ourselves	1	2	3	4	5

- If scoring 2 or less, please rank the level to which the following factors prevent you from cooperating with other farmers.

Reasons	**Not at all**				**Main reason**
I do not trust the other farmers	1	2	3	4	5
I like to make my own decisions and do things the way I want to do it.	1	2	3	4	5
I am afraid that the quality of the other farmer's produce is poor which will cause my grading to be lower than it should.	1	2	3	4	5
Other (Specify)	1	2	3	4	5

5 Product Control

5.1 **Compared to other farmers in the region** please indicate on a scale from 1-7 the level to which you **use** the following activities to ensure the highest possible **yield.**

Activity	**Not at all**						**Always**
Timely and sufficient irrigation	1	2	3	4	5	6	7
Remove weeds below the vineyards	1	2	3	4	5	6	7
Timely pruning	1	2	3	4	5	6	7
Preventing soil compaction	1	2	3	4	5	6	7
Use same pruning team every year	1	2	3	4	5	6	7
Use same harvesting team every year	1	2	3	4	5	6	7
Use enough fertiliser	1	2	3	4	5	6	7
Use leaf feed	1	2	3	4	5	6	7
Ensure presence of organic ground cover	1	2	3	4	5	6	7

5.2 Please indicate when you have applied fertilizer during the following stages:

After harvest	Did not apply	Feb	Mar	Apr
After blooming	Did not apply	Aug	Sep	Oct
At fruit bearing (met set)	Did not apply	Sep	Oct	Nov

5.3 **Compared to other farmers in the region** please indicate on a scale from 1-7 the level to which you use the following activities to ensure a high proportion of Choice grade raisins.

Activity	**Not at all**						**Always**
Timely irrigation	1	2	3	4	5	6	7
Remove weeds	1	2	3	4	5	6	7
Timely pruning	1	2	3	4	5	6	7
Leaf management for exposure to sunlight	1	2	3	4	5	6	7
Testing maturity of the grape before harvest	1	2	3	4	5	6	7
Wait until the whole block is ready to be harvested before starting to harvest	1	2	3	4	5	6	7
Eliminating damaged/ contaminated grapes	1	2	3	4	5	6	7
You oversee all activities to ensure that harvested grapes are handled with care	1	2	3	4	5	6	7
Cleanliness of drying trays	1	2	3	4	5	6	7
Avoid over-stacking when drying	1	2	3	4	5	6	7
Turning over raisins when drying	1	2	3	4	5	6	7
Cover when raining	1	2	3	4	5	6	7
Use same pruning team every year	1	2	3	4	5	6	7
Use same harvesting team every year	1	2	3	4	5	6	7

5.4 Please indicate which of the following methods is the **final** method you use to test whether or not your grapes are ready to be harvested

I squash the grape between my fingers to see whether it is sticky	1
I taste the grapes to determine whether it is sweet enough	2
I take a sample to another farmer who test the sugar content with a test kit	3
I take a sample to the buyer who test the sugar content with a test kit	4
I have a test kit to test the sugar content	5

6 Financial records

6.1 On a scale from 1 - 5, please rate the following statements with regard to financial record keeping

Statement	Not at all				100%
I make sure that my financial statements are kept up to date	1	2	3	4	5

6.2 What is the debt-asset ratio of your farm business? ________________

APPENDIX B:

B1: PRINCIPAL COMPONENT REPORT OF EIGEN VALUES (FOR PRODUCTION EFFICIENCY)

Eigenvalues

<table>
<tr><th>No.</th><th>Eigenvalue</th><th>Individual Percent</th><th>Cumulative Percent</th><th>Scree Plot</th></tr>
<tr><td>1</td><td>4.564168</td><td>21.73</td><td>21.73</td><td>|||||</td></tr>
<tr><td>2</td><td>2.645806</td><td>12.60</td><td>34.33</td><td>|||</td></tr>
<tr><td>3</td><td>2.441287</td><td>11.63</td><td>45.96</td><td>|||</td></tr>
<tr><td>4</td><td>1.878127</td><td>8.94</td><td>54.90</td><td>||</td></tr>
<tr><td>5</td><td>1.758874</td><td>8.38</td><td>63.28</td><td>||</td></tr>
<tr><td>6</td><td>1.243117</td><td>5.92</td><td>69.20</td><td>||</td></tr>
<tr><td>7</td><td>1.201390</td><td>5.72</td><td>74.92</td><td>||</td></tr>
<tr><td>8</td><td>0.985535</td><td>4.69</td><td>79.61</td><td>|</td></tr>
<tr><td>9</td><td>0.780418</td><td>3.72</td><td>83.33</td><td>|</td></tr>
<tr><td>10</td><td>0.718154</td><td>3.42</td><td>86.75</td><td>|</td></tr>
<tr><td>11</td><td>0.694417</td><td>3.31</td><td>90.05</td><td>|</td></tr>
<tr><td>12</td><td>0.471216</td><td>2.24</td><td>92.30</td><td>|</td></tr>
<tr><td>13</td><td>0.434162</td><td>2.07</td><td>94.37</td><td>|</td></tr>
<tr><td>14</td><td>0.357002</td><td>1.70</td><td>96.07</td><td>|</td></tr>
<tr><td>15</td><td>0.211257</td><td>1.01</td><td>97.07</td><td>|</td></tr>
<tr><td>16</td><td>0.200117</td><td>0.95</td><td>98.02</td><td>|</td></tr>
<tr><td>17</td><td>0.157010</td><td>0.75</td><td>98.77</td><td>|</td></tr>
<tr><td>18</td><td>0.105577</td><td>0.50</td><td>99.27</td><td>|</td></tr>
<tr><td>19</td><td>0.077722</td><td>0.37</td><td>99.64</td><td>|</td></tr>
<tr><td>20</td><td>0.039393</td><td>0.19</td><td>99.83</td><td>|</td></tr>
<tr><td>21</td><td>0.035253</td><td>0.17</td><td>100.00</td><td>|</td></tr>
</table>

B2: PRINCIPAL COMPONENT REPORT OF EIGENVALUES (FOR QUALITY EFFICIENCY)

Eigenvalues

<table>
<tr><th>No.</th><th>Eigenvalue</th><th>Individual Percent</th><th>Cumulative Percent</th><th>Scree Plot</th></tr>
<tr><td>1</td><td>5.447424</td><td>34.05</td><td>34.05</td><td>|||||||</td></tr>
<tr><td>2</td><td>2.838243</td><td>17.74</td><td>51.79</td><td>||||</td></tr>
<tr><td>3</td><td>1.590629</td><td>9.94</td><td>61.73</td><td>||</td></tr>
<tr><td>4</td><td>1.289587</td><td>8.06</td><td>69.79</td><td>||</td></tr>
<tr><td>5</td><td>1.107320</td><td>6.92</td><td>76.71</td><td>||</td></tr>
<tr><td>6</td><td>1.003446</td><td>6.27</td><td>82.98</td><td>||</td></tr>
<tr><td>7</td><td>0.631390</td><td>3.95</td><td>86.93</td><td>|</td></tr>
<tr><td>8</td><td>0.577970</td><td>3.61</td><td>90.54</td><td>|</td></tr>
<tr><td>9</td><td>0.414147</td><td>2.59</td><td>93.13</td><td>|</td></tr>
<tr><td>10</td><td>0.317203</td><td>1.98</td><td>95.11</td><td>|</td></tr>
<tr><td>11</td><td>0.245046</td><td>1.53</td><td>96.64</td><td>|</td></tr>
<tr><td>12</td><td>0.168777</td><td>1.05</td><td>97.69</td><td>|</td></tr>
<tr><td>13</td><td>0.144397</td><td>0.90</td><td>98.60</td><td>|</td></tr>
<tr><td>14</td><td>0.090375</td><td>0.56</td><td>99.16</td><td>|</td></tr>
<tr><td>15</td><td>0.079474</td><td>0.50</td><td>99.66</td><td>|</td></tr>
<tr><td>16</td><td>0.054572</td><td>0.34</td><td>100.00</td><td>|</td></tr>
</table>

APPENDIX C:

C1: EIGENVECTORS (FOR PRODUCTION EFFICIENCY)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Farmers_age	0.1165	0.0260	-0.3119	-0.3717	0.0092	-0.4714	0.0724
Formal_educ	-0.2685	0.0727	0.3638	-0.0234	0.2885	0.0591	-0.0017
Farming_exp	0.1371	0.3589	-0.2337	-0.2092	-0.1880	0.0319	0.0715
off_farm_act	-0.1843	-0.2700	0.1864	-0.1995	0.2822	-0.0496	-0.1322
Land_tenure	-0.1554	0.3095	0.0696	-0.4279	0.1471	0.0116	-0.1441
Young_vines	-0.1722	-0.3708	0.0094	-0.1316	-0.2933	0.0123	-0.0326
Old_vines	-0.0667	0.1344	0.0473	0.5065	0.0070	-0.1880	-0.3877
Formal_credit	-0.1561	0.2041	0.1980	-0.0911	0.2250	-0.2538	0.1835
Informal_credit	-0.1131	0.2482	0.2676	-0.2025	-0.2893	0.2229	-0.4073
Labour_health	0.1323	-0.0132	0.2389	-0.2614	-0.5092	-0.1400	-0.0293
Record_keeping	-0.2448	0.1692	0.0217	0.1345	-0.3453	-0.0246	-0.0315
Fam_lab	0.2810	-0.3579	-0.0223	-0.1640	-0.0983	0.1382	0.0004
Tiime_suff_irrig	-0.3425	-0.0535	-0.3163	0.0512	-0.0619	-0.0215	-0.0638
Remove_weeds	-0.3449	-0.0699	-0.2707	-0.0046	-0.0718	-0.1338	-0.0646
Timely_pruning	-0.2226	-0.0342	-0.4159	-0.1150	0.0836	0.2810	0.1060
Prevent_soil_comp	-0.3755	-0.0666	-0.2129	0.0036	-0.0339	0.1244	-0.0657
Prune_team	0.2501	0.0059	-0.0563	0.0419	0.2598	-0.0044	0.0921
entrepreneurscore	-0.2340	-0.1840	0.2224	-0.2960	0.0993	0.1518	0.1780
DMIsland	-0.1151	-0.0448	0.1901	0.2209	-0.2434	0.2434	0.5958
SCI	-0.1724	-0.2813	0.1564	0.0641	-0.1172	-0.5993	0.0789
Area	-0.1505	0.3905	0.0144	0.0104	-0.0648	-0.1658	0.4164

C2: Square of eigenvector elements (for production efficiency)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Farmers_age	0.0136	0.0007	0.0973	0.1381	0.0001	0.2223	0.0052
Formal_educ	0.0721	0.0053	0.1324	0.0005	0.0832	0.0035	0.0000
Farming_exp	0.0188	0.1288	0.0546	0.0438	0.0353	0.0010	0.0051
off_farm_act	0.0340	0.0729	0.0348	0.0398	0.0796	0.0025	0.0175
Land_tenure	0.0242	0.0958	0.0048	0.1831	0.0216	0.0001	0.0208
Young_vines	0.0297	0.1375	0.0001	0.0173	0.0860	0.0002	0.0011
Old_vines	0.0045	0.0181	0.0022	0.2566	0.0000	0.0354	0.1503
Formal_credit	0.0244	0.0416	0.0392	0.0083	0.0506	0.0644	0.0337
Informal_credit	0.0128	0.0616	0.0716	0.0410	0.0837	0.0497	0.1659
Labour_health	0.0175	0.0002	0.0571	0.0683	0.2592	0.0196	0.0009
Record_keeping	0.0599	0.0286	0.0005	0.0181	0.1192	0.0006	0.0010
Fam_lab	0.0789	0.1281	0.0005	0.0269	0.0097	0.0191	0.0000
Tiime_suff_irrig	0.1173	0.0029	0.1000	0.0026	0.0038	0.0005	0.0041
Remove_weeds	0.1190	0.0049	0.0733	0.0000	0.0052	0.0179	0.0042
Timely_pruning	0.0496	0.0012	0.1730	0.0132	0.0070	0.0790	0.0112
Prevent_soil_comp	0.1410	0.0044	0.0453	0.0000	0.0011	0.0155	0.0043
Prune_team	0.0625	0.0000	0.0032	0.0018	0.0675	0.0000	0.0085
entrepreneurscore	0.0548	0.0338	0.0494	0.0876	0.0099	0.0230	0.0317
DMIsland	0.0132	0.0020	0.0361	0.0488	0.0592	0.0592	0.3550
SCI	0.0297	0.0791	0.0245	0.0041	0.0137	0.3592	0.0062
Area	0.0227	0.1525	0.0002	0.0001	0.0042	0.0275	0.1734

C3: Eigenvectors (for quality efficiency)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Harvesteam	0.1715	0.0834	-0.3616	-0.1897	0.0039	-0.6685
Leafmgnt	0.2808	-0.0269	0.3827	0.2501	-0.3327	-0.0638
Delayharv	0.2210	0.3377	-0.0042	-0.3150	-0.0630	0.0902
Eliminate	0.1838	0.2025	0.3537	-0.2914	0.2684	0.2670
Overseeact	0.3503	0.0581	-0.1798	-0.0835	0.0429	0.3187
Cleantrays	0.3782	0.0014	-0.1126	0.1312	-0.0570	-0.0162
Avoidstack	0.3526	0.0741	-0.0926	-0.2076	0.0110	0.3302
Turnraisins	0.3289	-0.0990	-0.3392	0.0500	-0.0347	-0.0600
Covrain	0.2124	-0.1115	-0.0981	-0.0482	0.6665	-0.1951
SCI_Mtest5	0.0459	-0.4971	0.0446	-0.3082	-0.0222	0.0126
Timelyprun	0.3523	-0.0457	0.1929	0.1947	-0.0698	-0.1260
Timelyirrig	0.3482	-0.0736	0.0498	0.2601	-0.2342	-0.0571
entrepreneurscore	0.1085	-0.0135	0.4923	0.2425	0.4336	-0.2362
SCI_Mtest3_4	-0.0661	0.1579	-0.3454	0.6040	0.1835	0.2629
Area	0.0335	-0.5432	0.0359	-0.0857	-0.1564	0.0386
Fam_lab	-0.0306	0.4810	0.1217	-0.1170	-0.2375	-0.2672

C4: Square of eigenvector elements (for quality efficiency)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Harvesteam	0.0294	0.0070	0.1307	0.0360	0.0000	0.4469
Leafmgnt	0.0788	0.0007	0.1465	0.0625	0.1107	0.0041
Delayharv	0.0489	0.1140	0.0000	0.0992	0.0040	0.0081
Eliminate	0.0338	0.0410	0.1251	0.0849	0.0720	0.0713
Overseeact	0.1227	0.0034	0.0323	0.0070	0.0018	0.1016
Cleantrays	0.1431	0.0000	0.0127	0.0172	0.0032	0.0003
Avoidstack	0.1243	0.0055	0.0086	0.0431	0.0001	0.1090
Turnraisins	0.1082	0.0098	0.1151	0.0025	0.0012	0.0036
Covrain	0.0451	0.0124	0.0096	0.0023	0.4442	0.0380
SCI_Mtest5	0.0021	0.2471	0.0020	0.0950	0.0005	0.0002
Timelyprun	0.1241	0.0021	0.0372	0.0379	0.0049	0.0159
Timelyirrig	0.1213	0.0054	0.0025	0.0677	0.0549	0.0033
entrepreneurscore	0.0118	0.0002	0.2423	0.0588	0.1880	0.0558
SCI_Mtest3_4	0.0044	0.0249	0.1193	0.3649	0.0337	0.0691
Area	0.0011	0.2951	0.0013	0.0073	0.0245	0.0015
Fam_lab	0.0009	0.2314	0.0148	0.0137	0.0564	0.0714