ECONOMIC IMPACTS OF LARGE-SCALE LAND INVESTMENTS ALONG THE EMERGING CHISUMBANJE SUGARCANE BIO-ETHANOL VALUE CHAIN IN ZIMBABWE

By

CUTHBERT KAMBANJE

Thesis submitted in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN AGRICULTURE (AGRICULTURAL ECONOMICS)

In

THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND ANIMAL PRODUCTION

In the
FACULTY OF SCIENCE AND AGRICULTURE
SCHOOL OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

At the
UNIVERSITY OF LIMPOPO

SUPERVISOR: **PROF A. BELETE**
CO-SUPERVISOR: **DR P. CHAMINUKA**

2016

Declaration

“I declare that the thesis entitled ‘Economic Impacts of Large-scale Land Investments Along the Emerging Chisumbanje Sugarcane Bio-Ethanol Value Chain in Zimbabwe’ hereby submitted to the University of Limpopo, for the degree of Doctor of Philosophy Degree in Agricultural Economics has not previously been submitted by me for a degree at this or any other University; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.”

Name……Signature……...Date……..……

Dedication

To Fortune for the unconditional love and my family for the unwavering support, you all are the greatest!

Acknowledgements

Foremost, I thank my lord, my creator, the one who rules, for allowing me to live through my dreams! A lot of people contributed to this product over the long journey; as one African adage goes, 'it takes a village to raise a child'! To my supervisors, Prof Abenet Belete and Dr Petronella Chaminuka, thank you very much for keeping me on the academic rails and guiding me to produce a product that will contribute to knowledge. Your consistent reviews and robust critiques sharpened not just the thesis, but also my intellect and in general my approach to life. I also thank members of the academic team at the Department of Agricultural Economics and Animal Production, those at the School of Agricultural and Environmental Sciences and the Faculty of Science and Agriculture whose ideas, reviews and comments contributed to this product right from proposal development to the point of thesis submission.

To the team at FAOZA, I say thank you for providing a home for showcasing my capabilities, and providing opportunities for me to grow professionally and within the realms of what I can do best. In particular, to Dr Tobias Takavarasha, I extend my highest gratitude for making me who I am today. I owe you a lot, Shumba! To the team at Barefoot Education for Afrika Trust, I say thank you for shaping my intellect and growing my strategic thinking capacities. In particular, Professor Mandivamba Rukuni, I thank you for making me what I am today. I owe you a lot, Moyondizvo. To the team at Ruzivo trust, I say thank you for the support including the data collection phase in Chisumbanje. In particular to Dr Prosper Matondi, thank you for making me what I am today! Special mention goes to my brother in law, Chief Nhema, Tsano Pardon, in facilitating my studies, I always came to you for everything, and I know they know you better than they know me in the department. I could not always be there at campus, but you were my eyes and ears throughout the journey. Thank you Baba, I owe you!

To my mother, Mbuya vaFidhe, I say thank you for making me what I am. You knew better, somehow, that God had this in the grand plan. Now you can relax and celebrate as your children, grandchildren and great-grand children come to the party. To my children and nephews, Fidelia, Silas, Blessing, Kudakwashe (Nicrose),

Munyaradzi Vannessa, Hope, Notia, Destiny, Chris, Tyron, Nigel, Michael, Chadley, Chengetai, Tinashe(General), Talitha and so on, here is a mark and a challenge to you! My sisters and brothers, Mai Blessing, Nyasha and wife, Moline, Bothwell and wife, Fungie, Melody, Blantina, Grace, Mkoma Jacob, Mkoma Jonathan, and all that I did not mention thank you for the support. To Baba Blessing, Mangwende, Dube, Mapfumo and all others (you know each other), thanks guys for the support. To my second mother in Zaka, I know I am blessed to have two mothers in a single lifetime. Thank you for your support and continuous encouragement. To my aunties, and Bamnini Chiko, Mainini Memo and all brothers in laws, Zvirandu, here is a present, and to Bamkuru Mgadza, you remain my beacon of achievement.

Lastly to my wife, my angel, and my companion, you cried when I was crying, you also jumped, when I was jumping from happiness, I thank you for standing by me always. For those I have not mentioned, kindly forgive me for the oversight. Your contribution to this project remains highly valued!

Abstract

Economic Impacts of Large-Scale Land Investments along the Emerging Chisumbanje Sugarcane Bio-ethanol Value Chain in Zimbabwe

Large-scale investments in agricultural land for biofuels production have become a common phenomenon in Africa. In Zimbabwe, the government went into a partnership with a private investor to set up the Chisumbanje ethanol project. Statutory provisions and regulations make it impossible for any bio ethanol producers who are not in partnership with government to produce and sell bio ethanol for petrol blending purposes in Zimbabwe. There are knowledge gaps with respect to empirical understanding of the economic aspects of the emerging sugarcane bio ethanol value chain. Policy makers and development practitioners alike can benefit from empirical evidence of value and wealth creation and how they are distributed along this chain. In addition, while government has been actively changing policies with regard to ethanol, there is a dearth of empirical evidence on the impacts of these policy changes. Within the context of large-scale land investments (LSLIs), the study applies quantitative approaches to analyse the creation and distribution of value added and gross margins as well as impacts of alternative ethanol blending and indigenisation policies along the emerging bio ethanol value chain.

The study is based on both primary and secondary empirical data collected along the bio ethanol value chain starting from the primary sugarcane production process in Chisumbanje to the ethanol retail and consumption level. Data collection involved multiple approaches including household-level questionnaires, focus group discussions, key informant interviews and observation. A total of 200 questionnaires were administered at household level in Chisumbanje, while 10 focus group discussions were held with various groups including war veterans, women's groups, youths and other community members. Key informant interviews were held with a number of agents along the chain including the company's management, political leaders, traditional leaders, local and national level government officials and regulatory officials.

The study pursued three objectives. The first was to characterise the emerging sugarcane bio ethanol value chain in terms of the activities, product flows and relationships between the economic agents. Using supply utilisation accounts (SUA) and value chain governance concepts the study interrogated the typology of the key elements of this emerging value chain. It was concluded that the value chain is characterised by the pervasiveness of monopolistic tendencies and dominance of powerful private corporates being supported by government. This emerging value chain systematically excludes smallholder farming community from directly participating in the productive aspects of the chain. There are strong opportunities for rent seeking as the investor lobbies powerful players to pursue high private economic benefits. This is done through legislative changes that are in support of the investment and direct protection by powerful government and political institutions. Production systems have changed for the local communities that have been displaced and there are indications of losses of traditional livelihood sources.

The second objective was to analyse the creation and distribution of value added and gross margins along the emerging bio ethanol value chain. To achieve this objective the study customised input-output modelling and multiple gross margin analysis along the sugarcane bio ethanol value chain. The evidence shows that income distribution is skewed towards vertically integrated large corporates and this value chain in general is not inclusive of smallholder farmers. The private investor (and its subsidiaries) is getting more than 73% of the income that is generated along the whole chain. The War veterans and Settler farmers are getting 2% of the income while government through the Agricultural and Rural Development Authority (ARDA) is getting 8%. The rest of the income goes to the fuel wholesalers and numerous retailers. The analysis showed that the primary production phase where price of raw sugarcane is pegged at US$4 per tonne is a loss-making enterprise, but investors then recoup their profits after processing, which is a level that is not accessible to smallholder farmers. This pricing is a potential systematic disincentive to any potential entrants into primary sugarcane production. The analysis done brings to the fore some indications with respect to the inclusiveness of the emerging sugarcane bio ethanol value chain.

The third objective pursued was to simulate the potential impacts of alternative policy scenarios for mandatory blending levels of E5, E10, E15, E20, E85, 100% and different forms of effecting indigenisation policy on incomes and their distribution along the value chain. This objective was achieved by application of input–output (I-O) approaches developed along the value chain and counterfactual analysis. The results show that as the blending level increases the private investor gets more and more compared to other economic agents. The analysis also showed that changes in shareholding and implementation of community share ownership mechanisms are potential approaches to address the skewed distribution of income along the Sugarcane bio ethanol value chain.

Basing on the empirical findings, it is recommended that the pricing model of raw sugarcane to feed the processing plants should be reviewed to promote inclusive incorporation of smallholder farmers in the primary production process. Further, increases in ethanol blending levels should be preceded by systematic technical analysis of the impact on local and national economies and distribution of additional income generated. Changes in shareholding and community share ownership mechanisms in line with the country's indigenisation policies can potentially change the income distribution along the sugarcane bio ethanol value chain. Lastly, the study recommends further research work on the nexus between energy (fuel), water scarcity and food security within the context of large-scale land investments.

Key words: *land investments, value chain governance, political economy, supply utilisation accounts, sugarcane –bio ethanol value chain, value added, gross margins, vertical integration, mandatory blending, policy impacts*

Table of Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

ARDA	Agricultural and Rural Development Authority
AU	African Union
CBA	Cost Benefit Analysis
CEO	Chief Executive Officer
CGE	Computable General Equilibrium
COMESA	Common Market for East and Southern Africa
CSOT	Community Share Ownership Trust
CZI	Confederation of Zimbabwe Industry
DFiD	Department for International Development
EPA	Environmental Protection Agency
EU	European Union
FAO	Food And Agriculture Organisation
FGDs	Focus Group Discussions
FTLRP	Fast Track Land Reform Programme
GDP	Gross Domestic Product
GNU	Government of National Unity
GPA	Global Political Agreement
HQCF	High Quality Cassava Flour
HVO	Hydro Treated Vegetable Oil
IDBZ	Infrastructural Development Bank of Zimbabwe
IDC	Industrial Development Corporation
IDS	Institute of Development Studies
IMF	International Monetary Fund
I-O	Input-Output
MDC	Movement for Democratic Change
MEPIP	Ministry of Economic Planning and Investment Promotion
MMCZ	Minerals Marketing Corporation of Zimbabwe
MoAMID	Ministry of Agriculture Mechanisation and Irrigation Development
MSEs	Micro and Small Enterprises
MTP	Medium Term Plan
NOCZIM	National Oil Company of Zimbabwe
PEA	Political Economy Analysis
RECs	Regional Economic Communities
RED	Renewable Energy Directive
SADC	Southern African Development Community
SAM	Social Accounting Matrix
SI	Statutory Instrument
STERP	Short Term Economic Recovery Plan
SUA	Supply Utilisation Accounts
USA	United States of America
USAID	United States Agency for International Development
VA	Value Added
VCA	Value Chain Analysis
ZANU PF	Zimbabwe African National Union-Patriotic Front
ZAPF	Zimbabwe Agricultural Policy Framework
ZERA	Zimbabwe Energy Regulatory Authority
ZIM Asset	Zimbabwe Agenda for Sustainable Socio-economic Transformation
ZISCO	Zimbabwe Iron and Steel Company
ZMDC	Zimbabwe Mining Development Cooperation
ZNCC	Zimbabwe National Chamber Of Commerce

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Large-scale investments on agricultural land for biofuel production are becoming a common phenomenon in Africa. Private multinational companies from Western countries, Asian countries and sometimes from African countries are acquiring large tracts of land for the purposes of investment for biofuel production (Cotula *et al*, 2011, Matondi *et al*, 2011). In Zimbabwe, the government through the Agriculture and Rural Development Authority entered into a partnership with the Zimbabwe Bio-Energy Ltd operating as Green Fuels in February 2009 to set up the Chisumbanje ethanol[1] project. The project involves primary production of sugarcane and processing it into anhydrous bio-ethanol. The Chisumbanje Bio ethanol project, which at the time of its conception was based on a build-operate-transfer model, was established in a 20-year agreement. Primary production of sugarcane was projected to be established on over 40 000 hectares of land[2].

In support of the investment, the Zimbabwe Energy Regulatory Authority (ZERA) in August 2013 announced regulations for mandatory blending of unleaded petrol with anhydrous ethanol under the provisions of Statutory Instrument (SI) 17 of 2013 and Petroleum Act [Chapter 13:22] (ZERA, 2013). The regulations meant that all fuel

[1] Ethanol fuel is ethanol (ethyl alcohol), the same type of alcohol found in alcoholic beverages. It is most often used as a motor fuel, mainly as a biofuel additive for gasoline.

[2] There is conflict on some of the land between the investor (Zimbabwe Bio Energy and Agriculture and Rural Development Authority, ARDA) on one side, and communal farmers on one side.

service stations were to sell product popularly known as E5[3]. In October 2013, the Government of Zimbabwe announced a 10% mandatory blending for all petrol coming into the country. The ratio was raised to E15 in November 2013 under terms of Statutory Instrument 147a of 2013. The plan was to get to E20 by March 2014.

The statutory provisions and regulations make it impossible for any bio ethanol producers who are not in partnership with government to produce and sell bio ethanol for petrol blending in Zimbabwe. Therefore, as of December 2015, all the ethanol being used for mandatory blending is produced under the Chisumbanje Ethanol Project. Against the background, this study applied value chain analysis (VCA) approaches to investigate the location and distribution of value added and gross margins along the emerging sugarcane bio ethanol value chain in Zimbabwe. The study also investigated the potential impacts on different economic agents and their activities in the value chain of different policies instituted or that will be instituted, such as mandatory blending levels (E5, E10, E15 and E20), to support the investment.

1.2 Socio-economic and geo-political Setting

The economic and political situation in Zimbabwe has potentially helped shape the developments around bio ethanol production in Zimbabwe. From 1999, Zimbabwe's socio-economic and political terrain has gone through some remarkable transformations that have shaped the economic- and social position of the country.

[3] Fuel containing ethanol normally has an "E" number that explains the mixture. E10 consists of 10 % ethanol and 90 percent gasoline whereas E85 is a blend of 85 percent ethanol and 15 % gasoline. E5 and E7 are also common ethanol blends.

The formation of an opposition party[4] and the events that followed including *inter alia*, the Fast Track Land Reform Programme (FTLRP) and, most importantly, the increasing isolation of the country as its relations with Western governments became sour. According to the World Bank (2013), the economy performed badly between 2000 and 2008 with GDP declining by over 40%. Industry capacity utilisation went down to below 10%. This resulted in massive job losses and high unemployment rates of over 90%. The World Bank (2008) also notes that during this period, hyperinflation reached astronomical levels of 231 million% and the socio economic status of the general populace worsened.

Two opposing dialectical dimensions help in defining the context of post Government of National Unity (GNU) bio ethanol production and use in Zimbabwe. There has been debate on the nature and impact of targeted sanctions, with two opposing views. The first is that the West has imposed sanctions that have crippled the economy and are hurting ordinary Zimbabweans, while the second holds that Zimbabwe has undergone 'restrictive measures' without meaningful economic impact.

These debates are important to understand for positioning the analysis carried in this study because the issue of sanctions and the environment post-election could have created an ambient environment for the fuelling of government support of ethanol

[4] Movement for Democratic Change (MDC), formed in 1999,could arguably have posed a potential competitor to Zimbabwe African National Union –Patriotic Front (ZANU PF)

production. In addition it can be argued that a key driving force behind government support to bio ethanol production was the desire to bust the sanctions.

1.3 The problem statement

The investments in large-scale sugarcane production for processing into ethanol fuel that have occurred in Zimbabwe generated heightened debate in the media in particular and among the public in general. There is an active and an elevated level of debate in the public on, first, the potential impact of the investment on incomes of different agents along the value chain and, second, the potential impact of government energy policy (particularly ethanol petroleum blending levels) on incomes of different economic agents.

In developing countries, particularly in Africa, most of the current analysis on land-related biofuels investments has been based on document analysis and review of secondary literature to explore recent trends and investigate the interests and agendas shaping investments (for instance: Hall, 2011; Geisler and Feldman, 2011). The analysis of impacts has been largely based on extrapolation and limited quantitative empirical economic analysis.

1.3.1 Dilemma on ethanol blending policy

Government has been actively changing its policies on ethanol production and around the Chisumbanje ethanol project. Such policies include ethanol blending levels, indigenisation and ownership and nature of partnership between government and the investor. Further, while these changes have been happening and debates

have escalated, there is no evidence on the potential impacts of these policy changes on the welfare of the economic agents along the sugar ethanol value chain.

In theory, trade-offs have to be made between three policy objectives. These objectives are equity, efficiency and security (Pearson and Monk, 1989). In reality, these are very difficult choices to make, but choices could be simplified by availability of evidence. The analysis in this study generates evidence on some of the economic impacts on the communities in which the large-scale investments are taking place. There are possibilities that many smallholder rural households have been integrated into the new value chains carrying out different activities such as production, provision of labour and other services in many of these new value chains across Africa. There is, however, a lack of understanding of the new value chains that have emerged as systems adapt to the investments. The production, processing, marketing and distribution of traditional crops could have potentially changed as well. The roles of the traditional agents along the value chains have changed as new products are sought and as government policy shifts in support of these new value chains.

1.3.2 Information gaps on the character of emerging large-scale land-based value chains

The changes resulting from the investment in Chisumbanje created information gaps. The lack of empirical understanding of the economic aspects and performance of the whole sugar ethanol value chain that would permit informed policy decisions was a major problem identified. A lack of empirical evidence on the value added, profits and how they are distributed along biofuel value chains was identified. This

study, by generating empirical evidence on the nature of the emerging value chains in terms of the costs and benefits accruing to different economic agents, contributes to addressing the problem of a lack of an evidence-based policy on biofuels.

1.4 Purpose and objectives of the study

The purpose of this study was to deepen the understanding of the economics of the large-scale land-investment-based (LCLI) emerging sugarcane bio ethanol value chain, including the impact of certain government policies on the welfare of economic agents along the chain. This purpose is achieved by determining the location and distribution of value added and gross margins as well as the impact of government policy on economic agents along the sugar ethanol value chain. The study pursued the following specific objectives:

1. To investigate the key elements (economic agents and their activities) of the emerging sugarcane bio ethanol value chain;
2. To investigate the creation and distribution of value added and profits along the sugarcane bio ethanol value chain;
3. To simulate the potential impacts on different economic agents along the value chain of alternative policy scenarios instituted or that will be instituted (e.g. mandatory blending of E5, E10, E15, E20, E85) to support the investments; and
4. To provide policy recommendations on measures that could be instituted to minimise the unintended impacts of investments in bio ethanol production.

1.5 Research questions

The study was guided by the following research questions:

1. What are the key elements (economic agents and their activities) of the sugarcane bio ethanol value chain?
2. How are value added and profits being created and distributed among different agents along the sugarcane value chain? and,
3. What are the potential impacts of alternative policy scenarios instituted or that will be instituted (e.g. mandatory blending of E5, E10, E15, E20, E85, indigenisation) to support the investments.

1.6 Hypotheses

To guide the analysis the following hypotheses were tested:

1. The sugarcane bio ethanol value chain is not competitive;
2. The distribution of profits along the value chain is not equitable; and
3. As the level of ethanol petrol blending increases, the net benefits accruing to different agents do not increase proportionately.

1.7 Significance of the study

The study is significant in that it generates empirical evidence on how agents along biofuel value chains are organised, and how important resources and income are distributed among economic agents along the chain. By investigating the value added and gross margins and their distribution, the analysis provides a better understanding of some of the costs and benefits associated with engaging in

different agricultural activities along the value chains created through similar biofuel investments. The study also helps to identify the “winners” and “losers” of some of the sugarcane bio ethanol value-chain-related policy measures instituted by government to support the investment.

Within the wider context of the global discourse on large-scale land investments, the study contributes to the body of knowledge by generating the evidence on the impacts of such investments. Many current studies (for instance, Hall, 2011; Cotula *et al*, 2011; Mutopo, 2011) have highlighted the potential losses of livelihoods and the potential negative impacts of large-scale land investments on the environment. Some have quantified the amount of land that has been acquired and the reasons driving these investments (Anseew, 2013; Hall, 2011; Boche and Anseew, 2013). What these studies have not done is a succinct quantification of the impacts of the large-scale land investments, especially from an economic standpoint. This study deepens the analysis of wealth creation and distribution along one of the emerging value chains resulting from large-scale land investments. Further to this, the study also simulates the impacts of alternative government policies that (dis)incentive these investments; for instance, the case of blending policy sand indigenisation policy on the sugarcane bio ethanol value chain in Zimbabwe.

From a methodological standpoint, the study applies a methodology which has potentially not been used before especially when it comes to investigating economic impacts of large-scale land investments. There is no readily available evidence which shows input-output (I-O) modelling being customised and applied along a

value chain, more so modified and applied together with counterfactual analysis to analyse impacts of alternative policies. The results are unique, clear and can be readily usable as information to enrich policy development. The methodology is unique, replicable and applicable to analyse policy impacts in instances where data is a problem. Therefore the study is significant both in terms of contributing to the discourse on impacts of large-scale land investments, but also with respect to methodologies that can used to analyse impacts of policies.

1.8 Organization of thesis

This thesis is divided into eight chapters, which fit into one or the other two broad categories. Chapters 1-4 present the motivation, theoretical underpinnings and methodologies applied, whilst chapters 5-8 are the analytical and results-presentation chapters.

Specifically, in Chapter 1 the research is introduced. In Chapter 2 and 3, the literature review is presented, with Chapter 2 focusing on the global and Zimbabwean context of biofuel production. Chapter 3 provides the theoretical framework underpinning the study. Chapter 4 focuses on the research methodology and provides the conceptual and analytical frameworks for the research. It also outlines the sampling and data collection procedures adopted by the study.

Chapter 5 presents a structured empirical characterisation of the sugar bio ethanol value chain, focusing on key elements (economic agents and their activities) of the sugarcane bio ethanol value chain.

Chapter 6 takes the analysis a step further by determining the distribution of value added and profits as well as the net gains to the society when all activities in the sugar value chain are considered at social or opportunity cost prices.

Chapter 7 simulates the potential impacts of alternative policy scenarios that have some bearing on this emerging value chain.

Chapter 8 deals with summary, conclusion, policy recommendations and areas for further study.

CHAPTER TWO: CONTEXT AND EVOLUTION OF BIOFUEL PRODUCTION AND USE

2.1 Introduction

World biofuel production is gaining momentum. The contexts appear to be different but, in most instances, investments in biofuels have been supported by national governments pursuing specific economic-management objectives. Countries that have taken up biofuel production with government support are particularly driven by: the need for the countries to be self-sufficient in fuel: the need to reduce dependence on oil and fuel import for importers; and the need to capture the benefits associated with biofuel investments, such as increased revenue bases, employment and overall contribution to national economic growth. As world biofuel production enters new markets and local economies, naturally, there is potential that it is reconfiguring local contexts.

With particular focus on Africa, where factor and product markets are least developed, and in many cases missing, also where agricultural production is dominated by smallholders, this expansion brings new challenges and opportunities. However, the emergent value chains are barely understood, and so is the impact on different economic agents along the new value chains. Because this is a fairly new trend that is gaining space in modern science, the literature is still scarce and the analysis that have been done so far has not yet generated the critical mass of knowledge to inform policy development and practice across the world. This chapter presents the global and Zimbabwean context for biofuel production and use. The review focuses on trends in biofuels and in particular bio ethanol production at

various levels – global, Africa, and Zimbabwe. Literature on the geopolitical context with particular emphasis on Zimbabwe is reviewed.

2.2 Global and Southern African context of sugar ethanol production

In this section a history of ethanol production is provided showing that its use as a motor vehicle fuel started in the 18th century and has been developing since then. The second part looks at the global trends in biofuel production, use, investment and drivers for the developments in these aspects. The literature generally shows that ethanol production and use is gaining momentum and spreading to all parts of the world and is largely driven by government support for private sector investment.

2.2.1 History of ethanol as a fuel

Gustafson (2014) provides the most elaborate account of the history of ethanol production and use. This author agrees with other authors, for instance Kovarik (2008), that Ethanol was first used to power an engine in 1826. In the USA, Ethanol was used as a lighting fuel in the 1850s, but its use was curtailed when it was taxed as liquor to help pay for the Civil War. Ethanol use as a fuel continued after the tax was repealed and fuelled Henry Ford's Model T in 1908. The first ethanol blended with gasoline for use as an octane booster occurred in the 1920s and 1930s, and was in high demand during World War II because of fuel shortages. Gustafson (2014) also brings to attention that contemporary ethanol production and use began in the 1970s when petroleum-based fuel became expensive and environmental concerns involving leaded gasoline created a need for an octane. Table 2.1 provides a chronology of events in the production and use of ethanol as a fuel up to the 1990s.

Table 2.1: A chronology of events in ethanol production and use

Year	Event
1824-1826	U.S. inventor Samuel Morey, chiefly known for creating the world's first internal combustion engine, develops an engine that runs on ethanol and turpentine.
1860	German inventor Nicholas Otto uses ethanol as fuel in one of this engine.
1862	In the U.S., a special tax is placed on industrial alcohol by the Union Congress to help pay for the Civil War. The tax is $2 per gallon and this makes ethanol fall out of favour as a fuel in the U.S. Prior to 1962, ethanol was commonly used in lamps.
1896	Henry Ford builds his first automobile (The Quadricycle), and the engine is designed to run on pure ethanol. This is naturally a very important step in ethanol car industry.
1906	The 1862 tax on industrial alcohol is repealed by Congress. Ethanol is now once again a fuel of interest in the United States.
1908	The first Ford Model T leaves the factory. The engine is a flexible hybrid engine capable of using ethanol, gasoline or kerosene. This car is produced until 1927.
1919-1933	During the prohibition era in the United States, it is illegal to sell, manufacture and transport alcohol. This makes it impractical to use ethanol cars. Ethanol fuel sellers are accused of being allied with moonshiners, and ethanol could only be sold when mixed with gasoline.
1920s	World War I is over and gasoline, not ethanol, becomes the most popular fuel in the United States as well as in many other parts of the world. However, Standard Oil starts adding ethanol to gasoline to get the octane number up and reduce engine knocking.
	In Brazil, automobiles can be seen on the streets for the first time in history. Sugarcane from Brazil's huge sugarcane plantations is used to produce ethanol fuel for them.
1930s	Driving your car on gasohol becomes popular in the U.S. Midwest. Over 2 000 stations sell gasohol; this is gasoline with an ethanol content of 6%-12%.
1939-1945	World War II increases the demand for fuel, but most of the increased demand for ethanol is actually not due to driving ethanol cars but for non-fuel wartime uses.
	In Brazil, a war time law was enacted in 1943 that made it mandatory for car fuel to comprised at least 50% ethanol.
1945	World War II ends in 1945 and gasoline becomes cheap and easily accessible. This reduces the interest in ethanol cars. From a U.S. and European perspective, the following decades are not a very productive part of ethanol car history. However, in other parts of the world, such as Brazil, the interest in ethanol cars continues.
1970s	Oil embargoes and higher oil prices once again makes the ethanol car more interesting. Also, several nations worried about their increased dependence on imported oil.
1974	In the United States, the Solar Energy Research, Development, and Demonstration Act of 1974 in enacted. This leads to increased research regarding how to best turn organic materials into fuel. Yet another important step in ethanol car history has been taken.
1975	Brazil launches its Program Nacional do Álcool, a nation-wide programme intended to promote ethanol fuel on the domestic market.
1976	Once again, blending gasoline with ethanol becomes mandatory in Brazil. (Over time, the required minimum percentage has varied

	from 10% to 25% since 1976.)
1979	As an effect of the oil crisis, the Brazilian government is considering imposing a ration on gasoline.
	Mario Garnero, President of the National Association of Automotive Vehicle Manufacturers, convinces the four major automobile producers in the country – Ford, Volkswagen, General Motors and Fiat – to establish the dauntless goal of producing 1 million ethanol cars. This is equal to the entire automobile production of 1978.
	Fiat 147, the first modern car running on ethanol only, is launched on the Brazilian market that same year. Three years later, 90% of Brazil's new automobiles are ethanol cars. Garnero is dubbed "The Father of the Ethanol Car" for his role in ethanol car history.
1979	The Amoco Oil Company starts marketing alcohol-blended fuels. They are soon to be followed by others, such as Texaco, Beacon, Ashland and Chevron.
1980	The U.S. Congress places a tariff on foreign-produced ethanol to stop countries such as Brazil from selling cheap ethanol to the U.S.
1992	This is an important year in U.S. ethanol car history, because this is when the Energy Policy Act of 1992 is enacted. The Act makes it mandatory for certain car fleets to start buying vehicles capable of running on alternative fuels. The Act defines ethanol blends with at least 85% ethanol as alternative fuel. The Act also gives tax deductions to those who purchase a vehicle capable of running on alternative fuel, or convert an old vehicle for the same purpose.
2010	US domestic production capacity increased fifteen times after 1990, from 900 million US gallons to 1.63 billion US gal in 2000, to 13.5 billion US gallons in 2010[5]
2013	In January 2011 the US Environmental Protection Agency (EPA) granted a waiver to allow up to 15% of ethanol blended with gasoline E15) to be sold only for cars and light pickup trucks with a Model year of 2001 or later[6]

Source: Gustafson (2014) except 2010 and 2013,

5 Renewable Fuels Association (2011).

6 Renewable Fuels Association (2013).

2.2.2 Contemporary global biofuel trends: Status, drivers and projections

The main biofuels produced and used globally are bio ethanol, biodiesel[7], and HVO[8]. According to the REN21 global renewals status report (REN21, 2014), liquid biofuels account for the largest share of transport fuels derived from renewable energy sources. As of 2013, they fulfilled about 3% of total road-transport fuel demand, and around 2.3% of final liquid fuel demand and a very small but growing portion of aviation fuels, although the share increases in some countries such as Brazil and the USA. The REN21 report also brings to attention that global biofuel consumption and production increased 7% in 2013, to a total of 116.6 billion litres, following a slight decline in 2012. It was also noted that World fuel ethanol volumes increased by around 5% to 87.2 billion litres, and biodiesel production increased by over 11% to 26.3 billion litres, while hydro treated vegetable oil (HVO) continued to increase, but from a low base.

The world's top five ethanol producers are the United States, Brazil, China, Canada, and France. Production is dominated by the United States and Brazil, accounting for 87% (61 percent and 26 percent, respectively) of the global total basing on 2012 figures. The REN21 2014 report shows that Global investment in biofuels equalled about $5 billion in 2012, down 40 percent from 2011; $3.8 billion of this was in industrial nations and $1.2 billion in developing nations.

[7] A fuel produced from oilseed crops such as soy, rapeseed (canola), and palm oil, and from other oil sources such as waste cooking oil and animal fats. Biodiesel is used in diesel engines installed in cars, trucks, buses, and other vehicles, as well as in stationary heat and power applications.

[8] A "drop-in" biofuel produced by using hydrogen to remove oxygen from waste cooking oils, fats, and vegetable oils. The result is a hydrocarbon fuel that blends more easily with diesel and jet fuel than does biodiesel produced from triglycerides as fatty acid methyl esters (FAME).

National governments have been at the forefront of driving investments in biofuels by creating an enabling environment and proving the necessary incentives. It appears that biofuel demand is strongly driven by blending mandates and supported by subsidies. The REN21 2014 report shows that 76 states, provinces, or countries had such mandates in 2012, up from 72 the previous year. Based on the REN21 report, global subsidies for liquid biofuels were estimated in 2012 to be well over US$20 billion. Further, mandates or targets have been established in 13 countries in the Americas, 12 in the Asia-Pacific region, and 8 in Africa including Zimbabwe. In Europe, the EU-27 group of countries is subject to a Renewable Energy Directive (RED) that called for 5.75 percent bio fuel content in transportation fuels in 2012.

The United States and China have established targets of between 15 and 20 percent no later than 2022 while Brazil has already achieved these; India has also mandated 20 percent ethanol by 2017. Mussatto *et al*, (2010) also agree with these authors, pointing out that ethanol use as a fuel additive or directly as a fuel source has grown in popularity as a result of governmental regulations and in some cases economic incentives based on environmental concerns, as well as a desire to reduce oil dependency. As a consequence, several countries are interested in developing their internal market for use of this biofuel.

OECD-FAO Agricultural Outlook (Green Car Congress, 2013) expected that in developing countries, ethanol production is projected to rise from 42 billion litres in

2012 to 72 billion in 2022. The projections also highlight that Brazil would account for 80% of this supply increase, followed by China, and a small part from other countries, including those in Africa.

2.2.3 Biofuels as a driver for new wave of large-scale land investments

There is a double coincidence of the world economic crisis of 2008 and associated investment risk in the developed world investment markets and the emerging biofuels sector as a safe and well supported investment destination for world capital. Starting in 2008, the world experienced a crisis driven by i) rising global imbalances (capital flows), (ii) monetary policy that might have been too loose, (iii) inadequate supervision and regulation of local economies (Merouche and Nier, 2010). It became more risky for investors to invest in their traditional markets because of these developments. Investors began to look for alternative investments opportunities as destinations for capital.

The main investor groups in large-scale land markets in Africa in general are oil-rich Gulf States such as Saudi Arabia, United Arab Emirates, Qatar, Bahrain, Oman, Kuwait and Jordan; populous and capital strong Asian countries such as China, South Korea, Japan and India; as well as Western and multinational private companies (Daniel & Mittal 2009; Görgen *et al*. 2009; Smaller & Mann 2009). On the other hand, South African investors, and especially the South African farmers' organization Agri SA, play a major role in the large-scale land deals in several

recipient countries (Friis *et al*., 2010). In this regard, Hall (2012) identifies four drivers of large-scale land investments in Africa and these are:

i) Asian powers seeking to secure food supply;

ii) Oil-rich (but land and water poor) Gulf States;

iii) European and North American banks, financiers and sovereign funds, responding to financial crisis; and,

iv) All the three in partnerships with African governments and/or domestic partners.

2.3 Zimbabwean context of sugarcane ethanol production

2.3.1 Zimbabwe socio-economic and geopolitical context

From the year 2000 to 2008, Zimbabwe experienced its most severe macro-economic instability in recorded history, characterised by hyperinflation. During this period, official estimates recorded show that hyperinflation peaked at 231 million percent in July 2008 (RBZ, 2008). Agriculture, which is regarded as the back-bone of the economy, (FAO, 2001[9]),shrank as a result of reduced access to production inputs by farmers and the changes in the agrarian sector brought about by the Fast Track Land Reform Programme (FTLRP). Recurring droughts also worsened food insecurity, resulting in a large proportion of Zimbabweans relying on food aid. Zimbabwe suffered a continuous economic decline over the ten-year period 1999-2008. In real terms, Gross Domestic Product (GDP) fell by over 40 percent during

[9] Study prepared for FAO by Dr. Moses Tekere (with the assistance of James Hurungo and Masiiwa Rusare), Trade and Development Studies Centre, Harare.

this period[10]. The souring of international relations and political instability also contributed to the decline in foreign direct investment. In general, all the key economic sectors – i.e. agriculture, mining and tourism – declined. With a dualistic agro-based economy, the country's economic performance had traditionally depended on agricultural output from both small-holder- and commercial farmers.

In September 2008[11], Zimbabwe's main political parties signed a Global Political Agreement (GPA) which led to the formation of a Government of National Unity (GNU) in February 2009. The GPA acknowledged the need for restoration of economic stability and growth.

Key macroeconomic policy developments from 2009

The GNU launched the country's Short Term Emergency Recovery Programmes (STERP I and II) in March 2009. Both STERP I and II[12] were aimed at stabilising the macro-economic environment and increasing capacity utilisation. With the introduction of a multiple currency regime, the government was able to arrest the problem of hyperinflation. The Medium Term Plan (MTP) was developed on the foundations of STERP I and II, to guide all government policy documents and set out national priorities for the next five years (Government of Zimbabwe, 2011). The current economic blueprint is the Zimbabwe Agenda for Sustainable Socio-Economic Transformation – ZIM Asset (2013-2018), whose vision is towards an empowered

[10] IMF-Zimbabwe Staff Report 2009, Article IV Consultation.

[12] There was STERP 1 and STERP 2 of which the STERP 2 was the Three Year Macroeconomic Policy And Budget Framework

society and growing the economy, with key themes being social inclusion and development. The ZimAsset has four clusters, which are: food security and nutrition; social services and poverty eradication; infrastructure and utilities; and, value addition and beneficiation (Government of Zimbabwe, 2013).

The Zimbabwean economy grew by 5.7% in 2009 and by an estimated 8.1% in 2010 (Ministry of Finance, 2010). This growth was attributed to the strong performance in the mining and agriculture sectors. In 2011, the economy again grew by an estimated 9.3% owing to the marked growth in the mining and agricultural sectors. According to the African Development Bank Zimbabwe's economic outlook report (2014), the average GDP growth rate of 7.5% during the economic rebound of 2009-12 was moderating. In real GDP terms, growth was estimated to have decelerated to 3.7% in 2013 from an estimated 4.4% in 2012.

The AFDB noted that this economic slowdown was due to liquidity challenges (e.g. the lack of and high cost of capital and revenue underperformance), outdated technologies, structural bottlenecks that included power shortages and infrastructure deficits, corruption and a volatile and fragile global financial environment. In terms of financing, the country is still operating on a large current account deficit (over 30%), which continues to widen. This widening takes into account an expected increase in imports, given that the industrial sector is still highly dependent on imports. For instance, the country recorded a current account deficit of 34.30 percent of the country's Gross Domestic Product in 2013.

2.3.2 Profile of the agricultural sector

There are various farming categories existing in Zimbabwe and they are as follows: 1.3 million communal area farmers on 16.4 million hectares; 145,775 A1 resettlement farmers on 4.1 million hectares; about 300 large-scale commercial farmers on 3.4 million hectares; 76, 000 old resettlement farmers on 3.5 million hectares; 16, 386 A2 resettlement farmers on 3.5 million hectares; about 8,000 small-scale commercial farmers on 1.4 million hectares; and 721,000 hectares of state and plantation farms (FAO, 2011; Matondi, 2012; GoZ, 2009) . Various commodities contribute to agricultural GDP as follows: tobacco 25%, maize 14%, cotton 12.5%, beef and fish 10%, sugar and horticulture 7% and at least 24% is devoted to the rest of the livestock sector.

In the 2011/2012 season, between 10%-20% of population in rural areas were chronically food insecure in Zimbabwe, while the percentage became higher in drought years. The urban food insecure fell from 33% in 2009 to 13% in 2011 due to improved economic stability. The key drivers of this substantial drop were: improved availability or supply of food due to opening up to imports; a significant drop in inflation levels to below 5% on a year-to-year basis; and improved provision of water and sanitation (FAO, 2010).

Zimbabwe's agricultural sector has significantly de-industrialised recently because of the high cost of borrowing, limited funds for recapitalisation, erratic supplies of

energy and stiff competition from imported commodities (Rukuni *et al*, 2013). Since 2003, agriculture has been struggling to supply raw materials to industry and its contribution to export earnings has declined. Agriculture contributes significantly the largest number of formal and informal employment. The performance of the sector temporarily improved after dollarization in 2009 when food availability greatly improved.

2.3.3 The agricultural policy environment

The Zimbabwe's Agricultural Policy Framework (ZAPF) (1995–2020) lays out the long-term policy objectives for the agricultural sector. According to this policy, agricultural development is based on the principles of land and agrarian reforms, institutional development, and development of a public sector investment programme to support agricultural development (FAO 2008; Gumbo 2006). However, it can be argued that this policy framework is no longer applicable to the current situation, and could arguably be outdated. In addition, the framework does not speak to the issue of biofuels as an important aspect of current agricultural production.

2.3.4 Overview of Zimbabwe's energy sector

Zimbabwe uses coal, fuel wood, and electricity and petroleum fuels as the main sources of energy (GoZ, 2008). According to the draft energy policy document, the national energy balance of 2000 shows that wood provides the bulk (53%) of the total energy supply, followed by coal (20%), liquid fuels (14%) and electricity (13%).

According to Mashange (2007) the energy sector in Zimbabwe accounts for 8%-9% of the country's GDP, but it contributes only 1% to formal employment. More significant is its share in aggregate investment, foreign borrowing, and debt. Investment in the fuel sector during 1996-1998 totalled about Z$ 985 million (US$ 18 million). The sector is foreign-exchange intensive and its foreign exchange requirements tend to strongly influence economic policy decisions. While Zimbabwe is 84% self-sufficient in energy requirements, petroleum products need to be imported in their entirety.

According to statistics from Energy Information Administration (EIA)[13], in 1980 Zimbabwe's average daily consumption was 12,800 barrels per day (1 526 278 million litres) which peaked at 31,000 barrels per day (3 696 455 million litres) in 1999. It is also highlighted that since 1999 petroleum consumption sharply declined each year to a record post-independence low of 12,500 barrels per day in 2009. However, with the ushering in of the multi-currency regime, petroleum consumption has been on the increase, peaking in 2012 at 20,970 barrels per day (2 500 473 million litres), before declining to 19,010 barrels (2 266 761 million litres) in 2013.

Mashange (2007) highlights that since the last quarter of 1999; Zimbabwe has intermittently experienced fuel shortages. Supplies became erratic to the extent that the country had at times operated with as low as 40% of normal supplies. This was mainly witnessed before the multicurrency regime. These shortages have been

[13] Energy Information Administration(2015): Zimbabwe Statistics: http://www.eia.gov/beta/international/?fips=ZI,

attributed mainly to foreign exchange shortages and alleged mismanagement and corruption at the National Oil Company of Zimbabwe (NOCZIM). As the shortages become more severe, problems of product shortage began to unfold. The public began to question the industry's policies and questions were raised on the sustainability of the liquid fuel sector policies in Zimbabwe. Of particular concern were policies regarding regulatory mechanisms, pricing, distribution, and utilisation of storage facilities, supply routes and NOCZIM management. The challenges faced by the petroleum subsector are summarised in the Government of Zimbabwe's draft energy policy as follows:

1. Inadequate foreign currency;
2. Inefficiencies in procurement and distribution;
3. Idle / underutilised infrastructure (pipeline, storage facilities);
4. Unstable policies on pricing, procurement and blending. For instance, the petrol/ethanol blending introduced in the early 1980s was discontinued. Plans are to re-introduce it
5. Unclear regulatory framework; and
6. Limited national capacity to respond to global fuel supply disturbances.

2.3.5 Sugarcane and bio ethanol production trajectory in Zimbabwe

Overview of sugarcane production

According to Shumba *et al* (2011), the sugar industry accounted for 1.4% of Zimbabwe's GDP before 2000. It was dominated by two companies (Hippo Valley

Estates and Triangle Limited) that contributed 85% of the total sugar output. The country's processing capacity is 600 000 tons of raw sugar and 260 000 tons of white refined sugar against a historically high national white sugar demand of 230 000-250 000 tons per annum during the 1990s. The surplus is exported. However, the same author notes that low sugar cane production in the last few years led to sugar imports. For example, 39 330 tons of sugar were imported in 2009 after only 2.4 million tons of sugarcane were produced. It is also noted that Zimbabwe's two sugar mills produce molasses, a by-product of the sugar making process. The molasses are used to produce ethanol at the Triangle distillation plant.

A number of authors (for example Deenanath *et al*, 2012; Shumba *et al*, 2011; and Thomas and Kwong, 2000) examine historical bio ethanol production in Zimbabwe. These authors show that ethanol production in Zimbabwe was planned in the 1970s but actual production commenced in 1980. Thomas and Kwong (2000) particularly highlight that this was mooted as a mechanism to 'burst' the economic and trade sanctions imposed on Rhodesia (the colonial name for Zimbabwe) in the 1970s. According to these authors, the issue of sanctions had generated the need for an independent, self-sufficient source of automotive fuel. Triangle has 40 million liters of annual ethanol production capacity and during the 1980s total annual ethanol production of the plant was about 30Ml (ibid,).

The same literature also shows that the termination of this first phase of ethanol production was triggered by the 1992 drought, during which the contractual

relationship with government expired. After the drought when the Triangle refinery resumed production, the managers opted for export since they realised they could get a better price. For the Triangle plant all ethanol has been exported since then.

As highlighted in Chapter 1, the Government of Zimbabwe through the agriculture and rural development authority went into a partnership with the Zimbabwe Bio-Energy Ltd operating as Green Fuels in February 2009 to set up the Chisumbanje ethanol project. The project involves primary production of sugarcane and processing it into anhydrous bio-ethanol. The Chisumbanje project which at the time of its conception was based on a build, operate and transfer model established in a 20-year agreement. Primary production of sugarcane was projected to be established on over 40 000 hectares of land. The Chisumbanje plant has capacity to produce 120 million litres of anhydrous ethanol per annum. It is public that the price of ethanol produced at the plant is set at an average of $0.95 per litre[14].

In February 2014, The Biofuels Digest (Sapp, 2014) reported that Triangle was set to supply 3 million litres of ethanol to the local fuel market to help fill the gap left by Green Fuel which was having production problems due to incessant rains. Supposedly Triangle was planning to sell the ethanol at 80 cents per liter and could supply up to 4 million litres.

[14] http://www.fin24.com/Economy/Zim-pet...in-SA-20131023,

In terms of competitiveness of ethanol production, Shumba *et al* (2011) posited that Zimbabwe's ethanol production is relatively competitive within the region, basing on the Triangle Plant. It is argued that the cost of producing 1 litre of ethanol in Zimbabwe ranges between $0.25 and $0.40 compared to $0.50 and $0.60 in Malawi. The costs are all however higher if compared to the costs in Brazil, which range between $0.19 and $0.25.

The current situation is that the Chisumbanje ethanol plant is receiving all forms of support from government and Triangle plant is not getting the same support and incentives. Only ethanol from Chisumbanje is allowed to be used to blend all the country's petroleum under the mandatory requirements. The study in later chapters further interrogates the character of the emerging chain, how value and incomes are being created and distributed and also how government blending levels affect the welfare of agents along this new value chain. The purpose is to generate empirical evidence to inform government decisions along the sugarcane bio ethanol value chain.

2.4 Conclusion

This chapter analysed the empirical context in which the sugarcane bio ethanol value chain is occurring. Global developments with respect to production and use of bio ethanol were provided, indicating that the bio ethanol industry as a growing sector was mostly buoyed by government support and incentives. The Zimbabwean context both current and in retrospect alike is characterised by similar government support.

The next chapter focuses on a theoretical framework for analysis of the sugarcane bio ethanol value chain positioning the study within broader economic theory.

CHAPTER THREE: THEORETICAL FRAMEWORK FOR ANALYSIS OF THE SUGARCANE BIO ETHANOL VALUE CHAIN

3.1 Introduction

This study generates further empirical knowledge on the emerging bio ethanol value chains. In this chapter, the available literature is reviewed to bring out the theoretical issues with respect to analyses of biofuel value chains placing focus on the models of analysis that have been used and the results that have been obtained. The review focuses on value chain theory and analyses aspects such as such as value chain governance and other related concepts around this theory. Linkages between this theory and economic analysis, providing crucial entry points for the study, are also provided. Some empirical studies on value chain analysis demonstrating the literature gaps with respect to both rigour and spatial relevance are also reviewed. The chapter concludes with a review of the specific theoretical foundations for cost benefit analysis profit and value added analysis, value chain governance and impact analysis as some of the analytical concepts applied in the study.

3.2 Typology of the generic global bio ethanol value chain

Chan and Reiner (2011) provide a characterisation of the typical generic global bio ethanol value chain. The authors note that the chain is produced by a crossover of two value chains; that is the agro commodity value chain and energy value chain. The upper tail of the industry is the traditional agricultural value chain, which consists of three stages – the land, cultivation, trading and transporting of agricultural

products. In the middle, there are ethanol manufacturers and traders. An auxiliary stage, which is not a stage along the main value chain, is also included to capture technology providers and other suppliers of production inputs such as chemicals, yeast, enzymes and utility. The downstream stages are similar to the downstream chains of conventional transport fuel, where ethanol is blended and distributed to retail fuel stations. This characterisation highlights three components of the bio ethanol value chain as upstream agro-commodity segments, the midstream ethanol manufacturing segments, and downstream transport fuel segments. Figure 3.1 depicts the characterisation of the generic bio-ethanol value chain.

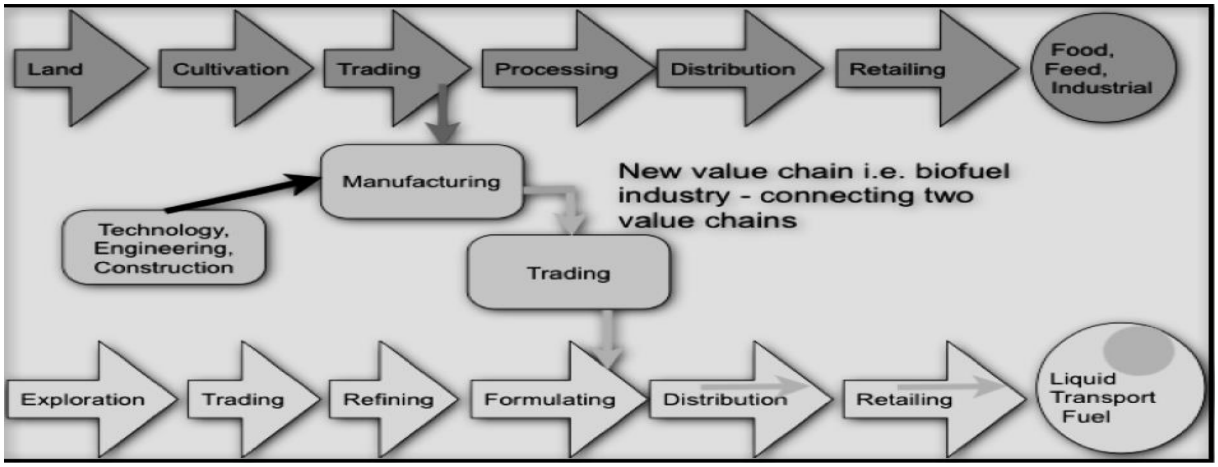

Figure 3.1: Ethanol value chain showing a crossover from agro-commodity to energy
Source: Chan and Reiner (2011)

3.3 Theoretical foundations of the value chain approach

3.3.1 Porter's value chain model

Synthesis of the literature – for instance, Kaplinsky and Morris, 2000, Bellu, 2013, Johnston *et al*, 2007 – shows that there is agreement that the value chain consists of a set of activities that a firm operating in a specific industry performs in order to

deliver a valuable product or service. Kaplinsky and Morris, (2000) highlight that value chains are complex sets of interrelated elements (public and private agents, domestic and foreign markets, inputs, outputs, production agents, institutions, environment and natural resources). All value chain literature sources acknowledge the work of Michael Porter in a bestselling publication titled 'Competitive Advantage: Creating and Sustaining Superior Performance' (Porter, 1985) as the initial source of the concept of the vale chain. Porter suggests that business activities can be conceptualised to fall under two headings. The first is the primary activities, which are those that are directly involved with the physical creation and delivery of the product or service and include:

- *Inbound logistics*: which is the receiving and warehousing of raw materials, and their distribution to manufacturing as they are required;
- *Operations*: which is the process of transforming inputs into finished products and services;
- *Outbound logistics*: this is the warehousing and distribution of finished goods;
- *Marketing and sales*: which is the identification of customer needs and the generation of sales; and
- *Service:* this is the support of customers after the products and services have been sold to them.

The second are the support activities, which feed both into primary activities and into each other and consist of:

- *Organisational infrastructure:* these are the support systems and functions, such as finance, planning, quality control, and general senior management;

- *Human resource management:* this covers activities concerned with recruiting, developing, motivating, and rewarding the workforce of the organisation;
- *Technology development:* this development encompasses the managing information processing and the development and protection of knowledge in the organisation; and
- *Procurement*: how resources are acquired for the organisation; for instance, sourcing and negotiating with suppliers.

Porter's model depicts the internal value chain model as an important analytical model not only to understand the firm's cost advantages but also issues of product differentiation. With respect to costs the model leads to a better understanding of costs and possibly ways of minimising them in the value-adding activities of the firm. With respect to differentiation the model allows focus on those activities associated with core competencies and capabilities in order to perform them better than do competitors.

The model also highlights that the appropriate level for constructing the value chain is the business unit, in which a clear product passes through activities along a chain in order and at each activity gains some value. This analogue implies that the set of activities along the chain gives the product more added value than each of the activities along the chain. It also implies that a value chain may not be defined at a corporate level or division level, since these could be servicing a number of products.

Another term coined by Porter's model is the 'value system', which is defined as the larger stream of activities that are related to the firm. A value system encompasses all the agents and activities along the chain including suppliers, distributors, retailers and customers.

3.3.2 Physical, virtual and combined value chain

This classification as applied by a number of authors (for instance, Hamilton (2004); Vliet, (2010); and Sviokla and Rayport (1995)) denotes the activities of the value chain as being made up of two sets; one is the physical value chain and the second is the virtual value chain. Figure 3.2 shows a diagrammatic presentation of this categorisation by Vliet (2010).

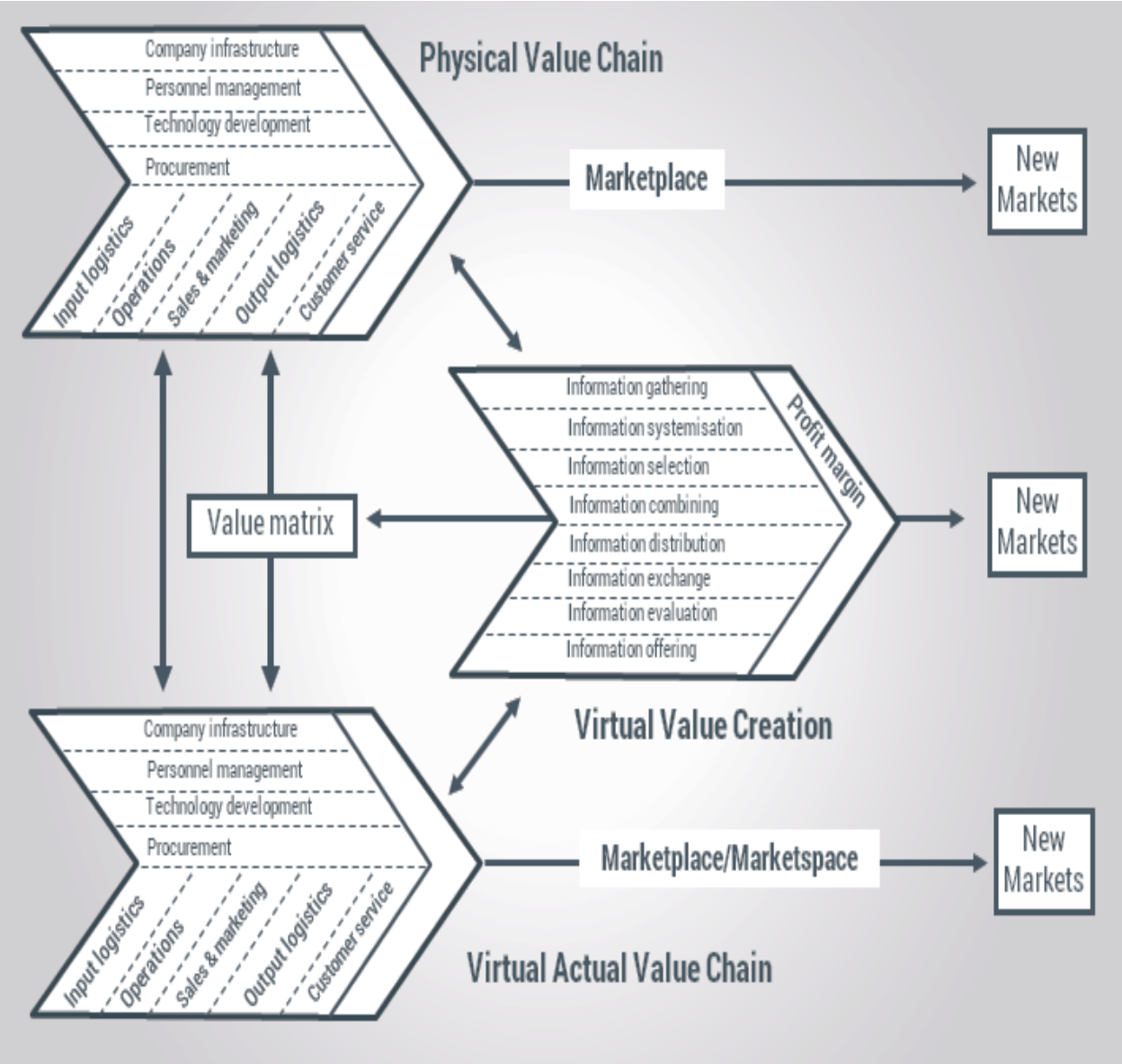

Figure 3.2: The physical and virtual value chains
Source: Vleit (2010)

While the physical or traditional value chain comprises those physical world activities performed in order to produce, enhance a product or service, the idea of the virtual value chain propounded by Sviokla and Rayport (1995) explains a business model describing the dissemination of value-generating information services throughout an extended enterprise. The interpretation of this concept is that with the advent of computers and other information and communication technologies, there is a new

horizon of market place in which no physical goods are exchanged but huge business is actually taking place. This situation is commonly referred to as cyber-market space. It is also worthy to note that businesses are better off sufficiently covering both the physical and cyber market and to avoid overreliance on the other.

3.3.3 Value chain governance

Johnston *et al* (2007) define value chain governance as the dynamic distribution of power and control among agents in a value chain. Another definition by Humphrey and Schmitz (2008) is that value chain governance comprises the relationships among the buyers, sellers, service providers and regulatory institutions that operate within or influence the range of activities required to bring a product or service from inception to its end use. Governance is about power and the ability to exert control along the chain at any point in the chain. A firm (or organisation or institution) sets and/or enforces parameters under which others in the chain operate. The authors emphasise that the fact that one firm or group of firms dominates the value chain, and has a controlling influence on the quantity, quality, and price of goods is an important factor. This argument is also supported by Pietrobelli and Saliola (2007), who point out that the power relationships among firms influence value chain competitiveness, opportunities for upgrading, and access to finance. Another important argument put forward by Johnston *et al* (2007) is that while there can be a single governance structure for an entire value chain, there are also varying

relationships at each step of the value chain that can be described with the same terminology.

3.3.4 The importance of value chain governance

Humphrey and Schmitz (2001) note that the concept of 'governance' is central to the global value chain approach. They also note that the concept is used to refer to the inter-firm relationships and institutional mechanisms through which non-market coordination of activities in the chain takes place. According to these authors, this coordination is achieved through the setting and enforcement of product and process parameters to be met by agents in the chain. The USAID-funded knowledge-driven agricultural development programme, Microlinks,[15] shows that understanding how and when lead firms set, monitor and enforce rules and standards can help micro and small enterprises (MSEs) and other firms in the chain to better integrate and coordinate their activities. These reports emphasise that governance is particularly important for the generation, transfer, and diffusion of knowledge leading to innovation, which enables firms to improve their performance and sustain competitive advantage. Further, awareness of the governance structure of a value chain can be seen to have the potential to provide governments, donors and development practitioners with information about how best to provide MSEs with the training and technical assistance needed to upgrade their position in the chain.

[15] https://www.microlinks.org/good-practice-center/value-chain-wiki/value-chain-governance-overview,

According to Humphrey (2002), value chain governance helps to determine the acquisition of production capability, market access, distribution of gains and leverage for policy initiatives. The importance of value chain governance is expanded in Table 3.1.

Table 3.1: Importance of value chain governance

Issue	Key aspects
Acquisition of production capability	• Lead firms can be very demanding about reducing costs, raising quality and increasing on-time performance. • Lead firms also provide knowledge and support. • MSEs learn by observing what their buyers are doing or, in other cases, the lead firm will transmit best practices through embedded services or provide hands-on advice on how to improve production processes and producers' skills
Market access	• Chains are often governed by a limited number of powerful buyers. • MSEs need to be on the radar of the lead firms of their chains because the lead firm frequently makes the decisions on where products will be produced and who will produce them. • Producers need access to lead firms and can gain it only by learning how to communicate with the firms and produce to specification.
Distribution of gains	• The activities that reap the highest returns are usually found in intangible competences (research and development, design, branding) characterised by high barriers to entry that are frequently synonymous with holding the lead firm status in the chain. • Understanding how a chain is governed provides MSEs and practitioners with valuable information on how to develop skills and with whom to develop relationships that would give them the flexibility and freedom to undertake additional functions in the chain, thus altering the current distribution of gains.
Leverage for policy initiatives	• Given the power lead firms have to impose product and process parameters on their suppliers, they are also excellent leverage points for the business environment to use to exert influence on what happens in their supplier firms. • Understanding chain governance and the power of lead firms can assist local and global, public and private, government and nongovernmental agencies and practitioners to advocate for better labour and environmental standards or a more equitable distribution of gains.

Source: Synthesized from Humphrey (2002)

3.3.5 Types of value chain governance

Gereffi *et al* (2003) provide an in-depth analysis of a theoretical framework to help explain governance patterns in global value chains. These authors identify three

variables that play a large role in determining how global value chains are governed and also how they change. These are: (1) the complexity of transactions, (2) the ability to codify transactions, and (3) the capabilities in the supply-base. The theory generates five types of global value chain governance – hierarchy, captive, relational, modular, and market – which range from high to low levels of explicit coordination and power asymmetry. In a different publication, Gereffi (2005) further explains that the connections between industry activities within a chain can be described along a continuum extending from the market, characterised by "arm's-length" relationships to hierarchical value chains illustrated through direct ownership of production processes. It is also highlighted that between these two extremes are three network-style modes of governance: modular, relational, and captive. Network-style governance represents a situation in which the lead firm exercises power through coordination of production vis-à-vis suppliers (to varying degrees) without any direct ownership of the firms. Table 3.2 presents an elaboration of value chain governance based on the work of Gereffi, Humphrey and Sturgeon (2003) and USAID-funded Microlinks.

Table 3.2: Types of value chain governance

Market	• Transactions are relatively simple, information on product specifications are easily transmitted, and producers can make products with minimal input from buyers. • Market linkages do not have to be completely transitory, as is typical of spot markets; they can persist over time, with repeat transactions. • Costs of switching to new partners are low for both parties.
Modular	• Modular governance occurs when a product requires the firms in the chain to undertake complex transactions that are relatively easy to codify. • Products made to a customer's specifications, which may be more or less detailed. • Suppliers take full responsibility for competencies surrounding process technology, use generic machinery that limits transaction- specific investments, and make capital outlays for components and materials on

	behalf of customers.
Rational	• Interactions between buyers and sellers are characterised by the transfer of information and embedded services based on mutual reliance regulated through reputation, social and spatial proximity, family and ethnic ties, and the like. • Complex interactions between buyers and sellers often create mutual dependence and high levels of asset specificity. • The role of spatial proximity in supporting relational value chain linkages, but trust and reputation might well function in spatially dispersed networks where relationships are built up over time or are based on dispersed family and social groups.
Captive	• Small suppliers are dependent on a few buyers that often wield a great deal of power and control. • Such networks are frequently characterised by a high degree of monitoring and control by the lead firm. • Suppliers face significant switching costs and are, therefore, 'captive'. • Such networks are frequently characterised by a high degree of monitoring and control by lead firms.
Hierarchy	• Hierarchical governance describes chains that are characterised by vertical integration and managerial control within a set of lead firms that develops and manufactures products in-house. • Hierarchy usually occurs when product specifications cannot be codified, products are complex, or highly competent suppliers cannot be found.

Source: Synthesized from Gereffi (2005) and USAID-funded Knowledge-Driven Agricultural Development program, Microlinks

3.3.6 Determinants of value chain governance structure

A number of authors – for instance, Rasheed and Geiger (2000) and Gereffi *et al* (2003) – concur that the form of value chain governance can change as an industry evolves and matures, and governance patterns within an industry can vary from one stage of the chain to another. The dynamic nature of governance has three variables: the complexity of information that the manufacture of a product entails (design and process); the ability to codify or systematise the transfer of knowledge to suppliers; and the capabilities of existing suppliers to efficiently and reliably produce the product. Additional influences on the governance structure include the quality, stability, and power of the business-enabling environment and institutions, as well as other sources of power in the chain, such as suppliers and consumers.

3.4 Theoretical foundations of economic analysis along value chains

3.4.1 Definition of economic analysis

This study is an economic analysis of the sugarcane bio ethanol value chain and, therefore, it is ideal to review the basic theory of economic analysis. The study applies basic economic theory concepts such as cost/benefit analysis and welfare analysis and also attempts to predict/simulate the impact of policy on certain economic agents. By way of definition, economic analysis can be understood to include tools, concepts, models and theory for understanding, predicting and generalising economic (and other) phenomena (Westall, 2009). The same author particularly brings to attention the fact that economic analysis can be applied to any phenomenon, noting that although economic analysis has mixed and controversial applicability, this type of analysis has been applied to many complex areas of behavior such as marital instability or terrorism.

McAfee (2006) asserts that economic analysis is carried out for two prime purposes: the first is what is described as positive economics and is a scientific understanding of how allocations of goods and services (scarce resources) are actually determined, and this is similar to the other natural sciences. The second purpose of economic analysis suggests how distinct changes in laws, rules and other government interventions in markets will affect people and, in some cases, one can draw a conclusion that a rule change is, on balance, socially beneficial. Such analyses

combine positive analysis predicting the effects of changes in rules with value judgments and are known as normative analyses.

The study analyses costs/benefits as well as incomes and how they are distributed along the value chain. McAfee (2006) makes it explicit how cost/benefit analysis and welfare analysis are important components of economic analysis. McAfee (2006) highlights that cost/benefit analysis weighs the gains and losses to different individuals and suggests carrying out changes that provide greater benefits than harm. To a significant extent, the study determines how government policy is affecting the welfare of different economic agents. This brings another aspect of economic analysis known as “welfare analysis”, which provides another approach to evaluating government intervention into markets. McAfee (2006) notes that welfare analysis posits social preferences and goals, like helping the poor. In addition, it also covers carrying out cost/benefit analysis, considering not just the overall gains and losses, but also weighing those gains and losses by their effects on other social goals. In the study, attempts are made therefore to analyse how various agents along the bio ethanol value chain are gaining or losing.

3.4.2 Linkages between economic analysis and value chain analysis

The most defining aspect of this study is the approach of performing economic analysis along a whole chain. This is not only unique but also poses specific challenges, especially with respect to defining the unit of economic analysis, which is

usually the firm or individual. Bellu (2013) outlines a framework that provides linkage between value chain analysis and economic analysis. This conceptualisation shows that economic analysis is actually a central and integral part of value chain analysis. There are other 'domains' that are identified and that all build the case for holistic value chain analysis. The author identifies six domains for value chain analysis, as summarised in Table 3.3:

Table 3.3: Six domains of value chain analysis

Socio-economic context of the value chain.	• Key elements of the context where value chain develops - the geo-strategic, - macro-economic - social situation of the country(ies) • Explains how these elements influence the value chain and vice-versa.
Demand for value chain outputs.	• Consumer side of a value chain focusing on current and potential demand of the various final output(s), their various destinations and related price trends
Analysis of the institutional set-up.	• Identification and appraisal of the institutional set-up focusing on set of interactions taking place among agents and the formal and/or informal rules governing them
Analysis of input and output markets.	• Specific focus on agents' behaviour and exploration of the institutions governing the value chain because there are close relationships among markets' set-up, rules and agents' choices. • The degree of competitiveness, the existence of monopolies, monopsonies, oligopolies, market segmentation etc.
Functional analysis of the value chain.	• Detailing profile of the industry structure and production technology by identifying, describing and quantifying in physical terms the sequence of operations concerning commodity production, processing, marketing and final consumption and related agents carrying them out
Economic analysis of the value chain.	• Assessment of the value-added creation and -distribution processes. Allows for assessing the value added created by the overall value chain, the value added and margins for each economic agent at each stage of the chain, the value added distribution among factors (capital, profits, labour, wages, other assets, rents). • Analysis is carried out from the perspective of private agents, using market prices, and from the perspective of the society as a whole, using the so-called "reference prices".

Source: Summarised from Bellu (2013)

3.5 A review of empirical work on value chains

In this section, summaries of studies done on value chains are presented. What emerges from synthesising these empirical studies is that the sugarcane bio ethanol value chain in Africa is a rare area of study and this could be attributed to the emergent nature of the industry. It is also apparent that the underlying parameters in each of the reviewed VCA studies differ and range from broader issues of value chain governance to issues to do with the organisation and structure of the value chain itself (Chan and Reiner 2011). Issues of value chain performance and competitiveness (Kleih *et al*, 2013); as well as market potential analysis, also emerge as an important analytical dimension (Kaminski *et al*, 2013).

Chan and Reiner (2011) apply a value-chain-analysis approach to examine the forces shaping industry structure, entry and inter-firm governance modes. They classified the 40 largest global and regional companies in the ethanol-manufacturing stage into pre-entry industry of origin. It was shown that firms with pre-entry history in feedstock supply have shown higher resilience to market shock. The authors also observed a trend of dual-directional vertical integration. Firms backward integrate to secure feedstock supply; firms forward integrate to gain access to the retail market. Security of feedstock has been identified as a critical success factor of the manufacturer in this resource-intensive industry. Another critical success factor is gaining control over the end user market via forward integration. The authors propose that a critical success factor is the important determinants of inter-firm governance mode.

Kaminski *et al*, (2013) analyse the maize value chain and implications for competitiveness in Burkina Faso. The development of the maize value chain according to the authors is hindered by several constraints affecting productivity and competitiveness. This study applies value chain approaches to examine the constraints and the opportunities facing maize value chain in Burkina Faso and proposes actions needed to enhance maize competitiveness. The analysis focused on demand agents affecting cereal and maize consumption patterns in Burkina Faso. There was an in-depth analysis of the entire maize value chain starting from input markets, production, processing and marketing and an extensive review of the factors affecting the competitiveness of the maize value chain. The study concludes that the roles of policy, regional trade and maize producer organisations need to be emphasized in ensuring more inclusive maize value chain development

Kleih *et al*, (2013) revisited the understanding of the Ghana market for cassava and cassava products building. The study covered aspects of the cassava value chain and analysis of industrial demand for dried cassava products (High Quality Cassava Flour (HQCF), industrial flour, and dried chips). Checklists were used for the value chain analysis and the different industries visited in the course of the fieldwork. From this study it was clear that differently processed cassava products have potential utility in different end-user markets. The authors also concluded that it was more likely to develop markets in the short- to medium term in instances where cassava is

a secondary raw material (i.e. plywood and animal feed) compared to markets where it is a more principal component, e.g. bread baking.

Shikida (2010) analysed the relationship of path dependence in the economic and institutional system of ethanol in Brazil. The analysis was against a context where ethanol, after stages of growth and challenges, has become part of the Brazilian energy matrix. The study noted that a route (path) was chosen, with performance of institutions (mills and distilleries, sector of machinery and equipment for construction mills and distilleries, automotive industry, state organisations, corporatist organisations, research and development) and economic agents (consumers) interested, directly or indirectly, in the maintenance of the route chosen. The author cites what is termed “interest arrangements” as the basis for support for ethanol as the most appropriate energy option for the replacement of gasoline/diesel in Brazil. It was concluded that “orchestration of interest’’ arrangements, the trajectories and the institutional sector’s new shape after deregulation were configured by the mechanism of path dependence for this important product of the sugarcane agribusiness.

Mukonza (2014) identified and analysed the socio-economic factors that affect production and distribution of biofuels among rural farmers in Zimbabwe. The study applied both qualitative and quantitative methods to analyse data collected in Mutoko and Chisumbanje districts in Zimbabwe. The Technology Innovation Systems made up the underlying theoretical framework for this study. The key findings of this study

were that there were key players involved in the production and distribution of biofuel technologies in Zimbabwe and each one of them had different perceptions on the importance of biofuels. The author notes that lack of incentives (prices, subsidies etc.), information, access to markets, institutions, economic development and lack of clear policy are some of the factors that have been found to have an effect on production and distribution

3.6 A theoretical review of analytical approaches espoused in the study

3.6.1 Value added and its distribution along the value chain

This study computes value added and its distribution along the sugarcane bio ethanol value chain. Value added can be regarded as the enhancement a firm/farm/company gives its product or service before offering the product to customers. It can therefore describe instances where a firm takes a product that may be considered a homogeneous product, with few differences (if any) from that of a competitor, and provides potential customers with a feature or add-on that gives it a greater sense of value (Coltrain *et al*, 2000).

Amanor-Boadu (2003) argues that economists have long measured added value using the metric value added. It is highlighted that VA is regarded as the difference between value of shipments and the cost of all purchased inputs used in the production. The author notes that VA can be estimated at the firm level and aggregated across firms in an industry to get industry value added. When summed across all industries, the value added of the whole economy or GDP is the result.

The same author, quoting earlier work by Wood (1978), also highlights that value added is, thus, a measure of the wealth generated by the efforts and ingenuity of mankind and avoids problems of double counting when aggregated across firms and industries.

Any step in the production process that improves the product for the customer and results in a higher net worth. Bellu (2013) also supports the notion that value added is a measure of the wealth created by an economic activity. Based on this analysis of the literature, the study computes value added at each stage of the sugarcane bio ethanol value chain and attempts to explain its distribution among economic agents.

3.6.2 Profits and their distribution along the value chain

Gross margin analysis which yields the profit is a concept that has been used as measure of profitability that is a useful tool for cash flow planning and determining the relative profitability of farm enterprises. According to Wong *et al* (2011), the essence of gross margin analysis is: to compare the relative profitability of current enterprises; to estimate changes in enterprise profit caused by changes in price, cost or yields; to pinpoint high-cost- or low-income areas in the existing plan; and to evaluate the profitability of a re-organisation of the enterprise mix. Bellu (2013) shows that along the value chain, profits can be calculated at each stage to determine who is making what profit along a value chain. Therefore profit generation and their distribution along the value chain were regarded as a key analytical entry point for this study.

3.6.3 Costs/benefit analysis along the value chain

The study borrows from cost/benefit analysis approaches to simulate policy impacts of different ethanol petroleum blending levels in Zimbabwe. This analysis, as will be shown in Chapter 6, is achieved by building a baseline scenario/reference scenario (for instance zero blending, 5% blending and so on) that is used to compare the impacts on each economic agent for each successive change in the level of blending. By reducing the positive and negative impacts of a project to their equivalent money value cost/benefit analysis determines whether on balance the project is worthwhile (Watkins, 2013).

Stern and Dreze (1987) highlight that the purpose of cost/benefit analysis is to provide consistent procedures for evaluating decisions in terms of their consequences or costs and benefits. The same authors note that in order to evaluate a project from the point of view of its consequences, it is crucial to have a model that predicts the total effect on the state of the economy of undertaking a particular project. This total effect involves a comparison of the economy "with" the project and the economy "without" it. In support of the use of cost/benefit analysis principles in economic analysis of the value chain, Bellu (2013) particularly highlights that economic analysis of a value chain, just as cost/benefit analyses (CBAs), is carried out both from the perspective of private agents and from the perspective of the society as a whole.

3.6.4 Value chain governance analysis: Power and authority along the value chain

Questions of power and authority come to the fore when different interests among economic agents in any economic space lead to conflict. The sugarcane bio ethanol value chain has been a subject of debate and contestation, sometimes violent! Political economy is founded on the predicament of economic choices in a society comprising heterogeneous agents (Serrat, 2010). The same author notes that political economy analysis investigates the interaction of political and economic processes in a society. The processes are set out here:

- The power and authority of groups in society, counting the interests they hold and the incentives that drive them in conducting particular activities;
- The role that formal and informal institutions play in allocating scarce resources; and
- The influence that values and ideas, including culture, ideologies, and religion, have on shaping human relations and interaction.

Source (Serrat, 2010)

An important aspect of value chain governance analysis is political economy analysis, which focuses primarily on how power and resources are distributed and contested in different contexts, and how these economic and political interactions affect development. Political economy analysis gets beneath the formal structures to analyse the underlying interests, incentives and institutions that enable or frustrate change (DFID, 2009). Political economy analysis enriches economic analysis by unpacking what drives political behaviour, how this shapes particular policies and

programmes, who are the main winners and losers, and what the implications are for development strategies and programmes.

The study treats political economy analysis as a golden addition to the value chain analytical framework by bringing in a more explicit way of analysing issues of roles of different institutions including informal institutions, impact of values, ideas and beliefs, religion and cultural factors. This analysis enriches and makes unique the analysis of the sugarcane bio ethanol value chain performed in this study.

3.6.5 Policy impact analysis along the value chain

The study as highlighted in the previous paragraphs analyses the impact of ethanol blending levels on the welfare of economic agents along the value chain. Bellu (2013) highlights that the analysis of socio-economic impacts of policy options is often carried out in a "*counterfactual*" framework. This approach applies also when using the VCA framework for policy analysis. After having identified development objectives and related policy options to achieve them, analysts need to determine and "measure" the likely impacts of the different policy options of the socio-economic system. Although counterfactual analysis has its own challenges[16] as highlighted by Menzies (2014) and Horwich (1987), it can be used in cases where the input output relationships are very clear. As noted by Menzies (2014), there are also a number of

[16] For instance the theory assumes that causation is an absolute relation whose nature does not vary from one context to another.

scholars and authors (Moore 2009, Paul 2009; Paul and Hall 2013) who actually argue for the use of counterfactual analysis in impact analysis.

Alternative impact models that the study could have applied include the Computable General Equilibrium (CGE) approaches. However these approaches are data intensive and more often used in developed-country settings. These use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. On CGE approaches Lofgren *et al* (2002) note that these are used widely in policy analysis, especially in developed-country academic settings. The authors also highlight the intensive data requirements and the absence of such data in most less developed countries. Partial equilibrium demand and supply models and full social accounting matrix approaches alike for this particular sugarcane bio ethanol value chain face the same data challenge and therefore are not deemed appropriate.

The analysis particularly in Chapter 6 and 7 attempts to some extent to analyse transactions and transfers between different production activities, factors of production, and institutions (households, corporate sector, and government) within the value chain to build two accounts – a production- and an income account), for the value chain. However, analogue does not amount to Social Accounting Matrices (SAM) methodology. The approach applied for simulating the welfare impacts of different ethanol blending levels along the sugarcane bio ethanol value chain is the most appropriate under the data circumstances of most developing countries.

3.7 Conclusion

This chapter analysed the theoretical framework for analysis of the sugarcane bio ethanol value chain. The chapter analysed value chain theory, looking at concepts such as value chain governance and other related concepts around this theory. Linkages between this theory and economic analysis, providing crucial entry points for the study, were also provided. Some empirical studies on value chain analysis demonstrating the literature gaps with respect to both rigour and spatial relevance were also reviewed. The chapter concluded by reviewing the specific theoretical foundations for cost/benefit analysis, profit- and value-added analysis, political-economy analysis and impact analysis as some of the analytical concepts applied in the study. The empirical studies show that the sugarcane bio ethanol value chain in Africa is a rare area of study and this could be attributed to the emergent nature of the industry. The next chapter presents the approaches applied in the study including sampling, data requirements and sources, conceptual and analytical frameworks.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This study analyses the location and distribution of value added and gross margins as well as the impact of government policy on economic agents along the sugar ethanol value chain Concepts in economics such as value added and gross margin/profit analysis, value chain governance and policy impact analysis are applied to achieve the study's specific objectives.

The study takes a case study approach by placing focus on the bio ethanol value chain whose primary production activities are carried out in Chisumbanje Village located in Chipinge district of Zimbabwe. The Chisumbanje Ethanol project is Zimbabwe's sole producer of anhydrous ethanol. This chapter describes the methods applied in this study. First, a conceptual framework for analysing the economics of sugar ethanol value chains is laid out. This framework is followed by a description of geographical focus areas for the study. The data requirements, sampling and data collection approaches are presented next.

The mainstay of the chapter is an elaboration of the analytical framework for the three specific objectives pursued in this study with three components. Presented first are approaches considered for characterising the sugarcane ethanol value chain in Zimbabwe. The second is an outline of how input-output (I-O) model and approach are applied for calculating value added, gross margins and how they are distributed along the value chain. Presented last is a presentation of the impact model to

simulate effects of various policy instruments on economic agents along the sugar ethanol value chain.

4.2 General approach to the study

The study was focused on analysing use and distribution of economic resources along the sugarcane ethanol value chain and how policies impact on it. The research methods followed in realising the aim of this study included a combination of approaches that are primarily theoretical and analytical. The study provided a contextual and theoretical review of literature in the history of ethanol production in Zimbabwe and beyond (Chapters 2 and 3). The study also covered exploration of the literature on the socio-economic context, characterisation and economic issues related to sugarcane ethanol value chains. The policy and institutional framework for investment along the chain within the purview of energy policy in Zimbabwe and beyond was also reviewed.

The study relied on primary and secondary data sources. The study made use of appropriate primary data collection instruments namely survey questionnaires, semi-structured interview guides, and focus group guides developed for specific target respondents. Secondary data and information was also used partcicularly in cases where primary data could not be obtained.

Because of the multiplicity of data collection approaches, a multipronged analytical framework was applied to analyse data from the different sources. The first approach was multivariate descriptive statistics that were used to characterise the sugar

ethanol value chain in an analysis that espoused value-chain governance-analysis concepts. The second were calculations of value added and gross margins at each stage of the sugarcane bio-ethanol value chain were used to determine the creation and distribution of wealth among economic agents along this chain. The last was a simulation model that was used to analyse the economic impacts of different policy choices on the creation and distribution of wealth by economic agents along the sugarcane bio-ethanol value chain. This simulation model was applied to analyse the effects of changes of the policy measure (or variables controlled by it) on the socio-economic variables (of economic agents) relevant to the policy measure. The purpose was to generate information to provide a better understanding of how biofuel value chains in developing countries are organised; how they are creating and distributing wealth among agents; and how different policies in the energy sector may impact on the economic agents in these chains.

4.3 Conceptual framework for economics of sugarcane bio- ethanol value chain

As highlighted in chapter 3, a generic industry value chain model was coined by Michael C. Porter (1985) as a way of constructing value as related to the end user. In his model, any industry has some primary activities, which include inbound logistics, operations, outbound logistics, marketing and sales and services. This value chain also has some support services, which include the firm's infrastructure, human resources management, technology development and procurement. Based on this model, an agricultural value chain would consist of various players linked through a number of production- and marketing activities. According to Recklies (2001), based

on the work of Porter (1985), within the whole value system there is only a certain value of profit margin available. This margin is noted as the difference of the final price the customer paid and the sum of all costs incurred with the production and delivery of the product/service (e.g. raw material, energy etc.). This analogue emphasises the importance of profits along a value chain. The author also notes that the model depends on the structure of the value system, how this margin spreads across the suppliers, producers, distributors, customers, and other elements of the value system. Each member of the system still uses its market position and negotiating power to get a higher proportion of this margin. Nevertheless, members of a value system can cooperate to improve their efficiency and to reduce their costs in order to achieve a higher total margin to the benefit of all of them.

Other authors such as Raphael and Morris (2000) and Webber and Labaste (2010) broaden this definition to include the interactions of firms and processes that are needed to deliver products to end users, and the opportunities for and constraints against increasing productivity. For instance, Raphael and Morris (2000) highlight that a value chain describes the full range of activities required to bring a product or service through the different phases of production, including physical transformation, the input of various producer services, and response to consumer demand. Building on these definitions, the conceptual framework applied in this study comprises a generic sugarcane bio-ethanol value chain with a number of stages at which there are some value addition activities.

Ethanol production in Zimbabwe comprises a number of activities that are carried out by some economic agents. These economic agents are driven by the desire to make profits. The concept of the 'invisible hand' propounded by Adam Smith (1776)[17] that determines what, how and for whom any marketed product is produced helps one to understand what drives activities of economic agents along the value chain. Adam Smith notes that:

> B*y directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it. I have never known much good done by those who affected to trade for the public good. It is an affectation, not very common among merchants, and very few words need be employed in dissuading them from it.''*
>
> (Smith, Book IV, Chapter II)

In line with Adam Smith's reasoning, economic agents are assumed to do whatever it takes to make profit along the sugarcane bio ethanol value chain. In conceptualising the analytical approach, the study also derives a lot from the work of new institutional economists, namely Doward *et al* (2005),[18] who put

[17] Adam Smith, *Wealth of Nations,* First published in 1776, the book offers one of the world's first collected descriptions of what builds nations' wealth and is today a fundamental work in classical economics.

[18] The framework was developed by Doward Andrew , Omamo Were W, Meinzen-Dick Ruth and Gabre-madhin Eleni and presented in A Chapter in New Institutional Economics by Kirstein and Vink (2005); University of Pretoria

forward a conceptual framework for analysing institutions. The framework is rooted in the identification of an 'action domain' within the sphere of activities such as economic exchange of goods and services, management of natural resources, insurance or safety nets. In this study, therefore, the 'sphere' will be production and marketing of bio ethanol. According to Dorward *et al* (2005), critical to the analysis is the identification of the institutions, activities, and agents that are important in the sphere. To complete the analysis, the framework also defines a wider environment, which affects the action domain (sphere) and this environment comprises three major components: policy and governance, socio- economic and physical, and infrastructural environments.

As depicted in Figure 3, the three entry points for the study are: 1) to characterise the economic agents at each stage of the chain: 2) to analyse the creation of value and its distribution among agents: and 3) to analyse the impact of policy along the value chain.

Activities and agents

The generic sugarcane bio-ethanol value chain is seen to be at the centre of the domain and involves a number of activities such as production, processing, transportation, retail, exportation *inter alia* as shown in Figure 4.1. There are various economic agents involved at each stage, making decisions on allocation of resources to add value and pass on to the next stage of the chain until the final

product reaches the consumer. At this point an important research question for the study was who the economic agents are and what their activities are?

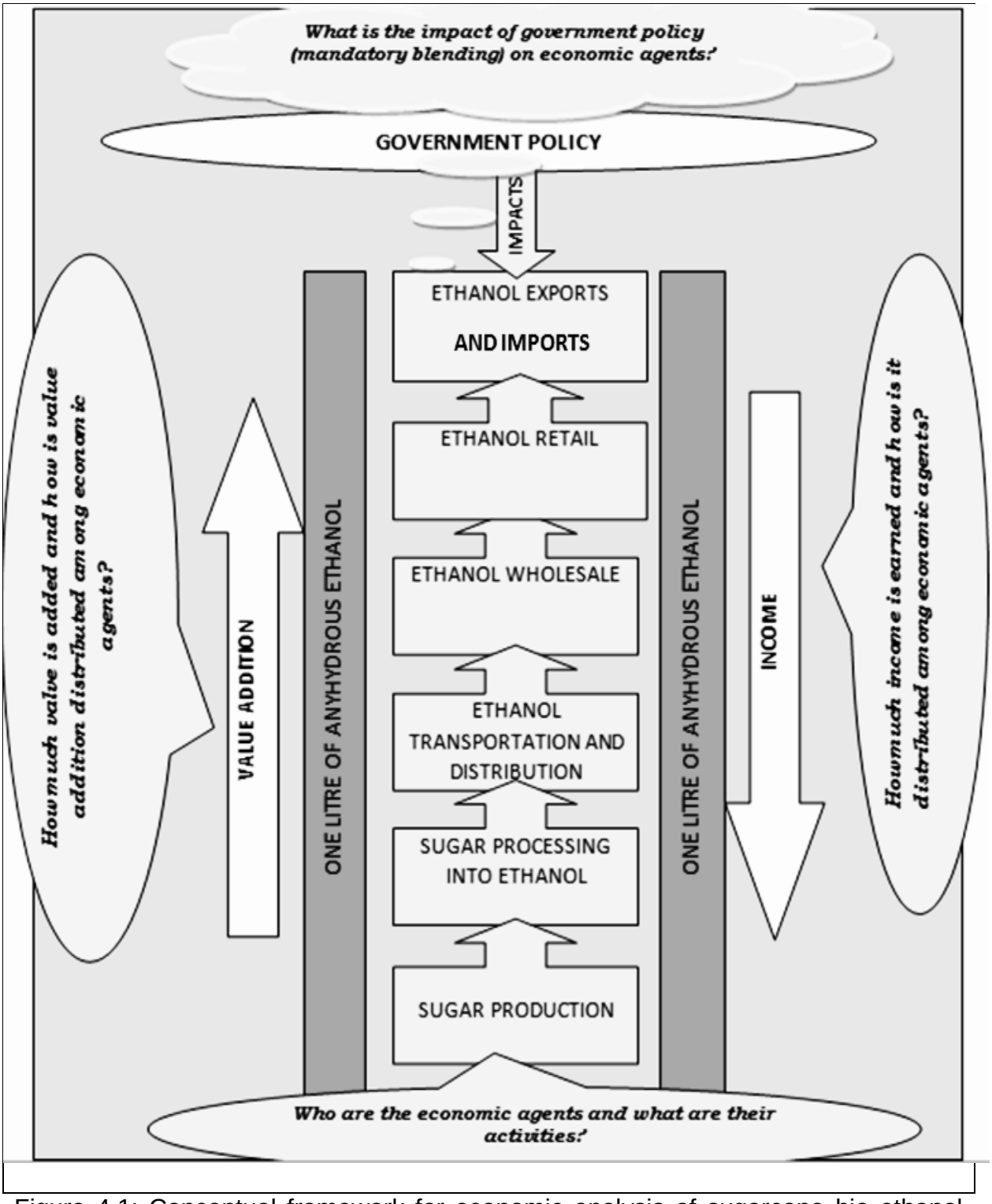

Figure 4.1: Conceptual framework for economic analysis of sugarcane bio ethanol value chain

Source: Developed by Author

Value addition along the value chain

The activities along the value chain are arranged diametrically to deliver a litre of ethanol with a specific price to the fuel consumer. At each stage of the value chain, economic activities occur that add value to economic resources namely land, labour, capital and entrepreneurial ability to deliver a product that becomes an input in the next stage of the chain. In this study, a general assumption is that the amount of value added and how it is distributed along any agricultural value chain differs across commodities. Given this assumption an important research question for the study was how much value is added at each stage of the chain, and how is it distributed among economic agents?

Maximisation of profit along the value chain

At each stage of the chain, economic agents perform value-addition activities to maximise profits (margins). Profits are seen as the difference between the costs incurred in production and the gross income obtained after selling a value-added product to the next economic actor in the chain. In line with the dictates of classical economic theory, economic agents are not expected to maximise benefit and neither are they expected to minimise costs. They are expected to attempt to maximise the level of net benefit (total benefit minus total cost) from any activity in which they are engaged. A research question that arises is how much income is earned and how is it distributed among economic agents?

Impact of mandatory blending and indigenisation policies on wealth of economic agents

The GoZ is targeting a minimum petrol ethanol blending level of 20% by 2015 and the rate is going to rise in line with government's energy policy. The impact of these changes on the agents along the chain and on the economy as a whole is a subject of unending debate in many circles.

4.4 Description of the areas of focus for the study

To describe the areas of focus for the study, focus is placed on two broad domains, these are, first, the energy sector in Zimbabwe and, second, Chipinge district where the Chisumbanje ethanol project was established.

4.4.1 Overview of Zimbabwe's petroleum energy sub-sector

Zimbabwe has no known gas or oil reserves (GoZ, 2012). It relies on imports for its petroleum needs. The petroleum sub-sector, which has been liberalised, forms the foundation of the transport sector. An independent regulator, ZERA, is responsible for sector-wide regulation with a common vision to protect consumers and ensure affordable pricing. ZERA implements the licensing regulations, product and service standards and investment promotion. According to the GoZ (2012), the policy challenges lie in increasing diversification in the procurement of petroleum products, developing a pricing mechanism suitable for the country, and increasing the storage capacity for products so as to mitigate supply disruptions. The GoZ in its Energy Policy Statement of 2012 notes that currently there is no coordinated research in the energy sector. It is also highlighted that a key policy measure is the reduction of the fuel import bill by import substitution through the incorporation of biofuels and coal-

conversion technologies; for example, the expansion of ethanol production for blending with petrol is important.

As discussed in Chapter 2, in the early 1980s, the country introduced 15–20% ethanol blending for petrol. Ethanol was introduced based on production in the Lowveld (Triangle and Hippo Valley) of 40 million litres a year. The project was suspended in 1992 following a drought. Suspending the project was also the result of market liberalisation brought about by the Economic Structural Adjustment Programme (ESAP). The government could not sustain the support to the sugar producers. In 2009 a partnership between government (through Agriculture and Rural development Authority) and the Zimbabwe Bio Energy Company formed Greenfuels, which introduced 10% ethanol blending as an initial phase to restore previous blending capacity. In lne with these developments, in its policy statement, the GoZ notes that to stimulate and sustain the development and expansion of biofuels the Ministry needed establish, by 2012, long-term targets and timeframes for increasing the share of biofuels, in line with international best practice. In the interim, the following guidelines were provided:

- A minimum ethanol/petrol blend target of 20 % was set by 2015, and a 5 % biodiesel blend by 2020;
- Shift the focus from food crops (e.g. soya beans) to non-food crops (e.g. jatropha) for the production of biofuels;
- Promote out-grower schemes and mini-processing plants for smallholder farmers; and,

- Undertake research for the improvement of feedstock quality and yields and processing technologies.

4.4.2 Description of case study site

Chipinge District stretches from Birchenough Bridge, which is located on the Sabi (Save) River 62km from Chipinge Township, 100km south of Mutare along the Masvingo road to Chisumbanje, which is just about 60km from Chiredzi. To the north, Chipinge borders with a range of mountains in Chimanimani district. On the eastern side, Chipinge shares an international border with Mozambique (Saungweme, 2011). Chisumbanje is the name of a village located in Chipinge District, in the province of Manicaland, Zimbabwe. It is located in the Dowoyo communal land on the eastern bank of the Save River. It is about 95 km south of Birchenough Bridge on the Birchenough Bridge-Chiredzi road. The large-scale investments in sugar production and the establishment of an ethanol plant in the Chisumbanje village is the focus of this study. The project is a joint partnership entered by the Agricultural and Rural Development Authority with the Zimbabwe Bioenergy Company (trading as Greenfuels, with two subsidiaries – Rating and Macdom Investments). Figure 4.2 shows the location of Chisumbanje.

Figure 4.2: Map showing location of Chisumbanje

4.5 Data requirements

To complete the economic analysis of sugar-ethanol-value-chain's economic activity data at each and every stage of the value chain was required. This section outlines the specific data requirements classified as, input (in primary production), processing, output, primary processing and production processes and trade.

- **Primary production process:** Before data collection, it was assumed that there were number of producers involved in the primary production of sugarcane. The data required included the production systems on average farm size of

representative farms, their numbers, yields, and production as well as any losses. Output storage capacities were also taken into account.

- **Output**: The output was defined as the product at each stage of the chain, for instance, at sugarcane production level, the output is cane ready for processing, whilst, for the ethanol plant, the output was pure anhydrous ethanol, whilst for retailers, the output was ethanol blended petrol. Therefore, producer and consumer prices, quantities of traded commodity, markets and their location, home consumption (in some stages of the chain) and numbers of potential and actual producers were used.

- **Inputs and factors for primary production**: Just as with the outputs, the inputs were defined at each stage of the chain from primary production to consumption. The production technical coefficients (input/unit output), prices, production scale (area, yields, capacities e. etc.) and all costs (storage costs, packaging, transport, taxes, wages, land costs, water, depreciation etc.) were considered.

- **Processing:** It was assumed that the main processing in the sugar ethanol value chain occurs in the ethanol plant at Chisumbanje. The data required included, quantities processed and sold, prices of raw materials (including labour, depreciation and storage etc.), conversion coefficients and prices of processed ethanol. If there were any differences brought about by seasons, then they needed to be taken into account.

- **Collection and trade of sugarcane as well as processed ethanol:** At the primary production level, it was assumed that there was some trade in sugarcane as a product. Similarly, once ethanol is produced, domestic and international trade was also expected to occur. Data on the typology of representative trading agents, type of markets (competitive, monopsony etc.) and contractual arrangements were also sought. The facilities available for the collection trade of the raw commodity (storage capacity, specific infrastructures etc) as well as transportation costs from production to the processor were also considered. Other transaction costs (informal taxes, losses etc.) incurred directly or indirectly were also brought into consideration.

- **Wholesalers, exporters and/or importers of the processed commodity:** In any value chain, some agents are involved in the transportation and distribution of sugarcane and ethanol as intermediary and final products in the sugar ethanol value chain. Available data on the transportation costs, equipment and facilities costs, asset investment costs and depreciation, quantities involved and prices were also collected.

- **General and institutional context:** The existence of economic and social infrastructure available (electricity roads, schools, hospitals, markets, communications, etc) as well as laws and bylaws directly and indirectly impacted on the value chain. Such data and information on national laws and or

international treaties affecting the value chain, market regulations, and producers' organisations acting in support of the value chain were also collected.

4.6 Data collection and instruments

The whole sugarcane ethanol value chain in Zimbabwe is the area of focus for the study. Both secondary and primary data was collected from the sources along the value chain (economic agents along the value chain, such as the farmers, the processors, retailers and wholesalers, suppliers, central and local government authorities). A household-level questionnaire, focus group discussions and key informant interviews were used to collect data along the value chain. The following methods were applied in conducting field research:

- *Household level questionnaire:* A questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents (Gillham 2008). The questionnaire was used to collect data in the activities of the smallholder farming households. The questionnaire had both open-ended- and closed questions and was pretested before being administered. A total of 200 questionnaires were used to allow for wide coverage and a large enough sample for drawing inferences.

- *In-depth interviews*: Taylor and Bogdan (1984) defines in-depth interviews as, "repeated face-to-face encounters between the researcher and the informants directed towards understanding informants' perspectives on their lives, experiences or situations as expressed in their own words." At each stage of the

chain – that is, at primary production, processing, wholesale and distribution, retail as well as export – key informants were interviewed.

- *Focus group discussions (FGDs):* These are also known as “group interviews” because they serve as a means of better understanding how people think or feel about an issue, product or service. Kumar (2005) define a focus group as a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment. The FGDs comprised men, women, youth, community leaders and war veterans. Five group discussions were held in the smallholder farming communities as a means to triangulate findings from the household questionnaire and the key informant interviews.

4.7 Sampling approaches

Household questionnaire: The study employed a number of approaches to sampling for the household-level questionnaire. In Zimbabwe, the local administrative structure in a district comprises of wards; the number of which varies by district. Each ward has a number of villages, which range from 10 to 70. Each ward has a councillor, who is a political figure and sits in the district council. The administrative structures at ward- and village levels are the ward development committees and the village development committees respectively. Villages to be involved in the household study were chosen using purposive sampling, since there was a need to target

respondents with specific attributes for use in the value chain (such as whether they are sugarcane growers; whether they are employees). In cases where resources permit and there are no other issues considered to change the sample size, a sample size for questionnaire administration at household level is normally calculated based on a 95% confidence level and 5% margin of error. Cochran's sample size formula is then used to determine the sample size as follows[19]:

$$SS = \frac{Z^2 * (p) * (q)}{d^2}$$

Where

Z = value for selected alpha level of .025 in each tail = 1.96. (alpha level of .05)

(p)= (q) = 0.5 (maximum possible)

PQ=estimate of variance = 0.25

d = acceptable margin of error for proportion being estimated = .05 (error we are willing to except)

And adjust for the finite population by

Sample size used =SS/ (1+ (SS-1)/population)

Under normal circumstances, therefore, a tentative sample size would be 384 respondents, which can be rounded off to 400 as in many studies. In this study, there were some issues that were considered to get the sample size and that are not particularly based on this theoretic calculation of sample size. The first are the limitations within the study's area of focus, which made it difficult to administer many

19

questionnaires. These were issues to do with the displacement of smallholder farmers and how GoZ has dealt with the issue. In this regard, in the study, the sample was limited to the lowest number that would allow the researcher to make sound statistical inferences to maintain scientific acceptability. The study used 200 questionnaires, which were administered over five villages that are within the vicinity of the Chisumbanje Ethanol project.

Key informant interviews: Key informant interviews were held at each stage of the sugar ethanol value chain. While there was no upper limit to the number of interviewees at each stage, at least three respondents were interviewed. This meant that more interviewees were to be done where there was still some missing information. The sampling approach that suited this type of interviews was a snowball sampling approach where the interviewer got the names of the next respondents from the current respondent.

4.8 Data analysis

Various authors (Taylor, 2008; Bellu, 2013; Belli *et al*, 1998,) agree that economic analysis can be viewed as a systematic approach to determining the optimum use of scarce resources, involving comparison of two or more alternatives in achieving a specific objective under the given constraints and assumptions. The definition implies that economic analysis takes into account the opportunity costs of resources employed and attempts to measure in monetary terms the private and social costs and benefits of an investment project to the community or to the economy.

According to Bellu *et al* (1998), economic analysis can describe the implications of policy alternatives not just in terms of economic efficiency, but also in terms of the magnitude and distribution of an array of impacts. These components of the definition and scope of economic analysis raised in these definitions imply that there are many aspects and variables for economic analysis, which cannot be covered in a single study over a specific issue. Given this background, this study placed focus on specific components of economic analysis, which are outlined in this section.

The model of analysis used in this study was largely informed by the landmark work of Bellu (2013), which describes the tools for quantitative value chain analysis. The model of analysis was modified slightly to incorporate other concepts such as value-chain governance analysis, which are not included in Bellu's framework. Household-level data was managed and prepared for analysis using the statistical package for social scientists (SPSS). FAO Value Chain Analysis Tool Software was used to put together the computations performed in the study. The specific areas of focus for the economic analysis performed in this study was guided by the three objectives and the proceeding sections outline analytical- and hypothesis- testing procedures followed in the study.

4.8.1 Objective 1: Characterising the emerging sugarcane bioethanol value chain

The first objective was to investigate the key elements (economic agents and their activities) of the sugarcane ethanol value chain. This investigation laid the basis for the economic analysis. To achieve this objective, the study employed multivariate

descriptive statistics, supply utilisation accounts, as well as value chain governance focusing on analysis of power and authority of the economic agents to characterise the key elements of the sugar ethanol value chain. The functional analysis details the structure of the industry by identifying, describing and quantifying in physical terms of the organisation activities to bring the product from primary production through processing and marketing to its final consumption. To achieve the first objective, the analysis focused on:

- Unpacking the technical aspects of operations involved from primary production to final consumption;
- Quantifying the inputs used and intermediate outputs produced at each stage of the chain;
- Characterising the economic agents involved at the different stages of the value chain and their roles; and
- Quantifying the physical flows of the product among the different economic agents at different stages of the chain.

The hypothesis tested in the processes of achieving the first objective was that the sugarcane bio ethanol value chain is not competitive. A number of parameters such as number of agents, level of information available to sellers and buyers, entry/exit barriers for sellers and buyers, control binding the supply, control over prices and nature of product were assessed using descriptive and qualitative approaches to test this hypothesis.

Activities along the sugar ethanol value chain

In order to understand how the sugarcane ethanol value chain works, it was important to identify the main activities undertaken along the chain. Therefore, the analysis focused on:

- Describing sugarcane primary production processes: focusing on both the perceived smallholder and large-scale systems in Chisumbanje;
- Describing the various processes in converting sugarcane into ethanol;
- Unpacking transport, handling, storage and other service activities along the chain;
- Describing the wholesale and retail distribution of ethanol; and,
- Identifying any intermediary processing activities in the sugarcane ethanol value chain.

Whilst the analysis could have been strictly limited to activities directly related to ethanol, there was merit in providing limited analysis of the provision of strategic services to the chain; for instance, extension, equipment, credit, and policy environment, as these were believed to have some impacts on the activities along the value chain.

Economic agents along the sugarcane ethanol value chain

After identifying and unpacking the activities along the chain, the next step was to understand the types of economic agents who perform them. This part of the

research involved an examination of the roles. This study made use of value chain governance analysis to understand the roles of different economic agents along the sugar ethanol value chains.

Determination of physical flows of products

Once the economic agents and the activities they are engaged were matched, the information was presented in a flow chart and a functional analysis table (see Chapter 5). The flow chart shows how different economic agents are linked while the functional analysis table shows the agents, the activities there are engaged in and the outputs they produce. The quantification of physical flows occurs through yields per unit of activity (e.g. ha) and the times the number of ha are cultivated. The study makes use of Supply Utilization Accounts (SUA), consisting of a double-entry accounts that allows one to check consistency at each stage of the chain, between the quantities of the commodity supplied by upstream agents and the quantities absorbed by the downstream ones. According to FAO (2013), SUAs provide linkages between primary agricultural commodities and their derived products.

4.8.2 Objective 2: Determining value added and gross margins and their distribution

The second objective the study aimed to determine the creation and distribution of value added and profits and, to some extent, the net gains to the society when all activities in the sugar value chain are considered. This dimension of economic analysis allowed the researcher to assess revenues, costs and margins (value

added and net benefits) of each activity, each agent, segments of the value chain and the whole value chain. This assessment used prices actually paid and received by economic agents along the sugarcane ethanol value chain, but in a few of the cases prices and costs had to be extrapolated due to lack of data.

To compute value added and net benefits attributable to each economic agent and process, this dimension of economic analysis relied on the construction of two accounts – a production account and an income account. The production account yields either the net or gross value of capital goods consumed in the production process, which is the value added (VA). The VA is calculated as the difference between the value of the output and the value of the inputs required to obtain that output. The income account determines how the value added is distributed among the agents participating in the production process. These various economic agents are involved, as in any economic system, through the provision of fundamental economic resources of land, labour, capital and entrepreneurial abilities. The hypothesis tested as part of achieving the second objective of the study was that the distribution of profits along the value chain is not equitable.

Input-output model for analysing value added and profits along a value chain

The approach for computing value added and profits along the sugarcane bio-ethanol value chain espoused in this study is grounded in input-output modelling and concepts. According to Rey (2000), the basis of I-O approach is that production of an output requires inputs. Typically, the I-O linkages are recorded in a “transactions” or “flows” matrix that records all payments to and from a sector within a year. The

model works on the basis of double-entry bookkeeping, so that gross outputs must equate to gross inputs. Further, according to Nijkamp and Blaas (1994), I-O models also focus on inter-industry relationships, the related income and employment.

The ability of I-O models to show the supply chain linkages, capture the full system effects and be applicable to scenario (what if) analysis made it suitable for the purpose of the study. In addition, Rey (2000) notes that the approach is a suitable model for investigating and analysing impacts along a specified value chain. However, Rey (2000) highlights some challenges and weaknesses in the standard I-O models and their application: the often common unavailability and unreliability of data; the assumption that production techniques are fixed; susceptibility to import propensity changes, and susceptibility to industry linkages changes.

The application of the I-O approach along the value chain is a unique approach applied in this study. Conventional I-O modelling traces input and output relationships between different sectors of the economy. The same analogy is applied along the sugarcane bio ethanol value chain to trace the creation and distribution of wealth at different stages of the chain. Based on this I-O approach, the model for the analysis carried out in this chapter can be articulated as follows:

Let:

- Outside intermediate inputs used by *i* (IIOC) be denoted x_i
- Total output value in the Account for agent I be denoted y_i
- Total intermediate inputs (from outside and inside chain) used be agent i be z_i
- Value added created by agent I be denoted λ_i (i.e. $VA_i=\lambda_i$)

Also note:

When i=1 then agent is producer (prod)

When i=2 then agent is processor (proc)

When i=3 then agent is trader (trad)

In view of the above, the following hold:

$$VAprod = \lambda_1 = x_1 - z_1$$

$$VAproc = \lambda_2 = z_1 + x_2 - z_2$$

$$VAtrad = \lambda_3 = z_2 + x_3 - z_3$$

The total value added above can be defined as follows:

$$TVA = VAprod + VAproc + VAtrad$$

$$= \sum_{i=1}^{3} x_i - z_i$$

4.8.3 Objective 3: Simulation of impacts of alternative policy scenarios

The third objective pursued in this study was to simulate the potential impacts on different economic agents along the value chain of different policies instituted or that will be instituted (e.g. mandatory blending of E5, E10, E15, E20, E85, as well indigenisation policies)[20] to support the investments. The hypothesis tested was that as the level of ethanol petrol blending increases, the net benefits accruing to different agents increase disproportionately. The approach and model espoused to determine the impacts of policy along the sugarcane bio ethanol value chain builds on the three agent I-O model outlined in the earlier section. The I-O model is modified through application of counterfactual analysis approaches to model policy impacts on the

[20] The 'E' stands for Ethanol, implying that E5 blend would have 5% ethanol.

value chain. The model used to simulate the impact of policies can be defined as follows:

At any stage, let:

- n represent number of inputs
- m represent number of outputs

Case (1) Base scenario:

At production level

Total inputs are:

$$\sum_{i=1}^{n} Pa_i \times Qa_i = \sum_{i=1}^{n} Xa_i$$

where Pa_i denotes price of ith input; Qa_i quantity of ith input; and Xa_i value of ith input.

Total outputs are:

$$\sum_{i=1}^{n} Pf_i \times Qf_i = \sum_{i=1}^{n} Yf_i$$

where Pf_i denotes price of ith output; Qf_i quantity of ith output, and Yf_i value of ith output.

The margin for primary production ($Mprod_0$) is then obtained as follows:

$$Mprod_0 = \lambda_0 \left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right]$$

Where $\lambda_0 = Sprod_0$ (i.e. the scale factor),

At processing level

In a similar fashion, we have margins for processing ($Mproc_0$) is as follows:

$$Mproc_0 = \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right]$$

where $\lambda_1 = Sproc_0$ (constant scale factor) and Yq_i and Xq_i denote the ith output and input values respectively.

The value chain margin is then calculated as follows:

$$WoP = Mvc_0$$

$$= Mprod_0 + Mproc_0$$

$$= \lambda_0\left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right] + \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right].$$

Case (2) policy scenario (i.e with policy)

Let the policy scenario be represented by z, $Mprod_z$ be the margin for primary production and $Mproc_z$ be the margin for processing.

Then,

$$Mprod_z = \lambda_0\left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right]$$

And,

$$Mproc_z = \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right].$$

Now, cost of policy has to be incorporated as follows:

$$\text{Cost of policy} = Cpol_z$$

$$= \sum_{i=1}^{n} Xg_i.$$

It then follows that,

$$\text{Value chain margin} = Mvc_z$$

$$= Mprod_z + Mproc_z - Cpol_z$$

$$= \lambda_0\left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right] + \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right] - \sum_{i=1}^{n} Xg_i.$$

The key processes of building a baseline scenario that corresponds to a benchmark situation were carried out. Impacts were investigated by generating the blending and indigenisation policy measures and how they impact on specific parameters in the value chain starting with modifying the original reference scenario.

4.9 Challenges in data collection

Developments along the sugarcane bio ethanol value chain have been subject to debate in the public. As a result getting the appropriate information along the sugarcane value chain was not easy. Ethanol cost and sales information was particularly difficult. Therefore, in some instances as shown in chapters 6 and 7, there was reliance on secondary data.

4.10 Conclusion

This chapter presented the methods applied to achieve the objectives set out in the research. The conceptual framework for analysing the sugarcane bio ethanol value chain from an economic discipline standpoint is presented. This conceptual framework defined the entry points for the study, which are 1) the character of the emerging chain, 2) the value and profits that are being created and how they are distributed; and 3) the impact of policies particularly blending and indigenisation policy. The chapter also described the country's energy sector and the Chipinge district where the investment has been established as the areas of focus for the study. The data requirements, sampling, and analytical approaches for the three objectives pursued in the study were also presented. The next chapter presents a characterisation of the sugarcane bio ethanol value chain focusing on the agents and their relationships, activities, as well as product movement along the chain.

CHAPTER FIVE: CHARACTERISING THE EMERGING BIO ETHANOL VALUE CHAIN

5.1 Introduction

The investments in large-scale sugarcane production for processing into bio ethanol fuel that have occurred in Zimbabwe have generated active and elevated multidimensional debate in the public in general. Among many of dimensions of this debate are issues to do with the potential impact of the investment on welfare of different economic agents, fairness and competitiveness of the value chain itself, and the role of various agents shaping the governance of the value chain, which include political, administrative and business dimensions. The potential impact of government energy policy particularly ethanol petroleum blending levels on incomes of different economic agents has also been an issue among stakeholders. In this chapter, a characterisation of this emerging sugarcane bio ethanol value chain is performed.

The chapter begins by outlining the empirical approaches applied perform the analysis. The rest of the chapter presents the findings focusing on a description of the activities along the chain, the movement of product from primary sugarcane production to consumption of bio ethanol as a fuel using simple supply utilisation accounts (SUA) and analysing the different economic agents along the chain.

5.2 Objectives of the chapter

The overall objective of the chapter was to characterise the emerging sugarcane bio ethanol value chain in Zimbabwe, tracing ethanol produced at the Chisumbanje ethanol project. This chapter draws on empirical investigations carried out along the Chisumbanje sugarcane bio ethanol value chain to identify and characterise the key elements, economic agents and their activities as part of the sugarcane bio ethanol value chain. The chapter interrogates the typology of the key elements of this emerging value chain. The hypothesis tested is that the emerging bio ethanol value chain is not competitive. The analysis done in this chapter lays the basis for the further economic analysis along the value chain presented in chapters six and seven.

5.3 Overview of methodology for the chapter

As highlighted in Chapter 4, the characterisation of the value chain presented in this chapter entails the 'functional' analyses of the value chain. It details the structure of the industry by identifying, describing and quantifying in physical terms of the organisation activities to bring the product from primary production through processing and marketing to its final consumption. The analysis focuses on:

- Unpacking the technical aspects of operations involved from primary production to final consumption;
- Quantifying the inputs used and intermediate outputs produced at each stage of the chain and quantifying the physical flows of the product among the different economic agents at different stages of the chain; and

- Characterising the economic agents involved at the various stages and their roles.

As an important addition to this framework, this study deepens the analysis of the roles of different economic agents along the sugarcane ethanol value chains. The analysis goes further to analyse governance and issues related to power along the value chain. As discussed in Chapter 3, Johnston *et al* (2007) define value chain governance as the dynamic distribution of power and control among agents in a value chain. This analytical dimension is important as governance becomes a determinant of socio-economic outcomes. Humphrey and Schmitz (2008) explain that value chain governance also pays attention to the relationships among the buyers, sellers, service providers and regulatory institutions that operate within or influence the range of activities required to bring a product or service from inception to its end use. Governance is about power and the ability to exert control along the chain at any point in the chain, some firm (or organisation or institution) sets and/or enforces parameters under which others in the chain operate.

Once the economic agents and the activities they are engaged in are matched, the information is presented in a flow chart and a functional analysis table. The flow chart shows how different economic agents are linked whilst the functional analysis table shows the agents, the activities there are engaged in and the outputs they produce.

5.4 Findings: Characterising the sugarcane bio ethanol value chain in Zimbabwe

The analytical framework espoused in this chapter included: 1) unpacking the technical aspects of operations involved from primary production of sugarcane to final consumption of bio ethanol; 2) defining the inputs used and intermediate outputs produced at each stage of the chain; and, 3) characterising the economic agents involved at the stages of the sugarcane bio ethanol value chain. The product is a characterisation that is presented as a flow chart and functional map of the value chain.

5.4.1 Activities along the sugar ethanol value chain

To assist in characterising the sugarcane bio ethanol value chain in Zimbabwe it is important to begin by delineating the stages along this chain. According to Hellin and Meijer (2006), this is important because the stages along the value chain need to be identified for effective value chain analysis. Basing on the information collected along the sugarcane ethanol value chain, the stages in this chain can be broadly categorised into three to include 1) 1-O relationships in production (farm level) of sugarcane; 2) 1-O relationships in the processing of sugarcane into bio ethanol; and 3) I-O relationships in the marketing and distribution of bio ethanol.

Primary production of sugarcane

Sugarcane is the feedstock that is used in ethanol production in Chisumbanje. In interviews, officials explained that the sugarcane that is used in the ethanol plant is grown under a highly mechanised system of production. Field production of

sugarcane takes place at two main sites, namely Chisumbanje and Middle Sabi. As a key economic resource land is one of the important inputs in the production of sugarcane. The interviewees also explained that in Middle Sabi, Greenfuels through its subsidiary Rating Private limited is utilising 3500ha of original ARDA land with no displacement of the community. It was highlighted that there is a plan to develop 6000ha in Middle Sabi for an out grower scheme under the A2 model[21]. In Chisumbanje again through another subsidiary known as Macdom Investments Pvt (Ltd), the company is utilising 6500 ha of land. Recent publications in public media show that the company is planning to extend the land under sugarcane by another 1000 hectares at Chisumbanje[22].

In Chisumbanje part of the land being used is under conflict. All interviewees concurred that there is significant displacements of smallholder farmers to pave way for the large-scale sugarcane production. At the time of interviews in 2014, there were indications that there are 1008 families who lost land ranging from 2 to 40ha depending on the family size. Out of the 1008 families who lost land 172 families were compensated with the 0.5ha of irrigated land. In the Chisumbanje area the 10 affected villages are *Tazwa 1, Tazwa 2, Guwarekipi, Madhwayi 1, Madhwayi 2, Madhwayi 3, Mazembe, Vhutuza, Muyondozi and Ndofeni*. In Chinyamukwakwa, 388 families out of the 694 families affected were compensated, again with 0.5ha of

[21] The A2 model is the commercial model of the Fast Track land reform programme where farmers are resettled in a way such that an individual has a farm with minimum size from 6-10hectares up to 500 hectares, where crop and livestock production is carried out within the farm.
[22] https://www.newsday.co.zw/2014/10/22/green-fuel-targets-1-000ha-sugarcane-2015/,

irrigated land[23]. This paper is not focused on the issue of land. Other scholars, for instance Mutopo and Manase (2012); Matondi and Nhliziyo (2014) provide richer accounts of the conflict around the land at the Chisumbanje site.

The production systems at Greenfuels' sister subsidiary companies Macdom and Rating are identical. From land preparation to the point of harvesting, the production system is the class of any First World highly mechanised process. The production cycle takes roughly 300 days for a sugarcane crop to be planted, harvested and sent for processing into ethanol. Table 5.1 shows some of the characteristics of the primary production cycle.

Table 5.1: Some characteristics of primary production process

Parameter	**Value**
Length of sugarcane production cycle(days)	300 days
Approximate size of land planted annually(hectares)	10000 hectares
Estimated yield per hectare(t/ha)	135t/ha
Remuneration of labour/days($)	$4
Amount of fertilizer(kgs/hectares)	500kgs
Cost of fertilizer/hectare	$37/bag

Source: Primary interviews with Greenfuels officials

It takes less than an hour from the stage the sugarcane is harvested for it to be fed into the processing plant to produce ethanol. There is a highly mechanised and well timed continuous process of harvesting the sugarcane from the field and transporting it to the plant for processing. This well-timed process stems from the quality control requirements associated with a highly sophisticated chemical process to follow in the processing stage. The quality of the feedstock for ethanol production has to be

[23] There was also debate around the correct figures; for instance, the company says 176 families have been compensated in Chisumbanje area, whilst interviews with other informants highlighted that it was much lower than 172.

maintained at a constant level. This has important implications for the overall discussion on the character of the emerging bio ethanol value chain, particularly with respect to the involvement of smallholder farmers in the actual primary production process.

The issue of out growers raises an important analytical dimension with respect to the inclusivity of the business model in the Chisumbanje sugarcane bio ethanol value chain. In interviews officials explained that there are 116 out growers under 400ha of land and 125 war veterans under 250ha of land. However, the model is a unique model in that the farmers are not much involved in the production but they are just land owners and the company does everything for them and pays them at the end of every harvest. From the company's perspective this is because the farmers do not have expertise in the production of the expected quality of the sugar cane required for the production of ethanol. This means smallholder farmers are actually automatically excluded from actively participating in the primary production because of the sugar quality requirements for processing.

This issue of out growers becomes particularly important given the debates around inclusivity of the business model. As evidence in the interviews shows, the company has often used the 116 people on 400 hectares and 125 war veterans on 250ha as evidence of the out grower scheme the company has. In theory, an out grower is described to represent contractual partnership between growers or landholders and a company for the production of commercial agricultural products (Desmond and

Race, 2000). The lack of evidence of use of independent smallholder producers or out growers in the primary production process, poses serious questions on how inclusive the Chisumbanje ethanol value chain is. One question is why in the primary production process does one not see large numbers of smallholders being involved by supplying the processing plant. Therefore, it is justified to conclude that the primary production process in the Chisumbanje bio ethanol value chain is dominated by the two companies.

Processing of sugarcane into anhydrous ethanol

The processing of sugarcane into ethanol takes place at the processing plant in Chisumbanje. Greenfuels acquired from Brazil and installed at Chisumbanje village a plant that processes sugarcane into anhydrous ethanol. Informant interviews with company officials showed that the plant can process 1.5 million tonnes of cane in a 300 day season. The annual ethanol output is estimated at between 105 million litres, which convert to 350 kilolitres per day of 14,580 litres per hour. Interviews also reflected that there are four scientific stages which typify the processing stage, as shown in Table 5.2. Although the stages can be defined in terms of the scientific process occurring, the processing stage can be viewed as one big event in value chain parlance, since it takes hardly three hours before the crushed cane is turned into anhydrous ethanol. Further, all these activities are carried out in the processing plant at Chisumbanje.

Table 5.2: The technical stages in the processing of sugarcane into ethanol

Crushing	Fermentation	Distillation	Dehydration
• Stalks are washed, crushed and shredded at the mill using revolving knives and rollers. • The shredded cane is repeatedly mixed with water with collected juices containing 10%-15% sucrose. The remaining fibrous solids, called bagasse, are burned for fuel, making a sugar mill more than energy self-sufficient as surplus bagasse goes into animal feed, paper, chipboard and energy briquettes or electricity generation for re-sale.	• Two major components of plants – starch and cellulose – are both constituted with sugar and cane, in principle, are converted to sugars that can be fermented. • The cellulose part of the plant is broken down into sugars and subsequently converted to ethanol.	• For the ethanol to be used, it is important that water is removed, and this is achieved through distillation. • Purity is limited to between 95% to 96%, due to the formation of a low, constant boiling mixture of water-ethanol. • The 95.6% m/m (96.5% v/v) ethanol, 4.4% m/m (3.5% v/v) water mixture may be used as fuel alone, but unlike anhydrous ethanol, cannot be mixed in petrol, so the water fraction is typically removed in further treatment in order to burn in combination with petrol in petrol engines.	• There are five dehydration processes to remove water from an azeotropic (constant boiling mixture) of water/ethanol. • Modern ethanol plants such as the one at Chisumbanje have evolved to use molecular sieves to enhance energy saving.

Source: Interviews with Greenfuels company officials

Marketing and distribution of ethanol

Transportation

Greenfuels has its own transport system. Ethanol is transported from the Chisumbanje ethanol plant to registered fuel blenders. While the interviews could not establish the exact number of trucks that Greenfuels uses to transport the ethanol, it is clear that this is a huge fleet since it has to transport all the ethanol from Chisumbanje to specific blending sites. The transport system involves state-of the-art fuel tankers specialised to carry ethanol. There is no evidence of outsourcing of transportation of ethanol from Chisumbanje to various registered fuel blenders in the

country. The transportation is therefore integrated with the processing just as the primary production process is.

Blending and wholesaling

Blending of petroleum with ethanol takes place at different places and is carried out by licensed blenders. Zimbabwe Energy Regulatory Authority has licensed 36 fuel oil importers, (10 players import the bulk of the fuel) while there are six wholesalers. With regard to blending, ZERA indicates that as of October 2013, ten blending licences had been issued to four companies – Zuva Petroleum, Engen Petroleum Zimbabwe, Green Fuel and Sakunda Energy. The licences are site specific with the bulk of the blending to take place in Harare (5 sites) followed by Bulawayo (2 sites), Mutare (2 sites) and Triangle (1 site). The National Oil Company of Zimbabwe also blends fuel at its Msasa (Harare) and Feruka (Mutare) facilities.

Retailing of blended fuel

An important activity in the sugarcane bio ethanol chain is fuel retailing. Fuel retailers source the bio ethanol blended petroleum from the registered blenders. Whilst there appears to be no issues with regard to quantities of bio ethanol blended petrol, there appears to be some issues around its pricing. Based on information available in the public media the blending companies are selling blended fuel at different prices. For example, an article published in a local daily paper performed a comparative analysis of the prices of wholesale prices of blended fuel at different locations and shows the disparities as seen in Table 5.3.

Table 5.3 : Retail prices of petrol in Zimbabwe

	Harare		**Bulawayo**	
	29/07/12	17/10/12	29/07/12	
Wholesale price	$1.46	$1.48	$1.51	$1.53
Pump Selling price	$1.51	$1.53	$1.56	$1.58
Margin	$0.05	$0.05	$0.05	$0.05
% margin	3.42%	3.33%	3.31%	3.21%

Source: Compiled from Daily News (2012)

What is not clear is whether these differences in prices are a result of the quality of the fuel or a result of other factors or value-addition processes such as transportation to the convenient proximity of the user, associated services at pumps and so on.

Another key dimension to the analysis of the pricing of fuel is the role of government. The government charges duty on imported petrol and diesel and often uses this as a means to raise revenue; and often in many cases unbudgeted expenditure. For example, it is highlighted in the country's 2014 Medium Term fiscal policy (Government of Zimbabwe, 2014) that government was increasing excise duty on diesel and petrol from 25 and 30 cents per litre to 30 and 35 cents per litre, respectively. This was with effect from 15 September 2014. The stated reason was in order to raise additional revenue to finance inescapable expenditures. In addition the government through its revenue authority charges a petroleum importer's levy. The levy is pegged at US0.04 per litre of petroleum products imported by a petroleum importer and transported by road. The levy should be accounted for on a bill of entry and paid on entry. All importers of petroleum products are required to complete a declaration form indicating the destination of the products imported.

Further to this, with respect to ethanol, the government has the major say in the determination of the price of ethanol. The price of ethanol is fixed by the Zimbabwe Energy regulatory Authority and is currently fixed at US$0.95 per litre as of 2015. Government is in partnership through ARDA with Greenfuels in producing ethanol, and at the same time it has to enter into negotiations with Greenfuels as the sole licensed producer in negotiating a price for ethanol. This shows how government is a key factor in the pricing of fuel in the country.

5.4.2 Supply utilisation accounts along the sugarcane bio ethanol chain

The preceding sections provided a description of the activities along the sugarcane bio ethanol chain. In this section, Supply Utilisation Accounts (SUA), consisting of double-entry accounts that allow for one to check consistency, at each stage of the chain, between the quantities of the commodity supplied by upstream agents and the quantities absorbed by the downstream ones. The emerging characteristics of the sugarcane bio ethanol chain still allow for the SUA analysis. However, the fact that in many of the stages along this chain, there is only one player, which is the company, makes the analysis slightly different from situations where for instance there are many primary level producers, and many processors. It is important, however, for purposes of tracing value and how it is shared among economic agents, which is the focus of the next chapter. Table 5.4 summarises the flow of product from the level of primary production to the level of consumption.

Table 5.4: Flow of product along the sugarcane bio ethanol value chain

Stage of value chain	Parameter	Estimates based on potential
Primary production process (sugarcane production)	Land area (per annum)	10000ha
	Number of farmers	1[24] (subsidiaries of Greenfuels doing the farming, in addition, war veterans and settler farmers do not do the farming but are just paid at end of season)
	Yield per hectare**(tons)**	135
	Total sugarcane harvested per year (tonnes)	1 350 000
Processing stage	Raw sugarcane feed (per year)	1350000
	Number of processors	1
	Conversion rate (ethanol/t sugarcane)	75L
	Total ethanol per year	101250000
Blending and wholesale stage	Total amount of ethanol (litres)	101250000
	Number of economic agents	10
	Total amount used for blending (litres)	101250000
Retail stage	Total amount of ethanol	101250000
	Number of economic agents	400
	Number of consumers (all motor petrol users)	All petrol users

Source: Computations from primary data by Author (based on 2013/14 season estimates)

5.4.3 Governance of the sugarcane bio ethanol value chain

As noted in previous sections in this chapter, an analytical dimension pursued is the governance of the sugarcane bio ethanol value chain. Value chain governance is denoted as dynamic distribution of power and control among agents in a value chain. The analysis also goes deeper beyond the formal structures to analyse the relationships among the buyers, sellers, service providers and regulatory institutions that operate within or influence the range of activities required to bring bio ethanol

[24] Earlier discussions showed why the 116 settlers and 125 war veterans cannot be classified as producers since they are not involved in the actual production but as land lords

from inception to its end use. Value chin governance analysis enriches economic analysis by unpacking what drives certain behaviour along the value chain, how this shapes particular policies and programmes, who are the main winners and losers, and what the implications are for development strategies and programmes. The analysis focuses on agents both directly and indirectly involved in the sugarcane ethanol value chain.

For purposes of ease of analysis agents are categorised as primary and secondary economic agents. The primary agents are directly involved in performing activities along the sugarcane bio ethanol chain and these include Greenfuels, Macdom and Rating, various fuel blenders and numerous fuel retailers and dealers. The secondary agents are involved as service providers to the primary agents along the chain and these include ARDA, ZERA, Ministry of Energy, local community, war veterans, Security sector (Police, President's office) local traditional leaders, local interests groups, political party leadership, (Member of Parliament, Councillors), Chipinge district administration, Chipinge Rural district council. The analysis goes beneath the formal structures to show the underlying interests, incentives and institutions driving the activities.

Analysis of the structure of the investment that has occurred in Chipinge reflects complex relationships between various economic agents. In this chapter, what is critical is to analyse how the various players participate along the value chain.

Primary economic agents in the sugarcane bio ethanol value chain

1. *Greenfuels, Macdom Investments (Pvt) Ltd (MACDOM) and Rating Investments (Pvt) Ltd (Rating)*

Evidence shows that Greenfuels is a private company that owns the ethanol plant at Chisumbanje[25]. What is also emerging is that government has entered into a joint venture with Macdom and Rating, which are two private companies. This joint venture agreement facilitates the investors to utilise ARDA's facilities including land to produce sugarcane to supply the ethanol plant. Government through this joint venture is involved in primary production of sugarcane.

The arrangement is a clear mechanism for ensuring sugarcane supplies to the plant, and therefore can be seen as a vertical integration process confirming earlier argument on vertical integration by Msangi and Tokgoz (2009). These authors bring to attention that securing a stable and consistent biomass supply is crucial for favourable feedstock costs and profit margins. There are some issues that deserve to be interrogated further as one characterises the emerging value chain. The first issue is around of ownership structure. According to Zimbabwean laws, all investors can own up to 49% only with 51% reserved for Zimbabweans.

In FGDs the community highlighted that they are not happy to be driven out of the ARDA land to pave way for white farmers. It was highlighted that ARDA is part of government and in principle government owns the land on behalf of the people. A group of war veterans in Chisumbanje highlighted that during the war of liberation

[25] The Company is a private investment of Mr Billy Rautenbach

that brought the country's independence, they were motivated to go to war and fight to resist being driven out of this ARDA land. So the question is if people went to war because of this land, what will stop them from fighting for the sameland in the future? Considering the influence the war veterans have on the country's political scene, there is no guarantee that the Greenfuels subsidiaries, Macdom and Rating can continue using this land peacefully.

2. *Agricultural and rural development authority (ARDA)*

ARDA is an important actor because it provided the mechanism though which government contributed to the joint venture with the private investor. ARDA is a parastatal under the Ministry of Agriculture Mechanisation and Irrigation Development MoAMID. The government through the MoAMID appoints a board of directors to run the affairs of the authority. According to a report by the Zimbabwean Parliamentary Portfolio Committee on Agriculture Water Land and Resettlements (Government of Zimbabwe, 2010), at its establishment in 1965, the purpose of ARDA was to boost agricultural production and rural development as well as productive utilisation of State land. ARDA's function was to provide education and management services to small-scale farmers on both communal land and property purchased by the government.

According to government reports (Government of Zimbabwe, 2010), in 2008 ARDA embarked on a turnaround strategy and drive to find investment partners to rehabilitate their properties and pursue a vibrant social responsibility agenda for the benefit of the rural population. ARDA entered into a Build, Operate and Transfer

arrangement with private investors Macdom (Pvt) Limited and Rating (Pvt) Limited on the Chisumbanje and Middle Sabi Estates in Chipinge, Zimbabwe. ARDA has not been spared by the poor performance and poor management that generally characterises most government parastatals. In 2010 a parliamentary portfolio committee was set up to investigate the viability of ARDA operations and their impact on agricultural productivity and food security. The report on the investigations highlighted two important findings as follows (ibid):

- The contract between ARDA and Rating Investment Ltd, Macdom Ltd was poorly drafted and that the Government of Zimbabwe, represented by ARDA, was short-changed of proceeds that were to be harvested from the joint venture. This is so particularly because the agreement did not specifically state the expected harvest or product and the percentage that must be allocated to ARDA; and,
- Villagers, while welcoming the developments happening at Chisumbanje, were being displaced by the expanding sugar cane plantations and that there seems to be no plan in place to ensure the villagers benefit from the scheme since they are not being consulted in the whole process.

As other parts of this chapter have shown, there are protracted conflicts over some of the land that ARDA has used as part of its contribution in the joint venture entered with Macdom and Rating. ARDA maintains the land belongs to it and therefore has not grabbed land from the communities. ARDA's position is supported by all the local

authorities – the Member of Parliament, the District administrator and the CEO and the Ministry of Energy.

3. Fuel blenders

As highlighted in earlier sections, there were at least 10 licensed fuel blenders as of October 2013. The licences are site-specific since blending requires specialised infrastructure. As shown in earlier sections, the licences are shared by four companies namely Zuva Petroleum, Engen Petroleum Zimbabwe, Green Fuel and Sakunda Energy. Officials from Greenfuels highlighted that ZERA closely regulates the blending process. In interviews, Greenfuels highlighted that it receives instructions on the destinations of the ethanol from ZERA. The companies that blend petroleum become the *de facto* wholesalers of the product because of the special blending and additional storage facilities that need to be installed.

4. Fuel retailers

There are an estimated 400 retail outlets for petroleum in Zimbabwe. To operate the fuel retail business one has to be registered by ZERA and has to have three sets of licences: one from the local authority, one from ZERA and one from the environmental management agency. Fuel retailing is perhaps one part of the sugarcane bio ethanol chain where there are many agents who appear to be operating in a competitive environment. The only issue as alluded to in earlier sections is that these retailers are price takers, and they maintain their mark up or margin by simply passing on the cost to the consumer. It has also been shown that

the retail price of blended petrol is determined not only by the blenders' wholesale price but also by other factors, which include import laws, prices of ethanol, and transport costs.

Secondary agents in the sugarcane bio ethanol value chain

1. *Zimbabwe Energy Regulatory Authority (ZERA)*

The Energy Regulatory Authority Act of 2011 established ZERA. At its establishment, the mandate of ZERA was to regulate the procurement, production, transportation, transmission, distribution, importation and exportation of energy derived from any energy source' (section 4(1) (a)) (Government of Zimbabwe, 2012). The National Energy policy highlights that ZERA makes decisions on development, monitoring and enforcement of product and service standards, energy prices, dispute resolution, and the issuing, enforcement, renewal, amendment or cancellation of licences. Figure 5.1 shows the institutional roles of the ZERA.

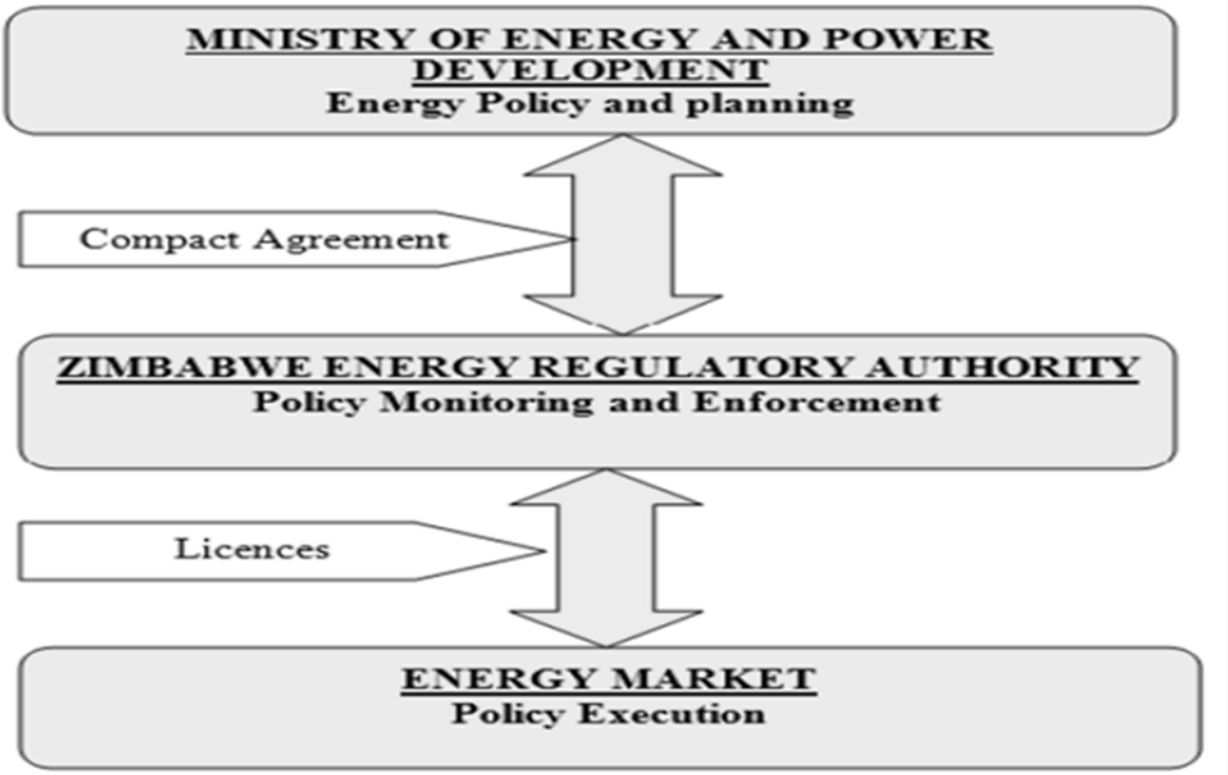

Figure 0.1: The institutional roles of the ZERA
Source: Zimbabwe National Energy Policy (2012)

Through the establishment of ZERA, the government also sought to address the weakness in the legal framework that did not provide the adequate degree of independence required for regulatory efficiency. The ZERA is an important agent in the sugarcane bio ethanol value chain. Its roles in this chain include licensing of all other agents; namely producers and importers, wholesalers and distributors. The other important function is the recommending of the appropriate pricing for petroleum products. The country's energy policy particularly highlights that it is an important mandate for ZERA as a government regulator to ensure sector-wide regulation with a common vision to protect consumers and ensure affordable pricing.

There has been some debate emanating from the escalations of the mandatory blending levels *vis a vis* pricing of ethanol and the subsequent pump price of blended

petrol. One emerging issue appears to be the overpricing of ethanol by Greenfuels. There also seems to be some controversy around how ZERA has allowed overpriced ethanol to be used as a basis for mandatory blending. The pricing according to government policy would be determined using a cost reflective approach. However, in reality, it is often a big challenge to determine the costs involved in bringing a litre of ethanol to the consumer. This is particularly so, given the information asymmetries surrounding the operations at Chisumbanje plant.

There is always debate on the figures that the investor shares as official for public consumption; for instance, the initial investment for the whole operation was first publicised as being worth US$600 million. There was much hype as players and decision makers got excited about the size of the investment, and many decisions could have been made on the basis of this figure. However, later on there was protracted debate around this figure with others questioning the authenticity of this figure and pointing out that the plant was only worth less than US$40 million in Brazil. In the interviews company officials highlighted that the investment was worth USD$300 million.

Another dimension is the pricing of ethanol. This becomes an issue when the prices of ethanol are compared with some international producers for instance in Brazil and the US. On average, the gate price of ethanol per litre in Brazil is between 35c to 75c depending on distance from the plant (Fetcher, 2010). Greenfuels in collaboration with ZERA quotes the wholesale (to blenders) price at USD$0.95c which is higher that the prices in Brazil. The investor has defended this citing high

costs of production compared to the production systems in Brazil and in South Africa. The issue of the true costs is therefore a very problematic. It is understandable for any private investor to inflate their costs figures in order to maximise profit in cases where the prices of the final product is regulated.

2. Ministry of Energy and Power Development

The Ministry of Energy and Power Development is an important secondary actor in the sugarcane bio-ethanol as it provides policy direction and mechanisms for regulation in the petroleum sector. The Ministry is mandated with developing appropriate legal frameworks to facilitate orderly operations of the oil industry and to ensure adequate supplies of petroleum products to facilitate economic turnaround and sustainable economic development. The ministry also has the mandate to develop and implement policies to promote indigenisation in the petroleum sector. The blending levels as well as mandatory blending scenario that the country is operating under are policy matters that are dealt with by the ministry. The ministry passed various pieces legislation with respect to blending level. For instance, in October 2013, the Government of Zimbabwe announced a 10% mandatory blending for all petrol coming into the country[26]. The ratio was raised to E15 in November 2013 under terms of Statutory Instrument 147a of 2013. The plan was to get to E20 by March 2014. These pieces of legislation have been the basis for sustaining the operations at the Chisumbanje project.

3. Local smallholder farming community

[26] http://www.theindependent.co.zw/2013/10/11/mugabe-gives-ethanol-blending/

The issue of displacement of smallholder farmers in the Chisumbanje project has been raised by a number of scholars (Mutopo, 2012; Manase and Mutopo 2010). The interviews reflect that villagers in over 12 villages are claiming that they have lost the land that they have worked on traditionally. As discussed in earlier sections, out of the 1008 families who lost land 172 families have been given the 0.5ha irrigable land. Analysis of household-level interview data shows that agricultural production is the main source of livelihood as indicated by 90% of the respondents. Other sources of livelihoods include agricultural labourer (1.1%), government worker (1.1%), trade (1%) and other technical artisanal work such as building, welding, carpentry etc (6.6%). The main cash crops grown are cotton (82%) and beans, while the most important food crops are maize and sorghum.

One striking finding from the dataset is that there is no local smallholder community member who is growing sugarcane for sale to the company for processing into ethanol. In focus group discussions, the local community members reflected that before the villagers lost the land, they could afford to live decent lives including paying school fees using proceeds mainly from cotton production.

The investments in Chisumbanje have changed the farming system and livelihoods for a significant part of the local community population. The land that has been historically used for cotton production by smallholder households is now being used for large-scale sugarcane production for processing into ethanol by Greenfuels. Although the smallholder farmers who lost land have been promised compensation

in the form of 0.5ha irrigated plots, this new farming system appears to be problematic. In interviews and FGDs smallholder households in Chisumbanje revealed some challenges that typify the new production economics being faced by the smallholder farmers who lost land. Some of the issues include:

- Although the 0.5ha plots are irrigated, they are too small to be economic and can never be compared with the situation before, Further some families are polygamous but were still given the same 0.5ha plots in this regard; they have lost their source of livelihood;
- The plots are too far away from their homesteads and most have to travel more than 10 kilometres to get to the plots and this has potential negative bearing on labour productivity, an argument supported by a number of scholars (Karangwa, 2010; McCall, 1985; Holden and Koru, 2008);
- The plots are located at the margins/periphery/boundary of the large-scale sugar plantation owned by the company and therefore they are being implicitly used as buffer for stray cattle and wild animals by the company; and,
- smallholder farmers have to learn new production techniques for the new crops they have to farm on the plots on their own and this is not easy; The irrigation scheme is not supported by adequate technical advice for the small-scale irrigators.

4. Liberation War veterans

Liberation War veterans in Chipinge can be considered an important economic agent in the Sugarcane ethanol value chain. In interviews, the local war veterans

explained how they were very influential in ‘educating’ the communities on the goodness of the Chisumbanje investment, a decision which they now regret. In these interviews the War veterans were very clear that they currently feel they sold out the community by using their esteemed position and power to convince the community to accept the project by surrendering their land.

They also explained that they were promised sugarcane plots on which they would work as out growers. They highlighted that is out of the 500 war veterans in the district, 125 war veterans were given 2 hectare plots of planted sugarcane. They, however, do not know where exactly these two hectares are, and therefore actually do not work on them. Each of those who have been allocated the 2 hectares is paid US$800 per year, which is broken down as US$4 per tonne assuming a yield of 100 tonnes per hectare. The company harvests once per year.

From these developments, a number of key issues can be raised which further corroborate the issue raised earlier in this chapter. First, is that the primary production process emerging in the sugarcane bio ethanol value chain does not include out growers. The second issue is how the company is setting the price for the output, and also dictating the yield per hectare with little or no room for negotiation with the land owner. The amount being paid to the War veterans per annum can be seen as a rental since they are not in any way involved in the production process. In other words, the rental for the land is being dictated by the tenant, instead of the land owner.

5. ARDA farmers

The ARDA farmers are settler farmers who had valid lease agreements with ARDA. Just as the war veterans, the ARDA farmers/settler farmers are also implicitly renting out their land to the company. They too used to grow maize and cotton on the land but now the land has been lost to the company, which is now using the land for growing sugarcane. They are also paid US$4 per tonne of sugarcane assuming 100 tonnes per hectare. The case of these settler farmers closely resembles that of the war veterans described earlier. The only difference is that the settlers are paid according to the size of their land on the original lease agreement with ARDA.

These two cases demonstrate the concentration of power in the company as it dictates the yield levels, the prices and in general the terms of the agreement. It also shows how impossible it is for smallholder households to be meaningful participants in the emerging sugarcane bio ethanol value chain.

6. Security sector

The security sector has also been part of the developments around the Chisumbanje ethanol project. The role of the security sector which for this chapter includes the Zimbabwe Republic Police and the President's Office has been maintaining law and order. In addition, the security sector has also been very important in maintaining and protecting the interests of the investor. It is also public knowledge that a number

of villagers have been arrested for different types of resistance, which might have been classified as threats to the project's security and, therefore, to national security.

7. Local traditional leaders

Traditional leaders are influential among a large majority of the population in Sub-Saharan Africa (SAfAIDs, 2010).They wield influence and command respect among their local communities. According to the Traditional Leaders Act of Zimbabwe (Chapter 29:11) (Government of Zimbabwe, 1998), traditional leaders in Zimbabwe consist of the Chiefs and their apex bodies, headmen, village heads, village assemblies, ward assemblies and development committees. The Traditional Leadership Act provides for the role of traditional leaders in Zimbabwe's rural local government. Because they yield much influence among the people, the leadership in Chisumbanje was also involved in the processes around the establishment of the Chisumbanje ethanol project.

Interviews with the Chief and his aides showed that the area in question falls under Chief Garahwa. The area has four headmen and over 200 villages that cover wards 26, 27, 28 and 29 of Chipinge rural district council. The area under Chief Garahwa's jurisdiction is commonly referred to as *Ndowoyo* Communal Lands, *Ndowoyo* meaning black rich soils that do not require fertiliser for plant production. They have never used fertilizer in agricultural activities. The people under this chieftaincy have been growing maize, ground nuts, cowpeas and sorghum for food and cotton as a cash crop. The area of land under dispute was land that belongs to the communal areas and under the Chief's jurisdiction as the traditional leader. The perspective of

the traditional leadership is that some of the disputed land belongs to ARDA, as it was leased to some farmers who would have trained as master farmers. Since ARDA was not utilising all of its land it leased the land to the local farmers. These farmers hold valid lease agreements and they have been paying for the land to the rural district council.

The interview with the Chief also showed that some of the land that Greenfuels took from the people belonged to the community and was not original ARDA land, implying that the company encroached into communal land. The Chief was involved in the consultation meetings, such that they even asked the company that what would become of the people who would have lost land; to which the company responded by promising jobs and other means of livelihood so that the people 'would not need their plots'. When Green Fuel came in, they made promises to the Chief and to the community as a whole, which they are now not fulfilling. According to the Chief, the investment is no longer benefiting the community as promised when the company came in. Some of the promises as highlighted by the Chief include:

- Upgrading of the Mathikwa-Mabee road, which by time of data collection had not been upgraded;
- Building an office for the chief, which had not been done;
- Electrification of the chief's homestead which had not been done;
- An 8-roomed house for the chief and a tractor which had not been done; and,
- Creation of jobs for the community.

The chief gave the permission to construct the project the traditional way in anticipation of the benefits based on these promises.

8. The local and national party leadership

The local and national political party leadership are an important piece in the developments around the Chisumbanje Bio Ethanol project. This is because they are at the centre of any community mobilisation that occurs. Interviews with the local politicians seem to suggest that politicians are in support of the project. The support is based on both seen and unseen benefits in the form of many promises that have been made by the company, with respect to rehabilitation of infrastructure.

Opportunities for rent seeking exist as the powerful politicians mobilise to protect and create an enabling environment for the investor's operations. According to Marrota and Russell (2015), rent seeking occurs when property rights are weakened and the ownership of someone's wealth or goods is debatable, and others gain more by trying to appropriate that wealth than by producing themselves. The ownership of land in Chisumbanje is highly contested and those in power are supporting the company to acquire the land from people who are not really seeing the benefits. Interviews with the senior politicians reflected that the company created employment and rehabilitated infrastructure. It was highlighted that the company is also assisting in the rehabilitation of roads and schools and there are plans to construct a factory for furniture (in Checheche) to supply 63 primary schools. On the ground however,

most of these promises have not been fulfilled as some of the benefits especially that of transforming the community for the better, remain pipe dreams.

9. Chipinge rural district council

The Chipinge rural district council and the administrator's office also have secondary roles in the chain. They administrate bylaws, which interpret national legislation, and therefore they are local custodians of land national legislation for the benefit of the people. The Chisumbanje ethanol project falls under the jurisdiction of the Chipinge rural district council. Interviews with these authorities showed that in the 1960s the then government of Rhodesia earmarked the area for irrigation purposes, and this was referred to as the "Greater Chisumbanje Plan" but because of financial constraints the government could not develop the whole area. About, 5172 ha was developed for irrigation, (original ARDA land) which was leased to TILCO by the then Department of Native Affairs. At independence, the Zimbabwean government ratified that decision to reserve that area for future expansion.

According these authorities, a number of studies were carried out but nothing took place in terms of expansion until 2008 when an investor came and revised the programme, initially taking the 5172 ha and then moving on the Chisumbanje side (western side) adding some 1000ha and moving to Chinyamukwakwa taking 2600ha as part of the expansion. From the interviews, the local authorities concede that there is contestation over the land and that the local communities should be compensated. They also concede that their role as the local authority comes in on

the land and the allocation of the 0.5ha to the farmers who lost their land is a process that involves the rural district council, the company, Agritex and the Department of Irrigation in the Ministry of Agriculture. The authorities are very clear that the investor expanded into the Chisumbanje area, which is communal, but earmarked for this project, and that is when the 0.5ha came in. From these interviews, it appears the Chipinge RDC is caught in a difficult situation where they have to legitimatise a project with which they actually see problems. But because of broader and bigger pressures they have to support the project.

5.5 Discussion of the character of sugarcane bio ethanol value chain

The activities, agents and accounts of product movement along the sugarcane bio ethanol value chain discussed in preceding sections can be depicted in a value chain flow chart and map. Figure 5.2 shows the sugarcane bio-ethanol value chain showing the distinct stages, a pictorial flow, supplying utilisation accounts, primary agents and secondary agents along chain.

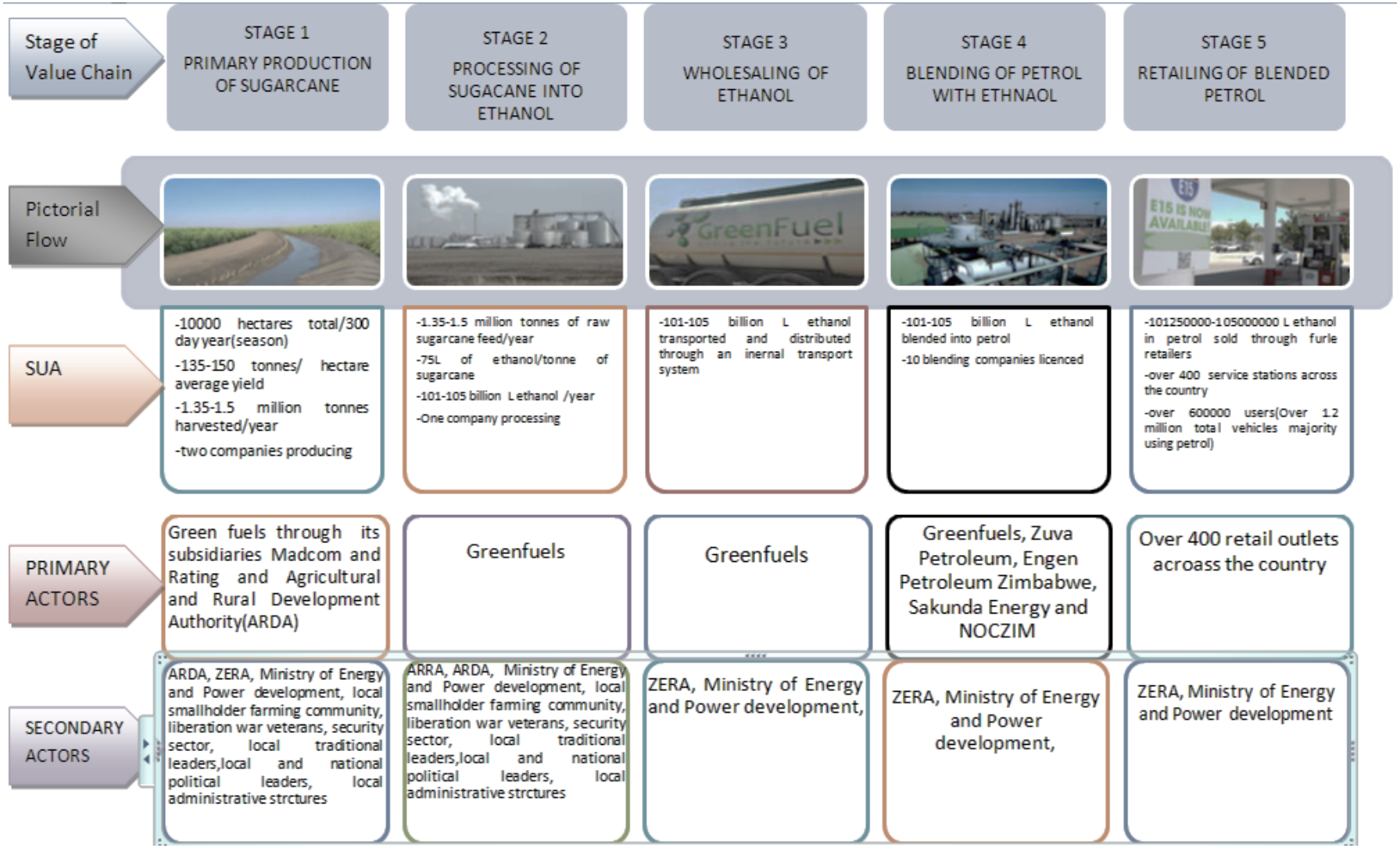

Figure 5.2: Flow chart and functional analysis table
Source: Developed by Author

As noted by Rasheed and Geiger (2000) and Gereffi *et al* (2003) the form of value chain governance can change as an industry evolves and matures, and governance patterns within an industry can vary from one stage of the chain to another. Based on the analysis done, a number of conclusions can be drawn with respect to governance along this value chain – with respect to integration, information asymmetries, pervasiveness of monopolistic behaviour, barriers to entry and related issues of inclusion of out growers and smallholders farmers and associated changes in socioeconomics and livelihoods.

5.5.1 Integration along the sugarcane bio-ethanol value chain

At the primary production stage, there is prevalence of two vertically and horizontally integrated companies that face no competitive pressure. The arrangement is a clear mechanism for ensuring sugarcane supplies to the plan and, therefore, can be seen as a vertical integration process.

5.5.2 Inclusion of out growers along the chain

The primary production process does not include conventional out growers. Rather, there are interest groups who get paid on a per hectare basis. The amount being paid to the war veterans per annum can be seen as a rental since they are not in any way involved in the production process. The nature of involvement of war veterans and settler farmers in the value chain demonstrate the concentration of power in the company as it dictates the yield levels, the prices and in general the terms of the agreement. It also shows how impossible it is for smallholder households to be meaningful participants in the primary production level of the emerging sugarcane bio ethanol value chain. In addition, the analysis showed that there are no local

smallholder community members growing sugarcane for sale to the company for processing into ethanol.

5.5.3 Changes in the socio economics and livelihoods for local communities

The investments in Chisumbanje have changed the farming system and livelihoods for a significant part of the local community population. The land that has been historically used for cotton production by smallholder households is now being used for large-scale sugarcane production for processing into ethanol by Greenfuels. These new developments have potentially changed the livelihoods of the people whose land has now been placed under sugarcane production. They have been introduced to new farming systems without adequate knowledge, the plots have been found to be too far away from homesteads and the distance has potential negative impacts on labour productivity.

5.5.4 Information asymmetries and barriers to entry into the value chain

Information asymmetries are apparent most at the primary production, processing and distribution of ethanol, which act as a barrier to entry into this business. The issue of ownership has been shrouded in secrecy and under these circumstances it is objective to conclude that there are fair chances that the public may be losing. According to Zimbabwean laws all investors can only own up to 49% with 51% reserved for Zimbabweans. There have been many articles in the public media on this issue highlighting that the partnership was not compliant to the investment laws. What makes the situation more complex is that ARDA is a public enterprise and thus must advance the welfare interests of the public. Complications are arising from this

arrangement where a private investor driven by the desire to make profit has partnered with a public entity that should, in principle, advance the interests of the public. This is also partly emerging from how the partnership has managed some sensitive issues particularly on land as a major source of livelihood for the rural community in Chisumbanje.

5.5.5 Pervasiveness of monopoly behaviour in the value chain

The analysis showed that the primary production, processing and distribution levels are carried out by Greenfuels. There are strong indications of regulatory agencies being manipulated by the company through systematic benefits to those in power to make decisions. There is apparent manipulation of powerful institutions involved in the whole chain to gain monopolistic advantages while there are apparent losses to powerless agents. Powerful agents are in support of the investments. The support is based on both seen and unseen benefits in the form of many promises that have been made by the company, with respect to rehabilitation of infrastructure. One can easily tell that there are opportunities for rent seeking as the powerful politicians mobilise to protect and create an enabling environment for the investor's operations.

5.6 Conclusion

In conclusion, the analysis carried out showed some salient features of the emerging bio ethanol value chain. It showed that the sugarcane bio ethanol value chain is a typical First World agro-industrial value chain, which is systematically vertically

integrated in primary production, processing and transport and distribution. These arrangements do not appear to create any entry points for real out grower schemes as the line of production is carefully timed and calibrated from the point of planting to processing. One major characteristic is the dominance by powerful agents, namely the investing company deriving their power from the financial capital. They are supported by and protected by state institutions in relationships that lend themselves to rent-seeking situations. Information asymmetries are apparent most at the primary production, processing and distribution of ethanol, which act as a barrier to entry into this business. Arguably, there is potential that local politicians and the security sector and to some extent war veterans at some point have provided protection to the company in exchange for some financial rewards. The next chapter takes the analysis further by zooming in on the creation and distribution of value added and profits along the chain.

CHAPTER SIX: CREATION AND DISTRIBUTION OF VALUE ADDED AND GROSS MARGINS

6.1. Introduction

The creation and distribution of profits or gross margins along any value chain provide important indications of efficiency of a value chain. At each stage of any commodity business chain value is created. More often if the specific business units along the chain are not vertically integrated, it is possible to determine the gross margins at each stage of the chain. Vertical integration in some cases makes it difficult to clearly separate the stages along a value chain into clear business units in which computable value added and subsequent profits are identifiable. Because there are a number of agents involved at each stage of the chain creating value, one can relate the value added to the gross margins/income that accrue to specific economic agents along the chain. The focus of this chapter is to analyse the creation and distribution of both value added and gross margins along the sugarcane bio ethanol value chain in Zimbabwe. The chapter begins by defining the I-O analytical model and the approach that is applied to pursue the objective. The rest of the chapter presents the findings on the creation and distribution of value added and gross margins along the sugarcane bio ethanol value chain.

6.2. Objectives of the chapter

In the previous chapter, focus was placed on characterising the sugarcane bio ethanol chain with respect to the specific activities at specific stages of the chain, the quantities of the product moving through the various stages and analysing the

agents and how they relate to each other. This chapter deepens the analysis by computing Gross Value added (GVA), and profit/gross margins at each stage and further demonstrates the distribution of value-addition activities and profits among the economic agents along the sugarcane bio ethanol value chain. Value added can be seen as a measure of the wealth created by an economic activity. The purpose of the analysis is to show how wealth creation is occurring and how the wealth created is being distributed among the various agents. The chapter investigates the benefits (costs) and in general the welfare gains that accrue to different agents along the sugarcane bio ethanol value chain.

6.3. The empirical model

As discussed in the preceding section, the analysis was aimed at determining the creation and distribution of value added and profits as well as the net gains to the society when all activities in the sugar value chain are considered. To determine wealth creation and its distribution along the sugarcane bio ethanol value chain, the analysis calculates gross profits and value added at each stage of the chain.

6.3.1. Customisation of input-output model for value chain analysis

As outlined in Chapter 4, the approach for computing value added and profits along the sugarcane bio-ethanol value chain used in this study is grounded in input-output modelling and concepts. According to Rey (2000), the basis of the concept of I-O approach is that production of an output requires inputs. Basing on this I-O approach, the model putting together the analysis done in this chapter can be expressed as follows:

Let:

- Outside intermediate inputs used by *i* (IIOC) be denoted x_i
- Total output value in the account for agent I be denoted y_i
- Total intermediate inputs (from outside and inside chain) used be agent i be z_i
- The value added created by agent I be denoted λ_i (i.e. $VA_i=\lambda_i$)

Also note:

When i=1 then agent is producer (prod)

When i=2 then agent is processor (proc)

When i=3 then agent is trader (trad)

In view of the above, the following hold:

$$VAprod= \lambda_1=x_1 - z_1$$

$$VAproc= \lambda_2 = z_1 + x_2 - z_2$$

$$VAtrad= \lambda_3 = z_2 + x_3 - z_3$$

From the above total value added can be defined as follows:

$$TVA = VAprod + VAproc + VAtrad$$

$$= \sum_{i=1}^{3} x_i - z_i$$

6.4. Results and discussion

6.4.1. Creation and distribution of VA and GMs at primary production stage

Inputs in production

As shown in the previous chapter, the primary production of sugarcane is a world class operation implying that the costs could potentially be compared to any similar operation in other countries with certain adjustments to match the local operating environment. There are special differences, which especially have to do with the

overall macroeconomic environment impacting on unit costs of inputs. Based on these issues, most of the production costs used in the model was extrapolated from similar sugarcane production operations in countries such as Brazil, Hawaii, and South Africa adjusted for the higher cost of doing business guided by the World Bank (2015). The primary producers along the sugarcane bio ethanol value chain were not forthcoming with the specific production costs. Interviews with households and war veterans who own some land in which production of sugarcane is being done showed that they are not aware of the actual costs.

Sunk costs assumption on land and capital: With respect to land as a primary input, part of the land being used in the production of sugarcane for processing into bio ethanol is contested. The same applies to the initial investments made in preparing land for production, setting up irrigation systems and so on. As discussed in Chapter 4, some of the land belongs to ARDA while the communities have alleged encroachment into communal land by the investors; while there is limited clarity on the actual capital investment that could be classified as part of primary production. The assumption that is made therefore is to assume both land and initial capital investments are sunk costs and only the costs of maintenance are included. This assumption affects government, communities and the investor in terms of initial investment.

Caveats for comparing Chisumbanje to Brazilian ethanol production systems

Although Brazil's ethanol production sector provides important benchmarks for analysis of the Chisumbanje Bio ethanol value chain, several caveats have to be

understood in order for one not to see what is happening in Brazil as a perfect match to Zimbabwe. The factors contributing to Brazil's competitiveness include favourable climate conditions, low labour costs, and mature infrastructure built over at least three decades. Some aspects are similar; for instance the favourable climate, low labour costs and high productivity. In fact productivity in Zimbabwe at 135t/ha is actually higher than that of Brazil estimated at 90t/ha. Between 1975 and 2000, modernisation of the sugarcane yield per hectare increased by 33 percent and ethanol yield from sugar rose by 14 percent. Currently in Brazil the economic cost of production of a litre of ethanol equivalent is between US$0.18 and US$0.25. One potential area of huge differences is investment costs, which are estimated at around US$ 0.017 per litre of ethanol in Brazil.

Outputs in primary production

A key finding in Chapter 4 was that the production process has two closely related companies doing the actual production, having put together 10000 hectares under sugarcane crop in 2014. There are however, some war veterans and settler farmers who have been allocated plots in the plantations but the companies do the farming for them. The estimated yield of raw sugarcane per hectare is 135 tonnes. The price per tonne of raw sugarcane offered to the war veterans and settler farmers is USD$4/tonne. The inputs and outputs and related prices at the primary production stage are as presented in Table 6.1.

Table 6.1: Estimated inputs and outputs at the primary production (2013 values)

Parameter	Value/Ha (US$)	Source/Comments
Price Per Tonne	4	This is the price paid per tonne of raw sugarcane by Greenfuels
Yield Per Hectare(tonnes)	135	This are the estimated yields at Macdom and Rating, No production is being done by smallholders
Estimated Total Costs Per Hectare	**4541.81**	**Includes fixed costs and variable costs**
TVC	**3841.81**	**Costs incurred only when operations are going on**
TFC	**700**	**Costs incurred even if operations are not underway**
Seed	0	The cost of cuttings required for planting a hectare of sugarcane is assumed to be a sunk cost
Fertiliser	370	For Chisumbanje: 10 bags of 3 different types of fertilisers valued at us$37
Operations	221	Includes all other consumables that are involved in running the business; for instance stationary, advertising , printing and so on
Fuel And Lubrication	400	Includes all costs consumables that are incurred in day to day operation of machinery(fuels, lubricants,
Repairs	600	Costs of repairing the huge fleet
Hired Labour	1900	As an input into production, labour is calculated as the total labour requirements for large-scale sugarcane production per hectare.
Purchases/Irrigation Water	22.3	22.3us$/1000m^3
Miscellaneous	328.51	Haulage, adjustments for higher costs of doing business in Zimbabwe
Total Estimated Variable Costs	**3841.81**	
General Farm Overhead,	700	Interests, capital replacement etc
Total Fixed Cash Expenses	**700**	

Source: Interviews with Greenfuels officials

Gross margins and value added at primary production

At a yield of 135t/ha and a price of US$4 per tonne of raw sugarcane, the primary production process is a loss-making venture. Table 6.2 shows the value added and gross margins at the primary production phase. The estimated loss per hectare is US$4001 when the estimated inputs costs of US$4541/ha are considered. Computations done using the conversions of yield/ha and tonnes/litre of ethanol

showed that the value that is placed on sugarcane feedstock at the factory gate is US$1447/ha, and this also does not compare with the costs of production per hectare.

Table 6.2: Value added and gross margins at primary production

Parameter	**Computed (Based on 2013 values)**
Inputs costs (USD)/Unit	US$4541/ha
Total output/unit	135t/ha
Price per/tonne	US$4
Total Gross margins/unit	(4001)/ha
Gross Value of Feedstock cost per hectare	US$1447
Total value of feedstock/annum	14.47million

Source: Computations from primary data

The continued engagement in this loss-making venture by Macdom and Rating as the main primary producers can be attributed to the fact that they are not independent firms, but are vertically integrated with the processing of sugarcane into ethanol. This is consistent with the arguments put forward by Msangi and Tokgoz (2009) (Chapter 2) that securing a stable and consistent biomass supply is crucial for favourable feedstock costs and profit margins. The argument was that long-term contracts with farmers or cooperatives will guarantee demand for the farmers and lower feedstock costs for the bio fuel processors.

One entry point for analysis is whether it is feasible for any players (other than Macdom and Rating) to produce sugarcane and supply the processing plant. This discussion also ties up with the issue of out growers raised in Chapter 4. The pricing of raw sugarcane (by the company) at unfavourably very low prices could arguably be seen as a mechanism by the vertically integrated economic agents to prevent

new entrants into primary production. The unfavourable pricing would appear as a systematic approach to aggregate profits at a higher level of the chain that is not accessible to the ordinary farmer. A key question is whether the price being placed on the raw sugarcane is a true reflection of the opportunity cost. From the analysis it can be concluded that the pricing is distorted and does not reflect the true value of the raw sugarcane.

Distribution of income at the primary production stage

Out of the estimated 10000 ha that is put under sugarcane for processing into ethanol, 660 hectares belong to the war veterans (250ha) and the settler farmers (410ha). Chapter 5 presented settler farmers and war veterans as part of the secondary value chain agents, because even though they own the land, they do not work on it and are paid a figure of US$4/tonne. For payment purposes the company uses a lower-band worst-case scenario yield of 100 tonnes/hectare. The analysis also showed that no other smallholder farmers produce sugarcane to supply the ethanol processing plant. Assuming that the losses experienced at primary production are eventually recouped through the profits made along the chain, and considering the aspect of vertical integration raised earlier, it makes sense to determine how the income generated at the primary production stage is distributed.

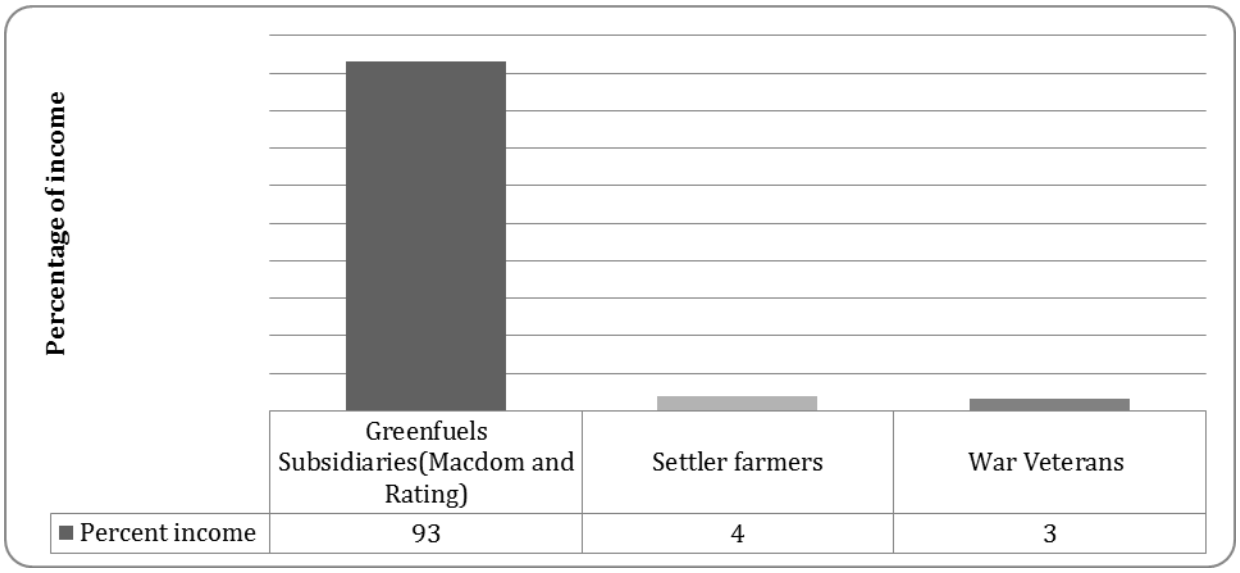

Figure 6.1: Distribution of profits at the primary production stage

Figure 6.1 shows the distribution of the computed US$ 14.47million among the economic agents. Going by the per hectare allocation of income, the two subsidiaries of Greenfuels get the bulk (93%), while settler farmers and war veterans get 4% and 3% of the income generated at primary production respectively. The dominance of the private corporate is therefore demonstrated in the distribution of income.

6.4.2. Creation and distribution of VA and GMs processing stage

Inputs in processing

The main inputs in the processing of sugarcane into bio ethanol at the Chisumbanje Plant include the feedstock (cane), which is estimated at 1.35million tonnes per annum. The price paid per tonne of sugarcane was established as USD4. However, in Brazil, the price paid per tonne of sugarcane is US$11.4 and a feedstock cost of US$ 0.143 per litre of ethanol are incurred (UNICA, 2005). These differences raise

important implications on the inclusiveness of the value chain as this pricing could be a disincentive to new entrants as analysis done in this chapter will show. The labour costs are estimated at $0.096 per litre and depreciation costs estimated at US$0.0896 per litre. The costs of inputs at the processing stage are presented in Table 6.3.

Table 6.3: Estimated costs of ethanol production at processing stage (2013 values)

Item	Values
Operating Costs	**0.3837**
Feedstock (Raw Sugarcane)	0.1496
Labour	0.096
Maintenance Costs	0.0354
Chemicals	0.0185
Energy	0.009
Interest (Working Capital)	0.0078
Rent	0.0066
Other	0.0608
Fixed Costs	**0.0961**
Depreciation	0.0896
Other	0.0065
Total Costs	**0.4798**

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain

Outputs at processing

The main output in the processing stage is anhydrous bio ethanol. Interviews with technical officers showed that the output of the processing plant at Chisumbanje is estimated at around 105 million litres annually, which convert to 350 kilo litres per day or 14,580 litres per hour in a 24-hour day. The processing plant can process 1.5 million tonnes of cane in a 300-day season. The conversion rate of sugarcane to

ethanol is estimated at 1(t) of sugarcane to 75 litres of ethanol. Other products include electricity and a number of chemicals that could be used in some downstream industries such as fertiliser manufacture, the cosmetics industry, explosives and beverage makers. These downstream industries are also likely to benefit from the venture. In particular with respect to electricity the company forecasted that 18 Mega Watts of power would be generated as a byproduct and supplied into the national grid as a byproduct of ethanol production. At peak, 50 Mega Watts of electricity will be generated.

Gross margins and value added at processing stage

The costs for processing raw sugarcane into ethanol are estimated at US$0.47/litre. This cost is at times contested as it is treated as classified and confidential information by the company. The study had to rely on extrapolation from similar processing technologies in Brazil and adjusted for the higher cost of doing business in Zimbabwe.

Table 6.4: Value added and gross margins at processing stage

Variable	**Computed value**
Inputs costs	US$0.4798/litre
Total Output(based on maximum capacity of plant)	105 million litters/annum
Price /Litre	US$0.95
Gross margins/litre	US$0.49371
Processing gross margin per tonne of raw sugarcane (total gross margin at processing)	US$37
Gross value of Ethanol	US$99.75 million

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain (2013)

Earlier sections showed that it costs between US$0.18 and US$0.25 to produce a litre of ethanol in Brazil. Assuming production at full capacity, the plant produces up to 105 million litres of ethanol per annum. This is sold at US$0.95/litre delivered at the blending site. This converts to a gross margin of US$0.49/litre of ethanol and total gross margin of US$51.84 million. The processing gross margin per tonne of raw sugarcane is US$37, while the gross value of the ethanol becomes US$99.75 million. Therefore, at the processing stage, total gross value created is US$85.28 million

Distribution of income at processing stage

The shareholding of Greenfuels is a subject of public contestation and debate. The debates are overshadowed by significant information asymmetries. The provisions of Statutory Instrument 17 of 2013 are that ethanol purchased for the purposes of mandatory blending shall be obtained from a licensed ethanol producer who is in a joint venture partnership with the Government of Zimbabwe. The joint venture should, however, satisfy the country's indigenisation laws, which stipulate that locals should own 51% of any business, which is over US$500 000. As of mid-2015, the company has been in operation and has not satisfied the lawful shareholding structure.

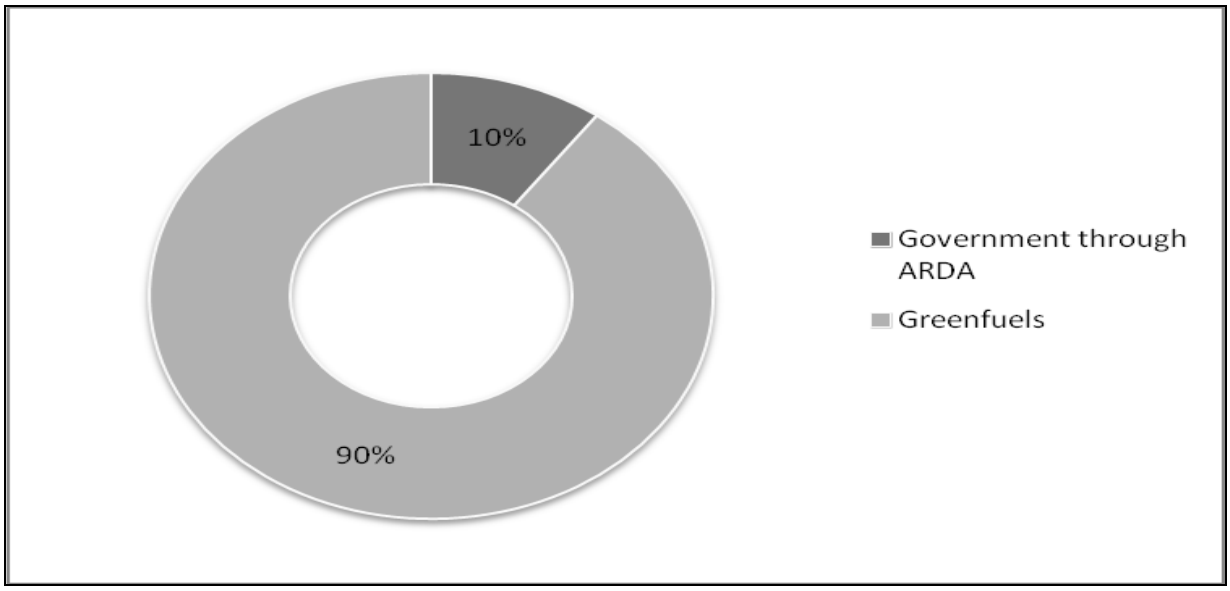

Figure 6.2: Distribution of income at the processing stage

The current structure is that ARDA owns 10% whilst 90% is owned by Greenfuels. Given this shareholding structure, Figure 6.2 shows how the income generated at the processing stage is being distributed between Greenfuels (90%) and ARDA representing government (10%).

6.4.3. Creation and distribution of VA and GMs at transport and distribution stage

Inputs at transport and distribution stage

The transport and distribution stage along the bio ethanol value chain is vertically integrated with the processing stage. When ethanol is produced, Greenfuels is directed to supply specific amounts of ethanol to specific blending depots by the Zimbabwe Energy Regulatory Authority (ZERA). The implication of this vertical integration is that until the ethanol reaches these specific sites, no other player can

participate in the transport and distribution process. In this regard, the transport and distribution to different blending depots only involves Green fuels as the only economic agent. The company has built into the wholesale price of ethanol the cost of transporting it to the blending sites. The cost of transporting a litre of petroleum according to South African road transport standards oscillates around 2.7% of the total price of one litre of petroleum[27]. This transport cost has been extrapolated to get a crude cost per litre of transporting ethanol from the plant in Chisumbanje to various blending sites.

Outputs transport and distribution stage

The output at the wholesaling stage is liquid ethanol fuel that has been transported to different blending locations across the country. It is assumed that that the difference between the price of ethanol offered to the blenders and the one they would get if they had purchased and collected at Chisumbanje factory is the transport cost charged (estimated at 2.7% of the total costs of a litre). The value created is in the change space/location of the ethanol.

Gross margins and value added

The transport and distribution of ethanol from the processing plant is carried out by Greenfuels. This stage of the chain is vertically integrated with the processing stage. Approximately 105 million litres are transported to the blending sites at a cost of US0.0256/litre based on transport being 2.7% of the value of ethanol per litre. Table

[27] http://www.ifleet.co.za/images/pdf/literature/FuelPrices_SouthAfrica_calculated_1116589733064.pdf, and

6.5 shows the computed value added and gross margins at transport and distribution stage.

Table 6.5: Value added and gross margins at transport and distribution stage

Variable	Computed value
Input costs	US$0.95/litre
Outputs	105 million litters/annum
Price per litre	US$0.0256/litre
Gross margins (ethanol only)	US$2.688 million
Total gross margins(net income)	US$99.75 million
Gross value of ethanol at blending stage	US$99.75 million

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain (2013)

The gross margins at the transport and distribution stage is US$2.688 million. The total value of ethanol remains at US$99.75 million as the transport costs are inbuilt in the US$0.95/litre wholesale price of ethanol.

Distribution of income at transport and distribution stage

As the transport and distribution stage is not separated from the processing stage, all the income that could have been generated had it been treated as a separated value chain enterprise stage or business accrues to Greenfuels. It is not wrong to point out that 100% of the income at this stage (amounting to US$2.688 million) is in build in the price of ethanol. The vertical integration with the transport system ensures control over the transport and distribution system, but also increases earnings of the company as it takes 100% control of an activity that could have been carried out by other service providers.

6.4.4. Creation and distribution of VA and GMs at ethanol blending stage

Inputs at blending stage

At blending stage liquid ethanol is mixed with unleaded petrol in line with government blending level requirements. The inputs include storage and other infrastructure, labour, pure petrol and anhydrous ethanol supplied by Greenfuels. Greenfuels sells anhydrous ethanol at an average of 95c/litre to the blenders, with the price being slightly higher depending on the distance from the Chisumbanje plant and vice versa. Assuming a total of both maximum production and total absorption of ethanol output by blenders, approximately 105 million litres are being produced and sold to the 10 licensed blenders, including Greenfuels itself.

Outputs at blending stage

The output at the blending stage is the blended fuel, in line with the government mandated blending regime. As discussed in Chapter 2, the ushering in of the multi-currency regime, petroleum consumption has been on the increase, peaking in 2012 at 20,970 barrels per day (2 500 473 million litres), before declining to 19,010 barrels (2 266 761 litres) in 2013[28]. The prices at wholesaling and retailing of fuel are closely monitored by government. This is because of the multiplier effects that fuel has throughout the economy. Fuel prices in general are however based on "a cost-plus model", which entails the free on board cost plus charges for transportation, levies and taxes, administration and distribution.

[28] Zimbabwe National Chamber Of Commerce reports

Under Statutory Instrument 80 of 2014, crafted by the energy ministry in consultation with the Zimbabwe Energy Regulatory Authority (ZERA), the selling price of any petroleum product shall not exceed seven per cent of the oil company's purchase price. In this regard, it is assumed that the blenders or wholesalers put a margin of 7% on the blended petrol; and therefore, indirectly, the ethanol.

The amount of ethanol that gets blended with petrol directly replaces the pure petrol. The implication is that of this total consumption it can be assumed that 15% of it is bio ethanol from Chisumbanje. The 2013 consumption level implies that a total of 340 014 litres of ethanol are supposed to be supplied to sustain the blending level. The demand for ethanol being created through the mandatory blending regime is putting pressure on the company to produce to full capacity if it still utilises one plant (with a total production capacity of 350 000 litres per day). A full analysis of the impacts of the blending regime on the different economic agents along the Chisumbanje bio ethanol value chain is presented in Chapter 6.

Gross margins and value added at blending stage

Blending companies purchase ethanol at US$0.95/litre from Greenfuels for blending and wholesaling at a mark-up which is not more that 7% under government regulations. Assuming that a total of 105 million litres are traded and that fuel-blenders put the highest mark up for ethanol (which is now blended with petrol); the price of ethanol will be US$1.0165/litre. Table 6.6 shows value added and gross margins at ethanol-blending stage.

Table 6.6: Value added and gross margins at ethanol-blending stage

Variable	Value
Input costs	US$0.95/litre
Outputs	105 million litters /annum
Price per litre	US$1.0165/litre
Gross margins (ethanol only)	US$0.0665
Total gross margins(net income)	US$6.9825million
Gross value of ethanol at blending stage	US$106.7325million

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain (2013)

The gross margin for ethanol only would be US$0.0665/litre while the total gross margin is US$6.982 million. The new gross value of ethanol traded at this stage is US$106.7325.

Distribution of income at blending stage

Although the market shares and quantities that are blended at each of the sites could not be established, the income/profits generated at the blending and wholesaling stage, which amounts to US$6.982 million, is shared among 10 licensed blending sites. As noted in Chapter 4 the licence is site specific and there are four companies, which include Zuva Petroleum, Engen Petroleum Zimbabwe, Greenfuels and Sakunda Energy. The bulk of the blending takes place in Harare (5 sites), followed by Bulawayo (2 sites), Mutare (2 sites) and Triangle (1 site).

6.4.5. Creation and distribution of VA and GMs at retailing stage

Inputs at retailing stage

Assuming the 2013 petroleum consumption levels as presented in the preceding section (outputs at the blending stage), petroleum retailers consume approximately

2 266 761 million litres of blended petroleum per day. Different blending levels (such as 5%, 10%, and 15%) would imply different amounts of ethanol actually used to blend pure petrol. Other inputs at this stage would include the other costs of running the petrol retailing business inclusive of government taxes, labour and so on.

Outputs at retailing stage

In Chapter 5 a price analysis based on a 5% blending level showed spatial differences in the pricing of petrol at retail service stations. In Harare retailers were buying at $1.46 and selling at $1.51 and getting a margin of 5c while in Bulawayo at the same time retailers were buying at $1.51 and selling at $1.56 maintaining the same margin of 5c per litre of petrol. The analysis also showed that any changes in the wholesale price of petrol would simply be passed on to the final consumer. It was shown that a 2c increase in wholesale price resulted in a 2c increase in the retail price. However, in the long run the retailers would need to widen the gap in order to maintain the same percent margin.

Gross margins and value added at retailing stage

Over 400 petrol retail companies purchase blended petrol from the 10 blending sites at different prices. Dealer margins are different but do not exceed the government regulated 7%. Assuming that 105 million litres of ethanol are blended in petrol and traded, the purchase price would be US$0, 99/litre of ethanol while the selling price would be US$1.0877/per litre. Table 6.7 shows value added and gross margins at the retailing stage of ethanol.

Table 6.7 : Value added and gross margins at retailing stage

Variable	Value
Input costs	US$0.99/litre
Outputs	105 million litters/annum
Price per litre	US$1.0877/litre
Gross Margins /litre (ethanol only)	US$0.071155/litre
Total Gross margins(net income)	US$7.4713millon
Gross value of ethanol at Blending stage	US$114.204 million

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain (2013)

The gross margins per litre are US$0.0711/litre and the total gross margin or income for the value chain stage is US$7.4713 million for the only volume of ethanol in the blended petrol. The gross value for this ethanol is US$114.204 million.

Distribution of income at retailing stage

As presented in Chapter 4, there are more than 400 registered fuel retail outlets that buy and sell blended fuel. This is a fairly competitive stage of the chain, although some corporates such as Redan, Engen and Zuva have many retail outlets. The outlets sell directly to consumers of petrol and many factors come into play with respect to final distribution of profits, which have to do with marketing strategies such as promotions, service, and pricing.

6.4.6. Discussion of results

The purpose of the chapter was to investigate the creation and distribution of value added and profits along the sugarcane bio methanol value chain. The analysis sought to examine how value added and profits are being created and distributed among different economic agents along the sugarcane bio ethanol value chain.

Table 6.8 summarises the total gross margins, value added and their distribution along the chain from primary production of sugarcane to retailing of ethanol.

Table 6.8: Total gross margins and value added along the value chain

Stage	Total Gross margin/Income (US$ Million)	Gross value (US$ Million)	GM as % of Total gross margin generated	GM as a % as a percentage of total gross value created	Summary of distribution among economic agents
Primary production		14.47	0	0	93%-Macdom and rating 4%-settle farmers 3%-war veterans
Processing	51.83	99.75	75.1	45.38	90% -Greenfuels 10%- ARDA
Transportation and distribution	2.688	99.75	3.89	2.35	90% -Greenfuels 10%- ARDA
Blending and wholesaling	6.9825	106.73	10.12	6.11	4 registered blending companies
Retailing	7.47	114.20	10.83	6.54	Over 400 registered
Total	68.97	114.20	100	60.39	

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain

The hypothesis tested to guide the analysis was that the distribution of profits along the value chain is not negatively skewed to smallholder farmers located at the lower end of the value chain. This hypothesis was rejected on the basis that most of the profits along the sugarcane bio-ethanol value chain are accruing to Greenfuels. As shown in Figure 6.3, Greenfuels and its subsidiaries Macdom and Rating is getting more than 73% of the income that is generated along the whole chain. This percentage (73%) actually excludes the income that accrues to Greenfuels at the blending stage since they are one of the four companies. This implies that the figure would be actually higher if incomes generated at blending are added.

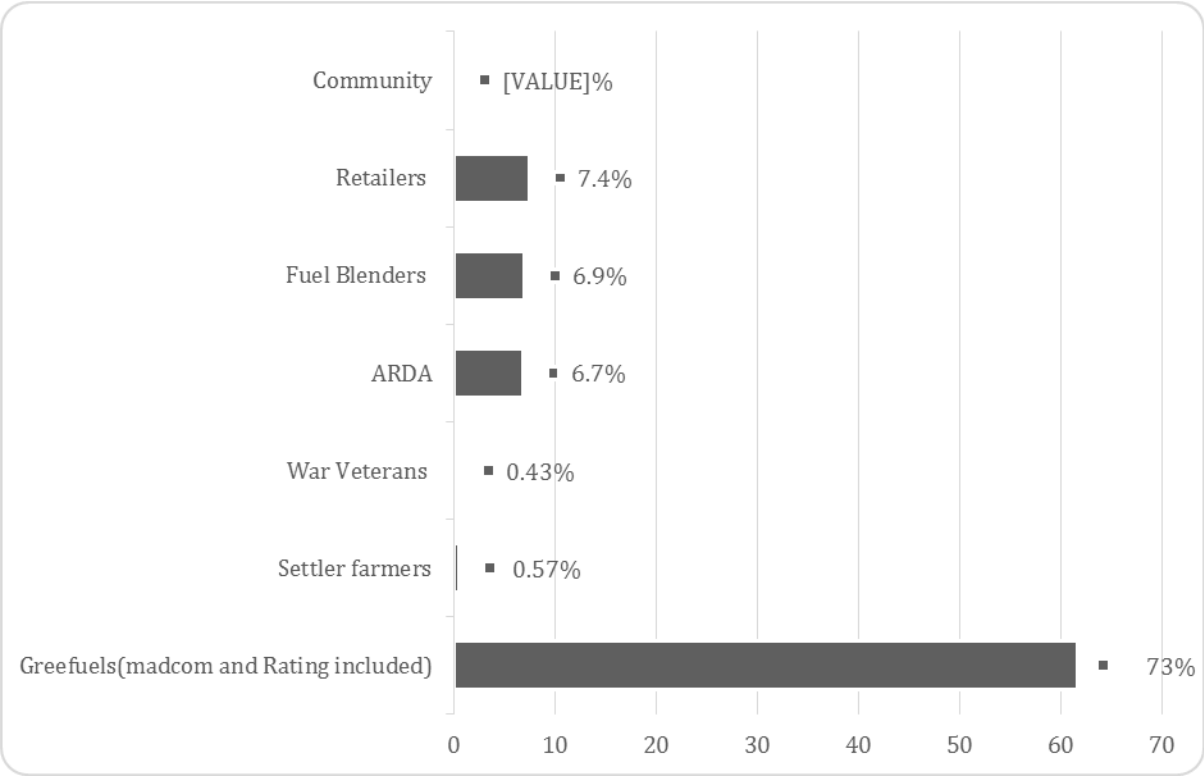

Figure 6.3: Distribution of income among economic agents

Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain

The distribution also shows that there are no incomes that are accruing to ordinary smallholder farmers since they are not primary agents along the chain. The war veterans and settler farmers are getting just 2% of the income while government through ARDA is getting 8%.

Although there are no readily available specific bio ethanol value chain analyses to which the results of the study can be compared, the finding that income distribution is skewed towards the investors is in line with earlier arguments put forward by various authors (for instance, Cotula *et al*, 2011; Matondi *et al*, 2013; Mutopo, 2011; Hall, 2011 among others). Using qualitative approaches of analysis, many of these

authors have highlighted that private investments in biofuels have tended to benefit private investors at the expense of local communities.

6.5. Conclusion

In conclusion, the analysis carried out brings to fore some indications of how inclusive the sugarcane bio ethanol value chain is. Questions can also be asked on the basis of the findings on whether modern biofuel chains, which are designed along world class standards and well timed systematic line operations, can actually have out growers. The issue of out growers is important because these are often used to justify large-scale land investments, some of them involving displacements of smallholders and contestations over ownership of land. In this regard, this analysis shows that it may be impossible to get smallholder farmers to be real growers of ethanol processing plants. The processors would prefer to be vertically integrated with the farming operations to ensure consistent supply of quality and sufficient quantities of feedstock. Basing on these findings, the pricing of raw sugarcane at US$4 per tonne could potentially be interpreted as a systematic disincentive for smallholders to venture into sugarcane production.

The analysis showed that the farming operations at the primary production phase at this price are a loss-making enterprise, but the investor then recoups its profits after processing and at a level that is not accessible by smallholder farmers. The result is an income distribution that is skewed towards the corporate, with virtually close to nothing going to the smallholders. Other mechanisms such as community share

ownership trusts could be better mechanisms to increase the level of income that goes to the communities from this value chain.

CHAPTER SEVEN: SIMULATION OF IMPACTS OF ALTERNATIVE POLICY SCENERIOS

7.1 Introduction

The Government of Zimbabwe has been making different policies to minimise the negative impacts of drastic changes in fuel prices on the economy. Often, policies can have both negative and positive impacts, some of which are not intended. The Government of Zimbabwe has made policies that have different impacts on the sugarcane bio ethanol value chain. In the previous chapter the aim was to compute value added and gross margins and determine how income is distributed at each stage of the sugarcane bio ethanol value chain. In this chapter, the analysis goes deeper by investigating the impacts of different policies along the sugarcane bio ethanol value chain.

The chapter starts off with a global theoretical overview or blending policies, showing that blending of petrol with ethanol is a common practice in many countries. The rest of the chapter presents the findings on impacts of policy on the value chain. The approach and model used to simulate the impacts of policy along the sugarcane bio ethanol value chain builds on the model outlined in Chapter 5. However, the model incorporates counterfactual analysis as an addition to input-output (I-O) approach as a basis to measure impact. Primary emphasis is placed on the impact of different mandatory blending levels as well as indigenisation policies.

7.2 Objectives of the chapter

The primary objective of the analysis presented in this chapter was to analyse the potential impacts of different policies instituted or that will be instituted (e.g. mandatory blending of E5, E10, E15, E20, E85, 100% and indigenisation policy) on incomes and their distribution along the sugarcane bio ethanol value chain. The hypothesis tested was that as the level of ethanol petrol blending increases, the net benefits are accruing to different agents increase disproportionately.

7.3 Context of blending policies and their impact

The use of ethanol (pure or blended) as a fuel for vehicles is gaining momentum. For instance, there are over 4 million cars running on pure hydrated ethanol in Brazil (Coelho, 2007). There are 700 000 flexi-fuel vehicles (using both pure petrol and blend). The REN21 report (2014) provides a list of some of the policies covering targets, quotas, and mandates that governments have put in place globally in support of biofuels production. Of particular relevance to this study, Table 7.1 adopted from REN21 (2014) shows biofuels blend mandates across the world as of 2014.

Table 7.1 : National /state/provincial biofuels blend mandates

COUNTRY	MANDATE
Angola	E10
Argentina	E5 and B10
Australia	E4 and B2 in New South Wales; E5 in Queensland
Belgium	E4 and B4
Brazil	E20 and B5
Canada	*National:* E5 and B2 *Provincial:* E5 and B4 in British Columbia; E5 and B2 in Alberta; E7.5 and B2 in Saskatchewan; E8.5 and B2 in Manitoba; E5 in Ontario
China	E10 in nine provinces
Colombia	E8
Costa Rica	E7 and B20
Ecuador	B5
Ethiopia	E5
Guatemala	E5
India	E10
Indonesia	B2.5 and E3
Jamaica	E10
Malawi	E10
Malaysia	B5
Mozambique	E10 in 2012–2015; E15 in 2016–2020; E20 from 2021
Panama	E5; E7 by April 2015; E10 by April 2016
Paraguay	E24 and B1
Peru	B2 and E7.8
Philippines	E10 and B5
South Africa	E2 and E5 as of October 2015
South Korea	B2.5
Sudan	E5
Thailand	E5 and B5
Turkey	E2
Ukraine	E5; E7 by 2017
United States	*National:* The Renewable Fuels Standard 2 (RFS2) requires 136 billion litres (36 billion gallons) of renewable fuel to be blended annually with transport fuel by 2022. The RFS for 2013 was reduced to 49.21 billion litres (13 billion gallons). *State:* E10 in Missouri and Montana; E10 in Hawaii; E2 and B2 in Louisiana; B4 by 2012, and B5 by 2013 (all by July 1 of the given year) in Massachusetts; E10 and B5, B10 by 2013, and E20 by 2015 in Minnesota; B5 after 1 July 2012 in New Mexico; E10 and B5 in Oregon; B2 one year after in-state production of biodiesel reaches 40 million gallons, B5 one year after 100 million gallons, B10 one year after 200 million gallons, and B20 one year after 400 million gallons in Pennsylvania; E2 and B2, increasing to B5 180 days after in-state feedstock and oil-seed crushing capacity can meet 3% requirement in Washington.
Uruguay	B5; E5 by 2015
Vietnam	E5
Zambia	E15 and B5; E20 in 2014
Zimbabwe	E5, to be raised to E10 and E15

Source: REN21. (2014)

In Zimbabwe there is contestation on the impact of blended fuel on vehicles. Final users of petrol (in particular motorists) have regarded the government's mandatory blending policies as a violation of consumer preferences. With respect to this reaction from consumers, a key point of contestation is that petrol blended with ethanol damages vehicles, especially if the vehicle is not fitted with a flexi-fuel gadget. The mandatory blending policy has also demands with respect to special infrastructure that is required to complete the blending process. The Brazilian Automobile Association has summarised the minimum necessary vehicle modifications for using ethanol blends. Figure 7.1 adapted from Coelho, (2007) shows compatibility of existing fleets with petrol-ethanol blends, demonstrating the minimal impact of blends, especially at percentages lower than 10%.

Ethanol Content in Fuel	Required modification	Carburettor	Fuel injection	Fuel pump	Fuel pressure devise	Fuel filter	Ignition system	Evaporative	Fuel tank	Catalytic converter	Basic engine	Motor oil	Intake Manifold	Cold Start System
< 5%	Not Necessary for any vehicle (NN)													
5-10%	For relatively new Fleets (10-15 years old)(NN)													
10-25%	Brazilian Application (PN)													
25-85%	USA Application (PN)													
>85%	Brazilian Application (PN)													

Key: Not necessary; Probably necessary

Figure 7.1: Modification in vehicles for different ethanol blend levels
Source: Adapted from Coelho, 2007

7.4 Analytical model applied

The approach and model used to determine the impacts of policy along the sugarcane bio ethanol value chain builds on the three-agent model whose basis lies in I-O modelling outlined in the earlier section. To determine the policy impacts, the model factors in counterfactual analysis approaches as discussed in chapter 2. The model shows how margins are calculated in the base case (WoP) scenario and in two different policy scenarios, WiP A and WiP B. In the base case, the primary production margins (Mprod0) are calculated as the value of outputs minus the value of inputs, adjusted by means of scale factors (Sprod0) for activities and agents. The processing margins Mproc0 are analogously calculated. The margins for the whole value chain Mvc0 result from the sum of Mprod0 with Mproc0. Policy-induced changes are hosted in the VCA framework by building one or more WiP scenarios. The accounting structure of the WiP scenarios is usually analogous to the WoP one. The model can be summarised as follows:

At any stage, let:

- *n* represent number of inputs
- *m* represent number of outputs

Case (1) Base scenario:

At production level

Total inputs are:

$$\sum_{i=1}^{n} Pa_i \times Qa_i = \sum_{i=1}^{n} Xa_i$$

where Pa_i denotes price of ith input ,Qa_i quantity of ith input and Xa_i value of ith input.

Total outputs are:

$$\sum_{i=1}^{n} Pf_i \times Qf_i = \sum_{i=1}^{n} Yf_i$$

where Pf_i denotes price of ith output, Qf_i quantity of ith output and Yf_i value of ith output.

The margin for $Mprod_0$ is then obtained as follows:

$$Mprod_0 = \lambda_0 \left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right]$$

Where $\lambda_0 = Sprod_0$ (i.e. the scale factor)

<u>At processing level</u>

In a similar fashion, we have $Mproc_0$ as follows:

$$Mproc_0 = \lambda_1 \left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right]$$

where $\lambda_1 = Sproc_0$ (constant scale factor), Yq_i and Xq_i denote the ith output and input values respectively.

The Value Chain Margin is then calculated as follows:

$$WoP = Mvc_0$$

$$= Mprod_0 + Mproc_0$$

$$= \lambda_0\left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right] + \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right].$$

Case (2) Policy scenario (i.e with policy)

Let the policy scenario be represented by z, $Mprod_z$ be the margin for primary production and $Mproc_z$ be the margin for processing.

Then,

$$Mprod_z = \lambda_0\left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right]$$

And,

$$Mproc_z = \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right].$$

Now, cost of policy has to be incorporated as follows:

$$\text{Cost of policy} = Cpol_z$$

$$= \sum_{i=1}^{n} Xg_i.$$

It then follows that:

$$\text{Value Chain Margin} = Mvc_z$$

$$= Mprod_z + Mproc_z - Cpol_z$$

$$= \lambda_0\left[\sum_{i=1}^{m} Yf_i - \sum_{i=1}^{n} Xa_i\right] + \lambda_1\left[\sum_{i=1}^{m} Yq_i - \sum_{i=1}^{n} Xr_i\right] - \sum_{i=1}^{n} Xg_i.$$

7.5 Results of simulations of alternative policy scenarios

7.5.1 Definition of the scope of analysis

The analysis of policy impacts carried out in this chapter focuses on two broad areas, which are impact of blending levels and impact of indigenisation policy on the value chain. With respect to blending, naturally different levels of ethanol blending impose different levels of demands on certain variables along the sugarcane bio ethanol value chain. The analysis focused on the impact on some selected variables: i) land put under sugarcane for purposes of ethanol production; ii) amount of raw sugarcane required per annum; iii) total amount of ethanol required per annum; and iv) gross value of ethanol at each stage of the chain. The impact on each of these variables is described in the proceeding section.

With respect to indigenisation policy, this is seen as a key determinant of the distribution of wealth along the sugarcane bio ethanol chain as this distribution spells out the shareholding and compensation mechanisms for local communities. The model applied traces how selected variables change in response to adjustments in policies in these aspects.

7.5.2 Defining the reference scenario and its parameters

To facilitate the analysis in this chapter, a 5% mandatory blending level is taken to be the baseline/reference scenario, since this was the initial blending level under which production of ethanol commenced. This assumption is important because a 0% reference assumption (meaning no blending is taking place) would render the analysis impotent. In this regard, the purpose of the analysis is to see how changes

in energy policies affect the creation and distribution of income and wealth along the sugarcane bio ethanol value chain. The analysis in this chapter varies the blending levels from 5, to 10, 15, 25 and 85% which are the standard blending levels that Greenfuels produces and that government has been pursuing. In addition, the analysis examines the implications of changes in indigenisation policy as well as various incentives that can be instituted in the energy sector.

Based on interview data, the yield of sugarcane applied is 135t/ha while the cost of production per hectare is $4541. The conversion rate of sugarcane to ethanol at Chisumbanje is estimated at 1 tonne to 75 litres of ethanol. Consumption of petrol per annum is based on daily estimated consumption of 2 266 761 litres per day (Mapako and Mbewe, 2004). The full baseline scenario, which is the reference situation at 5% ethanol blending level, is presented as column three in Table 7.3 Input costs per hectare, output per hectare, price per tonne and subsequent gross margins per hectare are not expected to vary over the simulation since they are given constants.

Table 7.2: Results of simulations of alternative ethanol blending levels

		Computed estimates					
Stage of value chain	**Parameter**	**at 5% ethanol (baseline/reference scenario)**	**10% ethanol blend**	**15% ethanol blend**	**25% ethanol blend**	**85% ethanol blend**	**100% ethanol**
Primary Production Of Sugarcane	Inputs costs (USD)/Unit($/ha)	4541	4541	4541	4541	4541	4541
	Total output/unit(t/ha)	135	135	135	135	135	135
	Price per/tonne($)	4	4	4	4	4	4
	Total gross margins/unit($/ha)	-4001	-4001	-4001	-4001	-4001	-4001
	Gross value of feedstock cost per hectare(US$/Ha)	1447	1447	1447	1447	1447	1447
	Amount of land put under sugarcane (ha) based on amount of ethanol required	513799.16	1027598.32	1541397.48	2568995.8	8734585.72	10275983.2
	Total value of feedstock/annum($)(standard)	743467384.5	1486934769	2230402154	3717336923	12638945537	14869347690
Processing Of Sugarcane into Bio Ethanol Into Ethanol	Amount of raw sugarcane required per year(tonnes)	513799.16	1027598.32	1541397.48	2568995.8	8734585.72	10275983.2
	Inputs costs($/litre of ethanol)	0.4798	0.4798	0.4798	0.4798	0.4798	0.4798
	Total amount of pure ethanol required(per year)(litres)	38534937	77069874	115604811	192674685	655093929	770698740
	Price /litre(US$)	0.95	0.95	0.95	0.95	0.95	0.95
	Gross margins/litre($)	0.49371	0.49371	0.49371	0.49371	0.49371	0.49371
	Total gross margin at processing($)	19025083.75	38050167.49	57075251.24	95125418.73	323426423.7	380501674.9
	Gross value of ethanol($)	36608190.15	73216380.3	109824570.5	183040950.8	622339232.6	732163803
Wholesaling and Transportation Of Ethanol	Inputs ($/litre)	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256
	Outputs (litres of ethanol)	41368388.25	82736776.5	124105164.8	206841941.3	703262600.3	827367765
	Gross income ($/annum)	1059030.739	2118061.478	3177092.218	5295153.696	18003522.57	21180614.78
	Gross value of ethanol ($)	37667220.89	75334441.78	113001662.7	188336104.4	640342755.1	753344417.8
Blending and wholesaling Stage	Input costs ($/litre)	0.95	0.95	0.95	0.95	0.95	0.95
	Outputs (litres)	41368388.25	82736776.5	124105164.8	206841941.3	703262600.3	827367765
	Price per litre ($)	1.0165	1.0165	1.0165	1.0165	1.0165	1.0165

	Gross margins (ethanol only)	0.0665	0.0665	0.0665	0.0665	0.0665	0.0665
	Total gross margins	2750997.819	5501995.637	8252993.456	13754989.09	46766962.92	55019956.37
	Gross value of ethanol at blending stage	40418218.71	80836437.42	121254656.1	202091093.5	687109718	808364374.2
Retailing stage	Input costs (7% maximum)	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975
	Outputs	41368388.25	82736776.5	124105164.8	206841941.3	703262600.3	827367765
	Price per litre	1.0877	1.0877	1.0877	1.0877	1.0877	1.0877
	Gross margins /litre (ethanol only)	0.071155	0.071155	0.071155	0.071155	0.071155	0.071155
	Total gross margins (net income)	2943567.666	5887135.332	8830702.998	14717838.33	50040650.32	58871353.32
	Gross value of ethanol at blending stage	43361786.37	86723572.75	130085359.1	216808931.9	737150368.4	867235727.5

7.6 Discussion of results

7.6.1 Impacts of alternative petrol bio ethanol blending levels

At the level of primary production of sugarcane, a key variable is the amount of land put under production. Naturally higher blending levels require more ethanol, which implies that more land will have to be under sugarcane to satisfy the higher demand. Because land, particularly in Chisumbanje, has been under contestation, it is important to understand the impacts and implications of increasing the blending levels on not just land but all other resources that are required in primary production of sugarcane for ethanol.

The results show that as the blending levels are increased, it is not just demand for ethanol that is going up, but also all the inputs that are used in the production of ethanol, including land labour and capital. Using land as a an example and based on the production systems assumed in the reference scenario, from 5% to 10%, the required land doubles from 5100 hectares to 10200 hectares (assuming the yield of 135t/ha and a 1tonne to 75 litres sugarcane to ethanol conversion ratio).

From the results, unless there are new technologies that increase the yield levels for the same land area; demand for land will always increase proportionately with increases in blending levels as shown in Table 15. The implication is that it may not be ideal to increase the blending levels without paying attention to the issue of land, especially in cases where the land is already contested. Although the analysis does not consider other inputs of production such as water and chemicals, it makes sense

to infer that increases in blending levels will lead to increases in uses of other inputs and, therefore, decisions on blending level should take into account the potential impacts on many other things.

In addition, increased production induced by raising the blending levels can lead to increased negative externalities. Pimentel (2003) brings to our attention the fact that in some cases governments promote increases in ethanol production without carefully considering the full economic costs. The costs on the local livelihoods, the environment and on the social systems, especially in cases where there are contestations, should therefore be fully considered when blending levels are raised.

At the processing level, increasing the blending ratio also has a similar effect. As the blending level is increased, for instance from 5% to 10%, it amounts to doubling the amount of ethanol required while raising the level to 25% implies multiplying the reference scenario amount 5 times. Changes in blending level have direct implications on the processing capacities. The current installed capacity at Chisumbanje processing plant is approximately 105 million litres of ethanol per annum. Under Statutory Instrument 147a of 2013, the Government of Zimbabwe raised the mandatory blending level from 10% to 15% with effect from the 30th of November 2013. In January 2014, the government relaxed its rules for the mandatory blending of ethanol in petrol from the statutory 15% to 10%. The key reason cited was the failure by the company to harvest because of heavy rains that made some parts of the sugar estates unreachable. What is clear is that as the blending level increases, it imposes new demands on both production and

processing capacity and, if these are not carefully considered, mandatory ratios may be raised, only to be reduced because of capacity challenges. Therefore, it could be that unless new plants are constructed, or new entrants enter the ethanol production industry, it may be technically impossible to sustain consistently the 15% blending level.

The hypothesis tested was that as the level of ethanol petrol blending increases, the net benefits that accrue to different agents increase disproportionately, with smallholder farmers getting less and corporate getting more and more. A key question to facilitate in testing this hypothesis is what happens to incomes of key groups such as war veterans and settler farmers and the community as the blending level increases. The results also show that increases in mandatory blending levels increase income that accrue to all other the primary agents along the value except war veterans and settlers since their land holding is fixed. The hypothesis is accepted on the basis that smallholders' incomes are not increasing with blending levels. The results could also imply that if more land is available, more members of the community could be incorporated into the project as 'outgrowers'.

For all the other economic agents, business increases because the value of ethanol proportionally increases since the prices are not going down as a result of increased supply. For instance, at the 5% mandatory blending level, the value of ethanol at processing is $36.6 million dollars. If the blending level is raised to 10%, the value of ethanol produced at processing levels doubles to $73.2 million. There are no

changes in distribution of income among economic agents. These findings imply that instituting higher mandatory blending levels that are not coupled with distributional policies or measures to ensure equitable distribution of the additional income generated serve to perpetuate the existing income-distribution patterns.

7.6.2 Impact of alternative indigenisation policies

An important analytical dimension is the impact of indigenisation policies on the sugarcane bio ethanol value chain, especially on the distribution of income. This dimension is important in that changes in the ownership structure/shareholding have potential to change how the income is distributed along the sugarcane bio-ethanol value chain. According to the Government of Zimbabwe's (2015)[29] Parliament portfolio committee report government concedes that the project does not comply with the Indigenisation and Economic Empowerment Act (Chapter 14:33). This Act is read with the Indigenisation and Economic Empowerment (General Regulations, 2010) that states that investment should be 49%/51% in favour of local investors, and that local communities should benefit from such investment through a 10% share community ownership. The Parliamentary report also notes that private investors have a 90% stake and the government owns the remaining 10% through ARDA. In addition Greenfuels was granted an ethanol blending license despite not fulfilling the 51%/49% joint venture with government, according to the spirit of Statutory Instrument No 17 of 2013 on Mandatory Blending.

[29] Report Of The Portfolio Committee On Youth, Indigenisation And Economic Empowerment On The Green Fuel Chisumbanje Ethanol Project: Second Session: Eighth Parliament

This background is important because it shows that the issue of shareholding and eventually how it affects income distribution along the sugarcane bio ethanol value chain is unfinished business and can therefore not be ignored in the analysis carried out in this chapter. Changes in shareholding and implementation of community share ownership trust are potential mechanisms through which the distribution of income along the sugarcane bio ethanol value chain could be changed. The income (profit) distribution pattern was presented in the previous chapter as 69% of profits going to Greenfuels, 8% to government through ARDA, 11% to retailers, 10% to blenders , 1% to settle farmers and 1% to war veterans. With a 51% shareholding acquired by the local entity (in this case ARDA), the new income distribution structure along the chain would be as shown in figures 7.2-7.5

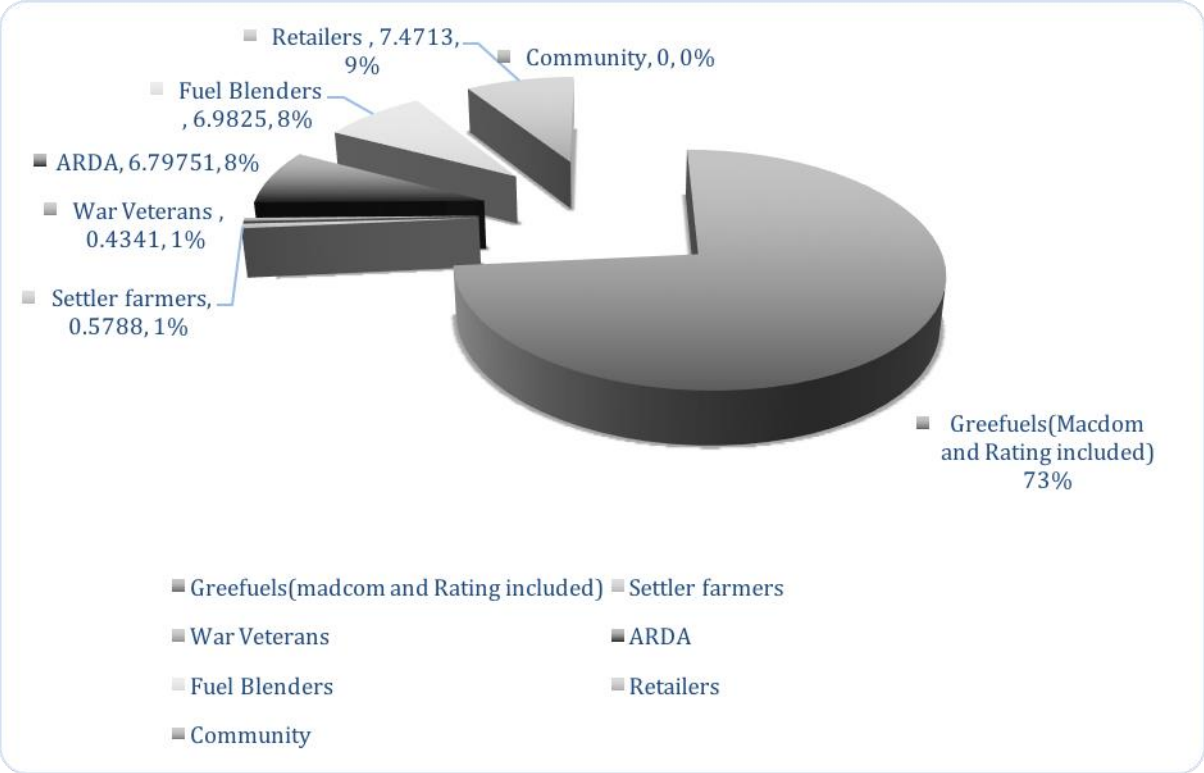

Figure 7.2: Baseline (current) income distribution patterns along value chain
Source: Computations based on primary data generated from interviews with respondents (economic agents) along the sugarcane bio ethanol value chain

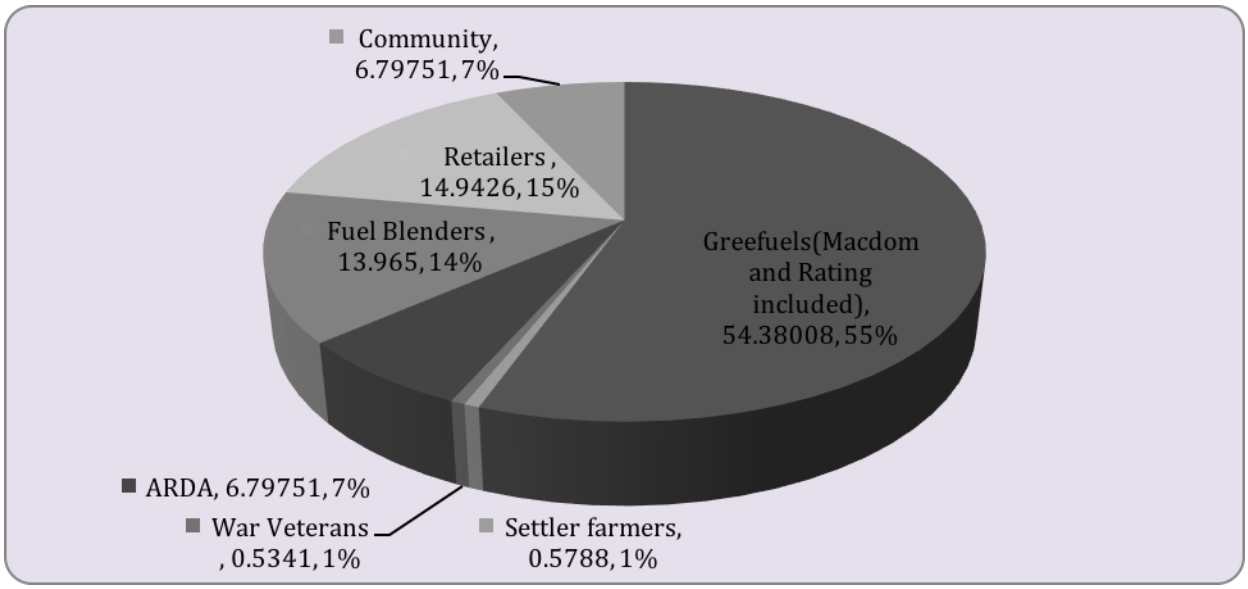

Figure 7.3: Impact of imposition of 10% share ownership trust (CSOT)

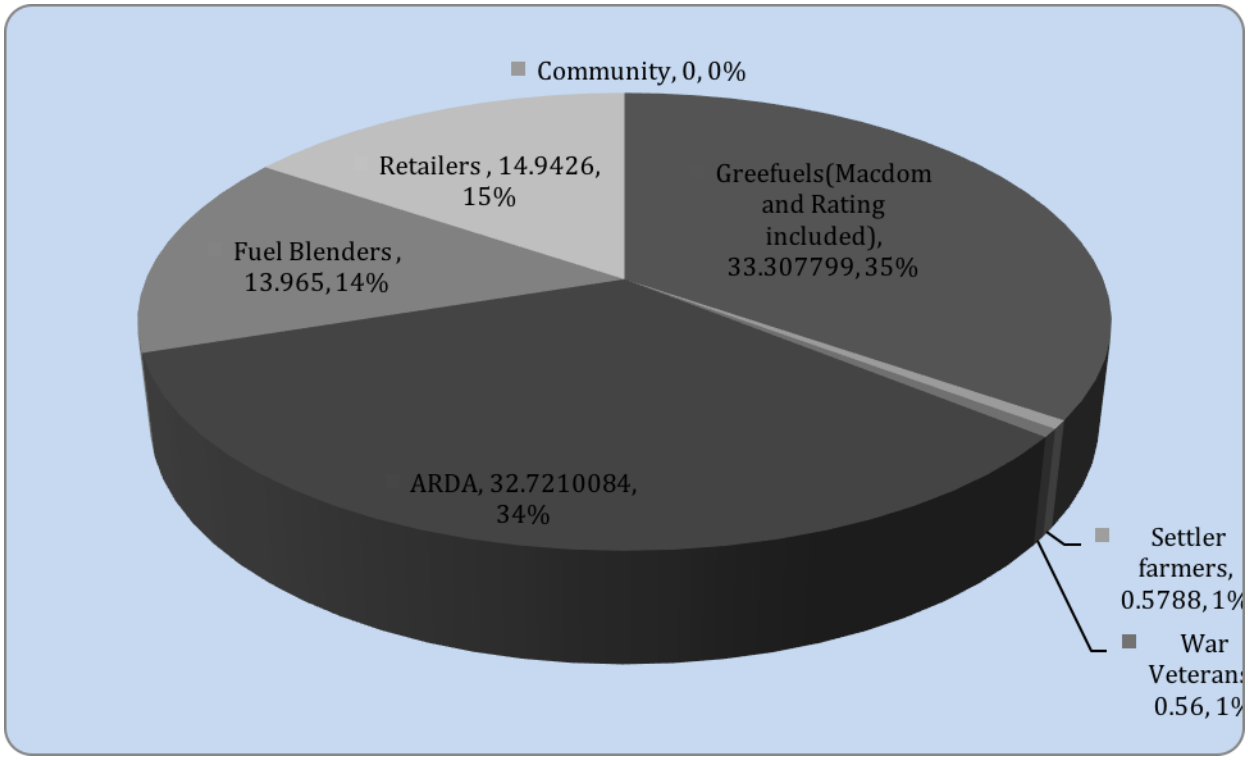

Figure 7.4 : Impact of implementation of 51/49 law in favour of ARDA

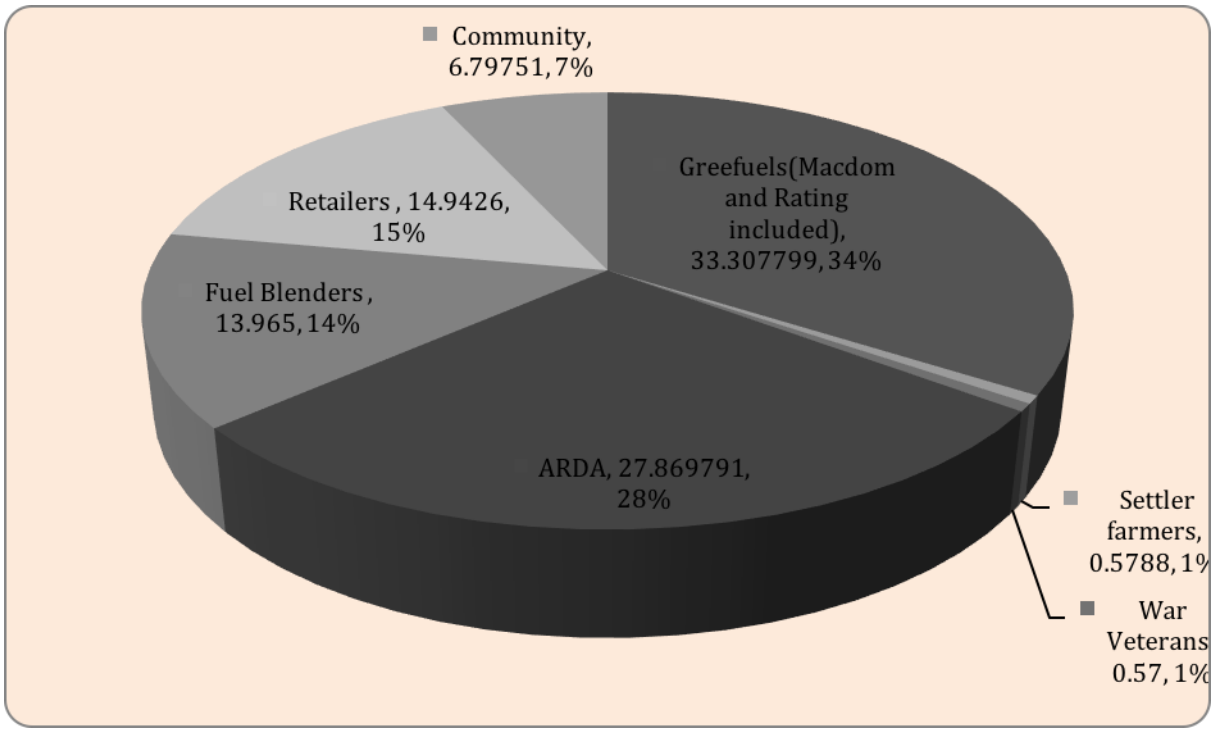

Figure 7.5 : Implementation of 51/49 law in favor of ARDA (41%) and community (10%)

The Government of Zimbabwe (2015) Parliament portfolio committee report recommends and considers Community Share Ownership Trust (CSOT) as a lucrative 'quick gain' in line with the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIM ASSET)'. While the analysis carried out in this chapter does not look at the broader issues of effectiveness of CSOT in delivering the required sharing of equity with the community, it is important to analyse the broader potential impact of such a policy on the distribution of income along the value chain. Figures 7.1-7.4 show that the implementation of 10% CSOT will result in the community getting at least 7% of the income generated from the value chain that is at production-, processing-, distribution- and blending levels.

The results show that as the blending levels are increased, it is not just demand for ethanol that is growing, but also all the inputs that are used in production of ethanol, including land labour and capital. From the results, unless there are new technologies that increase the yield levels for the same land area; demand for land will always increase proportionately with increases in blending levels. The implication is that it may not be ideal to increase the blending levels without paying attention to the issue of land, especially in cases where the land is already contested. In addition, increased production induced by raising the blending levels can lead to increased negative externalities. Therefore, the costs on the local livelihoods, the environment and on the social systems especially in cases where there are contestations should therefore be fully considered when blending levels are raised.

What is clear is that as the blending level increases, it imposes new demands on both production and processing capacity, and if these are not carefully considered, mandatory ratios may be raised, only to be reduced because of capacity challenges. Therefore, it could be that unless new plants are constructed, or new entrants enter the ethanol production industry, it may be technically impossible to sustain consistently the 15% blending level.

The hypothesis tested was that as the level of ethanol petrol blending increases, the net benefits accruing to different agents increase disproportionately, with smallholder farmers getting less and corporate getting more and more. The hypothesis is

accepted on the basis that smallholders' incomes are not increasing in line with blending levels.

Although there are no specific studies that deal directly with the impact of policy, a few studies have been done which focus on what has to happen as government makes policies on ethanol production and use. For instance, Grumet and Poltak (2001) highlight that the economic-, environmental- and health aspects have to be carefully considered since there are some significant impacts across the board. These authors also note the new infrastructural demands that are associated with increased use of ethanol such as new pipelines and other parent infrastructure because of the differences in water absorption rates. These authors also note the importance of predicting new demands that are brought by new levels of ethanol use.

7.7 Conclusion

In conclusion, the chapter has demonstrated the impact of blending level policy on various activities along the sugarcane bio ethanol value chain. A reference scenario of I-O relationships along the sugarcane bio ethanol value chain was created based on the initial blending level, set at 5%. The evidence shows that unless there are new technologies, which increase the yield levels for the same land area, demand for land will always increase proportionately with increases in blending levels, and therefore increasing blending levels should carefully consider the impacts on the supply side. Higher and higher blending levels impose new demands on all systems,

including production and processing as well the environment. Therefore, it could be that unless new plants are constructed, or new entrants enter the ethanol production industry, it may be technically impossible to sustain consistently higher blending levels. The analysis also showed that changes in shareholding and implementation of community share ownership trust are potential mechanisms through which the distribution of income along the sugarcane bio ethanol value chain can be changed.

CHAPTER EIGHT: SUMMARY OF FINDINGS, RECOMMENDATIONS AND AREAS OF FURTHER STUDY

8.1 Introduction

The primary objective of the study was to investigate the creation of value and distribution of income as well as the impact of government policies on the sugarcane bio ethanol value chain in Zimbabwe. Chapters 1, 2, 3 and 4 laid the foundation for the analysis. Chapter 1 focused on outlining the purpose of the study, including the specific objectives and hypotheses tested. Chapter 2 presented a review of the literature while Chapter 3 presented the approach used to achieve the objectives. Chapters 4, 5 and 6 are the analytical chapters. In Chapter 4, the character of findings from emerging bio-fuels value chains from the Chisumbanje sugarcane bio-ethanol chain in Zimbabwe was investigated. Chapter 5 looked at the creation and distribution of value added and gross margins along this value chain, while Chapter 6 focused on analysing the impacts of different policies along the sugarcane bio-ethanol value chain. This chapter presents a summary of the findings, recommendations and areas of further research.

8.2 Summary of findings

The study generated the evidence on the impacts of large-scale land investments. A quantification of the impacts of the large-scale land investments, especially from an economic standpoint, significantly enriches the current discourse. This study deepened the analysis by analysing wealth creation and distribution along the emerging value chain resulting from large-scale land investments. Further to this, the

study also simulated the impacts of alternative government policies that incentive these investments. The findings are summarised in the proceeding section.

8.2.1 Character of emerging bio-fuels value chains

At the primary production stage of the sugarcane bio ethanol value chain, there is domination of two vertically and horizontally integrated companies which face no competitive pressure. The arrangement is a clear mechanism for ensuring sugarcane supplies to the plant and, therefore, the process can be seen as a vertical integration process. The primary production process does not include convectional out growers. Rather, there are settler farmers and war veterans who can be referred to as interested groups who get paid on a per hectare basis. The amount being paid to the war veterans per annum can be seen as rental since they are not in any way involved in the production process. The nature of involvement of war veterans and settler farmers in the value chain demonstrate the concentration of power in the company as it dictates the yield levels, the prices and, in general, the terms of the agreement. The results also shows how impossible it is for smallholder households to be meaningful participants in the primary production level of emerging sugarcane bio ethanol value chain. Some of the key findings and conclusions with respect to the character of the emerging sugarcane bio ethanol value chain are set out below

Information asymmetries and barriers to entry into the value chain: Information asymmetries are apparent mostly at the primary production, processing and distribution of ethanol, which act as barriers to entry into this business.

Pervasiveness of monopoly behaviour in the value chain: The analysis showed that the primary production, processing and distribution levels dominated by the Greenfuels which is in partnership with government. Greenfuels is producing ethanol and at the same time it has to enter into negotiations with ZERA, (which is indirectly its partner) as the sole licensed producer in negotiating a price for ethanol.

Rent seeking opportunities: The evidence analysed in the study seems to suggest a strong case for rent seeking. There are strong indications of regulatory agencies being manipulated by the company through systematic benefits to those in power to make decisions. There is apparent manipulation of powerful institutions involved in the whole chain to gain monopolistic advantages while there are apparent losses to powerless agents. Powerful agents are in support of the investments.

Integration along the sugarcane bio-ethanol value chain: At the primary production stage, there is a domination of two vertically and horizontally integrated companies that face no competitive pressure. The arrangement is a clear mechanism for ensuring sugarcane supplies to the plan and, therefore, can be seen as a vertical integration process.

Inclusion of out growers along the chain: The primary production process does not include conventional out growers. Rather, there are interests groups who get paid on a per hectare basis. The findings show how impossible it may be for smallholder households to be meaningful participants in the primary production level of the emerging sugarcane bio ethanol value chain.

Changes in the socio-economics and livelihoods for local communities: The investments in Chisumbanje have changed the farming system and livelihoods for a significant part of the local community population. The land that has been historically used for cotton production by smallholder households is now being used for large-scale sugarcane production for processing into ethanol by Greenfuels. These new developments have potentially jeopardised the livelihoods of the people whose land has now been placed under sugarcane production. They have been introduced to new farming systems without adequate knowledge and the plots have been found to be too far away from homesteads. The potential negative impacts on labour productivity are obvious.

8.2.2 The creation and distribution of value added and gross margins

The analysis shows that Greenfuels and its subsidiaries Macdom and Rating are getting more than 73% of the income that is generated along the whole chain. This percentage (73%) actually excludes the income that accrues to Greenfuels at the blending stage since they are one of the four blending companies. This implies that the figure is actually higher if incomes generated at blending are added. The distribution also shows that there are no incomes that accrue to ordinary smallholder farmers since they are not primary agents along the chain. The war veterans and settler farmers are getting just 2% of the income while government through ARDA is getting 8%. The rest of the income generated is shared among the blenders and numerous retailers.

The analysis done brings to the fore some indications of how inclusive the sugarcane bio ethanol value chain is. Questions can also be asked on the basis of the findings on whether modern biofuel chains that are designed along world class standards and well timed systematic line operations can actually have out growers. The issue of out growers is important because these are often used to justify large-scale land investments, some of them involving displacements of smallholders and contestations over ownership of land. In this regard, this analysis shows that it may be impossible to get smallholder farmers to be real growers of ethanol processing plants. The processors would prefer to be vertically integrated with the farming operations to ensure a consistent supply of quality and sufficient quantities of feedstock. Basing on these findings the pricing of raw sugarcane at US$4 per tonne could potentially be interpreted as a systematic disincentive for smallholders to venture into sugarcane production.

The analysis showed that the farming operations at the primary production phase at this price are a loss-making enterprise, but the investors then recoup their profits after processing and at a level that is not accessible by smallholder farmers. The result is an income distribution that is skewed towards the corporate, with virtually close to nothing going to the smallholders.

8.2.3 Impacts of alternative policy scenarios

The analysis showed that as the blending levels are increased, it is not just demand for ethanol that is going up, but also all the inputs that are used in production of ethanol, including land labour and capital. From the results, unless there are new

technologies that increase the yield levels for the same land area; demand for land will always increase proportionately with increases in blending levels. The implication is that it may not be ideal to increase the blending levels without paying attention to the issue of land especially in cases where the land is already contested. In addition, increased production induced by raising the blending levels can lead to increased negative externalities. Therefore, the costs on the local livelihoods, the environment and on the social systems, especially in cases where these are contested, should be fully considered when blending levels are raised.

The analysis also showed that changes in shareholding and implementation of community share ownership trust are potential mechanisms through which the distribution of income along the Sugarcane bio ethanol value chain can be changed.

8.3 Recommendations

Basing on the findings outlined in the preceding section, the following recommendations are in order:

Promotion of inclusive incorporation of smallholder farmers in primary production process through favourable pricing of raw sugarcane: It has been shown that the pricing of raw sugarcane at US$4 against a market value of approximately US$70 could be systemically dis-incentivising any 'would-be smallholder sugarcane producers' to participate meaningfully in this value chain. Since government is already controlling many aspects of the value chain, it could as well control the price of raw sugarcane paid to any smallholder growers. In addition,

mechanisms to compel the company to buy from smallholder farmers at market-related prices should be explored. This would also reduce the concentration of power in one economic agent in dictating the yield levels, the prices and, in general, the terms of the agreements.

An independent comprehensive systematic review or enquiry of the costs and benefits of the investment to the local communities and national economy: This would assist in determining the level of support government should be giving to the investor in relation to other independent ethanol producers. Although ARDA is benefiting as a quasi-government institution and shareholder (currently 10%), it is not obvious that these benefits are meaningful enough for the country to be instituting mandatory blending based on them. Such an enquiry would systematically verify all the perceived/published benefits and costs, shareholding, and rationale for increasing mandatory blending levels based on one producer, a government supported monopoly operating privately.

Increases in ethanol blending levels should be preceded by a systematic technical analysis of the impact on local, and national economies and distribution of additional income generated: Higher blending levels obviously impose new demands on both production and processing capacity and if these are not carefully considered mandatory ratios may be raised, only to be reduced because of capacity challenges. Therefore, it could be that unless new plants are constructed or new entrants enter the ethanol production industry it may be technically impossible to sustain consistently blending levels higher than 10%

Changes in shareholding in favour of communities could be a mechanism to benefits to the community if the arrangements are effectively implemented: The analysis also showed that changes in shareholding and implementation of community share ownership trust are potential mechanisms through which the distribution of income along the sugarcane bio ethanol value chain can be changed.

8.4 Areas of further study

The study has recommended three areas of further study as follows:

1. **Most economically appropriate and progressive compensation mechanism for smallholder farmers whose production systems have been changed:** A key finding was that the investments in Chisumbanje have changed the farming system and livelihoods for a significant part of the local community population. The land that has been historically used for cotton production by smallholder households is now being used for large-scale sugarcane production for processing into ethanol by Greenfuels. Smallholder farmers have been introduced to new farming systems without adequate knowledge, the plots have been found to be too far away from homesteads so the potential negative impacts on labour productivity are clear. These new developments have potentially jeopardised the livelihoods of the people whose land has now been placed under sugarcane production.

2. **Feasibility of world class biofuel value chains to have out growers:** The analysis questioned whether modern biofuel chains which are designed along world class standards and well timed systematic line operations can actually

have out growers versus the tendency need to vertically integrate. Further enquiry would generate models that meaningfully ensure inclusive value chain development.

3. **Deep analysis of actual impact of the investment on the whole economy, focusing how the investment is benefiting different sectors within the economy:** While the analysis done in this study focused on the value chain itself, another area of further enquiry is the actual impact of the investment on the whole economy. This further enquiry could consider how the investment is benefiting different sectors within the economy, considering that mandatory blending is a pan-territorial policy. In addition, an analysis of the nexus between energy, water scarcity and food security within the context of large-scale land investments is important.

REFERENCES

1. Akuffo, K. (2009). The conception of land ownership in African customary law and its implications for development: Ealing Law School, Thames Valley University, London www.euppublishing.com,
2. Amanor-Boadu, A. (2003). A Conversation about Value-Added Agriculture: Visiting Assistant Professor and Director of the Value-Added Business Development Program, Department of Agricultural Economics, Kansas State University.
3. Anseeuw, W. Boche, M. Breu, T. Giger, M. Lay, J. Messerli, P. and Nolte, K. (2012). Transnational land deals for agriculture in the global south: Analytical report based on the Land Matrix Database: April 2012
4. Anseeuw, W. L. Alden, W. L. Cotula, and Taylor, M. (2012). “Land Rights and the Rush for Land: Findings of the Global Commercial Pressures on Land Research Project”. International Land Coalition, Rome
5. Anseew, W.(2013). The rush for land in Africa: Resource grabbing or green revolution?: CIRAD/University of Pretoria, South Africa
6. Belli, P. Anderson, J. Barnum, H. Dixon, J. Tan, J. (1998). Handbook On Economic Analysis Of Investment Operations: Operational Core Services Network Learning and Leadership Centre January 26, 1998
7. Bellù, L.G. (2013). A Software for Value Chain Analysis. Manual for FAO VCA Software Tool 3:1 EASYPol series n. 074, FAO-Rome www.fao.org/easypol

8. Boche, M. And Anseeuw, W. (2013). Unravelling “land grabbing” - Different models of large-scale land acquisition in Southern Africa: LDPI Working Paper 46: PLAAS: http://www.plaas.org.za/plaas-publication/ldpi-46#sthash.UUTaKUUx.dpuf,

9. Braun, J. and Meinzen-Dick, R. (2009). “Land Grabbing” by Foreign Investors in Developing Countries: Risks and Opportunities: International Food Policy Research Institute. Policy Brief 13, April 2009

10. Burns, D. Heywood, F. Taylor, M. Wilde, P. and Wilson, M. (2004). Making community participation meaningful. A handbook for development and Assessment. University of the West of England 2004

11. Chan, H. J. and Reiner, D. (2011). Dynamics of evolution in the global fuel ethanol industry: EPRG Working Paper 1111; Cambridge Working Paper in Economics CWPE 1129: University of Cambridge Electricity Policy Research Group.

12. Coltrain, D. Barton, D. and Boland, M. (2000). Value-Added: Opportunities and Strategies, Arthur Capper Cooperative Centre, Department of Agricultural Economics, Cooperative Extension Service, Kansas State University.

13. Cotula, L. Dyer, N. and Vermeulen, S. (2008). Fuelling exclusion? The biofuels boom and poor people's access to land. Rome: Food and Agricultural Organization of the United Nations and International Fund for Agricultural Development, and London: International Institute for Environment and Development.

14. Cotula, L. S. Vermeulen, R. Leonard, J. (2009). Land grab or Development opportunity. Agricultural investment and international land deals in Africa. IIED, FAO & IFAD, London/Rome

15. Daily News(2012): Fuel Prices go down: https://www.dailynews.co.zw/articles/tagged/Fuel,

16. Daniel, S. and Mittal, A. (2009): The Great Land Grab Rush for World's Farmland: The Oakland Institute: USA

17. Deenanath, E.D. Iyuke, S. and Rumbold, K. (2012). The Bioethanol Industry in Sub-Saharan Africa: History, Challenges, and Prospects: A Review Article: Hindawi Publishing Corporation: Journal of Biomedicine and Biotechnology: Volume 2012, Article ID 416491, 11 pages doi:10.1155/2012/416491

18. Desmond, H. D. (2000). Global Survey and Analytical Framework for Forestry Out-grower Arrangements: Department of Forestry; Australian National University, Canberra, Australia. Prepared for Food and Agriculture Organisation of the United Nations Rome, Italy.

19. Dreze, J and Stern, N. (1987). The Theory Of Cost-Benefit Analysis: London School of Economics Handbook of Public Economics, vol. II, edited by A.J. Auerbach and M. Feldstein © 1987, Elsevier Science Publishers B. V. (North-Holland)

20. FAO, (2001). WTO Agreement on Agriculture : The Implementation Experience: Trades And Markets Division: Study prepared by Moses

Tekere with the assistance of James Hurungo and Masiiwa Rusare, Trade and Development Studies Centre, Harare.

21. FAO.(2008). Zimbabwe: National Investment Report: Prepared for Conference on Water for Agriculture and Energy in Africa, 15–17 December: Sirte: Lybia.

22. Fetcher, W. (2010). Regional Bio energy from Cane vision: Tongaat Hulett Integrated agriculture And Processing Business, http://www.theindependent.co.zw/2013/10/11/mugabe-gives-ethanol-blending/

23. Gereffi, G. (2005). Export oriented growth and industrial upgrading: lessons from the Mexican Apparel case: World Bank case study for Uma Subramanian.

24. Gereffi, G. Humphrey, J. and Sturgeon, T. (2003). The Governance of Global Value Chains: Review of International Political Economy

25. Görgen, M., B. Rudloff, J. Simons, A. Üllenberg, S. Väth, and L. Wimmer. 2009. Foreign Direct Investment (FDI) in Land in Developing Countries. Bonn: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

26. Government of Zimbabwe Parliament. (2010).Viability of ARDA operations and its impact on agricultural productivity and food security: A report by the portfolio committee on agriculture water lands and resettlement: Third Session of Seventh parliament: Presented to Parliament on 2010

27. Government of Zimbabwe, (2015). Report Of The Portfolio Committee On Youth, Indigenization And Economic Empowerment On The Green Fuel Chisumbanje Ethanol Project: Second Session: Eighth Parliament

28. Government of Zimbabwe. (2008). Draft Energy policy: Ministry and Energy and Power Development

29. Government of Zimbabwe. (2008). Draft Energy policy: Ministry and Energy and Power Development.

30. Government of Zimbabwe. (2011). Zimbabwe Medium Term Plan: 2011-2015: Towards Sustainable Inclusive Growth, Human Centred Development, Transformation And Poverty Reduction: Ministry Of Economic Planning And Investment Promotion(MEPIP): Republic of Zimbabwe

31. Government of Zimbabwe. (2012). National Energy Policy: Ministry of Energy and Power development: Republic of Zimbabwe

32. Government of Zimbabwe. (2012). National Energy Policy: Ministry of Energy and Power development: Republic of Zimbabwe

33. Government of Zimbabwe. (2013). Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset) “Towards an Empowered Society and a Growing Economy” October 2013- December 2018

34. Government of Zimbabwe. (2014). The 2014 Mid-Year Fiscal Policy Review Statement:“Towards An Empowered Society And A Growing Economy” presented to the parliament of Zimbabwe, 11 September, 2014

35. Government of Zimbabwe.(1998). Traditional Leadership Act Chapter 29:11: Act 25/1998, Modified by S.I. 430A/1999, 22/2001.

36. Gray, D. 2004. Doing Research in the real World, London: SAGE Publications

37. Green Car Congress. (2013). OECD-FAO Agricultural Outlook projects global ethanol production to increase 67% over next 10 years to 44B gallons: http://www.greencarcongress.com/2013/10/20131006-oecdfao.html, retrieved 01/06/15

38. Grumet S. J and Poltak, R.F. (2001). Health, Environmental And Economic Impacts Of Adding Ethanol To Gasoline In North East States: Study by New England Interstate Water Pollution Control Commission and North East States for Coordinated Air Use management, Boston: USA

39. Gumbo, D. (2006). Zimbabwe Country Case Study on Domestic Policy Frameworks for Adaptation in the Water Sector," a report prepared for the Expert Group Seminar on Climate Change in Conjunction with the OECD Global Forum on Sustainable Development. http://www.oecd.org/dataoecd/58/58/36318866.pdf (accessed 26 March 2010).

40. Gustafson, C. (2014). History of ethanol production and policy: Energy Briefs: North Dakota State University

41. Hall, R. (2011). Land grabbing in southern Africa: The many faces of the investor rush: Review of African political economy: http://www.tandfonline.com/doi/pdf/10.1080/03056244.2011.582753.

42. Hall, R. (2011). The next Great Trek? South African commercial farmers move north. Paper presented at the International Conference on Global Land Grabbing. Organised by the Land Deals Politics Initiative.

43. Hamilton, J. (2004). Modelling, Information Flows, Performance, Strategy and Competitiveness across the Service Value Chain: School of Business, James Cook University: Journal of New Business Ideas and Trends

44. Hellin, J. and Meijerm, M. (2006). Guidelines for value chain analysis: www.fao.org,

45. Humphrey, J. (2002). Developing Country Firms in the World Economy: Governance and Upgrading in Global Value Chains: INEF Report No. 61 (2002). Duisburg: University of Duisburg.

46. Humphrey, J. and Schmitz, H.(2008). Inter-firm Relationships in Global Value Chains: Trends in Chain Governance and Their Policy Implications. International Journal of Technological Learning, Innovation, and Development

47. Humphrey. J and Schmitz. H. (2001). Governance in Global Value Chains: IDS Bulletin Volume 32 No 3 'The Value of Value Chains: Spreading the Gains from Globalisation' edited by Gary Gereffi and Raphael Kaplinsky. © Institute of Development Studies 2001.

48. IMF.(2009). Zimbabwe Staff Report 2009, Article IV Consultation.

49. Institute of Food and Development Policy.(2011). Food First: Land mark Conference on land grabbing: Large-scale land investments do undermine food security., Institute of Development Studies, University of Sussex, UK: http://www.foodfirst.org/en/Land+grabbing,

50. Johnston, C. Meyer, R.L. and Curtis, A.(2007). Value Chain Governance And Access To Finance Maize, Sugar Cane And Sunflower Oil In Uganda,

United States Agency for International Development or the United States Government: micro REPORT # 88

51. Kachika, T. (2011). Land Grabbing in Africa: A Review of the Impacts and the Possible Policy Responses: Pan African Programme of Oxfam International

52. Kaminski, J. Elbehri, A. and Zoma, J.P. (2013). An analysis of Maize value chain and competitiveness in Burkina Faso: Implications for smallholder-inclusive policies and initiatives, In: Rebuilding West Africa's Food Potential, A. Elbehri (ed.), FAO/IFAD

53. Karangwa, M. (2010). The Effect Of Land Fragmentation On The Productivity And Technical Efficiency Of Smallholder Maize Farms In Southern Rwanda: A Thesis Submitted To The Graduate School For The Award Of A Degree Of Master Of Science In Agricultural And Applied Economics Of Makerere University

54. Kirstein, J. and Vink, N. (2005). New Institutional Economics: University of Pretoria

55. Kleih, U. Phillips, D. Wordey, M.T. and Gregory, K.(2013). Cassava Market and Value Chain Analysis, Ghana Case Study: Natural Resources Institute: University of Greenwich, UK in collaboration with Food Research Institute, Accra, Ghana

56. Knight, S. R. (2010). Statutory recognition of customary land rights in Africa. An investigation into best practices for lawmaking and implementation. FAO legislative study 105. FAO Legal office: Rome

57. Koru, B. and Holden, S. (2008). Difference in maize productivity between male and female headed households in Uganda : Ethiopian Development Research Institute: Addis Ababa, Ethiopia and Department of Economics and Resource Management: Norwegian University of life Sciences (UMB):Norway

58. Kovarik, W. (2008). Ethanol's First Century: Radford University. http://www.runet.edu/~wkovarik/papers/International.History.Ethanol.Fuel.html. Retrieved 2008-11-13.

59. Kugelman, M. and Levenstein, S.L. (2009). Land Grab? The race for world's farmland: Woodrow Wilson Centre For Scholars: Asian Programme.

60. Lofgren, H. L.R. Robinson, S. (2002). A Standard Computable General Equilibrium (CGE) Model in GAMS: Microcomputers In Policy Research 5: International Food Policy Research Institute: Washington, D.C.

61. Mutopo, P and Manase, C (2010): Large Scale Land Deals, Global Capital and the Politics of Livelihoods: Experiences of Women Small- Holder Farmers in Chisumbanje, Zimbabwe" Paper presented at the International Conference on Global land Grabing II, Organized by the Land Deals Politics Initiative (LDPI) and and Hosted by the Department of Human sociology at Cornell University , Ithaca, NY

62. Mapako, M. and Mbewe, A. (2004). Renewables and Energy for Rural Development in Sub Saharan Africa: Zed Books

63. Marotta, J.D. and Russel, M. (2015). What is rent seeking behaviour?: The Forbes Magazine. http://www.forbes.com/sites/davidmarotta/2013/,

64. Marotta, J.D. and Russel, M. (2015): What Is Rent Seeking Behavior?: The Forbes Magazine. http://www.forbes.com/sites/davidmarotta/2013/,

65. Mashange, K. (2007). A report of the AFREPREN/FWD Theme Group on Special Studies of Strategic Significance: Occasional Paper 16: An Assessment of Liquid Fuel Policies in Zimbabwe

66. Matondi, P. B. and Nhliziyo, C.(2014). Lessons From Land Investments In Zimbabwe: The Case Of Chisumbanje Ethanol Investment: Conference on Land Policy in Africa The Next Decade of land Policy in Africa: Ensuring Agricultural Development and Inclusive Growth 11-14 November 2014

67. Matondi, P. B. Havnevik, K. and Beyene, A. (2011). Biofuels, Land Grabbing and Food Security in Africa: Zed Books, July 2011

68. McAfee, P. R. (2006). Introduction to Economic Analysis, California institute of technology: http://www.introecon.com,

69. McCall, M.K.(1985). The significance of distance constraints in peasant farming systems with special reference to sub-Saharan Africa: Technology and Development Group: Applied Geography : Twente University of Technology: : The Netherlands

70. Menzies, P. (2014). Counterfactual Theories of Causation: First published Wed Jan 10, 2001; substantive revision Mon Feb 10, 2014: Stanford Encyclopedia of Philosophy

71. Merouche, O. and Nier, E. (2010). What caused the global financial crisis: evidence on the drivers of financial imbalances, 1999-2007: IMF working paper: Monetary and capital markets development: W10/265

72. Moore, M.(2009). Causation and Responsibility: An Essay In Law, Morals, and Metaphysics, Oxford: Oxford University Press.

73. Mukonza, C. (2014). Factors That Affect The Production And The Distribution Of Biofuels Products By Rural Farmers In Zimbabwe: Submitted in partial fulfillment of the requirements for the degree Doctor Technologiae In The Business School Faculty Of Management Sciences Tshwane University Of Technology

74. Mussatto, S. I., G. Dragone, P. M. R. Guimaraes, J. P. A. Silva, L. M. Carneiro, I. C. Roberto, A. Vicente, L. Domingues & J. A. Teixeira. (2010). Technological trends, global market, and challenges of bio-ethanol production. Biotechnology Advances, Vol. 28, No. 6, pp., ISSN 0734-9750|1873-1899.

75. Mutopo, P. and Chiweshe, M.(2012). Large Scale Land Deals, Global Capital and the Politics of Livelihoods: Experiences of Women Small- Holder Farmers in Chisumbanje, Zimbabwe: Paper presented at the. International Conference on. Global Land. Grabbing II. October 17--19, 2012. Organized by the land Deals Politics initiative

76. Mutopo, P. (2011). Gendered Dimensions of Land and Rural Livelihoods. The Case of New Settler Farmer Displacement at Nuanetsi Ranch, Mwenezi District, Zimbabwe. Paper presented at the International Conference on

Global Land Grabbing 6-8 April 2011 Organised by the Land Deals Politics Initiative

77. Mutopo, P. (2012). Large-scale Land Deals: Global Capital and the politics of livelihoods. Experience of Smallholder farmers in Chisumbanje: Zimbabwe. Global Land Grabbing 2012: Organised by the Land Deals Politics Initiative. Cornel University. Ithaca, NY

78. Parson, E. A. And Monke, S. R., (1989). The Policy Analysis Matrix For Agricultural Development: Outreach programme: Stanford university: Eric http://web.stanford.edu/group/FRI/indonesia/documents/pambook/pambook.pdf,

79. Paul, L. and Hall, N. (2013). Causation: A User's Guide, Oxford: Oxford University Press.

80. Paul, L., (2004). “Aspect Causation”, in Collins, Hall, and Paul 2004

81. Pietrobelli, C. and Saliola, F. (2007). Power Relationships along the Value Chain: Multinational Firms, Global Buyers, and Local Suppliers’ Performance : Paper prepared for the Conference on Micro Evidence on Innovation in Developing Economies United Nations University – MERIT Maastricht, the Netherlands May 31-June 1st, 2007 http://www.merit.unu.edu/MEIDE/

82. Pimentel, D.(2003). Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts are Negative: Natural Resources Research, Vol. 12, No. 2, June 2003

83. Porter, M. E. (1985). The Competitive advantage: Crating and sustaining superior performance: NY: Free Press, (1985). (Republished with a new introduction, 1998.)

84. Raphaela, K. and Morris, M.(2000): A Handbook For Value Chain Research: Prepared For The Idrc: Institute Of Development Studies: United Kingdom

85. Rasheed, H.S. and Geiger, S. (2000). Determinants of Governance Structure for the Electronic Value Chain: Resource Dependency and Transaction Costs Perspectives : University of South Florida

86. Rayport, J.F. Sviokla, J.J. (1995). Exploring the virtual value chain: Harvard Business Review

87. Recklies, D. (2001). The value chain: Recklies Management Project: www.themanager.org,

88. REN21.(2014). Renewable 2014 Global Status Report: REN21 Secretariat : Paris

89. Renewable Fuels Association. (2011). 2011 Ethanol Industry Outlook: Building Bridges to a More Sustainable Future" .

90. Renewable Fuels Association. (2013). 2013 Ethanol Industry Outlook: Building Bridges to a More Sustainable Future" .

91. Rey, S. J. (2000): Integrated Econometric and I-O models – Issues and Opportunities: Papers in Regional Science Vol. 79 pp271 – 292.

92. Rosenschein, A.D. Hall, D.O. (1991). Energy analysis of ethanol production from sugarcane in Zimbabwe. Biomass and Bioenergy, http://www.fin24.com/Economy/Zim-pet...in-SA-20131023,

93. Rukuni, M. Kambanje, C. Manymwa, H. (2013). Process and content of Agricultural policy in South Africa: Paper produced as part of the 5 country studies commissioned by BEAT and FAO in the process of the development of the Agricultural Policy Formulation Toolkit for Southern Africa.

94. Rukuni, M. and Kambanje, C. (2011): Impact of land rights on productivity of agriculture and natural resource enterprises in Africa: Paper commissioned by the Land policy initiative (LPI) for the IFPRI international Conference on Increasing Agricultural Productivity and enhancing food security in Africa: New Challenges and Opportunities, held in Addis Ababa, 1-3 November, 2011. Sub-theme: Investments, institutions, and policies for supporting agriculture

95. Rukuni, M. Matondi, P.B. and Kambanje, C. (2012). A critique of the Africa's capacity to develop and implement policy and strategy for FDI on land. Paper presented at Annual World Bank Conference on Land and Poverty 2012 entitle “Land governance in a rapidly changing environment”. April 24 and 25, 2012. World Bank Headquarters. Washington. D.C

96. Rukuni. M., Kambanje. C, Manyumwa H. (2012): Implications Of The Dynamics Between Agriculture And Manufacturing For The Recovery Of The Zimbabwean Economy: Paper Prepared and Presented at Confederation of Zimbabwe Industries(CZI) Conference, 2012.

97. Sapp, M. (2014). Triangle steps in to supply Zimbabwe ethanol market after green Fuels Slips: Biofuels Digest, Producer News

98. Serrat, O. (2010). Political economy analysis for development effectiveness. Washington, DC: Asian Development Bank.

99. Shikida, A.F.P.(2010). The economics of ethanol production in brazil: a path dependence approach: Western Paraná State University.

100. Shumba, E. Roberntz, P. and Kuona, K. (2011). Assessment of sugarcane Outgrower schemes For bio-fuel production In Zambia and Zimbabwe: WWF-World Wide Fund For Nature (formerly World Wildlife Fund) Harare, Zimbabwe

101. Siwa Msangi, S Tokgoz S, Batka, M and Rosegrant, R.(2009): Expert Meeting on How to feed the World in 2050: Food and Agriculture Organization of the United Nations Economic and Social Development Department Senior Research Fellow, Environmental Production and Technology Division International Food Policy Research Institute (IFPRI)

102. Smaller, Carin and Howard Mann (2009). A Thirst for Distant Lands: Foreign Investment in Agricultural Land and Water. International Institute for Sustainable Development

103. South world. (2013). Zimbabwe: EU Lists sanctions on Zimbabwe http://www.southworld.net/newtest/index.php/component/k2/item/531,

104. Taylor, T. (2008). Methodology Development for Cost- Benefit Analysis of Policy Implementation: Peri-Urban Land Use Relationships – Strategies And Sustainability Assessment Tools For Urban-Rural Linkages, Integrated Project, Sara Scatasta, Alberto Longo,

105. The Oakland Institute. (2011). Understanding land investment deals in Africa. Country reports. These case studies are part of Oakland Institute's (OI) seven-country case study project to document and examine land investment deals in Africa (Ethiopia, Mali, Mozambique, Sierra Leone, Sudan, Tanzania, and Zambia). www.oaklandinstitute.org,

106. Thomas, V. Kwong, A. (2000). Ethanol as a lead replacement: phasing out leaded gasoline in Africa: Elservier: Center for Energy and Environmental Studies, H-214 Engineering Quadrangle, Princeton University, Princeton, NJ 08544-5263, Energy Policy 29 (2001) 1133–1143USA

107. US Embassy of Zimbabwe. (2013). Sanctions Policy: Facts and myths: http://harare.usembassy.gov/sanctions_facts_myths.html, retrieved on 17 June 2015

108. US Embassy of Zimbabwe. (2013): US Targeted sanctions list(UPDATED 09/19/2013): http://harare.usembassy.gov/sanctions_facts_myths.html,

109. USAID. (2013). UAIAD funded Knowledge-Driven Agricultural Development program, Microlinks. , https://www.microlinks.org/good-practice-center/value-chain-wiki/value-chain-governance-overview,

110. Vliet, V.V. (2010). Virtual Value Chain model: Retrieved [28/05/15] from Tools Hero: http://www.toolshero.com/virtual-value-chain/,

111. Watkins, T. (2013). Introduction to Cost benefit analysis: Department of economics: San Jose State University

112. Webber, M. and Labaste, P. (2010). Using Value Chain Approaches In Agribusiness And Agriculture In Sub-Saharan Africa: A Methodological

Guide: Tools That Make Value Chains Work: Discussion and Cases Prepared for the World Bank: J.E. Austin Associates, Inc.

113. Westall, A. (2009). Econmic analysis and the third sector: Overview of economic analysis in relation to the third sector: Third sector research centre: Working paper 14: University of Birmingham, Birmingham

114. Wong, P. Hohenshelt, C. And Govindarajan, S. (2011). Where did my gross margin go? An analytical framework: Tech News: PricewaterhouseCoopers L: December 2011

115. Wood, E.G.(1978). Added Value: The Key to Prosperity, Tiptree, Essex: Business Books Ltd.

116. World Bank. (2011). Zimbabwe country brief: http://www.worldbank.org/en/country/zimbabwe, www.worldbank.org

117. World Bank. (2014). Doing Business 2015: Going Beyond Efficiency: Washington, DC: World Bank Group. DOI: 10.1596/978-1-4648-0351-2. License: Creative Commons Attribution CC BY 3.0 IGO

118. ZERA. (2013). Statutory instrument 23 of 2013: http://www.zera.co.zw/,

ANNEXURES

10.1 Annex 1: Data collection instruments applied in the research project

ECONOMIC ANALYSIS OF SUGARCANE ETHANOL VALUE CHAIN IN ZIMBABWE
STUDY QUESTIONNAIRE

Name of Enumerator _____Date _____Time_____

Introduction: This questionnaire is a tool being used to collect household level data on the economic activities of households involved in sugarcane for ethanol production in the Chisumbanje area of Chipinge district in Zimbabwe. The study is being undertaken by Mr Cuthbert Kambanje, who is a second year Doctor of Philosophy candidate at the University of Limpopo in South Africa. The study is expected to generate more knowledge and deepen the understanding of the emerging sugar ethanol value chain. This knowledge is important for policy makers, investors and local authorities in managing economic resources to enhance the performance and livelihoods of different economic agents including smallholder farmers along this value chain. The information gathered using this questionnaire is going to be used strictly for academic purposes.

CONTACT AND LOCATION DETAILS

1. *Ward……Village……*
2. *Name of respondent _____Sex of respondent{1=male 2=female}*
3. *Position of respondent in household* {1=male household head, 2=female household head 2=adult sibling 3=other adult
4. *Cell phone numbers_____Email address_____*
5. *Type of farming entity:_____ {*1: communal; 2: old resettlement; 3: irrigation scheme; 4: small-scale; 5: medium scale; 5: large-scale*}*
6. *For how long has the household been staying at this homestead?{*1=less than 5 years, 2=5-10 years, 3=10-35 years, 4=over 35 years}

HOUSEHOLD DEMOGRAPHIC AND SOCIAL PARTICIPATION INFORMATION

7. *What is the total household size_____*
8. *How many adults are in the household_____*

9. *How many adults are involved in decision making but do not stay at this homestead_____*
10. *How many siblings are in the family and how many contribute to the family labor(chores)_____*

    _____
11. ***Starting with the household head**, please provide the names, ages, levels of education, primary occupation and sex of each of the **adults** in the household.*

Name	age	Sex {1=male 2=female}	Highest Level of education {1=no education 2=primary 3=secondary 4=tertiary 5=Infant}	Primary occupation {1=Farmer, 2=Agriculture (farm) laborer, 3=Artisan, 4=Office worker, 5=Civil Servant, 6=Teacher, 7.=Health worker, 8=Trader, 9=Student, 10= Unemployed, 11=Not in labor force 12=Other non-agriculture worker}	Marital status {1=Married or living together under local custom, 2= Never married, 3=Previously married (currently divorced, separated, widowed), 4=Not applicable (child < 16 years}

14. *Is there a member of the household who is a member of a focused training program in agriculture? 1=yes 2=no*
15. *If yes please complete table*

Training program	***Whether there is a household member who has undergone such training. 1=yes 2=no***
Master farmer training	
Focused training in sugarcane production	
Farming as a business	
Certificate in agriculture	
Diploma in agriculture	
Degree in agriculture	
Other_____	

16. Indicate the institutions found here and whether members of your household participate

Type of social institution	**Name of institution**	***Whether there is a***

		household member who participates. 1=yes 2=no
Religious groups		
Agriculture consortiums		
Rural agro-processing club		
Farmer organization		
Women's organization		
Burial society		
Savings club		
Irrigation committees		
Co-operative projects		
School development committee		
Commodity associations		
Football club		
Health committee		
Other (specify)		

HOUSEHOLD ASSETS AND RESOURCE ENDOWMENTS

17. *What is the total dry land is owned by the household?(hectares)*
_____

12. *What is the type of ownership?* {1) communal settlement 2) leased 3) rented 4 old resettlement, 5: small-scale; 6: medium scale; 7: large-scale*}*
13. *How did you acquire this land?* 1) government's resettlement scheme 2) purchase from other farmers 3) inherited 4) others specify_____
___
18. When did you acquire this land? _____
19. *Do you rent in or out land? How much land has been rented out or rented in from the other farmers in the last 6 years, and what were the costs/fees. Complete table.*

Year	***Land Rent In(Hectares)***	***Cost(Amount Paid)***	***Land Rent Out (Hectares)***	***Fees(Amount Received)***	***Land Sold(hectares)***	***Price (Amount received)***	***Land Bought (hectares)***	***Price(amount received)***
2009								
2010								
2011								

2012								
2013								
2014								

20. *In cows what would you say is the value of your land (per hectare)? In other words, one hectare of the land you hold is equivalent to how many cows?* _____
21. *Suppose you are able to rent in/out land, what should be the cost/fee (US$) of renting out/in land per hectare?*

Rent in land estimate cost_____ rent out land estimate fee_____

22. *How much wet land is owned by the household*

_____

23. *Does the household have a garden ? {1=yes 2=no}*
24. *If yes, what if the size of your garden ?*

_____

25. *Indicate number owned of the following equipment, working status and whether household has sold or bought any in the last year?*

Household asset	Number owned	Number bought in the last 6 years	Number sold in the last 6 years
Car			
Scotch cart			
Plough			
Harrow			
Wheelbarrow			
Hoe			
Spade			
Shovel			
Other(specify)			
Other(specify)			
Other(specify)			
Other (specify)			
Other(specify)			
Other (specify)			

26. *What livestock does the household keep and how many, and how many were bought /sold in the last year?*

Livestock kept	Number owned	Number bought in the last 6 years	Number sold in the last 6 years
Cattle			

Donkey			
Goat			
Chicken			
Guinea fowl			
Turkey			
Sheep			
Rabbits			
Other (specify)			
Other (specify)			
Other (specify)			
Other (specify)			
Other (specify)			

AGRICULTURAL PRODUCTION AND MARKETING

27. Are you involved in agricultural production? 1=yes 2= no

28. List the three most important food crops and cash crops in order of importance

*Rank of importance(**1 is most important**)*	***List of most important food crops***	***List of most important cash crops***
1		
2		
3		

29. List other crops grown

_____

_____

_____

_____

_____

*30. For the most important **food crops** listed what were are areas put under crop and what were the yields in the following years*

Year	***Food crop***	***Area***	***Yield***
2010			
2011			
2012			
2013/14			

31. *Have you marketed any of the excess food crop? 1=yes 2=no*
32. *If yes, complete table*

Food Crop	***Where was it marketed***	***What were the transport cost per unit***	***What was the price per unit***

33. *What challenges did you face in marketing the excess food crops?*

_____
_____
_____

34. *For the most important **cash crops** listed what were are areas put under crop and what were the yields in the following years*

Year	***Cash crop***	***Area***	***Yield***
2010			
2011			
2012			
2013/14			

35. For the cash crops, where did you market, what transport costs, what price did you receive per unit?

Cash Crop	***Where was it marketed***	***What were the transport cost per unit***	***What was the price per unit***

36. *Dou you process any of you agricultural crop produce before marketing? If so complete table.*

Product(crops)	***What processing is done***	***Approximate cost of processing***

37. *Have you experiences losses of agricultural produce due to lack of markets(rotting, deterioration, or even throwing away) complete table.*

Commodity	***Type of loss(eg rotting, loss of quality)***

38. *What transport do you use to get to market? _____ {1=walk; 2=animal; 3=cart; 4=truck or other motorized vehicle; 5=Other (Specify)*
39. *What constraints do you face in agricultural production and marketing? {1=shortage of inputs,2=shortage of draft power,3=low prices for output,4=water shortage,5=poor soils, 6= shortage of land 7=other(specify)_____*

_____
_____
_____
_____
_____

40. *What companies/organization/institution have you done agricultural business within the past 6 years?*

Name of company/organization/ institution	***What type of business*** *(1- contracting company which provides inputs and purchases produce 2- provision of cash credit 3- purchasing of produce only 4- they sell other agricultural inputs(equipment, agrochemicals)*

41. *For the companies /organisations which you have done business with, what challenges did you face?*

Name of company/organization/ institution	***Challenges*** *(1-dishonesty 2- low prices for produce 3-late delivery of inputs 4-poor communication)*

42. *What are the areas/opportunities for improving business with these companies?*

_____

_____

_____

_____

SUGARCANE PRODUCTION INFORMATION

43. *Are you involved in sugarcane production? 1=yes 2= No*
44. *If yes how are you involved? 1= farmers 2= laborer 3=service provider(input supplier, transporter etc)*
45. *Indicate the following statistics on sugarcane production*

Year	***Area***	***Yield/hectare***
2009		
2010		
2011		
2012		
2013		

46. *List the inputs you use in sugarcane production and how much they cost per hectare of sugarcane production?*

Input/hectare(application rate)	***Source of inputs***	***Price per unit***

47. *List stages in sugarcane production and for each indicate the amount of person labour days you allocate per hectare?*

Stages/activities	**Labour days**
e.g. Land preparation	

48. *What is the cost of a labour day in this area for the following types of work?*

Permanent Farm laborer	
Casual farm laborer	
Civil servant employee	
Permanent Green fuel employee	
Casual(casual) Green fuel employee	
Household chore laborer	

49. *Are you involved in contract growing of sugarcane? 1=yes 2=no*
50. *If yes, what is the name of the contracting company?_____*
51. *Do you get information and advice on sugar production from extension workers? {1=yes 2=no},*
52. *How many times do they visit you per year? _____*
53. *Do you know where the extension agents are based? {1=yes, 2=no}*
54. *Have you visited the agents for help? {1=yes 2=no}*
55. *If yes, how frequently do you visit them? {1=monthly 2=once in a year 3=when there is a problem 4=occasionally*
56. *Do you pay for receiving extension advice? {1=yes 2=no}*
57. *The Extension officials who visit/contact you are from which organization? {1.=Government Agency 2= Agriculture research station 3= NGO 4= private company)*
58. *Have you received cash credit to enhance sugarcane farming activities from anyone in the past farming season? {1=yes 2=no}*
59. *If yes where did you get any cash credit, how much was it, what was the interest rate?*

Source of credit {1=government 2=other farmers 3=commercial bank 4=microfinance institution 5=contracting company 5=local agro dealer 6=other specify	*Amount of money(US$)*	*Interest rate*

60. Have you received any agricultural input credit in the past year? {1=yes 2=no}

61. If yes indicate the source and the amounts received?

Source of credit {1=government 2=other farmers 3=commercial bank 4=microfinance institution 5=contracting company 5=local agro dealer 6=NGO program 7=other(specify)	*Inputs received(1=seed, 2 =fertilizer 3=agrochemicals 4 equipment)*	*Quantity*

62. What bills do you pay with respect to sugarcane production?

Purpose	*Amount(us$) per unit*
e.g. Rent	
Electricity	

SOURCES OF LIVELIHOOD

63. What is the most important source of livelihood for the household?

1=Agricultural production , 2=Agricultural marketing , 3=Agricultural processing , 4=Business development (general), 5=Tailoring , 6=Carpentry , 7=Black smithing 8=Kniting/weaving , 9=Crafts , 10=Other (specify)

64. Over the last 12 months, what percent of total household net income is from non-farm activities (e.g. income (salary) from non-agriculture activities and other sources such as gifts, pensions, etc)? _____

65. *What are the sources of income for household and what are the yearly total incomes from these sources*?

Source of income	Estimated yearly income from this activity

ENVIRONMENTAL MANAGEMENT

66. *Are you involved in any work in any conservation work 1=yes 2= No*
67. *If yes what are the activities you are involved in? 1 =rehabilitation of dongas, 2= planting of trees , 3= conservation agriculture 4 =other specify*_____
68. *Have you seen any changes to your local environment and to what would you attribute these changes (complete the table)*

Changes in local environment (1=increased erosion, 2=increased siltation, 3=ffewer trees, 4= less and less animals 5 =other_____	What do you attribute these changes to? 1=increased population, 2=shortage of land 3=increased agricultural activities 4=lack of action by authorities 5=others_____

VISION FOR THE FUTURE

69. *What is your vision for Chipinge? 1=improved livelihoods 2=better living conditions 3=a prosperous community 4=others*_____
70. *What specific relationships do you want to see fostered with the following stakeholders?*

Stakeholders	***Type of relationship preferred****(1=strong relations, 2=mutually beneficial 3=others*_____
Government	
Private sector companies	
NGOs	