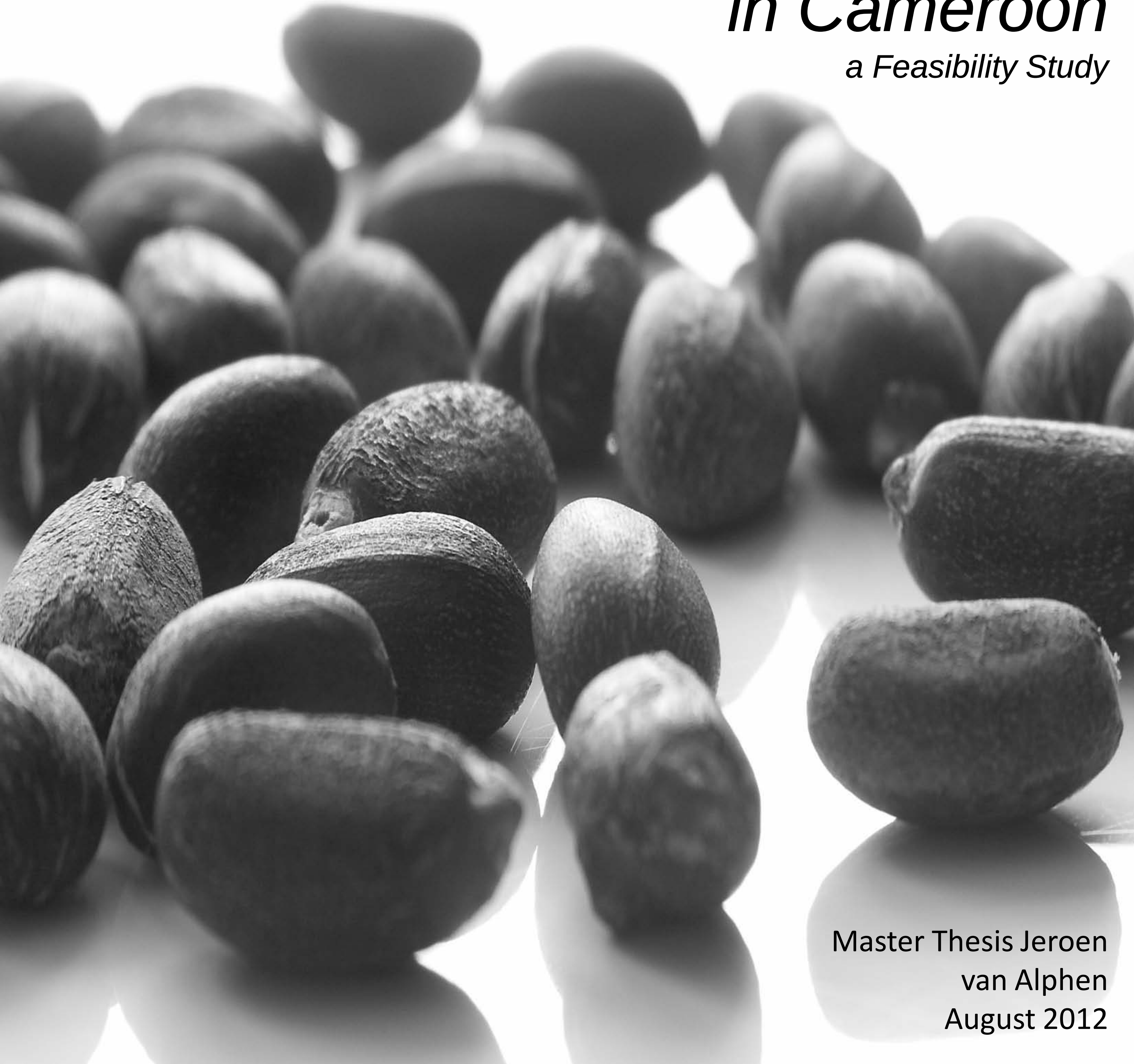
UNIVERSITY OF TWENTE.

Sustainably Developed Biofuel from Jatropha Production in Cameroon

a Feasibility Study



Master Thesis Jeroen van Alphen

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a Feasibility Study

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"The use of vegetable oils for engine fuels may seem insignificant today, but such oils may become in the course of time as important as the petroleum and coal tar products of the present time"

Rudolph Diesel, 1912

"Not much has changed, in one hundred years…"

Jeroen van Alphen, 2012

Preface

Dear reader, my name is Jeroen van Alphen and I studied Business Administration at the University of Twente, and my specialization is Innovation and Entrepreneurship. To finish this master I have written this thesis. Before graduating in Twente, I finished several other studies. I started at the Secondary Technical School in Utrecht, where I studied Electrical Engineering and Mechanical Engineering. After that I completed a Bachelor in Technology Management at the Hogeschool van Amsterdam. Before I came to Enschede, I studied a premaster Innovation Management at the Technical University of Eindhoven for one year and finished the premaster and the master at the University of Twente in Enschede.

People ask me why I keep on studying further and further. Is it persistence or stupidity? The reason for me to continue studying was that I am very much interested in combining technology with business management. I also enjoy learning new stuff and I like to challenge myself. None of the previous studies was sufficiency challenging and I did not feel I got the best out of myself. This study has been the most inspiring and challenging one for me.

To make it extra hard I started working two years ago (I had to because the Dutch government wouldn’t give me any (study)money anymore after being a sugar daddy for 10 years) at an engineering consultancy company in the areas of mobility, infrastructure and transportation systems. To finish this thesis I have collected all my vacation days and overtime, so now I can take off three months from work! The result is in front of you. With the finishing of this thesis, I will close a chapter of my (studying) life, or rather an entire book, or actually an entire encyclopaedia, or even better: with the finishing of my thesis, I will literally and figuratively close an entire library of my studying life.

Acknowledgements

Of all the people I would like to thank (family, friends, supervisors) there is just one person I would like to pay extra attention to: Joy! Joy, thanks for taking over the role of first supervisor when your predecessor suddenly left, thanks for the meetings at the airport, thanks for reading concepts during flights and holidays and thank you for continuously pushing me to finish this thesis. Without your help I wouldn’t have made it. I am sorry I caused you several grey hairs, but since the start of this thesis I have started to grow them myself as well…

Enjoy reading!

Jeroen van Alphen

Management Summary

This research is about Biofuels and Sustainable Development; two of the most discussed topics in energy production at this moment. Since biofuels are in a dynamic phase, serious question marks have to be placed regarding the production of this in developing countries such as Cameroon. Therefore this research has been set up for Reef's/ TRC's which core business is supplying wood from its own forest concessions in Cameroon, to civil engineering projects and the building industry in the Netherlands. The goal of this research is to create an answer to the following question: *"Under what conditions can Reef/ TRC produce three million litres of biodiesel a year, using Jatropha produced by local communities, in a sustainable manner, at an economic price?"*.

There are several production models conceivable to produce this biodiesel. These models vary from large plantations to farmers who produce Jatropha on a piece of unused farmland. There are many standards available to produce biofuel in a sustainably developed manner. However, these standards are not specifically applicable to Reef's business model, therefore these have been customised. This research has combined the principles and criteria of several sustainability standards, articles and wishes of stakeholders into a matrix. This matrix contains criteria including prevention of food-competition and deforestation, reduction of greenhouse gas and increased local prosperity and welfare for employees and local communities. This matrix has been discussed by means of scientific literature and in the perspective of the project of Reef/ TRC. Some of the criteria are beyond the range of control of TRC while others need extra attention. These discussions have lead to the final selection of customised criteria that have been used to evaluate the five production models. These models have been weighed using four evaluations, customised criteria, ease of implementation and practical feasibility. Next to these evaluations there was also a financial evaluation which includes purchasing of machinery, education and vehicles and salary for employees in plantations or the rewarding of farmers. The project costs may not exceed the current fossil fuel costs which are €2.225.000 (3 million litres of fossil diesel at €0,75/ litre).

Out of the five production models one model is chosen which is most applicable in this situation in Cameroon which is the Farmer Model. This model divides the total amount of needed plantation over a large group of farmers around the forest concessions, who will use a part of their own farm ground for Jatropha plantations. The Farmer Model is a feasible model, a lot of farmers or communities will benefit in an economic, environmental and sustainable way. Especially when this includes empowerment of women who are motivated to work in biofuel projects and use the money for better living conditions. It also has a lot of benefits for TRC because it is the easiest model to expand production.

The only disadvantages are the surveys and the formulation of the sourcing plans, which might be a time consuming operation. In addition it is still questionable whether farmers and communities will harvest and sell the Jatropha seeds or oil to TRC for the discussed price which is €0,13. It is calculated that there is a margin left in the Farmer Model of about €330.000,-. Calculation shows that the maximum price TRC can pay for the seeds per kilo is €0,16. These are figures that need to be examined in future research.

List of Acronyms

CIA:	Central Intelligence Agency
CM:	Collection point Model
DEFRA:	Department for Environment, Food and Rural Affairs
ECP:	Energy Capital Partners
EFM:	ECP-Farmer Model
EM:	ECP Model
EU:	European Union
FACT:	Fuels from Agriculture in Communal Technology
FAO:	Food and Agriculture Organisation
FLO:	Fairtrade Labelling Organisations International
FM:	Farmer Model
FSC:	Forest Stewardship Council
GHG:	Green House Gas
HCV:	High Conservation Value
IISD:	International Institute for Sustainable Development
ILO:	International Labour Standards
IMF:	International Monetary Fund
ISEAL:	International Social and Environmental Accreditation and Labelling Alliance
IUCN:	International Union for Conservation of Nature
JCL:	Jatropha Curcas L.
NGO:	Non-Governmental Organisation
PM:	Plantation Model
REDD+:	Reducing Emissions from Deforestation and Forest Degradation
RSB:	Roundtable of Sustainable Biofuels
RSPO:	Roundtable on Sustainable Palm Oil
RTFO:	Renewable Transport Fuel Obligation
SLA:	Sustainable Livelihood Approach
TRC:	Transformation Reef Cameroun
UN:	United Nations
UN-REDD:	UN Reducing Emissions from Deforestation and Forest Degradation
UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
WWF:	World Wide Fund for Nature

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1 Research Framework

1.1 Introduction

This research is about Biofuels and Sustainable Development; two of the most discussed topics in energy production at this moment. Sometimes these two topics reinforce each other while in other cases they could not repel more. Since the production of biofuels is in a dynamic phase, serious question marks have to be placed regarding the production of biofuel in developing countries such as Cameroon.

Media regularly report about the negative as well as positive consequences of biofuels. The disadvantages of biofuels have been elaborated upon extensively in the media. Remarkably, several media and reports suggested that the Mexican people cannot eat tortillas anymore because corn is converted into methanol to be used as petrol. Other media and reports even state that biofuel is the cause of worldwide food shortage, that it increases carbon emission, encourages deforestation and prevents governments from investing in real alternatives for transportation fuels and cleaner or more efficient fuel use (Oxfam, 2008).

On the other hand, positive consequences have also been highlighted by the media. Several media and reports suggested that residual-products of biofuels can be used for cooking and lighting, which reduces the need to cut down trees for fire wood. Other media and articles state that biofuel production can strengthen local economies in developing countries, increase food production and lower worldwide carbon emission (Cramer, 2007; Dornburg, 2008; Energieportal.nl, 2007; FACT, 2006; Heller, 1996; Henning, 2000, 2009; Nyamai, 2007). It is therefore a legitimate question in light of this uncertainty, whether it is feasible to conduct biofuel projects that are sustainable?, under what conditions can it be successful? and is it financially achievable?. In this context a case study, which is the basis of this thesis, was carried out on behalf of a Dutch company working in the Netherlands and Cameroon, which are interested in growing biofuels in a sustainable way.

This chapter will outline the research framework and environment. First the background and motivation of the key actors will be discussed which will result in the problem statement. This problem statement will result in several objectives and research questions. Hereafter the research strategy, methodology and data collection will be discussed. This chapter ends with the research structure.

1.2 Background and Motivation of the Key Actors

1.2.1 Reef Hout

Reef Hout (further mentioned as Reef) is a timber company based in the Netherlands and its core business is supplying wood to civil engineering projects and the building industry in the Netherlands. Reef has its own forest concessions in Cameroon and partnerships in various other concessions in other countries such as Brazil. Reef's timber mills in Cameroon allow them to deliver timber cut to customers' specifications, permitting direct shipment from the port to the project. Reef values the principles of sustainability and tries to apply this in its business activities. Examples of this are: obtaining the FSC certification in one forest concession, responsible use of building materials and fuel, participation in sustainable projects and contributing in social projects like building schools, bridges, water facilities and a hospital (ReefHout, 2008). Reef has to pay tax for every cubic metre of exported timber, which the government of Cameroon should use for financing these facilities (Schmidt, 2008). Because Reef never saw any results, they established "The Green Source Foundation" to finance these projects by themselves (TRC, 2008a).

Since the production of wood became more sustainable and social projects had been set up, Reef started to think about its other business activities. With the assistance of consultancy agency BGP Engineers, Reef brainstormed about several ideas and concluded to deliver a contribution to the reduction of carbon emission. One of the possibilities was to utilize non-used sawdust in dry-rooms in Cameroon. Another possibility was to produce pyrolysis-oil from waste. Pyrolysis-oil is a synthetic oil produced by thermo chemical decomposing of organic waste and this oil can be used in modified machines. A third possibility was to start the production of Jatropha biodiesel, produced around their forest concessions by local communities, (starting) in Cameroon (BGP, 2008). By producing Jatropha biodiesel Reef could solve two problems simultaneously: help local communities in a social, economic and sustainable way and reduce carbon emission without increasing costs. This research focuses on the third possibility, since the first possibility is already implemented and producing pyrolysis-oil from organic waste is contributing less in social projects than the Jatropha plantation possibility does.

1.2.2 TRC Company

TRC Company (Transformation Reef Cameroun) - a daughter company of Reef Hout, is based in Cameroon and has been in the timber profession since February 2002. Its main activity is the processing of AZOBE timber into finished products intended for the Dutch market. Conscious of the need for exploiting the forest in a sustainable way, and eager to quickly obtain an eco-certification of their production, TRC has obtained a forest concession of 125.490 ha themselves in 2004. This part of the forest has a FSC certificate since February 2008.

Including this forest concession TRC has a total of 250.000 ha forest concessions in Cameroon and has the intention to buy more concessions. Plans for the near future include achieving a FSC-certificate for all concessions in Cameroon (TRC, 2008c). Production of biodiesel should take place in and around the forest concessions of TRC and TRC will most likely lead the production and processing of biodiesel in Cameroon.

To indicate the scale of this project: TRC's intention is to produce as much Jatropha biodiesel as needed for the operation of their own trucks and other machines (such as skidders, forwarders, etc) in Cameroon (TRC, 2008a). Table 1 shows an overview of diesel consumption of TRC from 2005 until 2008 (Sprangers, 2008b). The table shows a clear trend in diesel consumption, therefore TRC was asked to verify whether this trend would continue for the next years. According to TRC (2008b) this is strongly dependent on whether TRC will obtain more forest concessions and for now there is no clear answer to this. After a discussion with TRC (2008b) it is concluded that further calculations will be based on two million litres of diesel a year (in Chapter 2 this will be increased until three million litres). TRC and Reef will henceforth be mentioned as TRC, since there is a large overlap between the two companies and their interest but it is TRC who will lead the operation.

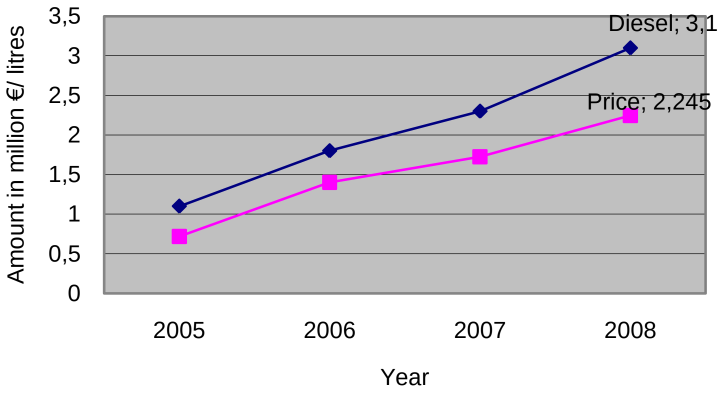

Table 1 Average diesel consumption TRC

Cameroon

The location where this project, which forms the case study for this thesis, should take place is Cameroon. Cameroon is a Western African country which was merged out of former French Cameroon and part British Cameroon in 1961. It has a population of nearly 19 million people with an average life expectancy of 53.7 years and a Gross Domestic Product per Capita of $2300. With these last two figures Cameroon belongs to the bottom 20 countries in the world (CIA, 2009). The total surface of Cameroon is just a little smaller than France and encloses all kinds of African landscapes; tropical rainforest in the southeast, mountains in the west, savannah in the middle and Sahel and desert in the north. Of the total land 12.5% is used as arable land and 2.5% is used for permanent crops. 70% of the total labour force works in this agricultural sector (CIA, 2009). According the World Fact Book (CIA, 2009) Cameroon has one of the *"best-endowed primary commodity economies in sub-Saharan Africa"* because of the good agricultural conditions and the modest oil resources.

Nevertheless it is still facing problems many developing underdeveloped countries face, like unequal income distribution, corruption and bribery which causes an unfavourable business climate (CIA, 2009).

1.2.3 Energy Capital Partners

Energy Capital Partners (ECP) is an investment company based in the Netherlands, set up by three energy and finance executives. The company aims to develop renewable energy solutions. The role of ECP is to bring together (proven) renewable energy generation technology and potential partners who are highly interested in renewable energy. ECP plays the role of project developer and financer; they have started to develop pyrolysis projects in Croatia and Romania and are now expanding into central Africa (ECP, 2008).

ECP met TRC when searching pyrolysis opportunities at Dutch timber companies. ECP took notice of TRC's idea to produce Jatropha and was willing to cooperate in this, for them unknown, new energy project. With the knowledge obtained from this project ECP is planning to set up a large (20.000-100.000 hectare) production operation in Cameroon to produce biodiesel for the commercial world market at a later stage. Both companies have no experience in Jatropha production.

1.3 Problem Statement

TRC wants to start Jatropha biodiesel production - produced by local communities in Cameroon - to replace two million litres of fossil diesel with biodiesel, but does not know whether this is possible. Will Jatropha actually grow in Cameroon? What will be the yield? Under what conditions will it be sustainable? Under what conditions is this feasible and will it be financially viable? Producing Jatropha can be done with several production models like large plantations or at a decentralised small-scale plantations using farmer' farmland. To select the best usable model these models have to be weighed according to sustainability criteria like greenhouse gas reduction and prevention of deforestation. Since there is no set of sustainability standards specifically applicable to TRC's business model which can be used to weigh the production models, this set has to be created. After selecting the best feasible production model, a calculation needs to be made to find out whether this model is financially interesting.

1.4 Objectives and Research Questions

The objectives of this research:

- *To assist TRC and ECP in their decision whether to start Jatropha biodiesel production to replace the fossil diesel consumption.*
- *To assist TRC and ECP in their decision which production model should be used.*
- *To assist TRC and ECP to find out whether this production model is financially feasible.*

The Research Question is:
Under what conditions can TRC produce three million litres of biodiesel a year, using Jatropha produced by local communities, in a sustainable manner, at an economic price?

Sub Research Question 1:

- *What are current sustainability principles and criteria used to assess biofuel projects?*

Sub Research Question 2:

- *Which criteria can be used to enable TRC to produce biodiesel in such a manner that it meets the company's sustainability goals?*

Sub Research Question 3:

- *Which production models are able to produce biodiesel in a manner that meets TRC's sustainability criteria?*

1.5 Research Methodology and Structure

1.5.1 Methodology

Research Purpose

The research reported in this thesis was carried out in response to a request for identifying European locations for pyrolysis projects which ECP had placed on the website of the School of Management and Governance of the University of Twente. After the first meeting with ECP the focus of this project started to change towards Jatropha since ECP met TRC and their ideas about Jatropha production in Cameroon, as mentioned in Section 1.2.3. Since ECP aims to develop renewable energy solutions they were also interested in this project and thus the new research question arose. In a discussion with TRC and ECP it is concluded that to answer the research question a considered production model for Jatropha plantation has to be developed. There are several production models conceivable thus a method has to be developed for a company to make a choice between the options.

Babbie (2004) has identified three purposes of research, which are exploratory, descriptive and explanatory research. Since a descriptive research describes data by means of statistics and explanatory research focuses of the behaviour of a target group, the centre of this research is an exploratory type of research. An exploratory type of research can answer questions like "what", "why" and in this case "how". Explorative studies can be used when the research goal is; to satisfy the researcher's curiosity and desire for better understanding, to test the feasibility of undertaking a more extensive study or to develop methods to be employed in any subsequent study (Babbie, 2004, p. 88). Since this research is a feasibility study and it will probably result in new questions for further research and therefore it fits the second research goal to test the feasibility of undertaking a more extensive study.

Data Collection

Exploratory research is often based on secondary data or desk research such as reviewing literature or other data, case- or pilot studies and qualitative interviews with key users (Babbie, 2004). The data for evaluating the production models will originate in sustainability standards, scientific literature, wishes of TRC, ECP and several other sources as explained below. This data will be collected via a qualitative literature reviews and semi structured interviews. Qualitative literature review is used because the goal of this research is to test the feasibility of this project and it will probably end in recommendations to undertake a more extensive study. These subsequent research questions will likely become descriptive and explanatory types of research which will be answered by quantitative literature reviews and structured interviews to get an empirical answer. This qualitative research is used to get an in-depth understanding of many disciplines. Semi structured interviews fit in an exploratory research because it is flexible, allowing new questions during the interview in response to what the expert is saying. This provides the opportunity explore the data. A structured interview with an inflexible and limited set of questions would not allow such exploration.

- Data about Jatropha and Jatropha biodiesel will mainly be found in handbooks and production manuals of Jatropha but also in scientific articles. These handbooks and manuals provide a clear and practical view on Jatropha production and its possibilities. To prevent a too optimistic view also scientific articles which strengthen or weaken these predictions have been included. Also a semi structured interview with an expert in Jatropha from the Plant Research International Wageningen is used to explore the possibilities and restrictions of Jatropha. See Chapter 2.
- Data about sustainable development and sustainability standards will be found using the words “sustainable” and “development” in online search engines such as Jstor and FindUT. Literature for the sustainability standards will be found by searching for “standards”, “principles”, “criteria” and “biofuel” in the search engines. The data will be selected based on their relevance and their applicability in this research. Sustainability Standards which are already in use, certifying biofuel chains have a priority on standards which are still in their pilot phase. And standards written for the Dutch market exceed standards for the German market since the two companies are based partly in the Netherlands. See Chapter 3.
- Data about which criteria can be used to produce biodiesel in a manner that it meets the company’s sustainability goals will be found by five qualitative interviews with TRC and ECP and by searching literature about principles and articles of influential stakeholders. Literature about the principles will be found by searching for out of the principles in online search engines such as Jstor and FindUT. Also one semi structured interview with an expert of the Max Havelaar Foundation is used to explore the possibilities and restrictions of Fair Trade production. See Chapter 4.

- Data about production models will be found by a few discussions with TRC and ECP and the principles and criteria matrix will be formed by combining the output of all the chapters. See Chapter 5.

Data Evaluation

The models will be evaluated using the customised criteria on a scale of 1-5. 5 points for best possibilities, 1 for worst, 0 point for equality. Equality occurs when the criteria are straightforward, meaning that the criterion has to be met, no matter which production model is evaluated. Commitment to long-term economic and financial viability is an example of this. Create shortest transportation distances is a criterion which varies between the production models and can be evaluated. In this case the shortest transportation distance scores 5 points and the longest scores 1 point. It will be attempted to always use the full 1-5 scale, thus 5 points for best, 4 points for second best etcetera. See Chapter 5.

It must also be considered that no sensitivity or uncertainty analysis has been performed on criteria which will be used to evaluate the production models. This means that the input of the models is subject to uncertain factors and the used criteria have not been weighed for their importance and relevance. Therefore the criteria have not been not ordered by importance and it is possible that heavy and light criteria are weighed as equal. To reduce the uncertainty of the models it is advised to perform an uncertainty and sensitivity analysis, for example as described by Saltelli et al. (2008).

Validity and Limitations

Due to the customisation of the criteria, the influence of TRC on the input of principles and criteria and the interviews only with TRC and ECP it must be considered that this study has a high internal validity but attention should be paid to this when generalising the outcomes of this research to external companies. There are choices which will be made in favour of the particular company and there will be an accent on some principles and criteria because these are of high importance of this company. This influences the outcome of this research which make it situation specific. If this research is to be used for generalisation it should be verified whether the considerations of TRC are equal for other companies. Furthermore it is also stated by Babbie (2004) that representativeness is one of the main limitations of exploratory research. Another limitation according to Saunders (2007) is that secondary data is often more general and sometimes outdated. The general aspect is neutralised due to the situation specific character of this research and since research on Jatropha is all rather recent this data will not yet be outdated.

Overview

To get a clear overview of the methodology first the keywords Jatropha and Jatropha biodiesel will be explained. Hereafter the three research questions will be clarified which includes an explanation of the words sustainable development, sustainability standards, production models and the principles and criteria matrix.

1.5.2 Jatropha Biodiesel

What is Jatropha and what are the possibilities? Information about Jatropha is mainly found in handbooks, production manuals of Jatropha and scientific articles (Achten, 2008b; FACT, 2006; Heller, 1996; Henning, 2000, 2009; Jongschaap, 2007). Since one of the articles (Jongschaap, 2007) was focussing on the possible false predictions of Jatropha productions, an appointment was made with Raymond Jongschaap of Wageningen Plant Research to discuss these predictions in the light of this research. With his help a calculation has been made to indicate a realistic prediction of the yield of Jatropha in Cameroon, see Chapter 2. To get a clear view on biodiesel from Jatropha first an introduction on the difference between biofuels and fossil fuels will be given, after which Jatropha Biodiesel will be introduced. A complete discussion on Jatropha will be given in Chapter 2.

Biofuels versus. fossil Fuels

The most familiar form of biomass, which has been used since man discovered fire, is wood. Biofuels are refined biomass, but what are biofuels actually and what is the difference with “normal” fossil fuels? The difference between the two types of fuel is mainly the time expired between the carbon fixation and emission. Fossil fuels are derived from biological material which fixated carbon, died and converted into (fossil) fuel millions of years ago. The fuel we derive from it now emits “long forgotten” carbon which was out of the carbon cycle for millions of years. Biofuels are refined biomass which is derived from biological material which has fixated carbon recently and died recently. The fuel we derive from it now emits carbon which is still in the current carbon cycle. In other words biofuels fixates and emits carbon from the current carbon cycle, so the amount of new carbon emission is zero compared with the current carbon cycle. Carbon emission from fossil fuels releases carbon from an old carbon cycle, thus carbon emission today is a 100% increase compared with the current carbon cycle.

The increased interest for using biofuels is driven by several global factors such as the decreasing amount of oil stock, causing increased oil prices, which then drives the need for an increased energy security. Another factor biofuels getting much more attention is the subsidies provided by the government. In addition, one of the sustainable development goals is reducing greenhouse gas emission which could be reached by reducing the need for fuel or by replacing fossil fuels with biofuels. In general it is stated that biofuels emit less greenhouse gas compared to fossil fuels.

Whether biofuels emit zero new carbon depends heavily on many factors. Even if you exclude all emission caused by transport and processing, because this is also needed at the fossil version, biofuels still need to be produced somewhere. When this production plant itself causes carbon emission, due to removing forest, adding fertilizers etc., the carbon emission of this biofuel will become larger than 0% compared with the current carbon cycle. But when this percentage stays below 100% compared with the current carbon cycle there is still a reduction of carbon emission by biofuel compared to fossil fuel.

Thus there is an increased interest in biofuels due to several factors and in general it is stated that biofuels emit less carbon compared to fossil fuels. The real reduction however is still being contested and still needs to be calculated.

Jatropha Biodiesel

There are two types of biofuels, bio-ethanol and biodiesel. The difference between these is that bio-ethanol is an alcohol made by fermentation of starch crops like corn. For biodiesel there are several types of feedstock - think of animal fat, soybean, rapeseed, sunflower, palm oil, algae and Jatropha. Some of them are more familiar than others and this is caused mainly because some of this feedstock gets (negatively) in the news now and then. Many people know the stories of palm-oil from Indonesia where giant areas of rainforest are erased to produce palm-oil. Although palm-oil is mainly used for products other than biodiesel (food, cattle feed, cosmetics) this production method is still not favourable to produce biodiesel. Another familiar news item is biodiesel plantations which are placed on fertile ground, thus preventing the production of food on these areas - needless to say these production methods are both unfavourable.

To the general public Jatropha is a less familiar crop which has some interesting characteristics. Jatropha can grow on less fertile ground and has some erosion preventing qualities. It produces inedible seeds that contain up to 40% oil. These seeds can be pressed and the oil can almost directly be used as fuel in modified diesel engines or can directly be used after processing in standard diesel engines. After pressing a seedcake remains which can either be used for local applications like fertilization, or can be processed into biodiesel (Achten, 2008b; FACT, 2006; Henning, 2000; Jongschaap, 2007). Thus for Jatropha there is no need to erase giant areas of rainforest or to produce it on fertile ground. These characteristics caused that Jatropha gained a lot of interest from biodiesel producers. Chapter 2 will give an elaborate description of Jatropha.

1.5.3 SRQ 1: What are current sustainability principles and criteria used to assess biofuel projects

To answer the first sub research question first the definition of sustainable development should be clear. To clarify the history and the definition, several scientific articles, institutes, and outcomes of conferences are used. These articles have been found using the words “sustainable” and “development” in online search engines such as Jstor and FindUT. But a definition of sustainable development does not provide us the answer what “in a sustainable manner” is. Thus after sustainable development it is needed to get a clear view on sustainability standards because these standards provide criteria which can be used to produce things in a sustainable manner. The literature for the sustainability standards will be found by searching for “standards”, “principles”, “criteria” and “biofuel” in the standard search engines. In the Netherlands the most familiar standard is the Cramer Criteria whose main goal was to formulate criteria for production of biomass and the processing of biofuels, not discriminating between origins - whether the origin of this biomass was the Netherlands, the EU or outside the EU. When you search for sustainability standards you will finds lots more standards like the Roundtable of Sustainable Biofuels (RSB, 2010), Roundtable on Sustainable Palm Oil (RSPO, 2007) and the Gold Standard (Gold-Standard, 2009). There appear to be dozens of sustainability standards written for biofuels since the 1990s. Since 2005 this work started to focus on sustainability standards especially for biofuel purposes (Partners-for-Innovation, 2010). An evaluation of the several sustainability standards and which will be used and which will not can be found in Chapter 3. First an introduction will be given in the topics sustainable development and sustainability standards.

Sustainable Development

The concept of “sustainable development” is recognised by the general public and we know we “need” it because we read it in the newspapers and hear it on the radio. But what is sustainable development, why do we need it, where does this need come from, and what does it really mean?

The International Institute for Sustainable Development (IISD) provides a clear indication of why we need sustainable development. IISD states that we should see the world as two systems: one system that connects space and another that connects time (IISD, 2012). In the space system you could understand that air pollution in for instance North America can affect air quality in Indonesia and insect spray used in Bulgaria could affect fish stocks in the Atlantic Ocean. In the time system you could understand that production methods of our grandparents have an impact on production models nowadays and our use of oil today could result in the lack of oil for next generations. The concept of sustainable development is rooted in this sort of systems thinking (IISD, 2012).

Thus the need for sustainable development comes from our better understanding of space and time, but this still does not provide us with a clear definition of sustainable development. Ciegis (2004) stated that *"Although the essence of the concept of sustainable development is clear enough, the exact interpretation and definition of sustainable development has caused strong discussions"*. Therefore Ciegis et al. (2009) have tried to get a clear definition of sustainable development and analysed hundreds of sustainable development definitions. They concluded that none of these definitions included all the aspects of the concept. Ciegis et al. (2009) as well as Hopwood et al. (2005) conclude that the best definition is provided by the book "Our Common Future" of Brundtland: *"Sustainable development is the development that satisfies the needs of the current time period without jeopardizing the ability of future generations to satisfy their needs"* (Brundtland, 1987). Thus, nowadays we are aware that the way we produce does not only affect the small environment around us, but the entire world and not only today but also in the nearby and distant future. Therefore we must think of producing in a way that is better for the environment for us and for next generations.

The concept of sustainable development is not something new and it has a long history. DEFRA (2012) (the UK Department for Environment, Food and Rural Affairs) had summarized this in a very brief history of sustainable development. The concept of sustainable development originates in the post-war environmental movement, which already identified negative impacts of human population growth and development on the environment and communities. Nevertheless, it was not until 1972 that the Club of Rome tried to model the consequences of a growing human population in a world of finite resources. They concluded that the current patterns of growth cannot be sustained indefinitely. Due to the United Nations Brundtland Commission in 1987, the term sustainable development became familiar (Ciegis, 2009; DEFRA, 2012; Hopwood, 2005). The concept of sustainable development received more attention when the United Nations organised the Conference on Environment and Development in Rio de Janeiro in 1992. During this conference the first steps were made to develop international strategies for sustainable development. During this conference there where representatives of over 300 national governments, heads of states and representative organisations. Never before there had been a larger gathering of national leaders about environmental issues. At this conference governments around the world committed to sustainable development. One of the outcomes was also a global agreement for a set of forest management principles which resulted in the establishment of the FSC.

During the next UN conference related to the environment, the World Summit on Sustainable Development in Johannesburg in 2002, there were again major outcomes in favour of the environment. These goals include targets on modern energy services, increasing energy efficiency and the use of renewable energy, reducing biodiversity loss on land, chemicals management and achieving sustainable patterns of consumption and production.

The output of these several agreements, commissions and conferences has formed the basis for countries to create their own path to the sustainable development goals. In June 2012 the fourth Earth Summit (Rio+20) took place in Rio de Janeiro, Brazil. This meeting has become the next milestone in the history of ongoing international effort to achieve sustainable development globally. The results of this gathering cannot be included in this research since these had not yet been published at the moment of writing.

Sustainability Standards for Biofuels

Sustainability standards or sustainability guidelines for biofuels are national or international agreements on how to produce, transport and process biofuels. Most of the time these standards deal with environmental, social, ethical and food safety issues. A comparison can be made with the FSC quality mark on wood and wooden products. The FSC mark can help wood buyers to select suppliers who are “environment friendly”. Another famous example is Fairtrade products. These two standards are more or less comparable with sustainability standards on biofuels.

Sustainability standards came into existence due to the lack of local, national and international legislation and the demand of customers and Non Governmental Organisations (NGO) for some sort of certification. For this reason a relatively small Dutch foundation started a standard for coffee beans. Max Havelaar certified coffee beans from Mexican coffee farmers since they called for help. These farmers stated that: *“Giving us help is nice, but giving us a fair price for our coffee beans is even better! Then we don’t need to beg for help anymore”* (MaxHavelaar, 2008). After Max Havelaar this initiative has been adopted by a large group of NGO’s (MaxHavelaar, 2008). Nowadays there are national standards which set criteria for using biofuels for the Dutch market. There are international standards which focus on the production of palm oil and standards which discuss biofuels in general. There are standards that focus more on the environment and there are those that focus more on the society.

These standards will be evaluated for their applicability to TRC’s requirements, those that match these requirements will be combined in a matrix. All these standards contain a list of principles and criteria. A principle is more the general regulation: “less greenhouse gas emission” and the criterion is a measurable rule like: “emit 50% less greenhouse gas during the lifecycle”. One of the main inputs for the matrix are the principles and criteria resulting from these sustainability standards, see Chapter 3 for the complete discussion.

1.5.4 SRQ 2: Which criteria can be used to enable TRC to produce biodiesel in a manner that it meets the company's sustainability goals?

To answer the second sub research question the matrix of the previous section will be used as an input. This matrix will be combined with the input of the introduction chapter about Jatropha. The next step is to obtain principles and criteria developed by means of other sources. These principles and criteria should not only ensue from scientific articles, but also from the companies' principles and articles of stakeholders. These stakeholders can be very influential and TRC already experienced this twice. The first time the Dutch "Milieu Defensie" started the campaign "Kappen met Kappen" in the Netherlands. This campaign wanted to stop deforestation and looting in tropical areas and brought the role of the Dutch forest industry under public attention (TRC, 2008a). The second time Greenpeace published an article (Greenpeace, 2003) where they accused TRC of illegal logging (what appeared to be a wrong measurement and mistakes in the land register (according to TRC (2008a)) and of not being as environmentally and socially responsible as TRC wants their customers to believe.
Both campaign and article had a negative impact on the customers of TRC (TRC, 2008a) and TRC noticed this by negative feedback during sales meetings. Also the demands of the FSC, another stakeholder, should be included, the outcomes of this research can never be in contradiction with the FSC principles.

After the matrix is filled with these principles and criteria (see Chapter 3 and Appendix 1) it needs to be customised for the specific situation of TRC in Cameroon. Information has to be found about the benefits for the people who will have to cooperate in this project, and whether these benefits can have a positive or negative impact on the environment. It is of course imaginable that benefits for people can have a negative impact on the environment, and vice versa. For instance, a farmer who deforests for a larger Jatropha plantation earns more money, but damages the environment. According to TRC some principles need more attention than others, for instance to prevention of deforestation, and therefore these get some extra attention in customising the criteria. These principles are one by one discussed by means of scientific literature found by searching for keywords in scientific search engines, see Chapter 4 Sustainability Principles and TRC.

1.5.5 SRQ 3: Which production models are able to produce biodiesel in a manner that meets TRC's sustainability criteria?

The final step is to answer sub research question three which uses the customised criteria to evaluate the production models. This sub research question is answered first by identifying the possible production models and then to evaluate these based on the customised criteria. Several production models will be made by means of brainstorming with TRC and ECP. Farmers for example could use a small part of their farmyard for Jatropha production or even or just as hedge. Picking the fruits or processing the oil can be done individually or by means of corporations. Maybe large plantations would be interesting, with local communities supplying employees. All the possible and plausible production models have to be assessed and these models will be evaluated. After this evaluation the financial consequences of these production models have to be assessed since TRC also stated as one of their criteria that the project should be at an economic price. See Chapter 5 and 6 for an elaborate discussion.

1.5.6 Analytical Framework

This research will not go into detail about the biological (im)possibilities of Jatropha in Cameroon. Thus questions about plagues and diseases, soil composition, how many nutrients are taken away by Jatropha and how much manure is needed will not be answered in this research. This research will also not go into detail to much about the social impact on the rural population, which does have to be assessed. This research is set up with a business management point of view and will mainly focus on the business conditions to find out whether this project is feasible.

1.6 Research Structure

The research structure is as follows: first of all an introduction in Jatropha is given, followed by the sustainability standards which will be weighed for their contribution to this thesis. The chosen standards and their principles and criteria will be placed in a matrix. These principles and criteria matrix will be weighed and customised for the specific situation of TRC in Cameroon and this matrix will be used to evaluate the different production models.

Before starting the overall evaluation there is a profit analysis in which the costs of the several production models will be calculated. It is logical that different production models are linked to different costs. This financial evaluation should not influence the choice of production model to a large extent, because the other criteria are infinitely more important. But these costs could be decisive in the final evaluation and it can indicate the feasibility of the project, since TRC set a precondition that this project should not cost more than the current situation.

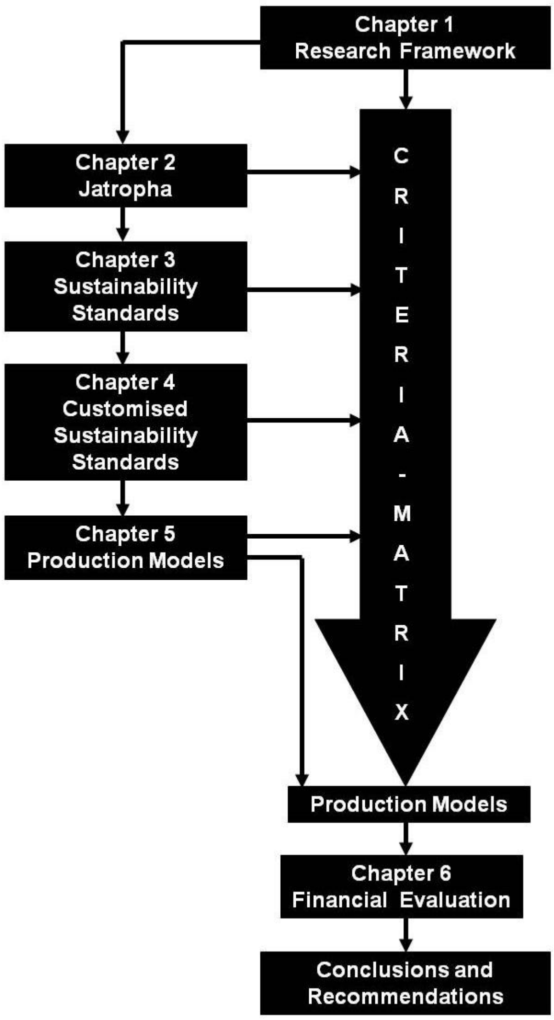

Figure 1: Schematic representation of research structure

Finally the evaluation will be described. All different production models will be weighed against the collected criteria from previous chapters. This way we can evaluate every production model on the criteria of the crop Jatropha, on benefits for farmers and impact on the environment, production characteristics and finance. This results in one production model and the circumstances under what conditions TRC can produce three million litres of biodiesel a year, using Jatropha produced by local communities, in a sustainable manner, at an economic price? See figure 1 for a schematic representation of the research structure.

2 Jatropha

As mentioned in the introduction it is critical to become familiar with the characteristics of the Jatropha crop. First an introduction in the biological characteristics will be given, followed by what these characteristics mean to the user of this crop. After that we will look at different literature written about Jatropha and the jeopardy of optimistic articles and books. Then a best as possible prediction of the yield of Jatropha in the specific area in Cameroon will be given. This prediction will be used for further calculations in this research. Finally the criteria to utilize the Jatropha characteristics at the utmost will be summarized and will be used as input for the principles and criteria matrix.

2.1 Characteristics of Jatropha

The name Jatropha is derived from the Greek words “jatrós” (doctor) and “trophé” (food), this implies medicinal uses of the Jatropha crop (Henning, 2009). Dependant on the cultivation method, Jatropha will become a drought resistant tall bush or small tree of up to six metres high which can grow on marginal soil with low nutrient content (FACT, 2006; Henning, 2000; Jongschaap, 2007; Nyamai, 2007). Jatropha is not a weed, thus it is not self propagating and has to be planted (Henning, 2000).

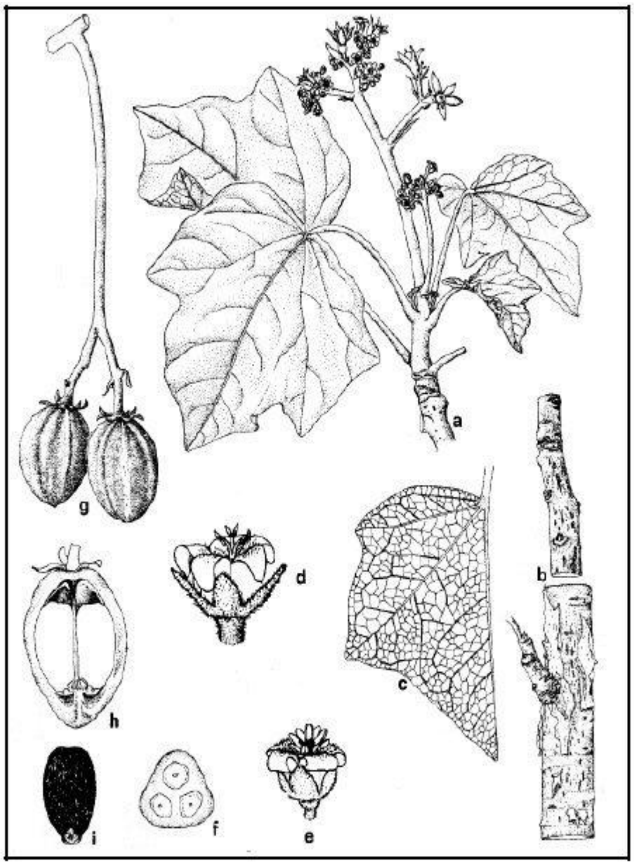

Figure 2: Important parts of the physic nut (Jatropha Curcas L): a) flowering branch, b) bark, c) leaf veins, d) pistillate flower, e) staminate flower, f) cross-cut of immature fruit, g) fruits, h) longitudinal cut of fruits. A, b, c, f and h (Aponte Hernandez, 1978), d and e (Dehgan, 1984); in (Jongschaap, 2007).

The lifespan of Jatropha is more than 50 years when established from seeds, when established from cuttings the lifespan is reduced to 10-15 years (Nyamai, 2007). Normally Jatropha develops one taproot and four lateral roots. Crops from cuttings do not develop a taproot (Henning, 2000). This taproot makes Jatropha a good erosion preventive shrub. After about three to five years Jatropha is at full production capacity and produces fruits that have an *“American Football type of shape of 40 mm length, each containing three seeds (on average), which look like black beans of 18 mm long (11-30) and 10 mm wide (7 – 11)”* (Henning, 2000, p. 2). See figure 2.

The seeds are literally and figuratively the core of this research. They contain more than 30% of oil by weight (FACT, 2006; Henning, 2000; Jongschaap, 2007; Nyamai, 2007). Yield figures given in literature vary from 300g to 9 kg per tree per year, meaning 1.5-7.8 tons of dry seed per hectare per year (Henning, 2009; Jongschaap, 2007). The fruits, seeds and leaves are inedible and therefore Jatropha is traditionally used as living fence because it is not browsed by most animals (Henning, 2000; Jongschaap, 2007). Due to the toxicity of Jatropha leaves some attention should be paid to human health (Achten, 2008a) although the toxic component Phorbol Ester digests in six days (Rug, 2000). The Jatropha crop itself as well as the revenues, which have a positive impact on the user, are indicated in figure 3 on the next page. Because this research will not go to much in to detail about the biological characteristics, only a quick list of features will be summed up here. Criteria will be developed to utilize these characteristics at most. These criteria will be discussed in Chapter 4.

2.1.1 Benefits Jatropha crop

Water conservation/ erosion control

Much literature (FACT, 2006; Heller, 1996; Henning, 2000; Jongschaap, 2007; Kiefer, 1986) mentions the advantages of water conservation and erosion control. This is caused by the taproot and the several lateral roots of Jatropha (Henning, 2009). The lateral roots, which are growing near the surface, protect the soil against erosion by runoff water after heavy rainfall (Henning, 2009). Also the shadow from the Jatropha leaves protect the soil from erosion and desertification (Jongschaap, 2007). The impact of water conservation improvement differs at different soil structures, thus real improvement can only be measured from a site specific perspective.

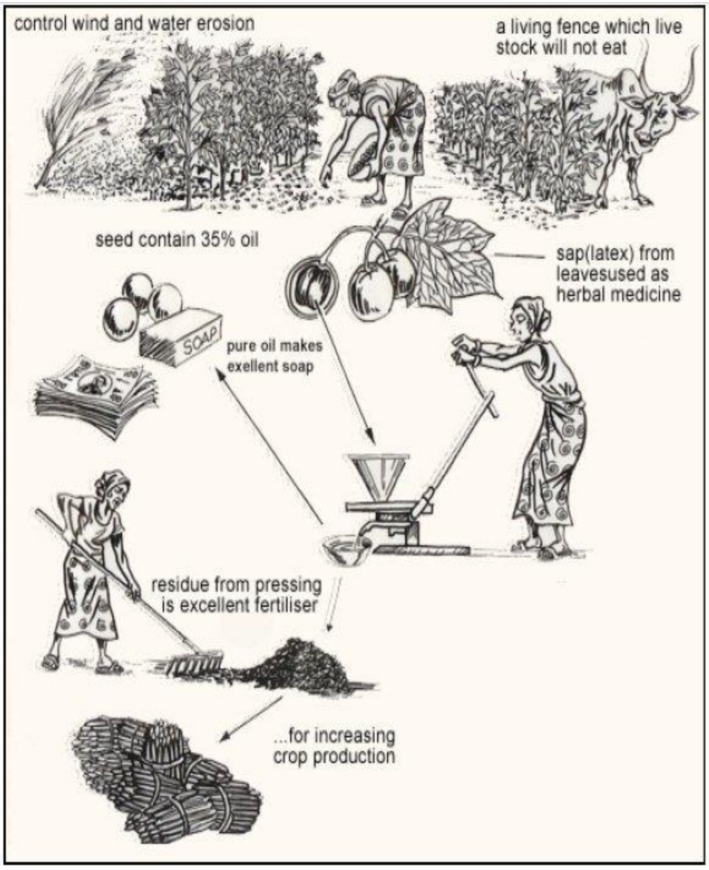

Figure 3: Indication of different uses of Jatropha (Jongschaap, 2007).

Hedge/ living fence

In addition, the use as hedge or living fence is mentioned by many researchers (FACT, 2006; Heller, 1996; Henning, 2000; Jongschaap, 2007; Kiefer, 1986). Due to the toxicity aspect of the leaves cattle will not browse Jatropha (Heller, 1996). These living fences will protect other plants from being eaten by cattle (FACT, 2006; Heller, 1996).

Soil improvement

When grown from seeds instead of from cuttings, Jatropha crops develop a taproot as mentioned before. This taproot reaches deep into the (marginal) soil and transports minerals to the plant. When leaves and fruits fall off and decompose, these minerals will be replaced at the surface (Henning, 2009). This results in a recycling system of nutrients from lower soil layers. A project in India demonstrated significant soil improvement after 18 months of Jatropha production. *"Macro-aggregate stability increased by 6-30%"* (Jongschaap, 2007). The impact of soil improvement differs at different soil structures, thus real improvement can only be measured from a site specific perspective.

Other

Next to the characteristics mentioned above, the Jatropha crop is also mentioned to be used as firewood/ combustibles and as green manure (FACT, 2006; Heller, 1996; Jongschaap, 2007; Kiefer, 1986).

2.1.2 Benefits Jatropha products

Fruit

The fruits themselves can be used as fertilizer (FACT, 2006; Heller, 1996; Jongschaap, 2007; Kiefer, 1986).

Fruit coat

The fruit coat is all the fruit around the seeds, which equals 30% of the total fruit weight (Jongschaap, 2007). This fruit coat is also used for medicinal purposes and has anti inflammatory substance (Jongschaap, 2007), but more often the use as fertilizer is mentioned (FACT, 2006; Heller, 1996; Henning, 2000; Jongschaap, 2007; Kiefer, 1986).

Seeds

Complete seeds can be used as insecticide or as fodder (Jongschaap, 2007).

Seed shells

Jatropha seeds are covered in a seed shell, these have to be removed before pressing (Henning, 2009). These shells can be used as combustibles or as organic fertilizer (Jongschaap, 2007).

Press cake

After the process of pressing the seeds a press cake remains. This press cake also has several purposes and all previously mentioned research highlights the utilisation as organic fertilizer (FACT, 2006; Heller, 1996; Henning, 2000, 2009; Jongschaap, 2007; Kiefer, 1986).

When using this fertilizer on Jatropha plantations or other crop plantations, yields will increase.

According to Henning (2000) one ton of Jatropha press cake fertilizer compares to 200 kgs of mineral fertilizer. FACT (2006) describes a project on the output of pearl millet where the effects of (5t/ha) Jatropha press cake was compared with (5t/ha) manure and (150kg/ha) mineral fertilizer and a control group with no fertilisers . The yield per hectare was 630 kgs for the control group, 815 kgs for manure, 1366 kgs for press cake and 1135 kgs for mineral fertilizer. Besides fertilizer all researchers mention the use of press cake as input for biogas production. To a smaller extent the use as input for charcoal production (FACT, 2006; Heller, 1996; Kiefer, 1986) the use as fodder (Jongschaap, 2007) or the use as insecticide (Henning, 2000) are mentioned.

Seed oil

The seeds can also be pressed which results in Jatropha oil. This can be used for instance for soap production, since *“Jatropha oil gives a very good foaming, white soap with positive effects on the skin, partly due to the glycerine content of the soap”* (Henning, 2000). Also the other articles mention soap production as an economically viable purpose (FACT, 2006; Heller, 1996; Henning, 2000; Jongschaap, 2007; Kiefer, 1986). Besides soap production Jatropha oil can also be used as insecticide (Jongschaap, 2007), can have medicinal uses (FACT, 2006; Heller, 1996; Jongschaap, 2007; Kiefer, 1986) or can be used as fuel in lamps (Henning, 2000). Last but definitely not least Jatropha oil can be used to produce biodiesel, the main topic of this research, which is probably the most cited end-use.

2.2 Jatropha in Cameroon

This section examines whether Jatropha will actually grow in the particular part, around the forest concessions in Cameroon. When it does it needs to be ascertained what the yield will be in his area. The first chapter concluded that two million litres of biodiesel are needed for this project, therefore it needs to be calculated how many hectares of plantation are needed to produce this.

2.2.1 Does Jatropha grow in this area?

According to the Handbook on Jatropha Curcas (FACT, 2006), Jatropha will grow in Cameroon. They state that*: “Jatropha is a succulent that sheds its leaves during the dry season. It is best adapted to semi-arid conditions (it is not found in the humid (moist) regions), where grassland-savanna (cerrado), or thorn forest shrub and caatingas vegetation prevail naturally”* (FACT, 2006). Henning (2009) on the other hand states that Jatropha does grow in the tropics and subtropics. Jongschaap (2007) elucidates these different opinions and states that Jatropha will grow in semi-arid conditions, and soil structure will significantly increase. However, under these circumstances Jatropha has not proven to be commercially successful.

Therefore tropical or subtropical climate with rainfall above 600 mm a year and a high average annual temperature (20-28 degrees Celsius) (FACT, 2006; Henning, 2000) will increase the yield of Jatropha and makes it possibly economically successful. The average rainfall in this area in Cameroon is above 2500 mm a year (Sprangers, 2008a).

2.2.2 Theoretical Yield Jatropha

A great volume of literature has been written about the positive claims of Jatropha being a high oil yielding crop. But these claims seems to have emerged from incorrect combinations of unrelated observations (Jongschaap, 2007). Achten (2008a) has reviewed these articles and gives *“an overview of the currently available information on the different process steps of the production process of biodiesel from Jatropha, being cultivation and production of seeds, extraction of the oil, conversion to and the use of the biodiesel and the by-products”* (Achten, 2008a, p. 1063). The main conclusion was that *“JCL is still a wild plant of which basic agronomic properties are not thoroughly understood and the environmental effects have not been investigated yet”* (Achten, 2008a, p. 1063).

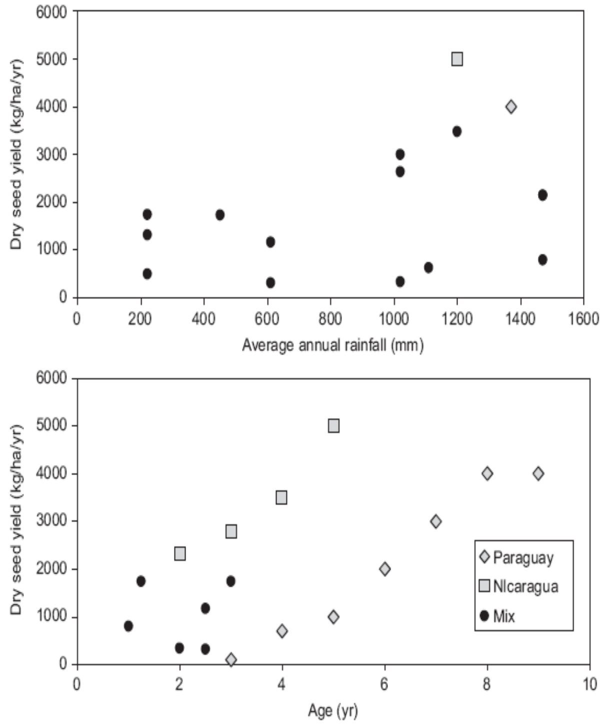

Figure 4: Yield of Jatropha based on average annual rainfall and age of the plantation (Achten, 2008a).

The main missing research is about the cultivation of the crop which is indicated in the graphs alongside, showing the average yield of Jatropha all around the world. As can be seen, there is no consistent prediction about the yield of Jatropha based on these indications. The different yields can be caused by seed selection methods, seed background, vegetative or generative propagation, production method, cultivation situation etc. Next to the questions about yield of Jatropha the article of Achten (2008a) also finds it difficult, based on available information, to conclude whether Jatropha biodiesel will *“meet the two essential minimum requirements for biofuels to be a more sustainable alternative for fossil fuels (i.e. (i) produced from renewable raw material and (ii) their use has a lower negative environmental impact)”* (Achten, 2008a, p. 1079).

2.3 *Calculated yield Jatropha*

Without an indication of the yield of Jatropha plantations in Cameroon it is very hard to continue this research. Therefore contact was made with several researchers in Cameroon who provided information about average rainfall, sun radiation, temperature, wind speed and evaporation (Ministry-of-Foreign-Affairs, 2008; Sprangers, 2008a).

With these data Raymond Jongschaap of Wageningen Plant Research is contacted because he can translate these data into potential biomass production in Cameroon.

On the next page you will find the biomass production estimates for Cameroon, see figure 5. These estimations are based on gridded data (FAO, 1995) and 30 years (1961-1990) average climate reference data (Mitchell, 2004) and an accumulation of a maize (C4) simulation model (multiple cropping seasons) (Jongschaap, 2008). In order to translate the biomass production into Jatropha oil, Jongschaap (2007) states that 25% of biomass is converted into wood (stems, branches), 25% into leaves and 50% into fruit. Of this fruit proportions are: 30% fruit coat, 70% seed. Thus 35% of biomass production is converted into seed. An average oil content of 35% in the dry seed is assumed. The last step is to press the oil out of the seed, which can be done in a range of 70% - 91%. This could be up to 99% with chemical extraction. Jongschaap (2007) calculates with 85% press efficiency.

The second map (right) shows the predicted “water limited biomass production” which includes the possibility of some water, nutrient or biotic stress. Because there has to be done some further research to clarify these factors the calculation will be based on the water limited biomass indication. The FSC forest concession of TRC is positioned within the red circle and it shows that the colours in the circle match with an average yield between 25 and 35 ton per hectare. For calculation purposes the average of an annual yield of 30 tons of biomass per hectare is used.

Calculated:

- 30 tons of biomass is 10.500 kg Jatropha seed per hectare (35% harvest index)
- 10.500 kgs of seed per hectare is 3675 kgs of oil content (35%)
- 3675 kgs of oil content is 3124 kgs of pressed oil (85% press efficiency)
- 3124 kgs of pressed oil is 3395 litres per hectare (0.92 oil density)
- Two million litres of diesel / 3395 litres per hectare = 589 ha plantation needed

To include some margin, further calculations will be based on 3.000 litres of Jatropha oil per hectare plantation, meaning 667 hectare plantation Jatropha is needed. These figures were presented to TRC and in accordance with the company, further research will be based on 1000 hectares of Jatropha plantation. The reason for this is the growing diesel consumption of TRC, the uncertainty of the actual yield and the consideration that overproduction can easily be sold (TRC, 2008b). 1000 hectares of Jatropha is assumed to yield approximately 9.277 million kgs of Jatropha seeds, which equals about 3 million litres of biodiesel annually.

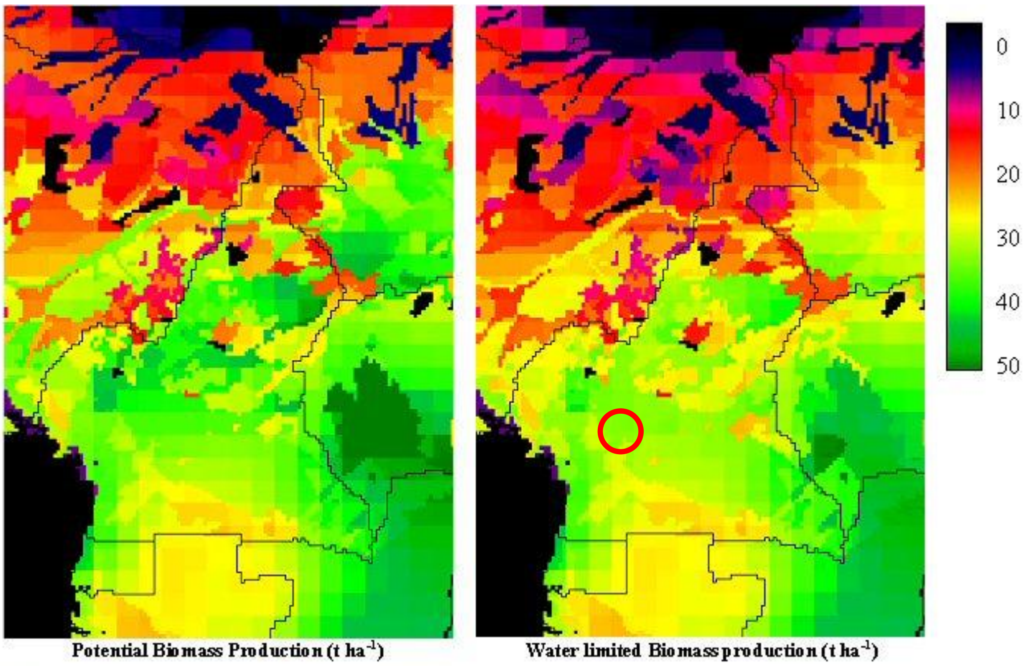

Figure 5: Estimated Biomass Production Cameroon (Jongschaap, 2008)1 in tonnes per hectare per year. Forrest concession of TRC and presumable project location is within the red circle, showing around 30 tonnes of biomass/ha/y is estimated.

2.4 *Important Remark Yield*

The indication above is a calculated and expected indication of the yield of Jatropha in Cameroon. These data should be verified further to make sure they are correct. This could be done by comparing the yield with existing plantations in the same area in Cameroon. This will give the most accurate indication. When there is no comparable plantation available, it will be necessary to start a trial plantation in this area. These verifications should provide the real yield of Jatropha in the presumable location in Cameroon.

Next to the yield there are some other facts that need further research. These facts are too detailed and biological to put in this Business Administration thesis, but are very important when TRC is starting plantations. The answers to these questions should be given by specialists working in this area. These questions involve (Jongschaap, 2007):

- Which plagues and diseases are threats for Jatropha in Cameroon?
- Nitrogen is scarce in tropical areas. Low nitrogen will impede the photosynthesis and consequently the growth of the fruit. How does this affect the harvest per hectare of the plantation? How can we evaluate and solve this?
- How much nutrients are taken away by the Jatropha fruits and how much manure is needed?

[1] *Disclaimer: This study is a concept-methodology in development, which may only be used as a demonstrator in the M.Sc. report of Jeroen van Alphen, University of Twente, the Netherlands. Plant research International will not take any liability for other use of this information. The original author (Raymond Jongschaap; raymond.jongschaap@wur.nl; T +31 317 413047) should be contacted in case of further use.*

2.5 Criteria to be used: Jatropha

This chapter has given a botanical description and has shown the advantages of the use of Jatropha. These advantages should be included in the set of criteria to evaluate the production models. To restrict the boundaries, this research will limit the use of Jatropha to the most mentioned and most feasible purposes. These are:

- The opportunity to utilize some or all of these characteristics.
    - To use the Jatropha crop for possible water conservation.
    - To use the Jatropha crop for possible erosion control.
    - To use the Jatropha crop as hedge/ living fence.
    - To use the Jatropha fruit coat as fertilizer.
    - To use the Jatropha seed shells and press cake as combustibles or as fertilizer.
    - To use part of the Jatropha oil for soap production.
    - To use part of the Jatropha oil for small scale energy production (lighting).
- The necessity to use the seed oil for biodiesel production.

To prevent this research from being infected by the most optimistic research available, a specific calculation has been made to predict Jatropha oil yield per hectare in the specific area in Cameroon. This calculation concluded that 667 hectares of Jatropha plantation are needed to produce two million litres of Jatropha biodiesel. In accordance with TRC the total research plantation area is increased to 1000 hectares. That will be the figure for further calculation. 1000 hectares of Jatropha means approximately three million litres of biodiesel a year. These data should be verified to make sure they are correct by comparing the yield with existing plantations in the same area in Cameroon or to start a trial plantation in this area.

3 Sustainability Standards for Biofuel

This chapter will answer the first sub research question: *"What are current sustainability principles and criteria used to assess biofuel projects?"*

As mentioned in Chapter 1 there are a lot of sustainability standards which certify biofuel industries. These standards are all including a list of principles and criteria. There is a large overlap among these principles and criteria but there are also some differences. To create a complete as possible set, the most important, and for this project specific, principles and criteria will be combined in a matrix. First a shortlist of applicable standards will be selected and than weighed against their relation with Jatropha production in Cameroon. After that this shortlist will be expanded with other principles from literature and stakeholders because of their specific influence on the situation. These principles and criteria are placed in a matrix, see Appendix 1, and expanded with input from the previous chapter about Jatropha and the demands of TRC. This matrix will be used as a basis to evaluate the several production models to produce biofuel without facing the problems mentioned in Chapter 1.

3.1 Shortlist Sustainability Standards

To define which sustainability standards to use the article of Partners for Innovation (2010) is used as a starting point. Partners for Innovation is a Dutch consultancy company for sustainable innovation with an expertise in sustainable biomass. In their selection of sustainability standards for pilot assessments of Jatropha producers in Mozambique, they identified and reviewed 44 sustainability standards. Out of these 44 standards Partners for Innovation (2010) has subtracted 11 most important and relevant standards because of their direct link with sustainable production of Jatropha. The selected standards are (Partners-for-Innovation, 2010):

1. **DE-ISCC:** The International Sustainability and Carbon Certification System: German-based but internationally oriented system for the certification of biomass and bio-energy. Open for certification since January 2010.
2. **EU-RED:** Renewable Energy Directive: key mandatory legislation in the EU that currently sets the reference in the international biofuel market.
3. **INT-CDM:** Clean Development Mechanism: established carbon-offset scheme that may enable Jatropha producers to have an additional income through emission reduction certificates.
4. **INT-COMPETE:** Good Practice Assessment for Bio-energy Projects: simple methodology aiming to have a balanced set of criteria that are important for both developed and developing worlds.
5. **INT-GS:** Gold Standard: established carbon offset scheme for voluntary offset projects and CDM projects. Compared with CDM it includes additional environmental and social criteria.

6. **INT-RSB:** Roundtable on Sustainable Biofuels: key voluntary sustainability certification scheme for biofuels that is developed in consensus by a large variety of stakeholders.
7. **INT-RSB / Jatropha Working Group:** Feedstock specific standard for Jatropha production that has been elaborated within the RSB.
8. **INT-RSPO:** Roundtable on Sustainable Palm Oil production: voluntary certification scheme for another feedstock that is in operation since two years and that is a qualifying standard within RTFO.
9. **NL-Cramer Criteria:** Framework underlying NTA8080.
10. **NL-NTA8080:** Netherlands Technical Agreement 8080: comprehensive biomass-specific standard against which certification can take place.
11. **UK-RTFO:** Biofuel Sustainability Meta-Standard: UK reporting scheme for biofuels which is operational since April 2008. Includes carbon, environmental and social requirements.

3.2 Research Specific Standards

Since not all of these standards are equally important for this research, as will be explained in section 3.3, the following standards of this shortlist will be used.

3.2.1 Cramer Criteria

To assure sustainable development of biofuel Dutch government wants to write sustainability criteria in relevant policy instruments. On the short term this influences Dutch subsidy schemes for electricity production and transport-biofuels. In the long term Dutch government wants a broader effort of this criteria like chemistry (Cramer, 2007). In preparation of this policy, Dutch government established the project group “Durable Production of Biomass” under the management of prof. dr. Jacqueline Cramer, from 2007-2010 Minister of Space and Environment, who was chairwoman of this project group. Goal of this project group was formulating criteria for production and processing of biomass, not discriminating whether the origin of this biomass is the Netherlands, the EU or outside the EU.

The project group constantly consulted the several parties involved to create a broad and solid basis, and also tried to create as much comparison as possible with other initiatives in the EU (Cramer, 2007). The report “Durable Production of Biomass” more familiarly known as the “Cramer Criteria” describes the testing framework for sustainable biomass as produced by the project group. According to Energieportal, a news site focused on alternative energy, this report contains the most progressive vision in the world about how we should make future energy flows, based on plants and trees, sustainable and durable. This report is signed by de Rabobank, Shell, Electrabel, Essent, OxfamNovib, Cargill and others (Energieportal.nl, 2007). These Cramer Criteria where published at the start of this project.

Since TRC is a company partly based in the Netherlands and the idea of ECP is to upscale the Jatropha project and export biodiesel for the commercial (Dutch) market, these criteria will be used as the foundation for the total set of criteria. The Cramer Criteria are the framework underlying NTA 8080 and therefore it would be more logical to use the NTA 8080 because it is an biomass-specific standard against which certification can take place but the European Commission has not recognised the NTA 8080 until August 2012.

3.2.2 The RSB and RSB Jatropha Working Group

The Roundtable on Sustainable Biofuels (RSB) and the RSB Jatropha Working Group (they use the same criteria) is a rather new international standard that brings together a large variety of stakeholders. These stakeholders vary from farmers to governments and from fuel blender to NGO. The RSB has developed third-party environmental, social and economic principles and criteria to ensure sustainability of biofuels production and processing. The RSB has created these principles and criteria through an open, transparent, and multi-stakeholder process. The RSB principles follow the ISEAL Code of Good Practice for Setting Social and Environmental Standards (RSB, 2010). Last year the European Union *"recognized these principles and criteria as a way to demonstrate and document compliance with the EU biofuels mandate"* (RSB, 2012b).

At the start of February 2012 the first company is certified in accordance with the RSB Global Sustainability Standard. This company (Shoalhaven Starches Pty Ltd, part of the Manildra Group, Australia) successfully achieved certification for its production facility at Bomaderry, Australia, where ethanol is produced from waste starch from wheat processing (RSB, 2012b). Partners for Innovation (2010) has selected the RSB as assessment methodology as the best way forward because it is biofuel-specific, it is complete, it is a practical standard for which extensive guidance is available, it aims to be really global, it covers all sustainability issues and it is anticipated to be of high importance for the biofuel sector (Partners-for-Innovation, 2010). They are added to the criteria for biofuel specific characteristics.

3.2.3 RSPO

The RSPO (Roundtable on Sustainable Palm Oil) is an international association of organizations who promote an open dialogue in the entire palm oil chain. This involves palm growers, palm-oil processors and traders, manufacturers, retailers, banks and investors, environmental and nature conservation NGOs and social and development NGOs. The production of sustainable palm oil is a combination of legal and economic feasibility, environmentally appropriate and socially beneficial management and operations. The RSPO created principles and criteria accompanied by indicators and guidance to assure this sustainable palm oil. Next to the indicators the RSPO also defines guidance for every criterion. This guidance contains useful information to help producers understand what these criterions mean in practice (RSPO, 2007).

RSPO criteria have been used for over four years and since palm-oil and the RSPO are a few years ahead of Jatropha, these indicators are used in the matrix.

3.2.4 Gold Standard

A carbon credit is a general term for the possibility to trade one tonne of carbon dioxide for money. These credits come from measurable greenhouse gas (GHG) reduction projects. For example, there are two factories, both emitting 100.000 tonnes of GHG a year. Their government stated that they both should reduce their GHG emission with 20%. Factory A is going to invest in a cleaner combustion furnace, recycle waste and reduce energy consumption which results in an emission reduction of 40%, thus they now emit 60.000 tonnes of GHG. Factory B is not going to invest (maybe because the factory will be rebuilt in 10 years) thus factory B has to buy carbon credits to reach the goal of the government. Factory A can sell 20 carbon credits to factory B. Now they both have theoretically reached the goal of reducing 20% GHG emission. Other projects where carbon credits can come from are replacing the use of fossil fuels with renewable energy, reducing the use of fossil fuels through energy efficiency or capturing and storing already released carbon in trees and other plants (Gold-Standard, 2012). Examples of these are when the Dutch government is placing a windmill farm in the North Sea, when people start a project where Tanzanian communities receive solar panels to prevent burning wood for lighting in the evening, or when a country is investing in capturing and storing carbon by protecting existing forest or by reforestation.

The Gold Standard is a high quality carbon credit label which has been established by the World Wide Fund for Nature (WWF). The Gold Standard Foundation is an international non-profit organisation that controls a certification scheme for Gold Standard Carbon Credits. Gold Standard Supporters are companies (like H&M, DHL, Nokia, Virgin Atlantic, Panasonic, TUI Travel and FIFA) and NGOs, more than 80 worldwide, who are connected to the Gold Standard. This means these companies and NGOs are committed to the mission of *“driving premium offset quality and sustainable development in carbon markets”* (Gold-Standard, 2009). The Gold Standard Foundation will only allow actors to associate in this brand when they fulfil their three basic principles namely: commitment, transparency and neutrality. Actors must demonstrate their dedication to commitment, transparency and neutrality through actions and written commitments. The Gold Standard will not function as a mediator between actors but it creates a marketplace (Golden Pages) which offers all actors who join the Gold Standard as an easy way to find each other for collaboration. Next to these basic principles the Gold Standard believes sustainable development can only be achieved through participation and bottom-up processes in an integrated design (Gold-Standard, 2009). This standard will be used in the set of criteria because of its commercial view on carbon credits and at the same time because sustainable development benefits in local communities are also measured, reported and verified.

3.3 Not Used Standards

The other standards will not be used because of the following reasons:

- **DE-ISCC** The International Sustainability and Carbon Certification System and the Biofuel Sustainability Meta-Standard **(UK-RTFO)** are very closely linked to the Cramer Criteria. These two criteria are focused on their home countries, Germany and the UK, while the Cramer Criteria is focused on the Netherlands.
- **EU-RED** Renewable Energy Directive is a mandatory legislation which aims to achieve a share of renewable energy of 20% in 2020. Production of Jatropha can contribute to this goal, but it is beyond the boundaries of this project.
- **INT-CDM** Clean Development Mechanism is closely linked to the Gold Standard, where the Gold Standard exceeds because it includes additional environmental and social criteria.
- **INT-COMPETE** Good Practice Assessment for Bio-energy Projects provide a clear and balanced guideline for Good Practices, but these guidelines have not been defined in criteria. There is also no intention to provide definitive criteria because the guidelines do not attempt to be a certification or verification system.
- **NL-NTA8080** Since the Cramer Criteria are the underlying framework of the Netherlands Technical Agreement 8080 the NTA8080 is not used. The Cramer Criteria were used at the start of this thesis when the NTA8080 was still under construction. The European Commission recognised the NTA 8080 in August 2012.

3.4 Added Specific Standards

Especially for this research other standards and articles will be added because of their specific influence on the situation.

3.4.1 Claims and Facts on Jatropha

Jongschaap (among others) from Plant Research International in Wageningen has written the “Claims and Facts on Jatropha Curcas L”. In this global Jatropha evaluation, breeding and propagation program the focus is mainly on all the claims and facts there are about Jatropha Curcas. There are a lot of positive claims on Jatropha, but only a few of those claims can be or are as yet scientifically proven. Next to the evaluation of claims, part of this article is about the sustainable livelihood approach (SLA) to improve the lives of small scale farmers (Jongschaap, 2007). In order to utilize the benefits of Jatropha for different applications and in different settings, an analytical framework is described. This framework allows a better understanding of the drivers for success and it is used to evaluate the effects on the different aspects of the farmers (Jongschaap, 2007). These claims and facts will be added to the matrix to get an insight in possible false predictions.

3.4.2 UN-REDD

The UN-REDD Program is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries. This program started in 2008 to assist developing countries preparing and implementing national REDD+ strategies. The UN-REDD has created a draft Social and Environmental Principles and Criteria. This draft is developed through a collaboration of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) (UN-REDD, 2012).

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is an initiative to create financial value for the carbon stored in forests. This means providing stimuli for developing countries to reduce emissions from deforestation and forest degradation and encourage conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+, 2012). This program is added because of its special interest in deforestation and forest degradation, one of TRC's biggest fears when implementing this project in Cameroon.

3.4.3 FSC

Forest Stewardship Council (FSC) is an independent, international and non-profit organization founded to promote responsible forest management worldwide. Responsible according to FSC means a balanced mix of social, ecological and economic aspects belonging to forest management (FSC, 2008). FSC covers a large volume of certified forest and has arranged this in a very transparent way. Because of this approach FSC is supported by all major environmental and development organizations.

FSC certified products provide a credible link between responsible production and consumption of forest products, enabling consumers and businesses to make purchasing decisions that benefit people and the environment as well as providing ongoing business value (FSC, 2008). FSC is represented in more than 50 countries and has membership status with the organizations:

- International Social and Environmental Accreditation and Labelling Alliance (ISEAL)
- International Union for Conservation of Nature (IUCN)

FSC only certifies wood at this moment but it may become a standard for the use of biomass for second generation biofuels (Partners-for-Innovation, 2010). Because the forest concessions of TRC are partly announced as FSC forest, the FSC principles and criteria (FSC, 1996) will be added to the matrix.

3.5 List of Principles

All the principles and criteria of the articles and standards mentioned above are placed in a matrix (see Appendix 1). Also the criteria of TRC (2008a) and the criteria extracted from Jatropha (Chapter 2) are added to this matrix. The baseline of this matrix comprises the nine principles and criteria of Cramer (2007) which are compared with the principles and criteria of the other articles and standards as mentioned above. When there are similarities the principles and criteria are combined, when there are small differences the principles are extended. Also three new principles have been added to this matrix therefore now the complete list consists of twelve principles, these twelve principles contain in total 120 criteria which can be found in Appendix 1.

The combined list of principles is as followed:

1. Greenhouse gas reduction
2. Carbon reservoirs
3. Competition food, energy and other local uses
4. Production of biomass compared with biodiversity
5. Production of biomass compared with soil quality
6. Production of biomass compared with ground- and surface water
7. Production of biomass compared with air quality
8. Production of biomass compared with local prosperity
9. Production of biomass compared with welfare of employees and local communities
10. Commitment to transparency
11. Energy efficiency and waste reduction
12. Monitoring and certification

4 Sustainability Principles and TRC

This chapter will answer the second sub-research question: *“Which criteria can be used to enable TRC to produce biodiesel in a manner that it meets the company’s sustainability goals?”*

The previous chapter resulted in twelve principles including about 120 associated criteria. These principles and criteria will be discussed in the perspective of TRC, using scientific literature. Some of the criteria are far beyond the range of control of TRC and are rather impossible to influence. Other principles are more important in TRC’s sustainability principles and will be discussed in more detail. In addition, some principles that are reasonably straightforward will result in some practical criteria while some other principles are rather abstract and will be translated into practical criteria. There is also some overlap in these criteria and could thus be combined into one criterion. Also several criteria concerning for instance working conditions could be combined into one criterion: comply with the current international labour standard. These discussions will lead to the final selection of criteria and will be used to evaluate the production models in the next chapter.

4.1 Greenhouse Gas Reduction

The first principle of the matrix is greenhouse gas (GHG) reduction. This principle is underpinned by all standards. The criterion used for this principle is reduction of GHG, including indirect effects of transportation and production. This reduction is the net emission reduction compared with fossil fuel and should be at least 50% (Cramer, 2007; RSB, 2010). In this GHG reduction also the indirect effects of GHG should be calculated as well. Indirect effects include all the other steps except the cultivation process, like fertilisation and irrigation, itself. The oil needs to be extracted from the seeds, it needs to be filtered and the crude oil needs to be processed into biodiesel. Also the transportation between all stations emits GHG. Especially the indirect effects can become an important factor which determines the success of the GHG reduction. According to Mierlo (2008) it is possible that, without including uncertain indirect effects, a presumed reduction of 50% could actually overturn in a serious negative reduction up to –679% (worst case scenario converting soybean oil into electricity in the Netherlands (Mierlo, 2008). In the vision of Mierlo the required reduction should be at least 50%, which is “acceptable” and more than 80% is “excellent”.

To get a clear indication about what will be the GHG reduction of Jatropha plantations a complete life cycle assessment for the specific location has to be carried out. Achten et al (2008a) claimed there were no complete life cycle assessments of the production of Jatropha biodiesel at least until 2008. The Renewable Transport Fuel Obligation (RTFO) has created a carbon calculator which is a programme that contains standard values for the carbon emissions associated with several types of biofuels.

This calculator makes it possible for fuel suppliers to calculate the carbon reduction on a batch of fuels (RTFO, 2012). Partners for Innovation (2010) as well as Chalmers & Archer (2011) recommend the RTFO for the carbon calculations. The reasons for choosing RTFO is the detailed guidance availability, there are Jatropha-specific defaults and two years of operational experience (Partners-for-Innovation, 2010). It is also recommended because it can be used regardless the amount of detailed and site specific information (Chalmers & Archer, 2011).

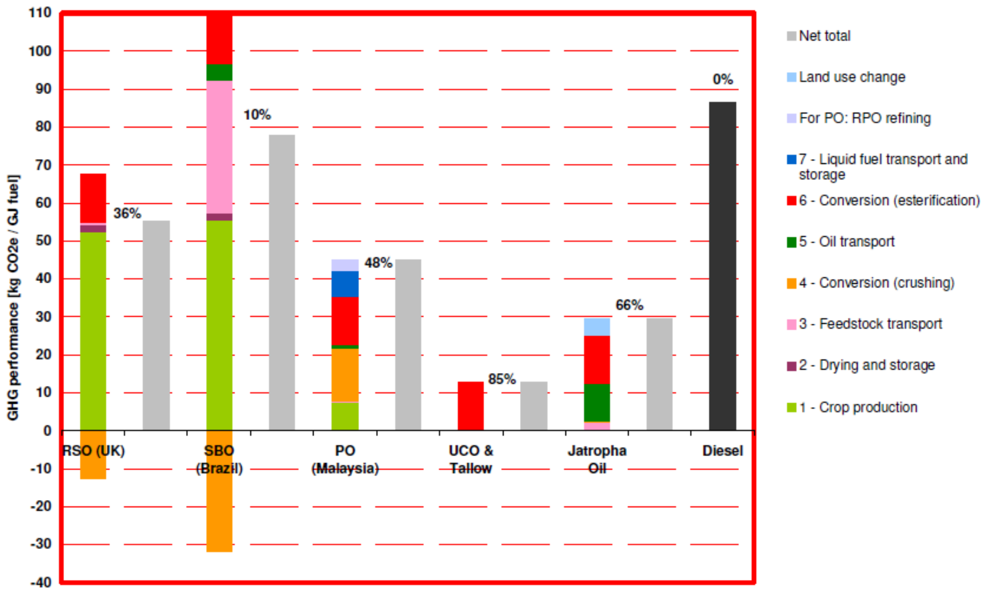

Figure 6: Renewable Transport Fuel Obligation GHG calculation for India (Dehue, 2008)

Dehue and Hettinga (2008) have performed such a RTFO GHG calculation focused on Jatropha production in India, see figure 6. Jatropha was being compared to other biofuel crops and they concluded that Jatropha scores better than fossil diesel with a GHG reduction of 66%. The supply chain measured here is based on Jatropha production in North and North-East India, processed in India and oil shipment to the UK. The GHG emission for this project could even be reduced further because there will be no shipment outside Cameroon. Therefore indications say Jatropha has a carbon emission reduction of approximately 60-70%. This is also stated by Prueksakorn (2006) who performed a LCA on Jatropha in Thailand and concluded that GHG reduction of Jatropha compared to fossil diesel is about 77% lower. As can be seen, used cooking oil and tallow score best since the production of the unused cooking oil is not included and the tallow can be seen as a by-product of food production. The main cause of the high GHG reduction of Jatropha is the low input in the cultivation phase. Jatropha by-products can be used as fertiliser which reduces the need of other fertilisers. Further significant improvements of GHG reduction are opted by Dehue and Hettinga (2008) through shorter transportation distances, more efficient transport because transport between and a mobile oil expeller. The largest improvement (approximately +22%) is site specific carbon stock measurement (Dehue, 2008) to prevent unlocking of carbon reservoirs, see Section 4.2. On the other hand there are also conditions that could cause an increase in GHG emissions, for instance destroying carbon reservoirs (defined in Section 4.2) and deforestation (defined in Section 4.4).

4.1.1 Criteria to be used: Greenhouse Gas Reduction

1. *Perform a location specific RTFO Greenhouse gas Life Cycle Assessment.*
2. *Ensure GHG reduction in comparison with fossil fuel should be at least 50%, or preferably higher.*
3. *Create shortest transportation distances between all parties.*
4. *Use most efficient transport or even a mobile oil expeller (which is available).*

4.2 Carbon Reservoirs

This section discusses the threats of Jatropha plantations destroying carbon reservoirs. Since this principle is a prolongation of the previous section and the criteria are reasonably straightforward, this principle will described in short. Carbon reservoirs are places, other than the atmosphere, where carbon is stored. Examples of above ground carbon reservoirs are forests, tropical rain forests and other above ground vegetations. Examples of underground carbon reservoirs are soils, limestone, coal deposits and the shells of various molluscs and bivalves, etc. All can be found in Cameroon!

As mentioned in the previous section the largest improvement to GHG reduction is site specific carbon stock measurement to prevent unlocking of carbon reservoirs (Dehue, 2008). Therefore Cramer (2007), RSB (2010), RSPO (2007) and UN-REDD (2011) have included the criterion conservation of above ground and underground carbon reservoirs. A site specific carbon stock measurement should be conducted to locate the carbon reservoirs, to prohibit plantations on these areas and to determine a baseline (Dehue, 2008). The results of this measurement and the agreements on how to conserve the carbon reservoirs should be documented in accordance with the local communities.

4.2.1 Criteria to be used: Carbon Reservoirs

1. *Perform a site specific carbon stock measurement.*
2. *Implement conservation of above ground carbon reservoirs.*
3. *Implement conservation of underground carbon reservoirs.*
4. *Register the baseline measurement and the conservation agreement.*

4.3 Competition Food, Energy and other Local Uses

This section discusses the threats of Jatropha plantations consuming space which was formally used for other local applications. This point is in line with the third principle of the Cramer Criteria (Cramer, 2007) and states that biomass production may not cause competition of land-use and may not substitute land used for other cultivations and applications. Thus it may not endanger food supply and local applications (like energy supply, medicine and building materials). Sources for current biofuels, the first generation biofuels, are usually cultivated on good quality farmland. First generation fuels are based on sugars, starch, vegetable oil or animal fats.

Second generation biofuels are based on energy crops or inedible parts of food crops. Although Jatropha belongs to the second generation, this does not mean it does not compete with food production, because it still could be cultivated on good quality farmland. Extra demand for biofuel sources increases the competition of farmland which could increase land- and food prices. On the other hand there is a chance of extension of sales possibilities which causes a lower risk for the producer, thus increase the continuity of the system (Cramer, 2007).

What is remarkable in this principle is that some of the standards included this as a prohibition in their criteria (Cramer, 2007; FSC, 1996; RSB, 2010; UN-REDD, 2011) but not all. RSPO (2007) included this, more or less, in their principle Responsible development of new plantings. In this principle it is stated that a social and environmental impact assessment should be undertaken before establishing new or expanding existing plantations. However it is up to the government to determine the threshold size of plantings when this assessment should be required. Furthermore this principle states that listing unacceptable negative social impacts, for example loss of food security for local people, could be considered (RSPO, 2007).

Competition for uncultivated land between different end-users and substitution of land currently in use can have several effects and Cramer (2007) has enumerated several effects. At first the economic effects like increasing ground prices and increasing food prices are mentioned. Effects on prices and availability of other products like fodder, building materials and medicines can also be expected (Cramer, 2007). Secondly, the effects of changed patterns in land use are listed. This includes the change or displacement of food production and cattle breeding. Besides the effects which are directly linked to substitution of food, medicine and building material, Cramer (2007) also mentioned other effects which can occur. These effects, change in ownership relations, deforestation and loss of nature reserve, are treated in following sections. To get a better understanding of these effects Cramer (2007) has suggested two criteria. These are: insight in the changes of land use and insight in changes in food and farmland prices in the region of the biomass production unit. As explanation of these criteria Cramer (2007) states that these criteria should be monitored on macro level and only when Dutch government asks for it. The reason for only testing on macro level is that the causes and effects exceed the company level and it is difficult to monitor them at the company level.

The production of Jatropha is relatively new and the academic literature about Jatropha displacing crops and causing land-use changes is limited. Therefore it is interesting to look at companies who could offer comparison material about this situation, the Max Havelaar foundation for instance. Max Havelaar helps small individual farmers and cooperatives in developing countries (MaxHavelaar, 2008).

Max Havelaar was taken as example because they pay farmers a fixed price and promise to acquire the farmer's coffee beans. The price these farmers get is higher than the price paid to other farmers who are not involved in the Max Havelaar group and the price is probably also higher than the selling price of food. Because of this it would be likely Max Havelaar farmers substitute for example food for coffee. Therefore it is interesting to find out how Max Havelaar prevents this. After an interview with the Max Havelaar Foundation in the Netherlands (Eshuis, 2008), it became clear Max Havelaar never indicated this problem because farmers are aware they are dependent on their own food production. Next to the need for their own food production, most Max Havelaar farmers have the problem they do not own much farmland. They can simply not produce more than they currently do. There are although several ways the farmers try to earn more money for instance by increasing production per hectare or cultivating specific coffee types which have a higher value.

Finally FARA (2008) states in their Discussion Paper "Bio-energy value chain research and development" that research priority should be given to plant oil production and use in remote rural areas. This way it is possible to reduce biomass destruction, when people in rural areas can use parts of the plant oils for cooking, lighting and electricity production. Next to competition of food and energy FSC (1996) has added the criterion that also sites of cultural or religious importance shall be clearly identified and protected in cooperation with indigenous peoples.

Sourcing Plan

Although Cramer (2007) states that it is more difficult to monitor the effects of Jatropha plantation on food production at the company level, thus even more on individual small-scale farmer level, Max Havelaar provides a solution. Max Havelaar works with cooperatives that have to make a sourcing plan together with the farmers. This sourcing plan contains the expected yield per farmer and the total cooperative. When yield increases without clear causes (for example the weather) Max Havelaar will investigate what are the causes of this phenomenon, and when violations of the sourcing plan, occur individual farmers can be banned from the cooperative. Eshuis (2008) states that in the long run, increase in value of building material, could indeed become a source of danger in the substitution of food crops, but it is more likely large enterprises are responsible for this substitution of land-use by driving away or buying out the original land users.

The Fair Trade Foundation (Fairtrade, 2009) has indicated the impact on Fair Trade cotton farmers in several villages in Cameroon. In Cameroon about 10% of a total of 320.000 cotton farmers are Fair Trade cotton farmers, they receive about 27p per kg cotton instead of 20p what conventional cotton farmers receive. This 7p extra is called the premium which farmers should spend on development projects.

According to Nathan Bello, of Sodecotton, a cotton ginning and marketing company, it used to be hard to convince farmers to adopt more responsible behaviour towards improving their quality of production and environment. Due to the premium farmers have a reason to do so (Fairtrade, 2009). Examples of purchases of the development premium are wells, grinders, a school and one village is even planning to build a hospital. Next to the fact that the approach of Max Havelaar makes it easier to convince farmers to adopt a more responsible behaviour, the farmers also benefit. This is concluded by Becchetti and Costantino (2008). They state that "*fair trade affiliation seems to be associated with superior capabilities, economic and social well-being, but also it shows that more can be done on the human capital side*" (Becchetti & Costantino, 2008). More about the benefits of farmers will be discussed in Section 4.9.

4.3.1 Criteria to be used: Competition Food, Energy and other Local Uses

1. *Ensure biodiesel production will not cause competition in food, energy and other local uses.*
2. *Create individual farmers/ cooperatives sourcing plans and monitor these.*
3. *Pay a fair price so farmers will adopt a more responsible behaviour.*
4. *Provide the possibility to use parts of the plant or oil for own use.*
5. *Protect sites of cultural or religious importance.*

4.4 Biodiversity

This section discusses the threat of Jatropha plantations consuming protected or fragile areas. The best known example is deforestation. This point is in line with the fourth principle of the Cramer Criteria and of the criteria of all other standards (FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007; UN-REDD, 2011). *"Biomass will not be produced at the expense of protected or vulnerable biodiversity, and strengthens where possible the biodiversity"* (Cramer, 2007, p. 14). According to Cramer biodiversity is defined as "*the variability of living organisms in ecological systems*" (Cramer, 2007, p. 9). Producing energy crops can negatively as well as positively contribute to the biodiversity. Therefore next to prevention of damaging the biodiversity Cramer (2007) also states that it would be desirable when biodiversity could be recovered or improved by biofuel plantations.

Cramer (2007) has summarised the potential effects of biofuel production on biodiversity divided into direct and indirect effects.

Direct effects of biomass production on biodiversity:

- Conversion of intact ecosystems, like primary forest and wetlands.
- Utilization of areas with high biodiversity value, including fragmentation of these areas.
- Large scale biomass monocultures with a low biodiversity will be produced at the expense of areas with a higher biodiversity value or a higher culture value.

Indirect effects of biomass production on biodiversity:

- Unlocking of relatively inaccessible areas (road construction, other infrastructure) makes it easier for people to access these areas and start cultivation.
- When original landowners are driven away or bought out, they often start cultivating larger areas elsewhere, often on more fragile soils like mountain slopes (Clancy, 2012).
- Replacement of food production by biomass causes food production elsewhere.
- Change of quality and quantity of water systems and ecosystems.

When searching for literature about biodiversity a lot of articles were found which deal for example with the decreasing amount of butterflies in large scale palm-oil plantations compared to tropical forest (Fitzherbert et al., 2008). To restrict the boundaries of this section further literature is sought in the direction of deforestation. Deforestation is one of the biggest fears of TRC (TRC, 2008a) and it is one of the main causes of damage of biodiversity. When searching for causes of deforestation in Cameroon it is noticed that, although Cameroon has a large attention of researchers and environmentalists, there are very few studies about deforestation in Cameroon (Gbetnkom, 2005). Therefore further literature about deforestation worldwide is being used.

To discuss the criteria which will be placed in the matrix, it is necessary to find out the causes of deforestation. In the literature review two mainlines where found; the macro causes and the causes on micro-/ meso-level. Although the macro-level causes and solutions cannot be influenced by TRC, they will be discussed here for completeness' sake. After that there will be a detailed focus on the micro and meso-level causes and solutions of deforestation.

4.4.1 Macro-level Causes and Solutions of Deforestation

The extensive discussion on macro-level causes and solutions of deforestation is placed in Appendix 2. These causes are at such that TRC cannot change anything to a large extent. Martin (2008) states about these causes that they all respond to different economic and social incentives, therefore different policy instruments or incentive systems are needed to reduce the cause of deforestation. Strategies developed to reduce deforestation must be aimed at a large and wide variety of actors (Martin, 2008).

Macro-level Causes of Deforestation

The macro-level causes mentioned in Appendix 2 can be grouped into four categories:

- Market Failure. This includes the increase of prices of export products, food products and raw material like fertilizers.
- Property Rights. This includes land tenure security and inadequate specification of property rights.

- Policy Failure. This includes the structural adjustment policies and the currency devaluation.
- Miscellaneous causes like poor management practices and the oil boom.

Macro-level Solutions of Deforestation

The solutions to the macro-level causes of deforestation mentioned above and in Appendix 2 can be grouped into five categories, namely:

- Increase protected areas. This can be done by individual companies or rather governments.
- Increasing employment. This includes employment of local communities in protected forests areas.
- Using mapping systems to detect deforestation in an early stage. This includes satellites, radar systems, fieldworkers and scientists.
- Increasing food and building material security. This also includes cooking sources and medicine.
- Increased intervention of the government. This includes some of the solutions mentioned above, like expansion of protected areas and using satellite-based licensing systems. This also includes intervention in prices, costs and speculative gains in deforestation and intervention in income and costs of maintaining forest.

4.4.2 Micro- and Meso-level Causes and Solutions of Deforestation

Another group of findings comprises the causes of deforestation which a company can change to a smaller or larger extent. As can be seen in figure 7 it is clearly that the major cause of area change in the entire world is primarily direct conversion of forest area for large scale permanent agriculture (25-40%) except from Africa (15%). In Africa the primary cause is direct conversion of forest area to small scale permanent agriculture (60%).

Martin (2008) explains the cause of this difference based on the low soil fertility and states:

- In areas where the soil fertility is always low, the poorest and weakest people and communities, who are unable to get hold of better quality land often need to “slash-and-burn” agriculture as a survival strategy. This also applies for people who are forced to settle in one place (Clancy, 2012).
- Due to the impossibility of improving farmland by fertilizers, the soils remain poor. Only one to three years of production are possible which has as result that the farmers are forced to move on.
- In some areas, this method has evolved into a repetitive cycle.
- Where the population following this cycle has increased, the negative consequences for the forest have also increased.

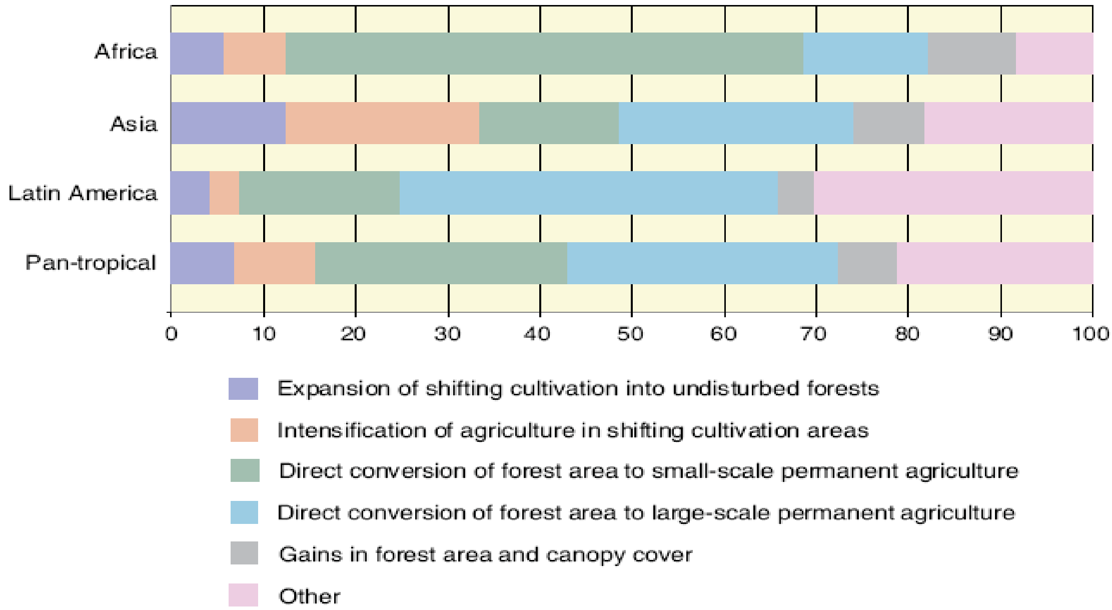

Figure 7: Percentage of total area change due to different causes, 1980–2000 (Martin, 2008).

Thus the African population, to a larger extent than other populations, deforest small scale areas for own use to provide themselves with food. Also Cleaver (1992) stated already in 1992 that small scale deforestation to meet the needs of the fast growing African population is one of the main causes of deforestation in Africa. An additional problem, next to low soil fertility, is the lack of tenure security. Kazianga (2006) stated that these farmers will not invest anything to improve their farming ground, because of this lack of land tenure security because they can be driven away any moment. This strengthens the cause of small scale deforestation for own use in Africa. Clancy (2012) stated that small-scale farmers (particularly in Africa) do not benefit from agricultural extension services and so they do not learn techniques for soil improvement, therefore some farmers have opted into biofuel schemes where they receive this type of support. Next to deforestation to produce food, deforestation also occurs for building material, cooking and electricity (FARA, 2008; Henning, 2009). Besides deforestation to fulfil peoples own needs of food security, Martin (2008) also provides some other reasons for deforestation, like "*the desire to acquire land as a source of collateral, as a store of wealth and as a hedge against inflation*" (Martin, 2008, p. 10).

Micro- and meso-level Causes of Deforestation

The causes mentioned above can be grouped into three categories, namely:

- Soil Characteristics. Low soil fertility leads to repeated deforestation to obtain soil with a high fertility.
- Market Failure. This includes the increase of prices of export products, food products and raw material like fertilizers and also the need of sources of collateral.
- Property Rights. This includes land tenure security and inadequate specification of property rights.

Micro- and meso-level Solutions of Deforestation

The small-scale causes mentioned before where grouped into three categories. Two of the major results of these causes in Africa are small scale deforestation by clearing land for own use, and that farmers will not invest in their land because of the lack of land tenure security or high fertilizer prizes. A third reason is deforestation for building material and urban charcoal. Therefore the need for small scale deforestation to create plantations on high fertility soil, and the need for deforestation for cooking and electricity can be taken away, some of the reasons for deforestation become obsolete. Fara (2008) states that to reduce biomass destruction a research priority should be given to plant oils and/or ethanol production and use for cooking and lighting as well as for electricity production in remote rural areas. These conclusions will be combined with the criteria provided by the standards.

The fourth principle of Cramer (2007) is divided into five criteria:

- Cramer (2007) states that no rules and laws should be violated because of biomass production and the production area where it is placed. This is supported by three other standards (RSB, 2010; RSPO, 2007; UN-REDD, 2011) which state that there is compliance with all applicable local, national and ratified international laws and regulations.
- Cramer's (2007) second criterion states that biomass production should not be placed in gazetted or protected areas or within five kilometres of these areas. This criterion is also one of TRC's principles (TRC, 2008a) and of almost all other standards (FSC, 1996; RSB, 2010; RSPO, 2007; UN-REDD, 2011).
- The third criterion (Cramer, 2007) in addition to the second, states that biomass should not only be avoided in protected areas, but also in High Conservation Value (HCV) areas. Also the RSPO (2007) states that it should be avoided to damage and deteriorate applicable habitats, and HCV areas. This is also underlined by other standards (FSC, 1996; RSB, 2010; RSPO, 2007; TRC, 2008a).
- Criterion four (Cramer, 2007) states that biodiversity should be maintained or recovered. In extension to this criterion Cramer (2007) states in criterion five that the biodiversity should also be strengthened where possible. These criteria are also stated by all the standards (FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007; TRC, 2008a; UN-REDD, 2011).
- Next to these criteria the RSPO (2007) added one extra criterion which states that agrochemicals should be used in such a way that it does not endanger the environment.

As mentioned in Chapter 2, Jatropha crops and products have some soil improving, water conservation and erosion controlling characteristics. Thus under the right circumstances Jatropha could reduce the necessity of displacement of food production every two or three years as mentioned by Martin (2008) because Jatropha can improve the soil fertility.

The possibility to use the Jatropha oil can replace the need to use wood for electricity, lighting and cooking (Cleaver, 1992; Harounan Kazianga, 2006; Henning, 2009). Of course this has no use when there is still a lack of land tenure security, which is one solution of the large scale solutions, but property could also be documented in the sourcing plan.

To ensure these solutions will be considered by local communities who will manage the plantations, some kind of controlling and certifying system has to be implemented (DuBois, 2008; Fairtrade, 2009; RSPO, 2007), which in this case could be the sourcing plan as mentioned before.

4.4.3 Criteria to be used: Biodiversity

1. *Do not place plantations on protected/ High Conservation Value areas or within five kilometres of these areas.*
2. *Where possible increase these areas and its biodiversity.*
3. *Comply with all applicable local, national and international laws and regulations on biodiversity.*
4. *Use Jatropha characteristics for the possibility of soil improving, water conservation and controlling erosion.*
5. *Agrochemicals should be used in such a way that it does not endanger environment.*
6. *Document property rights, including land tenure security and adequate specification of property rights.*
7. *Document these agreements in the sourcing plans and monitor these.*

4.5 Soil Quality

This section discusses the threats of Jatropha plantations degrading soil quality which should be protected. This principle is mentioned by all the standards (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; Jongschaap, 2007; RSB, 2010; RSPO, 2007; TRC, 2008a; UN-REDD, 2011) and also the criteria to use from the Chapter 2 Jatropha. The criteria are reasonably straightforward in this regard. Comply with all applicable local, national and international laws and regulations regarding soil conservation (Cramer, 2007; RSB, 2010; RSPO, 2007; UN-REDD, 2011). Use of rest products is not against other local functions (Cramer, 2007) which means that rest products which were formerly used to improve soil quality, like compost, may not be used to produce biofuel when this is unfavourable for other crops. Agro chemicals are used in a way that does not endanger the environment (RSPO, 2007). As minimum requirement for this last criterion the Stockholm Convention requirements should be met. This convention aims at eliminating or restricting the production and use of the twelve most harmful pesticides (Cramer, 2007). The other criteria depend heavily on the exact location of the plantation and are focused on using best practice to remain or increase soil quality and minimise and control erosion (Cramer, 2007; Gold-Standard, 2009; Jongschaap, 2007; RSB, 2010; RSPO, 2007; TRC, 2008a).

Section 4.2 already set as criterion a site specific carbon stock measurement and RSPO (2007) states that a soil survey could be added to this measurement. The results of this survey should be part of the sourcing plan. This soil survey will form the baseline for further monitoring of the soil quality. This information can be used for locating new plantations (RSPO, 2007). As concluded in Chapter 2, Jatropha could be a solution for soil improvement and erosion control and rest products like seedcake and fruit coat can replace part of the agrochemicals. The real potential of Jatropha improving soil, controlling erosion and replacing agro chemicals needs to be further investigated.

4.5.1 Criteria to be used: Soil Quality

1. *Comply with all applicable local, national and international laws and regulations regarding soil conservation.*
2. *Ensure use of rest products is not against other local functions.*
3. *Agro chemicals are used in a way that does not endanger the environment according to the Stockholm Convention.*
4. *Perform a site specific soil survey and set a baseline for further measurement.*
5. *Add the site specific soil survey results to the sourcing plans.*
6. *Minimise and control erosion.*
7. *Use best practice to remain or increase soil quality.*
8. *Utilise the Jatropha crop characteristics for possible erosion control.*
9. *Sourcing plan contains operating procedures which are implemented and monitored.*

4.6 Ground- and Surface Water

This section discusses the threats of Jatropha plantations influencing the quality and quantity of groundwater and surface water. This is in line with the principles of 6 out of 8 standards (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007; UN-REDD, 2011) and also with the criteria to use from Chapter 2. Again the criteria are reasonably straightforward. Comply with all applicable local, national and international laws and regulations regarding water conservation (Cramer, 2007; RSB, 2010; RSPO, 2007; UN-REDD, 2011). No use of water from non-renewable sources (Cramer, 2007) which means using groundwater at a higher rate than the natural recharge. The other criteria depend heavily on the exact location of the plantation and are focused on using best practice to limit water use and to maintain or increase ground- and surface water (Cramer, 2007; Gold-Standard, 2009; RSB, 2010; RSPO, 2007). Section 4.5 set as criterion a site specific survey. Also for protection of ground- and surface water a site specific survey should be performed and documented (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007). The results of this survey should be part of the sourcing plan mentioned in Section 4.3. This survey will form the baseline for further monitoring the quality and quantity of groundwater and surface water.

As concluded in Chapter 2 Jatropha could be a solution for water conservation caused by the taproot and the several lateral roots of Jatropha. The real potential of Jatropha to conserve water needs to be further investigated.

4.6.1 Criteria to be used: Ground- and Surface Water

1. *Comply with all applicable local, national and international laws and regulations regarding water conservation.*
2. *Ensure no use of water from non-renewable sources.*
3. *Perform a site specific water survey and set a baseline for further measurement.*
4. *Add and monitor the site specific water survey results to the sourcing plans.*
5. *Use best practice to limit water use and to maintain or increase ground- and surface water.*
6. *Utilise the Jatropha crop characteristics for possible water conservation.*
7. *The Sourcing plan contains operating procedures which are implemented and monitored.*

4.7 Air Quality

This section discusses the threats of Jatropha plantations influencing the air quality. This is in line with the principles of 4 out of 8 of the standards (Cramer, 2007; Gold-Standard, 2009; RSB, 2010; RSPO, 2007). Again the criteria are reasonably straightforward. Comply with all applicable local, national and international laws and regulations regarding air pollution (Cramer, 2007; RSB, 2010; RSPO, 2007; UN-REDD, 2011). No fires to build or manage biomass production units except in specific situations according regional good-practices (Cramer, 2007; RSB, 2010; RSPO, 2007). The other criteria depend on the exact location of the plantation and are focused on using best practice to restrict emission and air pollution (Cramer, 2007; RSB, 2010; RSPO, 2007). Section 4.5 set as criterion a site specific survey. Also for the protection of air quality a site specific survey should be performed and documented. Operating procedures should be documented, implemented and monitored (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007). The results of this survey should be part of the sourcing plan mentioned as criterion in Section 4.3. This survey will form the baseline for further monitoring the air quality.

4.7.1 Criteria to be used: Air Quality

1. *Comply with all applicable local, national and international laws and regulations regarding air pollution.*
2. *Ensure no fires to build or manage biomass production units.*
3. *Perform a site specific air quality survey and set a baseline for further measurement.*
4. *Add the site specific air quality survey results to the sourcing plans and monitor them.*
5. *Use best practice to restrict emission and air pollution.*
6. *Sourcing plan contains operating procedures which are implemented and monitored.*

4.8 Local Economic Development

This section discusses the goal of Jatropha plantations contributing to local prosperity. This is in line with the principles of all the standards (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; Jongschaap, 2007; RSB, 2010; RSPO, 2007; TRC, 2008a; UN-REDD, 2011). Once more the criteria are reasonably straightforward. Biomass production should contribute to local business activities and local economy (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; Jongschaap, 2007; RSB, 2010; RSPO, 2007; TRC, 2008a; UN-REDD, 2011). The RSB (2010) and RSPO (2007) add this criterion that this should be a commitment to long-term economic and financial viability. FSC (1996) and Jongschaap (2007) state that there should also be an aim for a local processing industry. This industry should be owned by the local communities instead of the latter just working there. Payment and conditions for employees meet at least legal or industry minimum standards (RSB, 2010; RSPO, 2007).

In regions of poverty, special measures shall ne designed and implemented, regarding biofuel operations, that benefit and encourage the participation of women, youth, indigenous communities and the vulnerable (RSB, 2010). *"Indigenous peoples shall be compensated for the application of their traditional knowledge regarding the use of forest species or management systems in forest operations. This compensation shall be formally agreed upon with their free and informed consent before forest operations commence"* (FSC, 1996, p. 5).

To measure the development a baseline must be set and the strategy used needs to be documented, implemented and monitored (FSC, 1996; RSB, 2010; RSPO, 2007) which could be done using the sourcing plan. The financial evaluation of this principle will be dealt with in Chapter 6.

4.8.1 Criteria to be used: Local Economic Development

1. *Ensure biomass production contributes to local business activities and local economy.*
2. *Commitment to long-term economic and financial viability.*
3. *Develop a local processing industry owned by the local communities.*
4. *Payment of- and conditions for employees meet at least legal or industry minimum standards.*
5. *Encourage the participation of women, youth and indigenous communities in biofuel operations.*
6. *Ensure indigenous peoples to be compensated for the application of their traditional knowledge.*
7. *Operating procedures are documented, implemented, monitored and compared with baseline.*

4.9 Welfare of Employees and Local Communities

This section discusses the goal of Jatropha plantations contributing to the welfare of employees and local communities. This is in line with all the standards (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; Jongschaap, 2007; RSB, 2010; RSPO, 2007; TRC, 2008a; UN-REDD, 2011) including the criteria from the Chapter 2. When looking at Appendix 1 there can be seen that this principle has the most criteria attached to it. Since it would not make things more clear when all these criteria would be mentioned here, these criteria have been regrouped.

Once again these groups of criteria are reasonably straightforward. The largest group of criteria deal with the working conditions of employees and sets no negative effects on working conditions of employees and no negative effects on human rights as a criterion (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; RSB, 2010). These criteria focus on health and safety, discrimination, sexual harassment or other violence, child labour and the right of all personnel to form and join trade unions. Most of these criteria find their origin in the International Labour Organisation (ILO) which is an organization that creates and monitors international labour standards (ILO, 2012). Cameroon is also a member of the ILO and therefore these criteria can be summarised to the criterion: comply with the ILO standard working conditions. Another criterion should be: when TRC is going to search for participants in the biodiesel production special attention should be paid to include the most vulnerable and marginalized groups (UN-REDD, 2011).

Another large group of criteria deals with the problem of land tenure security and it is stated that the use of land does not cause any violation in private property without approval of a well informed communities (Cramer, 2007; FSC, 1996; RSB, 2010; RSPO, 2007; UN-REDD, 2011). RSB (2010), RSPO (2007) and FSC (1996) state that the (legal) right to use the land can be demonstrated which again can be registered in the sourcing plan. Also agreements of compensations for loss of legal or customary rights are registered (RSPO, 2007). Finally owners are compensated for any agreed land acquisitions (RSPO, 2007). In addition, the possibility for farmers and communities to develop more tillage skills is mentioned (Jongschaap, 2007) and that all staff, workers, smallholders and contractors are appropriately trained (FSC, 1996; Gold-Standard, 2009; Jongschaap, 2007; RSB, 2010; RSPO, 2007) and good practices shall be implemented the entire production process (RSB, 2010).

Another important criterion is the possibility for producers to use some of the Jatropha products for their own use. Examples mentioned before are the use of Jatropha products as local energy source (for lighting, so children can learn at night), soap production or fertilizer. It is also highlighted by Beerens (2007) that the financial incentive alone might not be enough advantage for the farmers.

During Beerens' fieldtrips in Tanzania, local farmers seemed "*moderately motivated to grow Jatropha or collect seeds from wild Jatropha trees*" (Beerens, 2007, p. 46). The cause of this could be the low prices farmers get paid or the inability to judge long-term benefits. They have no direct benefits for oil or remains of the seeds and according to the farmers "*Jatropha is just another cash crop*" (Beerens, 2007). If they had more advantages like using the oil for electricity or cooking, there might be more motivation to grow Jatropha crops. But since this is only based on one source, this should be validated with a study in Cameroon.

Again the conditions of these criteria should be documented, implemented and monitored (FSC, 1996; RSB, 2010; RSPO, 2007) which can be done in the sourcing plan which should also include an occupational health and safety plan (RSPO, 2007). Also a survey for social impacts should be conducted as well. Plans to reduce negative impacts and promote the positive ones to accomplish continuous improvement are developed, registered and monitored (FSC, 1996; RSPO, 2007).

4.9.1 Criteria to be used: Welfare of Employees and Local Communities

1. *Comply with the ILO standard working conditions.*
2. *Create an occupational health and safety plan.*
3. *Perform a social impact survey.*
4. *Ensure all members are appropriately trained.*
5. *Ensure special attention to the most vulnerable and marginalized groups.*
6. *Ensure the use of land does not cause any violation of private property without approval of well-informed communities.*
7. *Ensure the (legal) right to use the land and agreements of compensations for loss of legal or customary rights are registered in the sourcing plan.*
8. *Create a possibility for farmers and communities to develop more tillage skills.*
9. *Provide the possibility for producers to use some of the Jatropha products for their own use.*
10. *Ensure operating procedures are documented and implemented, a baseline is set and monitored and added to the sourcing plan.*

4.10 Commitment to Transparency

This section discusses the desire for commitment to transparency of the entire biofuel chain. This is in line with the principles of 6 out of 8 standards (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007; UN-REDD, 2011). Just as in previous sections the criteria are reasonably straightforward. Biomass producers will provide adequate information for complete transparency (FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007; UN-REDD, 2011).

Management documents are publicly available (except when confidential) (Gold-Standard, 2009; RSB, 2010; RSPO, 2007; UN-REDD, 2011) and there is an open and transparent communication between all parties (Cramer, 2007; FSC, 1996; Gold-Standard, 2009; RSPO, 2007). This transparency should be the result of the sourcing plan discussed in the previous sections. When this sourcing plan is publicly available it provides perfect open basis from the producer's perspective to transparency. Also TRC or ECP should commit to this transparency making the management documents available (except from confidential documents). This transparency should also include transparency in money flows.

4.10.1 Criteria to be used: Commitment to Transparency

1. *Biomass producers will provide adequate information for complete transparency.*
2. *Make management documents publicly available (except when confidential).*
3. *Ensure open and transparent communication between all parties.*
4. *Create transparency in money flows.*

4.11 Monitoring and Certification

This section discusses the desire for monitoring and certification of the entire biofuel production chain. This is in line with principles (Jongschaap, 2007) and is the basis of almost all the standards (Cramer, 2007; RSB, 2010; RSPO, 2007; UN-REDD, 2011). The sourcing plan discussed in Section 4.3, extended with the criteria from the following sections can form a solid base for monitoring the biofuel chain. RSPO (2007) and FSC (1996) add to this criterion that this sourcing plan needs to be regularly monitored and reviewed. Also to develop and implement action plans that allow demonstrable continuous improvement in key operations (FSC, 1996; RSPO, 2007). As mentioned in Chapter 3 Partners for Innovation (2010) has selected the RSB assessment methodology as the best way forward for certification. It is biofuel-specific, it is complete, it is a practical standard for which extensive guidance is available, it also aims to be really global, it covers all sustainability issues and is anticipated to be of high importance for the biofuel sector (Partners-for-Innovation, 2010).

Although this research and several standards recommend such a certification, it is up to TRC and ECP whether and when they want to apply for such a RSB certificate. By obtaining a certificate it will be easier for TRC to sell any biodiesel excess to their requirement, if there is any, see Chapter 1. For ECP as well it would be easier to sell the biodiesel. On the other hand, it is unclear what the exact costs will be to obtain an RSB certificate, indications are about $10.000,- till $20.000,- a year (RSB, 2012a). In addition, it is questionable whether the advantage of a certificate is also applicable in Cameroon when selling the biodiesel there. It is also questionable whether it is not easier to implement a similar monitoring and certification as already used in the FSC forest concession. TRC has already an FSC certificate, thus maybe the documents of this certificate can also be used to monitor and certify the biofuel.

Another reason for not implementing the RSB certificate immediately is that Max Havelaar is at the moment working on a feasibility study to find out whether it is possible to create a Max Havelaar trademark for Jatropha (Eshuis, 2008). Although a Fairtrade standard for Jatropha production focuses on small farmers and small co-operations and not on larger plantations several problems mentioned before are neutralized. It is focused on food security, improved farm management, better access to energy and financial advantages for farmers and communities (Eshuis, 2008).

4.11.1 Criteria to be used: Monitoring and Certification

1. *Monitor the entire biofuel production chain.*
2. *Regularly monitor and review the sourcing plan.*
3. *Develop and implement action plans that allow demonstrable continuous improvement in key operations.*
4. *Apply for an (RSB/ FSC/ Fairtrade) certificate for the entire biofuel production chain.*

4.12 Energy Efficiency and Waste Reduction

The last section discusses the desire of energy efficiency and waste reduction in the entire biofuel chain. This is in line with the 4 out of 9 standards (FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007). Just as in previous sections the criteria are reasonably straightforward. Efficiency of energy use and use of renewable energy is maximised (RSPO, 2007). Waste is reduced, recycled, re-used and disposed in an environmentally and socially responsible manner (FSC, 1996; Gold-Standard, 2009; RSB, 2010; RSPO, 2007).

For Jatropha this means again that producers should be able to use parts of the biodiesel and seed cake and fruit coats which can be used to replace other fertilisers to improve the soil quality and the use Jatropha for energy generation.

4.12.1 Criteria to be used: Energy Efficiency and Waste Reduction

1. *Ensure efficiency of energy use is maximised.*
2. *Ensure use of renewable energy is maximised.*
3. *Ensure waste is reduced, recycled, re-used and disposed in an environmentally and socially responsible manner.*

4.13 Criteria to Use

The complete list of criteria results from the previous 12 sections and can be found in the Appendix 3. These criteria should be used to ensure biodiesel will be produced in such a way that it meets TRC's and its stakeholder's sustainability criteria. Since there is some overlap, these criteria can be regrouped into three groups of criteria:

- First of all, the criteria that deals with the time before approaching any producer in Cameroon. These are criteria dealing with the calculation of carbon reduction in general, with legal requirements and social impacts.
- The second group will be the group of criteria at the beginning of approaching the producers and at the start of the plantations. These criteria deal mainly with the sourcing plans including site specific surveys, documentation of agreements, economic and property agreements and agreements about working conditions.
- The final grouping of criteria deal with the conditions during production. This includes monitoring, reviewing and improving the sourcing plans, agreements on collecting the seeds, economic agreements and to reduce the environmental impact.

These customised criteria will be used to evaluate the production models in the next chapter.

4.13.1 Preliminary Research

- Carry out a RTFO Greenhouse gas Life Cycle Assessment to make sure that the carbon emission reduction in comparison with fossil fuel is at least 50%, or preferably higher. Indications say Jatropha has a carbon emission reduction of approximately 60-70%.
- Investigate legal policy to comply with all applicable local, national and international laws and regulations regarding soil and water conservation and air pollution.
- Carry out a social impact survey.

4.13.2 Beginning/ Create Sourcing Plans

General

- Operating procedures are documented, implemented and monitored.
- Everyone in the biodiesel production chain will provide adequate information for complete transparency, thus management documents are publicly available (except when confidential) and there is transparency in money flows.
- Commitment to long-term economic and financial viability.
- No use of water from non-renewable sources.
- No fires to build or manage biomass production units.
- Conservation of above ground and underground carbon reservoirs.

Surveys

- Perform site specific surveys, including a carbon stock measurement, a soil survey, an air quality survey and a water survey and set a baseline.

Economics

- Biomass production should contribute to local business activities and local economy.
- Develop a local processing industry owned by the local communities.
- Pay a fair price so farmers will adopt a more responsible behaviour.
- Biodiesel production may not cause competition in food, energy and other local uses.
- Use of rest products is not against other local functions.
- Provide the possibility for producers to use some of the Jatropha products for their own use.

Land use

- Do not place plantations on protected/ high value areas or within five kilometres of these.
- Where possible increase these areas and recover or increase biodiversity.
- Ensure land tenure security and adequate specification of property rights and to protect sites of cultural or religious importance. The use of land does not cause any violation in private property without approval of well informed communities. The (legal) right to use the land and agreements of compensations for loss of legal or customary rights are registered in the sourcing plan.

Working conditions

- Comply with the ILO standard working conditions and create an occupational health and safety plan.
- All members are trained.
- Encourage the participation of women, youth, and indigenous communities and give special attention to the most vulnerable and marginalized groups.
- Indigenous people shall be compensated for the application of their traditional knowledge.
- Agrochemicals are used in a way that does not endanger the environment according to the Stockholm Convention.

4.13.3 During Production/ Monitor Sourcing Plans

General

- Open and transparent communication between all parties.
- Regularly monitor and review the sourcing plan and develop and implement action plans that allow demonstrable continuous improvement in key-operations.
- Apply for an (RSB/ FSC/ Fairtrade) certificate for the entire biofuel production chain.

Transport

- Create shortest transportation distances.
- If possible, use most efficient transport/ mobile oil expeller.

Economy

- Increase community income security/ employment by using Jatropha.
- Increase food supply and material facilities by using Jatropha.
- Payment and conditions for employees meet at least legal or industry minimum standards.
- There is a possibility for farmers to develop skills.

Environment

- Use best practice, the Jatropha crop characteristics, to increase soil quality, erosion control, water conservation and restrict emission and air pollution.
- Efficiency of energy and use of renewable energy is maximised.
- Waste is reduced, recycled, re-used and disposed in an environmentally and socially responsible manner.

5 Sustainable production models

This chapter will answer the third sub-research question *"Which production models are able to produce biodiesel in the manner that meets TRC's sustainability criteria?"*

The previous chapter has resulted in 70 criteria regrouped into 36 criteria which belong to the twelve principles identified in Chapter 3. These 36 criteria will be used to evaluate the production models mentioned below. In consultation with TRC and ECP five basic models have been developed (TRC, 2008a). These models will be shortly described after which they will be weighed by means of the 36 criteria. At all these models it is assumed that processing like pressing (probably decentralised), filtering and transesterfication (the process to transform bio-oil into biodiesel) will be centralised. Because of possible difficulties implementing these models, a second evaluation has been made, namely the evaluation of ease of implementation. It is imaginable that executing for instance a soil survey on one location is easier and cheaper in time and manpower than the same survey on 200 locations. When evaluating these scenarios it is also kept in mind that the core of this project was to set up a social-economic project, that 1.000 hectare plantation is needed and that is has to be practically feasible. Therefore the models will also be evaluated on some practical criteria: plantation area, expansion possibilities, financial incentives, pre-cultivation, plantation facility and processing. These criteria where discussed and agreed in a meeting with TRC and ECP (TRC, 2008a).

5.1 Production Models

5.1.1 Plantation Model

The Plantation Model (PM) is imagined as 1.000 hectares of needed plantation divided over one/ three large central plantations near the forest concessions, totally managed by TRC. Local employees are attracted to work and harvest on the plantation. The employees will have a paid employment and do not have any problems concerning their land. In addition, a lot of other obstacles mentioned at the criteria section will be taken away. On the other hand, they have no further benefits other than money.

5.1.2 ECP Model

The ECP Model (EM) is like the plantation model except that this has a larger land area, about 20.000- 100.000 hectares. This area does not have to be near the forest concessions of TRC. ECP will start this plantation in co-operation with TRC and its knowledge and TRC will become a regular biodiesel customer of ECP. The advantage of this model is that TRC has no fixed costs. The disadvantages for local communities are the same as the plantation model and they have no further benefits other than money.

5.1.3 Farmer Model

The Farmer Model (FM) divides the 1.000 hectares of needed plantation over a large group of farmers around the forest concessions, who will use a part of their own farm ground for Jatropha plantations. The farmers harvest the seeds and sell the seeds or the oil alone to TRC. The farmers can utilise other benefits of Jatropha and earn some money at the same time. The disadvantage is that there is a lot of work to be done to create sourcing plans and all the surveys and there is a bigger threat of other negative consequences like deforestation.

5.1.4 Collection Point Model

The Collection point Model (CM) divides the 1.000 hectares of needed plantation over collection points where TRC collects and loads timber. Also riverbanks, verges and bridge ramps will be used. Normally TRC plants marram grass on verges and bridge ramps to prevent erosion. Farmers and local communities harvest the fruits and sell the seeds or the oil alone to TRC. There is less work to be done to create sourcing plans and surveys, farmers do not lose farmland and they earn some money. The disadvantage is that farmers still cannot utilise the other benefits of Jatropha.

5.1.5 ECP-Farmer Model

This model (EFM) is a combination of two models where ECP sets up a large plantation and runs the processing plant. TRC can exchange seeds produced by farmers at the processing plant for biodiesel. This way it combines the advantages of the farmer model and the low investment/ fixed costs for TRC.

5.2 Model Evaluation

The five models are weighed against the 36 grouped criteria on a scale of 1-5. 5 points for best possibilities, 1 for worst, 0 point for equality. Equality occurs when the criteria are straightforward, meaning that the criterion has to be met, no matter which production model is evaluated. Commitment to long-term economic and financial viability weighs equal for every model. Create shortest transportation distances is a criterion which varies between the production models and can be evaluated. In this case the shortest transportation distance scores 5 points and the longest scores 1 point. It will be attempted to always use the full 1-5 scale, thus 5 points for best, 4 points for second best etcetera. It must be considered that due to the customisation of the criteria, the influence of TRC on the input of principles and criteria and the interviews only with TRC and ECP that this study has a high internal validity but attention should be paid to this when generalising the outcomes of this research to external companies.

It must also be considered that no sensitivity or uncertainty analysis has been performed on criteria which will be used to evaluate the production models. This means that the input of the models is subject to uncertain factors and the used criteria have not been weighed for their importance and relevance. Therefore the criteria have not been not ordered by importance and it is possible that heavy and light criteria are weighed as equal. To reduce the uncertainty of the models it is advised to perform an uncertainty and sensitivity analysis, for example as described by Saltelli et al. (2008).

5.2.1 Criteria Based

Figure 8 shows the result of this evaluation which is included in Appendix 4. As can be seen in the appendix a lot of criteria are evaluated with a “0” because these are straightforward criteria. For a complete overview these will not be removed from the matrix. The evaluation is thus based on the criteria which differ amongst the models. The biggest deviations are in the principles Competition of food, energy and other local uses and Welfare of employees and local communities, since only in the FM/ EFM local communities can use some of the Jatropha products and characteristics themselves.

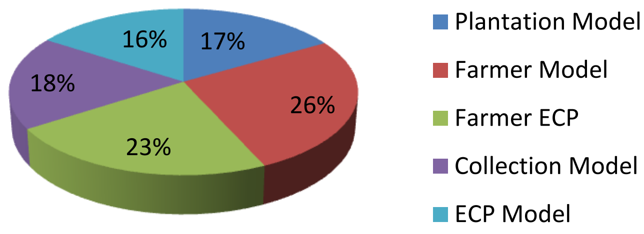

Figure 8: Criteria Based Evaluation

As can be seen the FM and the EFM score best. This is mainly caused by using the advantages of Jatropha for own use. On the other hand, in this diagram only the criteria and not the ease of implementation of the criteria are taken into account. For instance “Perform site specific carbon stock measurement” is an action which has to be performed in all different models. That this assessment is easier to perform in one large plantation than at hundreds of farmers is not taken into account. Therefore a second evaluation has been made.

5.2.2 Ease of Implementation

Because of the difficulties mentioned above a second evaluation has been made, namely the evaluation of ease of implementation, see Appendix 4. Again the five models have been weighed against the 36 grouped criteria on a scale 1-5 and 0 for equality. As can be seen in figure 9 the EM and PM are relatively the easiest to implement due to the many surveys required in the criteria. These surveys are easier to perform on one or a few locations instead of a large number of locations. A small amount of locations is also easier to monitor.

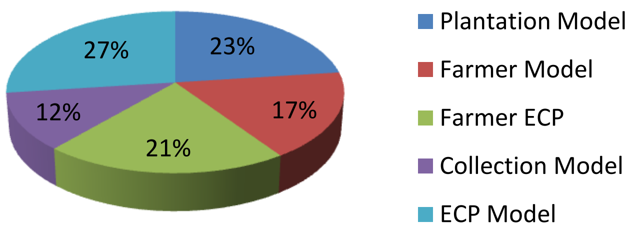

Figure 9: Ease of Implementation

Also the threat of competition of food and destruction of biodiversity is smaller since it is all concentrated in a few locations and managed by TRC. Summarized: TRC has more control over one large plantation instead of hundreds of small plantations.

5.2.3 Practical Feasibility Model Evaluation

Next to the criteria these models should also be weighed against some practical feasibility criteria: plantation area, expansion possibilities, convince population, pre-cultivation, plantation facility and processing. These criteria were discussed in consultation with TRC and ECP (TRC, 2008a). An elaborate description of this evaluation is included in Appendix 5.

Plantation Area

The first project is based on 1.000 hectares of needed plantation. At the plantation model you would need an area of 1.000 hectares in one piece. At the collection point model you would need about 2000 collection points or up to 5.000 kilometres of verge. At the farmer model you would need 200-1.000 farmers with a piece of available land between one and five hectares. Thus when we only look at using unused ground, the collection point model would be best because there is no valuable ground lost and there is no need for a large farming land. The main disadvantage is the wide spread area you will need for this. Thus when we look at the practical feasibility the farmer solution would be favourable because you need a less widespread plantation, and there is still no need for giant areas as the plantation solution claims. To make the threat of losing farmland even smaller, a way could be found to produce Jatropha in small communities/ villages, but this possibility has to be investigated.

Expansion Possibilities

When the first project is set up and successful ECP and TRC are willing to increase the size of the total project. Thus at this stage the expansion possibilities should already be thought of. With the plantation model you should almost immediately double everything, thus an incremental increase is rather difficult. At the farmer model it is rather easy to expand production, this could even be an ongoing project. Every time new farmers or villages are sought and contracted for new plantations. With the collection point model expansion is also rather easy, except for problem of the extensive number of kilometres of necessary roads needed. Thus the easiest expansion possibilities are at the farmer-scenario, this would be harder at the plantation- scenario and the hardest it would be at the ECP model.

Financial Incentives

What will make the local communities grow Jatropha or work at a Jatropha plantation? Since the Jatropha fruits cannot be harvested mechanically they have to be harvested manually. In the plantation model you will need to hire employees to harvest the fruit. The only incentive for them is money.

It is assumed that Jatropha in humid regions is flowering and developing fruits and seeds during the whole year (FACT, 2006; Nyamai, 2007) and that Jatropha produces 25 kgs seeds per day per hectare, meaning 37 kgs fruit, for the 1.000 ha plantation this means 37.000 kgs of fruit production a day which has to be harvested manually. In a case description about Diligent Energy Systems, a Dutch company that produces biofuels from Jatropha in Tanzania, it is stated that one person can harvest up to 20 kgs seed a day, meaning 28 kgs fruit (AliceO, 2007). Calculations show this means you need 1322 people to harvest on the plantation. On the other hand this seems to be the harvesting yield at the collection point model they used. There is a wide spread range of harvest indications which vary from 2 kgs dry seed a day up to 144 kgs a day (FACT, 2012). The average is about 50 kgs of dry seed a day, meaning 70 kgs of fruit can be picked manually every day. This would imply that only 528 people a day need to harvest. These people need to get paid a salary which according to Sprangers (2008a) is about €150,- a month, meaning €1800,- a year for unskilled employees. Of course there are some ups and downs in the harvesting season, but the indication of 37.000 kgs a day is used as an average.

In the farmer model there is no need to hire employees to harvest seeds, they only have to be paid for every kg of seeds they sell to TRC. As stated in the Diligent Case (AliceO, 2007) Diligent pays farmers in Tanzania €8,- per 60 kgs of Jatropha seed, which equals 13 eurocent per kg. In Tanzania the Gross Domestic Product (GDP) per Capita in 2012 is €467,- (577 dollar at an exchange rate of 1 US Dollar = 0.81 Euro) and the GDP based on purchasing-power-parity (PPP) per capita is €1.296,- (IMF, 2012). Both figures in Cameroon are GDP per Capita €964,- and GDP PPP is €1.880,- (IMF, 2012). As can be seen both figures in Cameroon are 1.5 till 2 times higher therefore it is questionable whether Cameroonian farmers and communities are willing to work for this price. Also when looking at the minimum prices Max Havelaar pays for Fair Trade products (FLO, 2009) this is an extremely low rewarding for crops.

- Soy beans €0,32/ kg.
- Seed Cotton average €0,44/ kg.
- Cheapest crop to be found are oranges from Argentina €0,12-€0,14/ kg.

When you look at these prices farmers would be foolish to start planting Jatropha because every other crop will have a higher financial yield and thus more income. On the other hand, one hectare of Jatropha production at the farmers land produces about 37 kgs Jatropha fruit a day, meaning 25 kgs seed. Thus €3.25 a day, €1.186 a year, meaning that with one hectare a farmer could already earn an average year salary although it must be discussed with the farmer that Jatropha should be a supplement, not a principal income. It is also stated that: *“Although the global growth in demand for biofuels had been driven by concerns about greenhouse gases and climate change, the interest in biofuels in developing countries is primarily related to new possibilities for income – at the household, village, and country level”* (Karlsson, 2009, p. 6).

In the last chapter of this thesis there will be a financial evaluation of the several production models and then it can be examined whether there is any margin in the price per kg.

In both production models there is a threat that farmers or communities will sell the seeds to another company than TRC. Due to globalisation these people have more and more access to information, by cell phones and internet, and could search for a company who will pay them a higher price for their seeds. This has been discussed with the Max Havelaar Foundation which states that they normally promote this kind of initiatives (Eshuis, 2012). Farmers will become more aware of the value of their products which makes them more independent. On the other hand Eshuis (2012) states that the price offered to farmers by Max Havelaar is still a fair price which has not been outbid by other companies on a large scale yet.

Farmers who do not possess two hectares of available farmland but less, could also still gain a guaranteed income by producing Jatropha as a hedge. This could be an incentive for them to start a plantation. Next to this guaranteed income farmers can also utilise the other benefits of the Jatropha plant and its products. Jatropha could be a good supplement for the income of the farmer by combining Jatropha with other crops. Besides this Jatropha can grow on marginal grounds or as hedges, where other crops cannot grow. By doing so the farmers can use grounds which formerly were useless. Next to this Jatropha produces waste (fruits, press cake) which can be used as fertilizer with which current food production can be increased and the oil can be used for cooking, lighting and electricity. Also Karlsson (2009) stated that biofuels can help farmers by giving them access to fuel for motorized farming equipment. With all these spin-off products, cultivation of Jatropha is interesting for farmers. The major advantage for TRC of approaching farmers is that the farmers have experience, expertise and probably (some) cultivation equipment. This makes it easier to approach these people.

In the case of the collection point model local communities harvest the Jatropha seeds instead of the farmers. This has the advantage that the communities will not utilise any ground of themselves. They will get paid for every kg of seed they collect but have little benefits from Jatropha as a crop except maybe the fruit coat and the press cake. Therefore their main incentive is money. As Beerens (2007) noticed during his field trips in Tanzania, not only farmers were moderately motivated to grow Jatropha, but also local community was not really motivated to collect Jatropha seeds from the wild Jatropha trees (Beerens, 2007). This was most likely also caused by the low prices Diligent pay them. As mentioned before in the last chapter it will be examined whether there is any margin in this price per kg. Only when a construction can be invented were the farmer harvests the fruits, takes them home where they will be pressed, then the farmer can utilise the fruit coat and the press cake to improve farmland.

Pre-Cultivation

Pre-cultivation entails all handling needed before the plantation can be started, meaning things like achieving the seeds, germination, nursery, planting, feeding and replanting. It is rather obvious that the fewer places pre-cultivation takes place, the easier it is because you can apply economies of scale. The plantation scenario has the lowest number of different cultivation places and therefore pre-cultivation can be at the utmost centralised. This makes it possible to centralize all the pre-cultivation activities in a nursery. Using a nursery increases the germination chance and with better methods the final Jatropha plant will probably have a better yield. Better properties will most likely lead to higher yield of biodiesel per hectare or per unit (Koh, 2007). But there is of course also the option of centralised pre-cultivation and after that transport and replant Jatropha on decentralised locations.

Plantation Facility

Similar to the pre-plantation conditions, also at the plantation scenarios the conditions are favourable when the fewest possible places are used. All material can be centralised, transportation costs lowest, harvesting and dehulling can all be centralised, which means least machinery necessary and thus lowest costs.

Processing

Same as the plantation conditions the processing phase is also easiest with the lowest number of sites. But only the collecting part of this phase is different from the other scenarios, since after the seeds are picked up they can be transported to one single place. Of course there an efficient as possible transportation process has to be thought of.

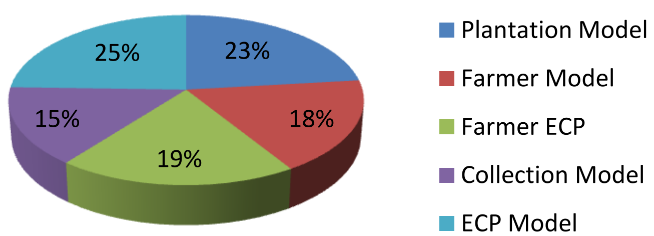

Figure 10: Practical Based Evaluation

Woman

What has not been included in this evaluation yet is the role women could play in Jatropha production. Narayanaswamy (2009) has surveyed over 680 households in India and concluded that in particular the women can be the key in biofuel production in rural areas. *"It is the women who can play all possible roles starting from harvesting the seeds from the biodiesel plants, de-shelling seeds, expelling the oil from the seeds to ultimately marketing the final product which could be oil"* (Narayanaswamy, 2009, p. 2).

It is stated that woman are motivated to work in biofuel projects because it will lead to *"new income-producing activities, so that women can afford to send their children to school, feed their families nutritious food, provide better health care and living conditions, and have more power to make decisions within their households and communities"* (Karlsson, 2009, p. 6). In addition Karlsson (2009) and Narayanaswamy (2009) state that the empowerment of women includes planning and management decisions instead of simply work in a biofuel plantation.

5.3 Selection of Production Models

When we look at the first evaluation of the models, weighed against the regrouped criteria, it can be concluded that the best model would be the farmer- or farmer-ECP model. This is mainly the result of the benefits that farmers and communities have from the characteristics and rest products of Jatropha production. However when we look at the ease of implementation the two plantation models are the best option because there are many surveys to accomplish which are easier when there are fewer plantation places. When we look at the third evaluation it can be seen that there are some practical issues like centralised pre-cultivation and processing, which cause shorter transport distances, which again is favourable for the reduction of carbon emission. On the other hand it is practically harder to find large unused plantation areas and at a later stage to expand these locations with again large unused plantation areas. Also the number of collection points and verges needed in the collection point model can cause some practical problems since you would need approximately around 2000 collection points or up to 5.000 kilometres of verge. To approach farmers is easiest because of their knowledge and they can use the benefits of Jatropha the most and can earn some money. Especially when this includes empowerment of women. When applying the plantation or ECP scenario the communities have only benefits in terms of money. At the collection point farmers and communities could gain some benefits of Jatropha products when a construction can be invented where the farmers can take the fruits home where they will be pressed. The farmer can utilise the fruit coat and the press cake to improve farmland.

5.3.1 Remaining Questions Related to the Models

Questions Related to the Plantation Model

- Could this model fit in the goals of TRC to create a social and economic production model?
- Is there 1.000 hectare low value ground available near the forest concessions of TRC?
- Is this ground for sale?
- Are there enough people available near the forest concessions of TRC to work there?
- Are these people willing to work at a plantation?
- Are these people willing to work for €150 a month?

- How many kilograms of seed can one person actually harvest in one day? Is this 20 kgs a realistic number?

Questions Related to the ECP Model

- In addition to the questions for the Plantation Model.
- Is there 20.000-100.000 hectare low value ground available near the forest concessions of TRC?

Questions Related to the Collection point Model

- Is there 1.000 hectare low value ground available in the forest concessions of TRC at collection points, riverbanks and verges?
- Are there enough people available near the forest concessions of TRC?
- Are these people willing to collect the seeds?
- Are these people willing to work for €0,13 per kilogram collected seed?
- How many kilograms of seed can one person actually harvest in one day? Is this 20 kgs a realistic number?

Questions Related to the Farmer Model

- Is there 1.000 hectare low value ground available at farmland of farmers or communities near the forest concessions of TRC?
- Is this farmland really unused?
- Whose possession is this land?
- Are there enough farmers available near the forest concessions of TRC?
- Are these farmers in general interested in producing Jatropha?
- Do they see the benefits other than money?
- Are these benefits useful to the farmers/ communities?
- Are these people willing to work for €0,13 per kilogram collected seed?
- What price else?
- How many kilograms of seed can one person actually harvest in one day? Is this 20 kgs a realistic number?

Questions Farmer-ECP Model

- In addition to the questions for the ECP Model
- In addition to the questions for the Farmer Model.

6 Financial Evaluation

This chapter will describe the financial evaluation of the different production models. An elaborate calculation of the costs can be found in Appendix 6. To start a Jatropha production, there are several investments to be made. The costs of investments versus the benefits compared with current diesel purchase will be discussed. First a rough indication of investments will be made:

- Education production leaders.
- Equipment production leaders.
- Education local communities.
- Import of seeds.
- Production costs.
- Press installation.
- Filtering installation.
- Collection equipment.
- Compensation local communities.
- Transesterfication equipment.
- Transportation costs.
- Maintenance costs.

The majority of these costs are marginal when you compare them with the total project costs which may not exceed the current fossil fuel costs which are €2.225.000,-, (3 million litres of diesel at €0,75/ litre). First these costs will be dealt with, hereafter a focus will be on the largest variables.

Again it must be considered that no sensitivity or uncertainty analysis has been performed on the input data of the financial analysis. This means that the input of the models is subject to uncertain factors and the used figures have not been weighed for their importance and relevance. To reduce the uncertainty of this evaluation it is advised to perform a sensitivity analysis.

6.1 Basic Costs

The basic costs are composed of the costs for education and equipment of production leaders who will educate local communities, salaries of production members, importation of the Jatropha seeds, purchasing several installations like pressing-, filtering- and transesterfication installations, production, transportation and maintenance costs. These costs are about the same for the Plantation, Farmer and Collection point Model. Some of these costs can be split in the Farmer-ECP Model and these costs are cancelled in the ECP model. Of course there is some financial shifting within these models.

At the plantation model there are less transportation costs but more cultivation equipment costs while at the Farmer Model farmers probably own cultivation equipment but this model includes higher transportation costs.

One of the basic costs which should be highlighted is the pressing process (only applicable in the Collection point, Farmer and Farmer-ECP Model). One of the most logic ways to do this is by collecting bags of seeds at the farmers, transport them to the central processing plant and press the seeds under ideal circumstances to gain the highest possible yield. Diligent presses the seeds centralised in Arusha because they say they need to use or sell the press cake to make the project financially feasible (Dilligent, 2012). On the other hand since it is stated before that the press cake is important for the local communities, it would be better to return the press cake to them. Since transporting seeds from one place to another on long distance and the cake vice versa is not preferable, it would be recommended to use decentralised press installations. This could mean several delivery points where farmers bring their seeds, get their money and press cake. This could also mean that every farmer has its own small press installation and TRC collects the oil. This may possibly even be a mobile press truck which drives around alongside all the farmers, presses the seeds and pays the farmer who also gets his cake back. The last option can be an interesting one, since it combines the advantages of high pressing yield and benefits for farmers.

Thus to conclude, the farmers need to restrain their press cake and preferably more, like oil for cooking, electricity or soap. This makes it hard to create centralised press installations because this causes an unacceptable high transportation factor. According to Beerens (2007) decentralised pressing is preferable because expansion into new geographic areas is easier as fewer investments are required. This also includes the use of the mobile press truck. The total of the basic costs is around €150k to €350k.

6.2 Variable Costs

The variable costs exist of salary costs at the Plantation Model and purchasing of seeds at the Collection point, Farmer and Farmer-ECP Model. First there will be a salary calculation to find out whether the Plantation Model is feasible and then there will be a calculation of the costs of purchasing the seeds from the farmers and the communities.

Plantation and ECP Model

As mentioned in Chapter 5 the Jatropha fruits cannot be harvested mechanically, they have to be harvested manually. In the Plantation Model you will need to hire employees to harvest the fruit. As assumed in Chapter 5 the average indication of harvesting per person per day is about 50 kgs of dry seed a day, meaning 70 kgs of fruit can be daily picked manually. This would imply that when Jatropha produces 25 kgs seeds per day per hectare this means for 1.000 ha 37.000 kgs fruit production a day which has to be harvested by 528 people.

According to Sprangers (2008a) the salary of unskilled employees is about €150 a month, meaning €1800 a year, which implies that harvesting 1.000 hectares plantation will cost €951.500. When you include that these people will not work 7 days a week but about 70% (including weekends and vacations) this would mean you need 754 employees, costing €1.357.200. What is not included in this price are the costs for purchasing the ground for the plantation. These costs will not be included in the calculation since the only indication to be found was €1,50 per square metre, meaning 15 million euro. This has to be verified.

Collection point and Farmer Model

In the farmer and Collection point Model there is no need to hire employees to harvest seeds, they only have to be paid for every kg of seeds they sell to TRC. As stated in the Diligent Case (AliceO, 2007) Diligent pays farmers €8 per 60 kgs of Jatropha seed, which equals 13 eurocent per kilo. One hectare of Jatropha production at the farmers land produces about 37 kgs of Jatropha fruit a day, meaning 25 kg of seed. Thus €3,25 a day, €1.186 a year, meaning that with one hectare a farmer could already earn an average year salary. To produce 3 million litres of biodiesel approximately 10.000.000 kgs of Jatropha seeds needs to be bought at the price of 13 eurocent per kilo which equals €1.300.000,-.

6.3 Conclusion Financial Evaluation

Table 2 shows that all the models seem to be financially feasible even when including a 20% uncertainty margin. As can be seen the Plantation Model is the most expensive model, but still has about €250k profit margin compared to the original price offered for fossil fuel. But taken into account that the purchasing of the ground is not included, this model most likely exceeds the price TRC is paying for its fossil fuel at this moment.

The Collection point Model ends at second place actually together with the Farmer Model. But since it is assumed at the Farmer Model that there is a smaller investment in material and education because farmers likely own some farming material and already have the knowledge, the Collection point Model ends second and the Farmer Model ends third. In these two models there is an assumed profit margin, in comparison with fossil fuel, of respectively €270k and €330k.

The next model is the ECP Model since all the fixed costs are for the account of ECP. It is assumed that ECP is willing to sell the biodiesel, they have produced rather cheaply due to scale advantages of about 10%, for the cost price of €0,50. With this assumption the possible profit will be €450k.

The model with the lowest costs is the combined Farmer and ECP Model. In this model a part of the fixed costs are for the account of ECP, this includes salary and other costs. When the assumptions in this model are correct, including an uncertainty margin, this model would result in a profit of approximately €480k compared with the current fossil fuel situation.

Looking back to the financial part of the research question, *"Under what conditions can TRC produce three million litres of biodiesel a year, at an economic price?"* it can be concluded that all the models seem to be financially feasible even when including a 20% uncertainty margin. But is has to be taken into account that no sensitivity or uncertainty analysis has been performed on the input data of the financial analysis. This input data has to be verified.

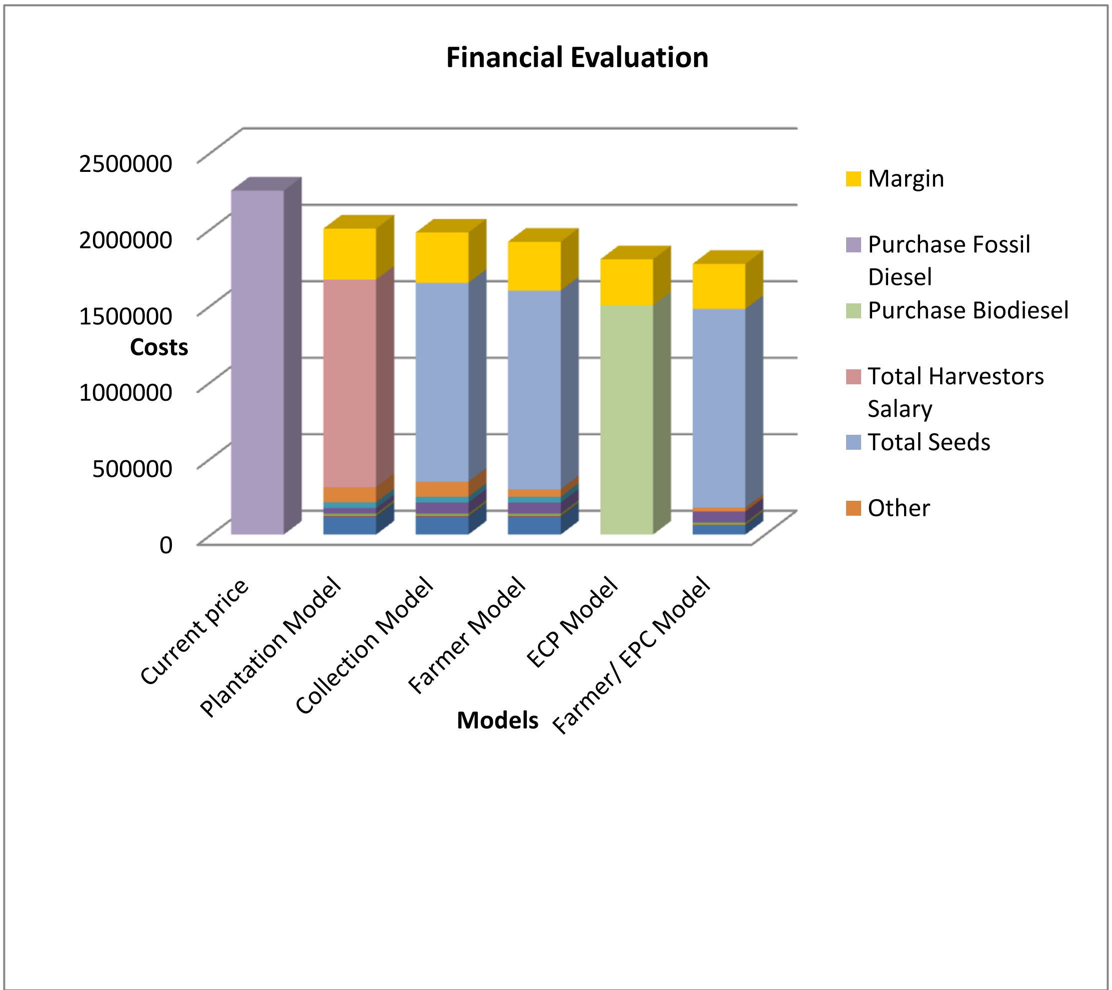

Table 2: Conclusion Financial Evaluation

7 Summary, Conclusion and Recommendations

7.1 Summary

The first chapter is set up to determine the research framework of this thesis, which has resulted in a literature review of all the keywords, has created the research question and three sub questions. In the second chapter a specific calculation has been made to predict Jatropha oil yield per hectare, which concluded that 1.000 hectares of Jatropha plantation is needed. The second chapter also concluded that it is preferable that the characteristics of Jatropha could be used by farmers and local communities. The third chapter has combined the principles and criteria of the articles and sustainability standards in a matrix and added the criteria of TRC and the criteria extracted from Chapter 2. Chapter number four has discussed these twelve principles including about 120 associated criteria. These discussions have lead to the final selection of criteria, which will be used to evaluate the production models. Since there was some overlap in these criteria, these have been regrouped into three sets of criteria: 1) criteria that need to be dealt with in the time before approaching any producer in Cameroon, 2) criteria at the beginning of approaching the producers and at the start up of the plantations where sourcing plans have to be made, 3) criteria that deal with the conditions during production.

Chapter 5 has started with the elucidation of the five production models, namely the Plantation Model, ECP Model, Collection point Model, Farmer Model and the Farmer-ECP Model. Hereafter these production models are evaluated, which is done in three steps. First they were evaluated according to the customised criteria mentioned in chapter 4. Because of possible difficulties occurring during the implementation of these models a second "ease of implementation" evaluation is made. Also a third evaluation on practical feasibility is made. The final chapter evaluates the financial consequences of the five production models and concludes that all the models seem to be financially feasible, even including a 20% uncertainty margin.

7.2 Conclusions

7.2.1 Conclusion Sub Research Question 1

"What are current sustainability principles and criteria used to assess biofuel projects?"

The current sustainability principles and criteria are combined in Appendix 1. These are the sustainability principles and criteria from the Cramer Criteria, the RSB and RSB Jatropha Working Group, the RSPO, the Gold Standard, the UN-REDD and the FSC standards. The principles and criteria resulting from these sustainability standards have been combined in a matrix and have been extended with the criteria resulting from Jongschaap's Claims and Facts on Jatropha, TRC's criteria and the criteria which resulted from Chapter 2 Jatropha.

The combined list of current sustainability principles used to assess biofuel projects is as followed:

1. Greenhouse gas reduction
2. Carbon reservoirs
3. Competition food, energy and other local uses
4. Production of biomass compared with biodiversity
5. Production of biomass compared with soil quality
6. Production of biomass compared with ground- and surface water
7. Production of biomass compared with air quality
8. Production of biomass compared with local prosperity
9. Production of biomass compared with welfare of employees and local communities
10. Commitment to transparency
11. Energy efficiency and waste reduction
12. Monitoring and certification

These 12 principles contain in total 120 criteria which can be found in Appendix 1.

7.2.2 Conclusion Sub Research Question 2

"Which criteria can be used to enable TRC to produce biodiesel in such a manner that it meets the company's sustainability goals?"

The criteria which should be used to enable TRC to produce biodiesel in such a manner that it meets the company's sustainability goals result from the previous 12 principles and 120 criteria and can be found in the Appendix 3. Since there is some overlap, these criteria can be regrouped into three groups of criteria:

- First of all, the criteria that deals with the time before approaching any producer in Cameroon. These are criteria dealing with the calculation of carbon reduction in general, with legal requirements and social impacts.

- The second and most important group will be the group of criteria at the beginning of approaching the producers and at the start of the plantations. These criteria deal mainly with creating the sourcing plans. These sourcing plans are written agreements between TRC and the farmers and local communities and include documented operating procedures. The complete list of operating procedures can be found in Appendix 3 and includes site specific environmental surveys, economic agreements, property agreements, environmental agreements, agreements about working conditions. Commitment to long-term economic and financial viability and commitment to transparency, and ensure to encourage the participation of women, youth, and indigenous communities and give special attention to the most vulnerable and marginalized groups.

- The final grouping of criteria deal with the conditions during production. This includes monitoring, reviewing and improving the sourcing plans, agreements on collecting the seeds, economic agreements and agreements to reduce the environmental impact. Examine the possibly to apply for an (RSB/ FSC/ Fairtrade) certificate for the entire biofuel production chain.

The complete list of criteria can be found in Appendix 3.

7.2.3 Conclusion Sub Research Question 3

"Which production models are able to produce biodiesel in a manner that meets TRC's sustainability criteria?"

ECP Model

The ECP Model has advantages in the ease of implementation, because there are many surveys to accomplish the sourcing plan, which are easier when there are less plantation places. This model also exceeds on some practical issues like centralised pre-cultivation and processing, which cause shorter transport distances, which again is favourable to the reduction of carbon emission. Finally the ECP Model has probably significant scale advantages. On the other hand it might be practically harder to find giant unused plantation areas and to expand the plantation in a later stadium, again giant plantation areas. Also the communities have only benefits in terms of money. Since the salaries of the fruit pickers will be the largest expenses for TRC this has a major impact on the total go/no go decision. Although this model is predicted as the second cheapest production model the ECP model is not favourable to meet TRC's sustainability criteria because of the minimal benefits for the communities around TRC's forest concessions.

Plantation Model

The most criteria mentioned in the ECP Model also apply for the Plantation Model. Only at the Plantation Model the salaries will have to be paid by TRC and there is less scale advantage. This model is predicted as the most expensive production model and provides minimal benefits, other than money, for the communities around TRC's forest concessions. Therefore the Plantation Model is not favourable to meet TRC's sustainability criteria.

Collection point Model

The Collection point Model could gain more benefits for local communities of Jatropha products when a construction can be invented where the communities can take the fruits home where they will be pressed. The communities can utilise the fruit coat and the press cake to improve their farmland. But on the other hand the amount of needed collection points and verges will probably cause practical problems, since you would need approximately around 2.000 collection points or up to 5.000 kilometres of verge.

This model has also more difficulties in the ease of implementation, because there are many surveys to accomplish the sourcing plan. And since it has been observed that collecting Jatropha for relatively little money is not an option, reward for the seeds has a major impact on the total go/no go decision. This model is predicted as the production model in the financial middle but due to the practical problems and the small benefits for the communities around TRC's forest concessions this model is not favourable to meet TRC's sustainability criteria.

Farmer Model

The Farmer Model could gain the most benefits for local communities. This is mainly the result of the benefits that farmers and communities have from the characteristics and rest products of Jatropha production. The Farmers are easy to approach because of their knowledge and they can use the benefits of Jatropha the most and at the same time earn some money. The farmers and communities can utilise the fruit coat and the press cake to improve their farmland. Especially when this includes empowerment of women. It is stated that woman are motivated to work in biofuel projects because it will lead to new income-producing activities and instead of simply work in a biofuel plantation it is stated that the empowerment of women includes planning and management decisions. On the other hand this model has also more difficulties in the ease of implementation, because there are many surveys to accomplish the sourcing plan. And it has been observed that collecting Jatropha for relatively little money is not an option but in this model the farmers have more benefits than money alone. This model is predicted as the production model in the financial middle but due to the benefits for the communities around TRC's forest concessions this model is most favourable to meet TRC's sustainability criteria.

Farmer ECP Model

The Farmer ECP model combines the advantages and disadvantages of these two models. The biggest advantage of combining these two are financial benefits for TRC since some basic costs can be shared with ECP. This model is predicted as the cheapest production model and due to the benefits for the communities around TRC's forest concessions this model is also favourable to meet TRC's sustainability criteria except that there are still some practical problems with usable land.

7.2.4 Conclusion Research Question

"Under what conditions can TRC produce three million litres of biodiesel a year, using Jatropha produced by local communities, in a sustainable manner, at an economic price?"

If we look back to the motives of TRC to start this project, to help local communities in a social, economic and sustainable way and to reduce carbon emission without increasing costs the following can be concluded. The ECP Model should be skipped because this is the least social, economic and sustainable model for the local communities around forest concessions of TRC, since the ECP plantation is presumably placed in another region.
Also in the Plantation Model there are only financial benefits. And as mentioned before the Collection point Model might be practically difficult due to the amount of needed verges.

Therefore, if TRC really want to help local communities in a social, economic and sustainable way and reduce carbon emission without increasing costs, they should choose the Farmer Model. This is a feasible model, a lot of farmers or communities will benefit in an economic and sustainable way. These benefits are not only in financial terms, but also in a social way if farmers and communities can use some of the Jatropha products themselves. There is a possibility of soil improvement and erosion prevention. Small scale energy production for lighting can help children to study at night and when this energy is used for cooking it can prevent small scale deforestation. Especially when this includes empowerment of women, including planning and management decisions. It also has a lot of benefits for TRC because it is the easiest model to expand production - this could even be a continuous project. Every time new farmers or communities are sought, surveyed and contracted for new small scale plantations. The only disadvantages are the surveys and the formulation of the sourcing plans, which might be a time consuming operation. All documents, agreements, surveys and baselines will have to be registered in the sourcing plan, which will be regularly monitored, evaluated and continuously improved. In addition it is still questionable whether farmers and communities will harvest and sell the Jatropha seeds or oil to TRC for the discussed price which is €0,13. It is calculated that there is a margin left in the Farmer Model of about €330.000,-. Calculation shows that the maximum price TRC can pay for the seeds per kilo is €0,16.

In order to have some extra margin in the total costs of this project it would be a possibility to combine the Farmer Model with the ECP Model. The farmers produce Jatropha just as in the Farmer Model, therefore they still can utilise the agricultural and economic benefits and TRC will also collect the seeds or oil as mentioned in the Farmer Model. TRC will only not process these seeds or oil themselves but this will be done at the large plantation and processing plant of ECP, somewhere else in Cameroon. TRC will sell/ exchange the seeds or oil for processed biodiesel.

This way the fixed costs of processing are accounted for ECP and this creates some extra margin for TRC to pay the farmers in the Farmer Model. And thus in this way you can combine a social-economic project with scale advantages of the ECP Model. This option would make it possible for TRC to pay € 0,18 per kilo Jatropha seed.

As mentioned before it must be considered that no sensitivity or uncertainty analysis has been performed on the input data of the analysis. This means that the input of the models might be subject to uncertain factors and the used figures have not been weighed for their importance and relevance.

7.3 Recommendations

This last section will discuss the recommendations for future research. It is recommended to perform several studies before starting a plantation anywhere, to make sure that all of the assumptions are right.

7.3.1 Recommendations for Future Research TRC/ Plant Research International Wageningen

The indication of the yield of Jatropha in Cameroon is a theoretical, calculated indication, which gives a yield figure of 10.500 kgs of Jatropha seed per hectare, whereas other yield figures given in literature vary from 1.5-7.8 tons of seed per hectare. These are therefore the first figures that should be verified to ensure these data are correct. This could be done by comparing the yield with that of existing plantations in the same area in Cameroon. This will give the most accurate indication. When there is no comparable plantation available it will be necessary to start a trial plantation in this area. These verifications should provide the real yield of Jatropha in the presumable location in Cameroon.

Next to the yield there are some other facts that need further research. These facts are to detailed and biological to put in this Business Administration thesis, but they are very important when TRC is starting plantations. The answers to these questions should be given by specialists working in this area. These questions involve:

- Which plagues and diseases are threats for Jatropha in Cameroon?
- Nitrogen is scarce in tropical areas. Low nitrogen will impede the photosynthesis and consequently the growth of the fruit. How does this affect the harvest per hectare of the plantation? How can we evaluate and solve this?
- How many nutrients are taken away by the Jatropha fruits and how much manure is needed?

7.3.2 Recommendations for Future Research TRC/ University of Twente

When the real yield and data about other biological questions are clear, there are some other studies to perform before a plantation is started. These are:

- Perform an RTFO Greenhouse Gas Life Cycle Assessment to make sure the carbon emission reduction compared to fossil fuel is at least 50% or preferably higher.
- Investigate legal policy to comply with all applicable local, national and international laws and regulations regarding soil and water conservation and air pollution.
- Perform a social impact survey.
- Perform an uncertainty and sensitivity analysis to reduce the uncertainty of the evaluation.

7.3.3 Recommended for Future Research TRC

Last but not least some practical questions are left concerning the Farmer Model. These are:

- Ensure there 1.000 hectare low value ground available at farmland of farmers or communities near the forest concessions of TRC.
- Ensure this farmland really unused.
- Examine whose possession is this land.
- Examine whether there enough farmers available near the forest concessions.
- Examine whether these farmers in general interested in producing Jatropha.
- Ensure they see the benefits other than money.
- Examine whether these benefits useful to the farmers/ communities.
- Examine whether farmers are willing to work for €0,13 till €0,18 per kg collected seed.
- Examine what price else?
- Examine how many kgs of seed one person can actually harvest in one day. Is 50 kgs a realistic figure?

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9 Appendixes

1 Combined Principles and criteria Matrix

		Cramer	RSB	RSPO	Gold standard	Jongschaap	UN-REDD	FCS	Reef	Jatropha
Principle 1	**Greenhouse gas:**									
	reduction of CO2 compared with fossil	x	x	x	x		x		x	
	Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels		x							
Principle 2	**Biomass vs carbon reservoirs**									
	concervation of above groud carbon reservoirs	x	x	x			x			
	concervation of undergroud carbon reservoirs	x	x	x			x			
Principle 3	**Competition food, energy and other local uses**									
	Monitor changes in landuse	x								
	Monitor changes in prices	x								
	Comprehensive and participatory independent social and environmental impact assessment is undertaken			x						
	Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions		x				x			
	Forest management shall not threaten or diminish, either directly or indirectly, the resources or tenure rights of indigenous peoples.							x		
	Sites of special cultural, ecological, economic or religious significance to indigenous peoples shall be clearly identified in cooperation with such peoples, and recognized and protected by forest managers.							x		
Principle 4	**Biomass vs biodiverity**									
	Don't break local rules according areas	x	x	x			x			
	no harm to biodiversity in protected areas	x	x	x			x	x	x	
	no harm to biodiversity other high-biodiverse areas	x	x	x				x	x	
	Remain or recovery biodiversity	x	x	x	x		x	x	x	
	Strengthen biodiversity where possible	x	x	x	x		x	x		
	Operating procedures are documented, implemented and monitored		x	x			x	x		
	Pests, diseases, weeds and invasive introduced species are managed using Integrated Pest Management (IPM) techniques		x	x				x		
	Agrochemicals are used in a way that does not endanger the environment			x						
	Ensure consistency with and contribution to national biodiversity conservation policies						x			
	Minimise indirect land-use change impacts of REDD+ activities on forest carbon stocks, biodiversity and other ecosystem services						x			
	Minimise adverse impacts on carbon stocks, biodiversity and other ecosystem services of non-forest ecosystems resulting directly from REDD+ activities (such as afforestation)						x			
	The rate of harvest of forest products shall not exceed levels which can be permanently sustained.							x		
	Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g., nesting and feeding areas).							x		
	Written guidelines shall be prepared and implemented to: control erosion; minimize forest damage during harvesting, road construction, and all other mechanical disturbances; and protect water resources.									
	A management plan -- appropriate to the scale and intensity of the operations -- shall be written, implemented, and kept up to date. The long term objectives of management, and the means of achieving them, shall be clearly stated.							x		
Principle 5	**Biomass vs soil quality**									
	Don't break local rules according soil conservation	x	x	x			x			
	use best practice to remain or increase soil quality	x	x	x	x	x			x	
	Use of rest products is not against other local functions	x								
	Operating procedures are documented, implemented and monitored		x	x				x		
	Practices minimise and control erosion and degradation of soils		x	x	x				x	
	Agro chemicals are used in a way that does not endanger the environment			x						
	Soil surveys and topographic information are used for site planning in the establishment of new plantings, and the results are incorporated into plans and operations			x						
	To use the Jatropha crop for erosion control									x

		Cramer	RSB	RSPO	Gold standard	Jongschaap	UN-REDD	FCS	Reef	Jatropha
Principle 6	**Biomass vs ground- and surface water**									
	Don't break local rules according water conservation	x	x	x			x			
	use best practice limit wateruse and to remain or increase ground- and surface water	x	x	x	x					
	No use of water from non-renewable sources	x								
	Operating procedures are documented, implemented and monitored		x	x				x		
	Include a water management plan which aims to use water efficiently and to maintain or enhance the quality of the water resources that are used for biofuel operations		x							
	To use the Jatropha crop for water conservation									x
Principle 7	**Biomass vs air quality**									
	Don't break local rules according air pollution	x	x	x			x			
	use best practice to restrict emission and air pollution	x	x		x					
	No fires to build or manage biomass production units (ASEAN guidelines)	x	x	x						
	Operating procedures are documented, implemented and monitored		x	x				x		
	Plans to reduce pollution		x	x	x					
	Other pollutants like noise/ light				x					
Principle 8	**Biodiversity vs local prosperity**									
	Biomass production should contribute to local business activities and local economy	x	x		x	x	x	x	x	
	Commitment to long-term economic and financial viability		x	x				x		
	Operating procedures are documented, implemented and monitored		x	x				x		
	Pay and conditions for employees meet at least legal or industry minimum standards		x	x						
	In regions of poverty, special measures that benefit and encourage the participation of women, youth, indigenous communities and the vulnerable in biofuel operations shall be designed and implemented.		x							
	Indigenous peoples shall be compensated for their traditional knowledge regarding the use of forest species or management systems in forest operations.							x		
Principle 9	**Biomass vs welfare employees and local community**									
	No negative effects on working conditions of employees	x	x		x			x		
	No negative effects on human rights	x	x		x					
	Use of land does not cause any violation in private property without approval of well informed community	x	x	x			x	x		
	The (legal) right to use the land can be demonstrated		x	x				x		
	Local people are compensated for any agreed land acquisitions			x						
	Possitive contribution to the welfare of local community	x			x	x	x		x	
	Reflection on possible violation of integrity of the company	x								
	Possibility for farmers to develop skills				x	x		x		
	All staff, workers, smallholders and contractors are appropriately trained		x	x						
	Ability to use biomass as local energy source (for lightning, so childeren can learn at night)					x				
	Ensure equitable, non-discriminatory and transparent benefit sharing and distribution among relevant stakeholders with special attention to the most vulnerable and marginalized groups						x			
	Develop a processing industry					x		x		
	Ability to use biomass as raw material for ea soap production					x				x
	To use the Jatropha oil for small scale energy production (lightning)									x
	To use the Jatropha crop as hedge/ living fence									x
	To use the Jatropha fruit coat as fertilizer									x
	To use the Jatropha seed shells and press cake as combustibles or as fertilizer									x
	Operating procedures are documented, implemented and monitored		x	x				x		
	Agrochemicals are used in a way that does not endanger health		x	x						
	An occupational health and safety plan is documented, effectively communicated and implemented			x						
	Forest management should meet or exceed all applicable laws and/or regulations covering health and safety of employees and their families.							x		
	Aspects of plantation and mill management that have social impacts are identified. Plans to mitigate the negative impacts and promote the positive ones are made, implemented and monitored, to demonstrate continuous improvement			x				x		

		Cramer	RSB	RSPO	Gold standard	Jongschaap	UN-REDD	FCS	Reef	Jatropha
	Mutually agreed and documented system for dealing with complaints and grievances (implemented and accepted by all parties)			x						
	negotiations concerning compensation for loss of legal or customary rights are dealt with through a documented system that enables all parties			x						
	The employer respects the right of all personnel to form and join trade unions of their choice and to bargain collectively			x						
	The rights of workers to organize and voluntarily negotiate with their employers shall be guaranteed as outlined in Conventions 87 and 98 of the International Labour Organisation (ILO).							x		
	Children are not employed or exploited. Work by children is acceptable on family farms, under adult supervision, and when not interfering with education programmes		x	x						
	Any form of discrimination is prohibited			x						
	There is a policy to protect woman from sexual harassment or other violence		x	x						
	Good practices shall be implemented for the storage, handling, use, and disposal of biofuels and chemicals		x							
	Respect and protect traditional knowledge and cultural heritage and practices						x			
	Indigenous peoples shall control forest management on their lands and territories unless they delegate control with free and informed consent to other agencies.							x		
	Appropriate mechanisms shall be employed for resolving grievances and for providing fair compensation in the case of loss or damage affecting the legal or customary rights, property, resources, or livelihoods of local peoples.							x		
	Ensure accountability and legitimacy of all bodies representing stakeholders, including through establishing responsive national feedback, complaints and grievance mechanisms, amongst others						x			
	A comprehensive and participatory independent social and environmental impact assessment is undertaken prior to establishing new plantings or operations, or expanding existing ones, and the results incorporated into planning, management and operations.			x	x					
	Ensure the full and effective participation of relevant stakeholders, in particular, indigenous peoples and other forest dependent communities, with special attention to the most vulnerable and marginalized groups						x			
Other	**Certification**									
	Certified production models	x	x	x		x	x			
Other	**Commitment to Transparency**									
	Biomass producers will provide adequate information for complete transparancy		x	x	x		x	x		
	Management documents are publicly available (except confidential)		x	x	x		x			
	Open and transparent communication between all parties	x		x	x			x		
Other	**Efficiency and waste**									
	Efficiency of energy use and use of renewable energy is maximised			x						
	Waste is reduced, recycled, re-used and disposed of in an environmentally and socially responsible manner		x	x	x			x		
	Growers and millers contribute to local sustainable development wherever appropriate			x						
	Growers and millers regularly monitor and review their activities and develop and implement action plans that allow demonstrable continuous improvement in key operations			x				x		
	Promote and enhance gender equality, gender equity and women's empowerment		x				x			
	Promote coordination, efficiency and effectiveness, including cooperation across sectors and in the enforcement of laws						x			
	Ensure the rule of law and access to justice						x			
	Forest management shall respect all national and local laws and administrative requirements.							x		
	All applicable and legally prescribed fees, royalties, taxes and other charges shall be paid.							x		
	Conflicts between laws, regulations and the FSC Principles and Criteria shall be evaluated for the purposes of certification, on a case by case basis, by the certifiers and the involved or affected parties.							x		

2 Large and small-scale Causes of deforestation

When searching for articles about the causes of deforestation, in general two major groups can be distinguished.

2.1.1 Large-scale global causes

First several global causes which are summarized by Gbetnkom (2005) and Martin (2008).

- Stryker et al. (1989) in found in Sudan that "increased producer prices of export crops encouraged woodland clearing for crop cultivation and this resulted in significant deforestation" (Gbetnkom, 2005).
- Angelsen et al.'s (1999) statistically analyzed in Tanzania that the "increase of agricultural output prices, in particular annual crops, is a major factor behind deforestation. The results of these authors were confirmed in Ivory Coast where the effects of price increases of export goods contributed to deforestation but to a lesser extent than the lack of a consistent and secure land tenure system (Reed, 1992) (Gbetnkom, 2005).
- Osei Asare and Obeng Asiedu (2000) found in Ghana "higher levels of fertilizer prices, food crop prices and coffee producer prices stimulate in the long-run higher levels of deforestation whereas higher levels of agricultural wages precipitates lower levels of deforestation (Gbetnkom, 2005).
- "Other empirical works reveal that devaluations undertaken in Ghana at the beginning of 1980s motivated forestry exploiters to intensify tree felling for more exploitation of timber and woodwork. This ended up accelerating deforestation (World Bank, 1994; Pimentel et al., 1991). These results were confirmed in Malawi (Cromwell and Winpenny, 1991), and in Botswana (Perrings et al., 1988)" (Gbetnkom, 2005).
- Lack of market reward for conserving forests (market failure) (Panayotou, 1992) (Martin, 2008).
- Inadequate specification of property rights (Pearce and Brown, 1994) (Martin, 2008).
- Policy failure, poverty (Otsuka and Place, 2001) (Martin, 2008)
- Poor management practices (Martin, 2008).

Large-scale causes Cameroon

The second major group of causes are the findings of Gbetnkom (2005) who investigated the immediate causes and consequences of deforestation in the time period of 1970 - 2000 in Cameroon. His findings show that there are several causes stimulating deforestation.

- Coffee, and cocoa producer prices.
- Food crop prices.
- Timber export price index.
- The oil boom.
- Structural adjustment policies.
- The devaluation of the CFA Franc.

Conclusion Large-scale causes deforestation

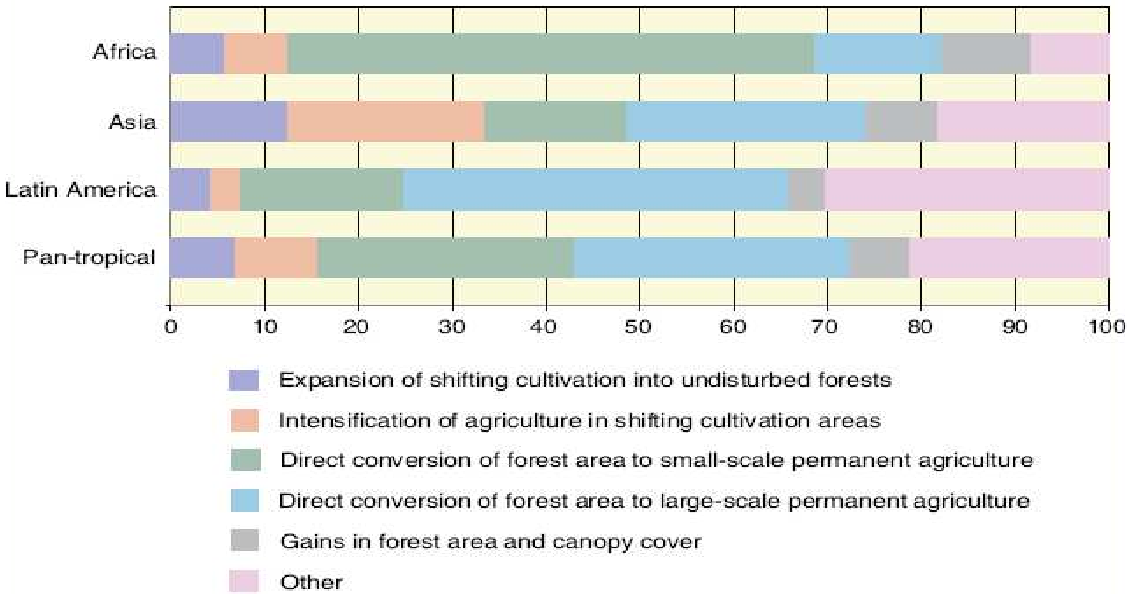
The large-scale causes mentioned above can be grouped into four categories, namely:

- Market Failure. This includes the increase of prices export products, food products and raw material like fertilizers.
- Property Rights. This includes land tenure security and inadequate specification of property rights.
- Policy Failure. This includes the structural adjustment policies and the currency devaluation.
- And the remaining causes like poor management practices and the oil boom.

These causes are at such an abstract and macro level that a small company alone can not change anything to a large extend. Martin (2008) states about these causes that they all respond to different economic and social incentives, thus different policy instruments or incentive systems are needed to reduce the cause of deforestation. Strategies developed to reduce deforestation must be aimed at a large and wide variety of actors (Martin, 2008).

2.1.2 Small-scale Causes

An other group of findings are the causes of deforestation which are not so abstract that a small company alone can change anything to a smaller or larger extend. In the diagram it is clearly that the major cause of area change in the entire world is primarily direct conversation of forest area for large scale permanent agriculture (25-40%) except from Africa (15%). In Africa, the primary cause is direct conversion of forest area to small scale permanent agriculture (60%).



Martin (2008) explains the cause of this difference based on the low soil fertility. He states that:

- In areas where the soil fertility is always low, the poorest and weakest people and communities who are unable to get hold of better lands often need to “slash-and-burn” agriculture as a survival strategy.
- Due to the impossibility of improving farmland by fertilizers, the soils remain poor. Only one to three years of production are possible which has as result that the farmers are forced to move on.
- In some areas, this method has evolved into a repetitive cycle.
- Where the population following this cycle has increased, the negative consequences for the forest have also increased (Martin, 2008).

Thus the African population, to a larger extend than other populations, deforest small scale areas for own use to provide themselves with food. Also Cleaver (1992) stated already in 1992 that small scale deforestation to meet the needs of the fast growing African population is one of the main causes of deforestation in Africa. An additional problem, next to low soil fertility, is the lack of tenure security. Kazianga (2006) stated that these farmers will not invest anything to improve their farming ground because this lack of land tenure security. This strengthens the cause of small scale deforestation in Africa. Next to deforestation to produce food, deforestation also occurs for building material, cooking and electricity (FARA, 2008; Henning, 2009).

Besides deforestation to fulfil the own needs of food security, Martin (2008) also provides some other reasons for deforestation, like “the desire to acquire land as a source of collateral, as a store of wealth and as a hedge against inflation” (Martin, 2008) (p10).

The opening of new roads (figure 2) is also a cause of deforestation. Over 70% of deforestation occurs within 50 km of paved roads
(*Azevedo-Ramos*, 2008), since new roads create possibilities for people to migrate to unexploited areas. (Meer voor Brazilie?)

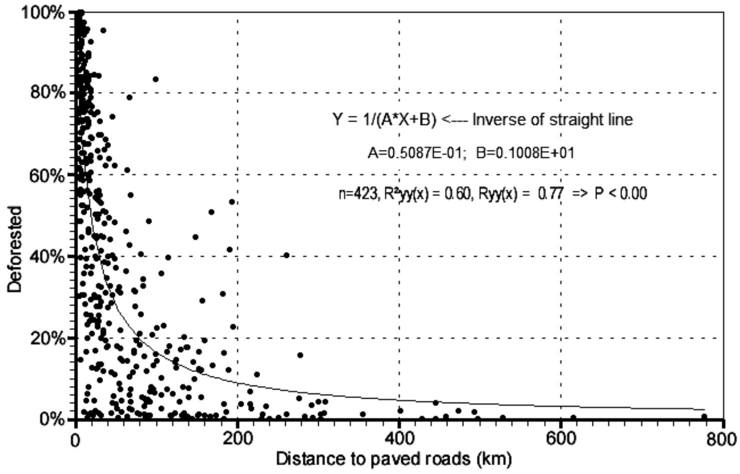


Figure 1: Percentage of total area change due to different causes, 1980-2000 (Martin, 2008)

Conclusion small-scale deforestation
The causes mentioned above can be grouped into four categories, namely:

- Soil fertility. Low soil fertility leads to repeated deforestation to obtain soil with a high fertility.
- Market Failure. This includes the increase of prices export products, food products and raw material like fertilizers. Also the need of sources of collateral can be grouped in this category.
- Property Rights. This includes land tenure security and inadequate specification of property rights.
- Policy Failure. This includes the opening of new roads.

2.1.3 Large-scale Solutions

Also in the solution part if this section, we can make a distinction between the solutions which are very abstract and macro level, and the solutions a small company can have influence on. At first a short impression of the macro-level solutions will be given to get a full overview.

- Koh and Wilcove (2007) suggested a new strategy to break the agriculture-biodiversity deadlock. They stated that using the revenue from high yielding palm-oil agriculture could be used to fund the acquisition of land to establish private nature reserves. Next to protecting endangered species, this also provides employment for local population.
- On a smaller scale this is already implemented by several companies, for instance Arauco from Argentina (Arauco, 2010). This company’s competiveness is based on forest resources and therefore they maintain more than 20% of their landholdings as natural forest. Next to maintaining Arauco also protects and conserves this forest in cooperation with local communities and they have opened some parts for public.

- Zhang (2005) has described the NASA Landsat Pathfinder Humid Tropical Deforestation Project which was set up to map deforestation activities in the humid tropics in Central Africa. This project uses datasets from both the Landsat TM (Thematic Mapper) and MSS (Multispectral Scanner System). This project has observed an annual deforestation rate of 0,42% (1012 square kilometres) varying among scenes from 0,03% to 2,72%. Besides deforestation this system has observed a additional 0,12% of forest degradation annually. Interesting point of this research was that the annual deforestation was significantly related to the population (Zhang, et al., 2005). This relation has also been found by Martin (2008), Henning (2009) and FARA (2008) who related growing population to the increasing need of small-scale permanent agriculture increasing deforestation for building material, cooking and electricity.
- This mapping used in the project described by Zhang can also be used to recognize deforestation is an early stage, as described by the UNFCCC (2008). Several studies

have been carried out in Brazil to detect forest degradation and selective logging using optical and radar systems. Next to the studies two early warning systems have been tested, namely DETER (Detection of Deforestation in Near Real Time) and DETEX (Detection and Monitoring of Selective Logging Activities). These studies and pilot systems have pointed out that not all types of forest degradation can be identified using these radar systems, thus observation from the ground will be required (UNFCCC, 2008).

- The Joint Research Centre describes two projects (TREES and FIRE) of a world-wide network of satellites, ground stations, forest fieldworkers and scientists they have set up (JCR, 1997). These projects make it possible to identify forest fires and deforestation in an early stage and makes it easier to understand the forest ecosystem and the ability to preserve them (JCR, 1997).

- Soares-Filho (2006) compared the potential influence of eight scenarios on the future trends in the Amazon deforestation. The eight scenarios varied from one extreme; the business as usual scenario (BAU), until the other extreme; the government scenario. The BAU scenario assumes that as much as 40% of forest in protected areas will be subject to deforestation and up to 85% outside these protected areas. At the other extreme, the government scenario, assumes that 100% of forest in protected areas will remain intact and only 50% of the forest outside protected areas will be subject to deforestation. The government scenario mainly achieves this through the expansion of the protected area network and the "enforcement of mandatory forest reserves on private properties through a satellite-based licensing system" (Soares-Filho, et al., 2006).

- Gbentkom (2005) has developed six policies for tropical forestry countries, focused on Cameroon, that neutralize the opportunities of deforestation. These policies should achieve that forest conversion will be less profitable, or that alternatives will be more profitable.
  Deforestation can be made less profitable by:
    - Reducing the demand or prices for products produced from newly cleared land.
    - Increasing the unit costs and risks of activities associated with deforestation.
    - Eliminating speculative gains in land markets (Gbetnkom, 2005).

  Alternatives to deforestation can be made more profitable by:
    - Increasing the income stream to be obtained from maintaining forests.
    - Reducing the costs of maintaining forests.
    - Increasing the opportunity costs of labour and capital that might otherwise be used in activities associated with deforestation (Gbetnkom, 2005).

The solutions mentioned above can be grouped into five categories, namely:

- Increase protected areas. This can be done by individual companies or government.
- Increasing employment. This includes employment of local community in protected forests areas and fieldworkers who joint the mapping activities.
- Using mapping systems to detect deforestation in an early stage. This includes satellites, radar systems, fieldworkers and scientists.
- Increasing food and building material security. This also includes cooking sources and medicine.
- Increased intervention of the government. This includes some of the solutions mentioned above, like expansion of protected areas and using satellite-based licensing systems. This also includes intervention in prices, costs and speculative gains in deforestation and intervention in income and costs of maintaining forest.

2.1.4 Small-scale Solutions

After having discussed the large-scale solutions, now the small scale or more practical solution will be discussed. At first the conditions which are provided by the criterions in the several principles will be discussed.

The fourth principle of Cramer (2007): Biomass production may not be produced at the expense of protected or vulnerable biodiversity and strengthens where possible the biodiversity, is divided in five criterions.

- Cramer (2007) states that no rules and laws should be violated according biomass production and the production area where it is placed. This is supported by the RSPO (2007) who state that there is compliance with all applicable local, national and ratified international laws and regulations.
- Cramer' (2007) second criterion states that biomass production should not be placed in gazetted or protected areas or within five kilometres of these areas. This criterion is also one of Reef' principles (Reef, 2008a).
- The third criterion (Cramer, 2007) in addition to the second, states that biomass should not only be avoided in protected areas, but also in High Conservation Value (HCV) areas. Also the RSPO (2007) states that it should be avoided to damage and deteriorate applicable habitats, and HCV areas. This is also underlined by Reef (2008a).
- Criterion four (Cramer, 2007) states that biodiversity should be remained or recovered. In extension to this criterion Cramer (2007) states in criterion five that the biodiversity should also be strengthened where possible. These criteria are also stated by the RSPO (2007), Reef (2008a), the Gold Standard (2009) and the Kyoto Protocol (UNFCCC, 2009).
- Next to these criteria the RSPO (2007) added one extra criterion which states that agrochemicals should be used in a way that it does not endanger health or the environment.

After having discussed the conditions provided by the principles, now the solutions provided by other literature will be discussed.
The small-scale causes mentioned before where grouped into four categories, namely low soil fertility, increased prices (of fertilizer), property rights and policy failure. Two of the major results of these causes in Africa are small scale deforestation for own use, and that farmers will not invest in their grounds because of the lack of land tenure security or high fertilizer prizes. A third reason is deforestation for building material, cooking and electricity. Thus if the need for small scale deforestation to create plantations on high fertility soil, and the need for deforestation for cooking and electricity can be taken away, some of the reasons for deforestation are taken away. Fara (2008) states that to reduce biomass destruction a research priority should be given to plant oils and/or ethanol production and use for cooking and lighting as well for electricity production in remote rural areas.

As mentioned in chapter two about Jatropha, Jatropha crops develop a taproot which reaches deep into the (marginal) soil and transports minerals to the plant and when leaves and fruits fall off and decompose, these minerals will be replaced at the surface, increasing soil fertility by 6-30% (Jongschaap, 2007). Also the seed shells and press cake can be used as fertilizer. The crop also increases water conservation, controls erosion and can be used as hedge to prevent cattle grazing food crops. Thus the Jatropha plant and some of its products like fruit shells and fruit cake can reduce the need of replacement of food production every two or three years because it improves the soil fertility. The possibility to use the Jatropha oil can replace the need to use wood for electricity, lightning and cooking (Cleaver, 1992; Harounan Kazianga, 2006; Henning, 2009). Of course this has no use when there is still a lack of land tenure security, which is a solution of the large scale solutions.
Koh (2007) states that the yield of these biodiesel plantations should be improved, since the higher the yield, the lower the amount of needed hectares. As mentioned in the large scale solutions deforestation should be detected in an early stage. Next to the satellite mapping systems the Joint Research Centre (JCR, 1997) stated that a network of ground stations and forest fieldworkers should be created.
The solutions mentioned above can thus be grouped into seven categories, namely:

- Location policy, thus do not place plantations on protected/ high value areas and where possible increase these areas and biodiversity.

- Location protection, thus create a network where violation will be detected in an early stage.
- Legal policy, thus do not break local rules and laws.
- Health policy, do not endanger health.
- Increase income security/ employment by using Jatropha.
- Increase food supply and material facilities by using Jatropha.
- Property Rights. This includes land tenure security and inadequate specification of property rights.

2.1.5 Conclusion

Thus Jatropha plantations can reduce some of the small scale causes of deforestation, considering the other solutions mentioned above. To ensure these solutions will be considered by local community who will manage these plantations some kind of controlling and certifying system has to be implemented (DuBois, 2008; Fairtrade, 2009; RSPO, 2007). Next to a controlling function a certification like fair trade can also have extra benefits. According Nathan Bello of Sodecotton, a cotton ginning and marketing company, it used to be hard to convince farmers to adopt more responsible behaviour towards improving their quality of production. Due to the (Fair Trade) premium farmers have a reason to do so (Fairtrade, 2009). Local community can use the premium to improve their environment. Examples of purchases of the development premium are wells, grinders, a school and one village is willing to build a hospital (Fairtrade, 2009).

2.1.6 Criteria to be used: Biodiversity

1. Location policy, thus do not place plantations on protected/ high value areas and where possible increase these areas and biodiversity.
2. Location protection, thus create a network where violation will be detected in an early stage.
3. Legal policy, thus do not break local rules and laws.
4. Health policy, do not endanger health.
5. Increase community income security/ employment by using Jatropha.
6. Increase food supply and material facilities by using Jatropha.
7. Property Rights. This includes land tenure security and inadequate specification of property rights.

3 Complete list of criteria from Chapter 4

3.1.1 Criteria to be used: Greenhouse Gas Reduction

1. *Perform a location specific RTFO Greenhouse gas Life Cycle Assessment.*
2. *Ensure GHG reduction in comparison with fossil fuel should be at least 50%, or preferably higher.*
3. *Create shortest transportation distances between all parties.*
4. *Use most efficient transport or even a mobile oil expeller (which is available).*

3.1.2 Criteria to be used: Carbon Reservoirs

1. *Perform a site specific carbon stock measurement.*
2. *Implement conservation of above ground carbon reservoirs.*
3. *Implement conservation of underground carbon reservoirs.*
4. *Register the baseline measurement and the conservation agreement.*

3.1.3 Criteria to be used: Competition Food, Energy and other Local Uses

1. *Ensure biodiesel production will not cause competition in food, energy and other local uses.*
2. *Create individual farmers/ cooperatives sourcing plans and monitor these.*
3. *Pay a fair price so farmers will adopt a more responsible behaviour.*
4. *Provide the possibility to use parts of the plant or oil for own use.*
5. *Protect sites of cultural or religious importance.*

3.1.4 Criteria to be used: Biodiversity

1. *Do not place plantations on protected/ High Conservation Value areas or within five kilometres of these areas.*
2. *Where possible increase these areas and its biodiversity.*
3. *Comply with all applicable local, national and international laws and regulations on biodiversity.*
4. *Use Jatropha characteristics for the possibility of soil improving, water conservation and controlling erosion.*
5. *Agrochemicals should be used in such a way that it does not endanger environment.*
6. *Document property rights, including land tenure security and adequate specification of property rights.*
7. *Document these agreements in the sourcing plans and monitor these.*

3.1.5 Criteria to be used: Soil Quality

1. *Comply with all applicable local, national and international laws and regulations regarding soil conservation.*
2. *Ensure use of rest products is not against other local functions.*
3. *Agro chemicals are used in a way that does not endanger the environment according to the Stockholm Convention.*
4. *Perform a site specific soil survey and set a baseline for further measurement.*
5. *Add the site specific soil survey results to the sourcing plans.*
6. *Minimise and control erosion.*
7. *Use best practice to remain or increase soil quality.*
8. *Utilise the Jatropha crop characteristics for possible erosion control.*
9. *Sourcing plan contains operating procedures which are implemented and monitored.*

3.1.6 Criteria to be used: Ground- and Surface Water

1. *Comply with all applicable local, national and international laws and regulations regarding water conservation.*
2. *Ensure no use of water from non-renewable sources.*
3. *Perform a site specific water survey and set a baseline for further measurement.*
4. *Add and monitor the site specific water survey results to the sourcing plans.*
5. *Use best practice to limit water use and to maintain or increase ground- and surface water.*
6. *Utilise the Jatropha crop characteristics for possible water conservation.*
7. *The Sourcing plan contains operating procedures which are implemented and monitored.*

3.1.7 Criteria to be used: Air Quality

1. *Comply with all applicable local, national and international laws and regulations regarding air pollution.*
2. *Ensure no fires to build or manage biomass production units.*
3. *Perform a site specific air quality survey and set a baseline for further measurement.*
4. *Add the site specific air quality survey results to the sourcing plans and monitor them.*
5. *Use best practice to restrict emission and air pollution.*
6. *Sourcing plan contains operating procedures which are implemented and monitored.*

3.1.8 Criteria to be used: Local Economic Development

1. *Ensure biomass production contributes to local business activities and local economy.*
2. *Commitment to long-term economic and financial viability.*
3. *Develop a local processing industry owned by the local communities.*
4. *Payment of- and conditions for employees meet at least legal or industry minimum standards.*
5. *Encourage the participation of women, youth and indigenous communities in biofuel operations.*
6. *Ensure indigenous peoples to be compensated for the application of their traditional knowledge.*
7. *Operating procedures are documented, implemented, monitored and compared with baseline.*

3.1.9 Criteria to be used: Welfare of Employees and Local Communities

1. *Comply with the ILO standard working conditions.*
2. *Create an occupational health and safety plan.*
3. *Perform a social impact survey.*
4. *Ensure all members are appropriately trained.*
5. *Ensure special attention to the most vulnerable and marginalized groups.*
6. *Ensure the use of land does not cause any violation of private property without approval of well-informed communities.*
7. *Ensure the (legal) right to use the land and agreements of compensations for loss of legal or customary rights are registered in the sourcing plan.*
8. *Create a possibility for farmers and communities to develop more tillage skills.*
9. *Provide the possibility for producers to use some of the Jatropha products for their own use.*
10. *Ensure operating procedures are documented and implemented, a baseline is set and monitored and added to the sourcing plan.*

3.1.10 Criteria to be used: Commitment to Transparency

1. *Biomass producers will provide adequate information for complete transparency.*
2. *Make management documents publicly available (except when confidential).*
3. *Ensure open and transparent communication between all parties.*
4. *Create transparency in money flows.*

3.1.11 Criteria to be used: Monitoring and Certification

1. *Monitor the entire biofuel production chain.*
2. *Regularly monitor and review the sourcing plan.*
3. *Develop and implement action plans that allow demonstrable continuous improvement in key operations.*
4. *Apply for an (RSB/ FSC/ Fairtrade) certificate for the entire biofuel production chain.*

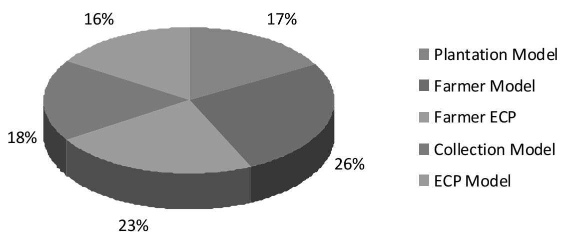
3.1.12 Criteria to be used: Energy Efficiency and Waste Reduction

1. *Ensure efficiency of energy use is maximised.*
2. *Ensure use of renewable energy is maximised.*
3. *Ensure waste is reduced, recycled, re-used and disposed in an environmentally and socially responsible manner.*

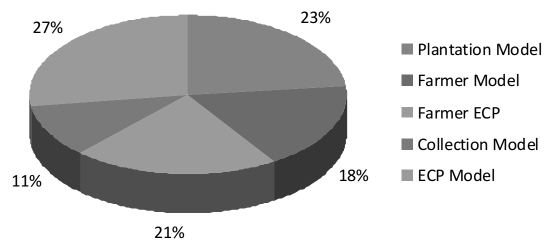
4 Criteria and Easiness Based Evaluation

	Criteria Based Evaluation					Ease Based Evaluation				
	Plantation Model	**Farmer Model**	**Farmer ECP**	**Collection Model**	**ECP Model**	**Plantation Model**	**Farmer Model**	**Farmer ECP**	**Collection Model**	**ECP Model**
Total points	22	35	30	24	21	104	79	95	48	122
Criteria										
Preliminary Research										
Perform an RTFO Greenhouse gas Life Cycle Assessment to make sure that the carbon emission reduction in comparison with fossil fuel is at least 50%, or preferably higher. Indications say Jatropha has a carbon emission reduction of approximately 60-70%.	0	0	0	0	0	0	0	0	0	0
Investigate legal policy, so no rules and laws regarding soil and water conservation and air pollution will be broken.	0	0	0	0	0	0	0	0	0	0
Perform a social impact survey.	0	0	0	0	0	0	0	0	0	0
Beginning/ Create Sourcing Plans										
General										
Operating procedures are documented, implemented and monitored.	0	0	0	0	0	4	2	3	1	5
Everyone in the biodiesel production chain will provide adequate information for complete transparency, thus management documents are publicly available (except when confidential) and there is transparency in money flows.	0	0	0	0	0	4	2	3	1	5
Commitment to long-term economic and financial viability.	0	0	0	0	0	0	0	0	0	0
No use of water from non-renewable sources.	0	0	0	0	0	4	2	3	1	5
No fires to build or manage biomass production units.	0	0	0	0	0	4	2	3	1	5
Conservation of above ground and underground carbon reservoirs.	0	0	0	0	0	4	2	3	1	5
Surveys										
Perform site specific surveys, including a carbon stock measurement, a soil survey, an air quality survey and a water survey and set a baseline.	0	0	0	0	0	4	2	3	1	5
Economy										
Biomass production should contribute to local business activities and local economy.	0	0	0	0	0	0	0	0	0	0
Develop a local processing industry owned by the local communities.	1	5	3	4	1	2	5	4	3	1
Pay a fair price so farmers will adopt a more responsible behaviour.	0	0	0	0	0	2	5	4	3	1
Biodiesel production may not cause competition in food, energy and other local uses.	5	1	1	3	5	4	1	2	3	5
Use of rest products is not against other local functions.	0	0	0	0	0	4	2	3	1	5
Provide the possibility for producers to use some of the Jatropha products for their own use.	1	5	4	3	1	1	5	4	3	1
Land use										
Do not place plantations on protected/ high value areas or within five kilometres of these.	0	0	0	0	0	4	2	3	1	5
Where possible increase these areas and recover or increase biodiversity.	0	0	0	0	0	4	2	3	1	5
Ensure land tenure security and adequate specification of property rights and to protect sites of cultural or religious importance. The use of land does not cause any violation in private property without approval of well informed communities. The (legal) right to use the land and agreements of compensations for loss of legal or customary rights are registered in the sourcing plan.	0	0	0	0	0	4	1	2	3	5
Working conditions										
Comply with the ILO standard working conditions and create an occupational health and safety plan.	0	0	0	0	0	4	2	3	1	5
All members are trained.	0	0	0	0	0	4	2	3	1	5
Encourage the participation of women, youth, and indigenous communities and give special attention to the most vulnerable and marginalized groups.	0	0	0	0	0	4	2	3	1	5
Indigenous people shall be compensated for the application of their traditional knowledge.	0	0	0	0	0	2	5	4	3	1
Agrochemicals are used in a way that does not endanger the environment according to the Stockholm Convention.	0	0	0	0	0	4	2	3	1	5

	Criteria Based Evaluation					Ease Based Evaluation				
	Plantation Model	**Farmer Model**	**Farmer ECP**	**Collection Model**	**ECP Model**	**Plantation Model**	**Farmer Model**	**Farmer ECP**	**Collection Model**	**ECP Model**
Total points	22	35	30	24	21	104	79	95	48	122
Criteria										
During Production/ Monitor Sourcing Plans										
General										
Open and transparent communication between all parties.	0	0	0	0	0	4	2	3	1	5
Regularly monitor and review the sourcing plan and develop and implement action plans that allow demonstrable continuous improvement in key-operations.	0	0	0	0	0	4	2	3	1	5
Apply for an (RSB/ FSC/ Fairtrade) certificate for the entire biofuel production chain.	0	0	0	0	0	4	2	3	1	5
Transport										
Create shortest transportation distances.	4	2	3	1	5	4	2	3	1	5
If possible, use most efficient transport/ mobile oil expeller.	0	0	0	0	0	0	0	0	0	0
Economy										
Increase community income security/ employment by using Jatropha.	2	5	4	3	1	4	2	3	1	5
Increase food supply and material facilities by using Jatropha.	1	5	4	3	1	1	5	4	3	1
Payment and conditions for employees meet at least legal or industry minimum standards.	0	0	0	0	0	4	2	3	1	5
There is a possibility for farmers to develop skills.	2	5	4	3	1	2	5	4	3	1
Environment										
Use best practice, the Jatropha crop characteristics, to increase soil quality, erosion control, water conservation and restrict emission and air pollution.	2	5	4	3	1	2	5	4	3	1
Efficiency of energy and use of renewable energy is maximised.	4	2	3	1	5	4	2	3	1	5
Waste is reduced, recycled, re-used and disposed in an environmentally and socially responsible manner.	0	0	0	0	0	4	2	3	1	5
Modus	**0**	**0**	**0**	**0**	**0**	**4**	**2**	**3**	**1**	**5**
Avarage	**0.61**	**0.97**	**0.83**	**0.67**	**0.58**	**2.89**	**2.19**	**2.64**	**1.33**	**3.39**



Criteria Based Evaluation



Ease Based Evaluation

5 Elaborate description of practical feasibility

How do I imagine the different situations in Cameroon:

- P) = One large plantation
- F) = Farmer/ village plantation
- C) = Collection points, riverbanks and bridges

5.1 Needed Space

The calculation stated 667 hectare plantation is needed, I will calculate further with 1.000 to prevent shortage when parts are used individual. To get a little notion of this, Goor has a total area of about 650-700 hectare.

- P) One of the possibilities is to create this area in one large plantation, or several smaller plantations. The major disadvantage of this solution is, you need an area of 3.5 x 3.5 kilometers which could be a problem. On the other hand, this would only be an area of 0.8% compared with the FSC certified forest and only 0.33% of the total forest surface of TRC in Cameroon. The greatest advantage is this is a controlled area, totally regulated by TRC, but since it cannot be planted on “spare” ground I see this as least practical solution
- F) Other possibility is the plantation divided over several farmers/ villages. Major advantage compared with one plantation is you do not need one giant plantation, and no one big area to start this. But still you need large pieces of unused land and this could be a problem. But as seen in my previous presentation the major cause of deforestation in Cameroon is small scale deforestation for private agriculture (Martin, 2008). When this ground is used for 3-4 years intense agriculture the farmers moves on to a new piece of forest. This would imply that there is enough space around farmers current agricultural ground, and these grounds should be used (Mulder, 2008). Assuming there is an average of 5 hectare (meaning 225 x 225 meters) per farmer available, a total of 200 farmers of fewer villages are needed. This 5 hectare per farmer is based on the project “CONCÓRCIO FLORESTAL PINHÃO MANSO” from João Lima. I also spoke to Max Havelaar and they state that they usually deal with small scale farmers who own between 1 till 10 hectare farmland (Eshuis, 2009a). In a second conversation it was stated that there are also villages with communal ground with will be more than 1-10 hectare (Eshuis, 2009b), but it has to be found out what the specific circumstances are in Cameroon.
- C) The least problems with using “spare” ground is the plantations on collection points and riverbanks scenario. There is space, which has no purpose so far, and this could be used to plant Jatropha. The main disadvantage is the wide spread distribution of these plantations. Assuming the collection points are 50x100 meters, meaning 0.5 hectare, you would need 2000 collection points. Or when you use roadsides, assuming there can be planted maximum 1 row of Jatropha each side of the road, with a distance in between of 2.5 meters. The Fact Foundation (FACT, 2006) researched several densities for Jatropha production and the longest research is based on 17 year exploration in India which use the 3 x 3m density, meaning 1089 Jatropha plants are needed per hectare, for the sake of convenience I will use 1100 plants in my calculation. 1.000 ha x 1.100 plants is 1.1 million plants, meaning when 2 sides of the road are planted a total of 1375 kilometer road is needed. With a closer density, used in hedges to protect gardens against browsing animals where Jatropha is planted every 5 cm this would end up in 27.5 kilometers. Since the Leaf Area Index (square meters leaf surface) (Jongschaap, 2007) is heavily decreased this way, yield per plant will most likely decrease heavily compared with free growing Jatropha. On the other hand the prediction of Raymond Jongschaap stated the maximum yield of biomass production, independent of the density. Thus we should calculate in square meters instead of number of plants. Assuming there space available on both sides of the road of 1 meter each side, you still need 5.000 kilometers of road to be planted (1 ha is 10.000 m2, thus 10.000.000 m2 total, divided by 1000 (meter/ kilometer) divided by 2 roadsides = 5000 kilometers). As can be seen in the two wide divided indications there is no clear prediction of the real needed amount of needed kilometers.

Thus to conclude, what is the best option for the needed space for this project, when we only look at using unused ground, the Collection scenario would be best. There is no valuable ground lost and no large pieces at once. Main disadvantage is the wide spread area you will need for this. Thus when we look at the practical feasibility I would tend to the farmer solution because you need a less widespread network, and there is still no need for giant areas as the plantation solution claims.

5.2 Land tenure security

Here we look at the threat of farmers losing their ground or the ground they are using when Jatropha is cultivated.

- P) When one large plantation is set up this is totally in hands of TRC. Assuming they will not chase away farmers, families or villages to create this plantation this scenario has the lowest threat of land tenure security being taken away.
- F) Here I assume that there are a lot of farmers who deforested the area around them for small scale agricultural activities (Martin, 2008). This could imply the land they use is not theirs, and this could be a problem when permanent agriculture starts at these areas. When a farmer starts a plantation he might be confronted in a later stadium that the ground he is using is not his. On the other hand a permanent plantation, combined with permanent food cultivation could give him more security and more incentives to invest in the plantation instead of slash and burn new agricultural ground.
- C) On the collection point and road sides there is no issue of land tenure security. All the land is owned by TRC thus all the plantations inside too. Same as the first bullet here I assume TRC will not chase away farmers, families or villages to create this plantations. But since these plantations are much smaller, the chance of land tenure security being disrupted by TRC is also smaller than the plantation scenario.

Thus conclusion: Best solution to secure land tenure is the collection scenario.

5.3 Expansion Possibilities

When the first project is setup TRC might be willing to increase the size of the total project. Thus in this stadium should already be thought about the expansion possibilities.

- P) When you want to increase one big plantation, you should almost immediately double everything, thus incremental increase is rather difficult. You might be able to increase the total area every time with some hectare ground, but is questionable whether this is possible. Another possibility might be a total double of the first plantation, including processing equipment. Maybe even at a totally new location. But you will need one big area, where you even can expand, or you need several big areas for several plantations.
- F) Here it is rather easy to expand production, this could even be an ongoing project. Every time new farmers or villages are sought and contracted for new plantations.
- C) Last possibility to expand the plantations are the collection points and besides roads. To expand here is also rather easy, except the problem of the massive kilometers of needed roads. Another disadvantage is that at a certain moment the roads and collection points in the concessions are all filled with plantations, thus there are no more expansion possibilities. I don’t know on which term this will be a problem

Concluding: The easiest expansion possibilities are at the farmer-scenario, the hardest this would be at the plantation- scenario.

5.4 Prevent deforestation

In this topic I would like to evaluate the several scenarios to find out which one can prevent deforestation at most.

- P) As mentioned earlier, when one large plantation is set up by TRC, I assume they have enough knowledge to set this plantation up in the maximum durable way. Thus they will not deforest anything.
- F) In this scenario there are two possible outcomes. First the negative, which is the contracted farmers or other farmers start deforestation to clear ground for Jatropha

plantations. On the other hand, as stated in my previous presentation (Martin, 2008) the major cause of deforestation in Africa is slash and burn activities for small scale permanent agriculture by farmers. In the poorest areas the soils remain poor, only one to three years of production is possible thus after that period the farmers are forced to move on. When they would start Jatropha plantations and use all the benefits of this, they might be able to stay on one location and stop deforestation. With the financial yield they might even invest more in improving the soil and increase their food production.

- C) Same as the plantation scenario, I assume TRC will start up a completely durable plantation. Thus there will be no deforestation. Only problem is, when collection points are planted, how do you deal with the sprouts of new trees? According FSC you have to leave alone the cutting area, thus also the collection points. When you would remove the sprouts of trees, you break the rules. When you leaven them, they will compete with the Jatropha plants in water, radiation and nutrition.

Conclusion: Here it depends on how you look at deforestation and what kind of deforestation you want to prevent. Prevent deforestation caused by Jatropha plantations or prevent deforestation as much as possible? It is rather clear that the smallest chance of deforestation caused by Jatropha is the plantation scenario, followed by the collection scenario. These two scenarios are completely in hands of TRC, thus by choosing for one of these options you can be rather sure this will not cause deforestation. This still does not prevent you from deforestation by third parties, but since the plantation situation is more or less arranged as a working area where employees get paid, this might not be an incentive for third parties.

However when you want to prevent deforestation in total, the farmer scenario might be the best solution, because this will most likely slow down or stop slash and burn activities for small scale agriculture, the biggest cause of deforestation in Africa. But on the other hand this causes bigger incentives for third parties to start a jatropha plantation themselves.

5.5 Practical space feasibility

By looking at the topics mentioned above it should be possible to extract the best feasible scenario to start the Jatropha plantation in terms of these major land-use topics. If you would sum up the independent points I gave to the several scenarios, the collection-point scenario would end on the first place because this scenario has on three of four criteria an average score. The major problem which makes this scenario practically impossible is the huge amount of kilometers road needed. Since there is little research done in several plantation densities, it is not clear how much it will be.

The huge centralized space needed and limited expansion possibilities, except double everything, makes this scenario also rather difficult. This could partly be solved using several smaller plantations, but than still the land tenure security might be insecure. Besides this the core reason of this project; social economic development, is hard to achieve this way since you can only hire people who do not benefit other than in terms of money.

The third possibility is the farmer scenario, which would be the ideal possibility in the middle of the other solutions. You do not need the huge amount of kilometers roadsides and you do not need the giant plantations at once. The only problem is you will need 150-300 farmers who are willing to cooperate and who posses unused farmland.

5.6 Accessibility

This topic discusses problems or possibilities of getting to the different areas. Thus are there any problems or opportunities concerning accessibility.

- P) First the plantation scenario. Since there are no plantations yet there is nothing to access yet, everything has to be created. This has major advantages because everything can be created to achieve ideal circumstances and thus causing the most advantages in following phases. This could also be a great disadvantage because all the infrastructure has to be created, this will be more expansive than using excising infrastructure.
- F) Assuming every farmer needs to get to the road every now and then, the infrastructure in this scenario is already more of less developed. This makes it easier to reach these persons,

makes it easier in following phases of the project and it is also cheaper to use existing infrastructure. Field research has to be done to evaluate the condition of these roads.

- C) Since the collection points are created to load and move big truck the infrastructure is well developed. Also the roadsides are obviously well passable.

Concluding: By accessibility I meant problems of getting to a area, mainly in the first place before the planting starts but also in following phases. Since getting there is not a problem in most scenarios the criteria in following phases has to be decisive. The fewest collecting points is in the plantation phase, followed by the farmer scenario and ends with the collection point scenario. Thus that will be the final judgment.

5.7 Approach Population

In this chapter I will look at the different possibilities or problems in approaching the population in terms of incentives. What will make them grow or work for Jatropha without it being so interesting that others will misuse this crop.

- P) In the plantation scenario you need to hire employees to collect the seeds. The only incentive for them is money. Assuming Jatropha produces 27 kilo seeds per day per hectare, meaning 37 kilo fruit, for the 1000 ha plantation this means 37.000 kilo fruit production a day which has to be harvested manually. In a case description of Diligent by Alice O (AliceO, 2007) it is stated that a person can harvest up to 20 kilo seed a day, meaning 28 kilo fruit. Calculated this means you need 1322 people to harvest on the plantation… All these people have to be paid, and this might be a costly operation. Thereby did the Cramer Criteria (Cramer, 2007) state that, when developing the sustainability criteria, special attention should be paid to “small-holders” and not to giant plantation holders.
- F) As stated in the Diligent Case (AliceO, 2007) Diligent pays farmers 120 Tanzanian Shilling for every kilo Jatropha seeds, which equals 10 Dollar cent. When looking at the minimum prices Max Havelaar pays for Fair Trade products (FLO, 2009) this is an extremely low rewarding for crops.
    - Cocoa beans (conventional) 1,75 $/kilo
    - Cocoa beans (organic) 1,95 $/kilo
    - Coffee average 2,6 $/kilo
    - Soy beans 0,39 $/kilo
    - Seed Cotton average 0,53 $/kilo
    - Cheapest crop I could find where oranges from Argentina which where 0,14-0,17 $/kilo

  When you look at these prices farmers would be crazy to start planting Jatropha because every other crop will have a higher yield and thus more financial income. This was also noticed by Beerens during his field trips in Tanzania where local farmers seemed “moderately motivated to grow Jatropha” (Beerens, 2007, p. 46). The cause of this could be the low prices Diligent pays the farmers, or the inability to judge long term benefits. Therefore farmers should not only have benefits in terms of money, but also the use of the plant and its products. Jatropha could be a good supplement for the income of the farmer by combining Jatropha with other crops. Besides this Jatropha can grow on marginal grounds, where other crops do not grow. By doing so the farmers can use grounds which formerly where useless. Next to this Jatropha produces waste (fruits, press cake) what can be used as fertilizer with which current food production can be increased and the oil can be used for cooking, lightning and electricity. Final advantage of Jatropha compared with other crops is when normal food production is lower due to bad weather the farmer has still yield of Jatropha thus it can be seen as some sort of insurance. With all these spin-off products cultivation of Jatropha is interesting for farmers.

  This approach is still no guarantee for preventing deforestation by third parties, because they can also benefit from the yield of Jatropha. The major threshold criteria is the long lead time before there is any yield of Jatropha. And when using the marginal payment Diligent uses, there is even less incentive for others, because it is more profitable for them to grow for instance coffee or cocoa. The final major advantage of approaching farmers is they have experience, expertise and probably (some) cultivation equipment. This makes it easier to approach these people, they know what they say yes to.

- C) In this case instead of farmers local community harvests the Jatropha seeds. This has the advantage that they will not lose any ground of themselves. They will get paid for every kilo seed they collect but have little benefits from Jatropha as a crop. Thus their only incentive is money. As Beerens (2007) noticed during his field trips in Tanzania, not only farmers where moderately motivated to grow Jatropha, but also local community was not really motivated to collect Jatropha seeds from the wild Jatropha trees (Beerens, 2007). This was most likely also caused by the low prices Diligent pays them. It is however hard to raise this price, as shown in my calculation, because even with this price the whole Jatropha-bio-diesel reaches its break-even point. Thus there is not much margin.

Conclusion: To approach farmers is easiest because of their knowledge and they can use the benefits of Jatropha at most. When applying the collection point or plantation scenario the community has only benefits in terms of money. It has been observed that collecting Jatropha for relatively little money is not an option. Adding a lot of people on the payroll might be an expansive operation and Cramer (2007) did not advocate for this solution.

5.8 Pre Cultivation

In this chapter I will look at the pre-cultivation problems or opportunities. With pre-cultivation I mean all handling needed before the plantation can be set-up. Thus things like achieving the seeds, germination, nursery, planting, feeding and replanting. In my opinion it is rather obvious that the less places pre-cultivation takes place, the easier it is because you can apply economies of scale. Therefore this topic does not need much explanation, the plantation scenario has to lowest amount of different cultivation places and thus pre-cultivation can be at most centralized. This makes it possible to centralize all the pre-cultivation activities like nursery. Nursery increases the germination chance and with better nursery methods the final Jatropha plant will have better properties. Better properties will most likely lead to higher bio-diesel feedstock per hectare or per unit (Koh, 2007).

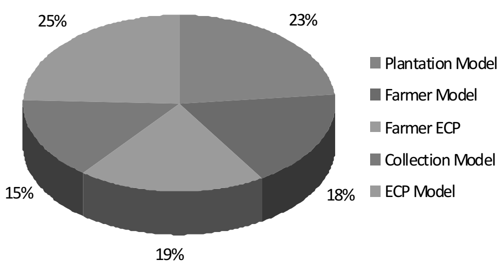
5.9 Plantation

Like the pre-plantation conditions, also at the plantation scenarios the conditions are favorable when the least possible places are used. All material can be centralized, transportation is lowest cost, harvesting and dehulling can all be centralized which means least machinery necessary and thus lowest costs. Also in terms of rewarding employees this could be an interesting option. When collecting seeds from farmers in the farmer plantation or collection point scenario, the total rewarding as calculated before, will cost at least one million euro. When you would use the plantation scenario, you only have to pay salaries. As roughly estimated before, at most you will need 1322 employees to collect the seeds from the giant plantation. With a year salary of about €750,- you could pay all these people, but when you would pay them the GDP of Cameroon, meaning €2300,-, you could pay at maximum 435 people. Erik Jan Sprangers informed me about the salary indication of uneducated employees who earn €150,- a month, meaning €1800,- a year, which implies 555 people can be labored. Thus money what has need to be paid to employees of rewarding for the seeds has a major impact in the total go- no go decision.

5.10 Processing

Same as the plantation scenario the processing phase is also easiest with the lowest variety in places. But only the picking-up part of this phase is different from the other scenarios, since after the seeds are picked up they can be transported to one single place.

	Plantation Model	Farmer Model	Farmer ECP	Collection Model	ECP Model
	Practical Based Evaluation				
Total points	87	67	73	56	92
Needed space					
Space	1	4	4	3	2
Landtenure	4	1	1	4	4
Expansion possibilities	2	4	4	1	3
Prevent deforestation	3	1	1	2	4
Practical feasibility	2	3	4	1	4
Getting there					
Accessibility	3	1	1	2	4
Approach population					
Incentives (interesting but not too)	3	4	4	1	2
Pre cultivation					
· Getting the seeds there	4	2	3	2	4
· Germinate	4	2	3	2	4
· Nursery	4	2	3	2	4
· Planting	4	2	3	2	4
· Feeding	4	3	3	2	4
· Replanting/ deeper planting	4	3	3	2	4
· Direct germination	1	1	1	1	1
Plantation					
· Does it grow there??	4	3	3	2	4
· Transport to the plantation	4	2	2	2	4
· Material on the spot	4	3	3	2	4
· Harvesting	4	3	3	2	4
· Dehulling	4	2	2	2	4
· Labor input (Jongschaap, 2007)	2	4	4	4	2
· Rewarding farmers	2	4	4	3	2
Processing					
· Pick up seeds	4	3	3	2	4
· Press (better with better machinery)	4	2	3	2	4
· Transport oil	4	2	2	2	4
· Filter	4	2	2	2	4
· Transesterfication	4	4	4	4	4
Modus	**4**	**2**	**3**	**2**	**4**
Avarage	**3.35**	**2.58**	**2.81**	**2.15**	**3.54**



Practical Based Evaluation

6 Financial Evaluation

6.1 Organization and Costs

To start a Jatropha production, there are several investments to be made. The costs of investments versus the benefits compared with current diesel purchase will be discussed in the next chapter. First a complete list of investments will be made:

Of course all calculations are dependent on the chosen scenario, thus this is just an indication.

- Education production leaders (€24.000,- for four years)
- Equipment production leaders
- Import of seeds (€6500,-)
- Education local community
- Production costs (Collection of seeds at the farmers:
  - €8,- per 60 kilo (Diligent, Tanzania)
  - 9000 kilo per ha = €1200,- ha/ yr
  - 1200 * 667 ha. = €800.000,-
  - Total for 2 mil. Liter = €1 mil. (build up from 0 till 100% in 5 years)
- Press installation (Solarix press truck €120.000,-)
- Filtering installation, Collection equipment
- Growing compensation local community
- Transesterfication equipment (Solarix conventional transesterfication machine the Sx 5 produces 2.25 million liter bio diesel a year. Costs €250.000,-)
- Transportation costs, Maintenance costs
- Other (€50.000,-)

6.2 Investments

To start a Jatropha production, there are several investments to be made. The costs of investments versus the benefits compared with current diesel purchase will be discussed in the next chapter. First a complete list of investments will be made:

- Education production leaders
- Equipment production leaders
- Import of seeds
- Education local community
- Production costs
- Press installation
- Filtering installation
- Collection equipment
- Growing compensation local community
- Transesterfication equipment
- Transportation costs
- Maintenance costs
- Other

6.3 Import of the fuel crop seeds

To start a Jatropha plantation two possible propagation methods are used, propagation by generative (direct seeding or pre-cultivated seedlings) and by vegetative (direct planting of cuttings) method. The vegetative method is more used for quick establishment and plantations for erosion control, and has as main disadvantage that this propagation method causes the plant to develop a thin root, unable to grow deep. This makes the plant more vulnerable for uprooting by wind and leads to more superficial water and nutrient competition with other crops (Heller 1996). Therefore the plantations should be propagated using the direct seeding or pre-cultivated seedlings method. Consequently seeds need to be bought to start the plantations.

Purchasing the seeds is not a matter of just finding a subcontractor but the selection of Jatropha seeds is a critical step. According Basha (2007) selecting these seeds should be based on successes of controlled breeding programs, but current results are not sufficient yet. To select the right seeds the best practice is to use “planting material obtained from the best performing trees of the best performing provenance available in the location of interest” (Gour 2007). So in practice this would mean setting up a trial plantation with several types and origins of Jatropha seeds where trees with a high yield, above 2 kg dry seeds and oil content above 30%, can be considered as good source. Instead of developing a trial plantation the seeds could also be bought from a specialized supplier of from an other plantation in Cameroon (Bamenda) if they did sophisticated research themselves.

Assuming excellent seed is developed or bought there needs to be found out how much seed is needed for production of two million liter bio-diesel. Again this is dependant on several criteria, and rather obvious one of them is the crop density. This density is dependant on rainfall, where “wider spacing should be used in semi-arid environments and denser plantations can be appropriate for sub-humid environments” (Achten 2008). This because of the competition of water and nutrients between plants. More competition leads to less fruit production. As mentioned before there is no sound research for a global answer for ideal crop density, according to Achten (2008) the optimal spacing can only be recommended after 5 years uninterrupted growth and yield. Several articles state different densities, Nyamai and Omuodo state 2 x 2,5 m is desirable, the fact foundation states 3 x 3m because higher density affects seed production. The Zambian Agricultural Research Institute states that “If growth conditions are ideal, i.e. good soils, sufficient rainfall and warm to hot climate, then extend spacing up to 500 cm x 500 cm to avoid ‘over-shading’ of leaves and over-lapping of branches. Production will increase considerably” (source: http://www.zari.gov.zm/Oilseed.php).

Since the prediction of the Fact Foundation is based on 17 year research in India I will use the 3 x 3m recommendation in my calculation. For this density 1089 Jatropha plants are needed, for the sake of convenience I will use 1100 plants in my calculation.
As assumed, (until better information of WUR), the Jatropha plantation in Cameroon will produce annually 3.000 liter oil, thus to produce 2 million liter oil, 666 hectare plantation is needed. I will continue with 750 ha. plantation, because this creates a margin of 10%.
1100 plants * 750 ha. = 825.000 plants. According Diligent they can sell seeds with a germination of 80%, which means to produce 825.000 plants, 1.031.250 seeds are needed. Also according Diligent 1 kilo seed contains 1500 seeds, thus 687.5 kilo seed is needed.

- Diligent sells Jatropha seeds for $5,- per kilo excluded shipping.

- The Indian company Global Flora can deliver 1000 kilo of Jatropha seeds for $3200, included shipping.

Thus to conclude this part: The costs of seeds are minimal, so it is better to invest (much) more in excellent developed and tested seeds, which are cultivated for the Cameroonian climate. Or invest in an own testing plantation to develop the best species of Jatropha. This investment will cause much higher yields.

6.4 Local education

The Tanzanian Jatropha producer Diligent has educated several field officers. These field officers have done an agricultural education themselves and are trained to educate the cultivation of Jatropha to local farmers.

"Center for Jatropha Promotion & Bio-diesel (CJP) is the Global authority for scientific commercialization of Jatropha fuel crop and designs and implements the growing of Jatropha curcas crops worldwide in a structured Agri-Supply chain, Value additions of Jatropha seeds and research activities thereon & provides support/services from "Soil to Oil" for development and establishment of the non -food Bio-fuel crops" (http://www.jatrophaworld.org/index.html). This center for Jatropha Promotion offers several training programs. One of them is a 5 day training in India and one of them is a distance training.

"CJP introduces its new Jatropha Distance Training (Learning) Package "JDLP" on Jatropha Bio-diesel & Agricultural Hi-tech techniques. A number of Power Point slides and a number of images and video clips teach you step by step Jatropha Science, Jatropha crop development & Bio-diesel Production Farm to Fuel technology & management for creating a successful Jatropha bio-diesel business venture". The price of this package is $2.100,- and includes business plan for plantations up to 100 hectare plantation at the time.
(source: http://www.jatrophaworld.org/distanttraining_54.html).

The 5 day course "enables participants to associate themselves from Concept to Commercialization of viable Jatropha projects right after undergoing the program as it aims to cover all aspects of Jatropha oil crop". The price of this course is $2.991,- for one person and $4.998,- for two persons and this is including lodging in a 5 star hotel including meals, boarding, training material and lectures. Travel arrangements such as air travel and visa are not included ($8.000,-).
(source: http://www.jatrophaworld.org/jwtp__course_70.html).

To lead the production plants it is recommended to first self-study the distance learning package to learn all the basics, and after that send 2 people to the training. These two people

on the agricultural part 2 people need to be educated and work full time. One year salary in Cameroon is about $2.300,-.
(http://hdrstats.undp.org/countries/country_fact_sheets/cty_fs_CMR.html). According to Erik Jan (finance TRC) one year salary for a well educated person is about 500.000 FCFA, which is €760,- a month. These people will provide further education to the local farmers and help them to set up the plantations. And therefore they need to transport themselves. Car costs (according Erik Jan) $55.000,- (depreciation in 4 year) + about $5.500 maintenance a year = $77.000,- in 4 years.

Next to this there is also a need for duplicating education material and providing other plantation materials to the local farmers. Since the costs of this are hard to predict, but I will assume this will not exceed $10.000,- a year.

Total the first 4 years:

- Training: $15.100,-
- Salary: $18.400,-
- Car: $77.000,-
- Training material: $10.000,-
- Total 4 years $120.500,-, meaning $30.125,- a year.
- In euros (according a currency on 28-11-2008 of €1= $1,29) this is €23.353,-.

6.5 Press installation

When the fruits are ripe they turn from green into yellow into black when they are dry. The ripe fruits need to be manually harvested, and this is best done “using a modified “apple picker”, a long wooden stick with a circular comb and a cotton bag at one end” (Nyama and Omuodo 2007 p33). With this tool the leaves are not damaged and the fruits are harvested easily. According Gressel (2008) attention should be paid to human health, because the toxicity of Jatropha the seeds and oil contain irritants affecting pickers and manual de-hullers”.

To extract the oil from the seeds, these seeds need to be pressed and this can be done in several ways. One of them is the Diligent way. They have 130 collection points in northern Tanzania where farmers can deliver their seeds and exchange them for money. According to the video of Diligent farmers get about 8 euro for 60 kilogram of Jatropha seed, this price is in line with the price offered for beans. Some Tanzanians in the video say this price is too low where other say it is a good price because they do not need to do invest money or labor but do get some money. Diligent presses the seeds centralized in Arusha because they say they need to use the press cake to close the business case.

Since the press cake is important for the local community, it would be better to return the press cake to them. And since transporting seeds from one place to another on long distance and the cake visa versa, it would be recommend to use decentralized press installations. This could be several delivery points where farmers bring their seeds, get their money and press cake. This could be that every farmer has its own small press installation and TRC collects the oil. And this could even be a mobile press truck which drives around alongside all the farmers, presses the seeds and pays the farmer who also gets its cake back.

Thus to conclude all above, the farmers need to restrain their press cake and preferably more, like oil for cooking, electricity or soap. This makes It hard to create centralized press installations because this causes an unacceptable high transportation factor. According Beerens (2007) decentralized pressing is preferable because expansion into new geographic areas is easier as fewer investments are required. On the other hand a centralized pressing installation causes higher yield per kilogram Jatropha seeds because of more efficient pressing methods.

In my opinion there are only two opportunities:

1. Give (or sell to) the farmers their own press installation and only collect the oil.
    a. Advantages
        i. Low transportation factor
        ii. Low labour costs
        iii. Low truck costs
        iv. Allows farmers to use press cake as fertilizer/ charcoal
        v. Allows farmers to use oil as soap/ cooking device, lightning or transform in electricity
        vi. Easy track and trace system (label barrels oil)
    b. Disadvantage
        i. Lower yield per kilo
        ii. Higher percentage oil in press cake
        iii. Worse combination of fertilizer and charcoal (use cake as fertilizer or as charcoal)
        iv. Threat of losing all the oil to local community
        v. Higher investment costs

2. Create mobile press installation truck
    a. Advantage
        i. Higher yield per kilo
        ii. Lower percentage oil on press cake
        iii. Better combination of fertilizer and charcoal (use cake as fertilizer and oil as charcoal)
        iv. Higher control over community use of oil
    b. Disadvantage
        i. Higher labour costs
        ii. Higher truck costs (Solarix can produce a truck with press installation for €120.000,-)
        iii. Harder track and trace system
        iv. Oil has to be returned to the farmer through a tap or something

The advantage of centralized press installation is the higher yield and the possibility of pre-treatment of seeds. Oil-yield out of the Jatropha seeds depends heavily on treatment of the seeds. Pre-press treatment for instance could be cooking. “Cooking causes increased cell wall rupturing thereby facilitating the outflow of oil. The oil point pressure decreases while pressure build-up increases due to increased viscosity in turn drastically increasing oil recovery”(Beerens, 2007).
The main disadvantage is the transport factor. Trucks have to collect the seeds which weigh tree times as much as the oil, and the press cake has to be returned to the farmer.

The choice of degree of centralization and the choice of truck vs. individual press installation depends on the whish of Reef and the transport possibilities.

6.6 Transesterfication installation

Solarix sells a machine the Sx 5 2.25 million litre bio diesel a year. Costs €250.000,-
Sx5 250-300.000, 1 man (www.solarix.nl)

6.7 Conclusions:

- Depends on new information new contact person Cameroon. In my first draft I assumed farmers would start plantations, but I can still take over large parts of this data.
- Education, salary, transportation and education material are needed.
- Seeds: The costs of seeds are minimal, so it is better to invest (much) more in excellent developed and tested seeds, which are cultivated for the Cameroonian climate. Or invest in an own testing plantation to develop the best species of Jatropha. This investment will cause much higher yields.
- Collection: Press truck, see next bullet
- Press: The farmers need to restrain their press cake and preferably more, like oil for cooking, electricity or soap. This makes It hard to create centralized press installations because this causes an unacceptable high transportation factor. According Beerens (2007) decentralized pressing is preferable because expansion into new geographic areas is easier as fewer investments are required. On the other hand a centralized pressing installation causes higher yield per kilogram Jatropha seeds because of more efficient pressing methods. A truck could solve these problems.

Source:

- Diligent, Center for Jatropha Production, Eric Jan, Achten 2008, Nyamai and Omuodo, Zambian Agricultural Research Institute, Fact Foundation, Global Flora, Solarix, Paul

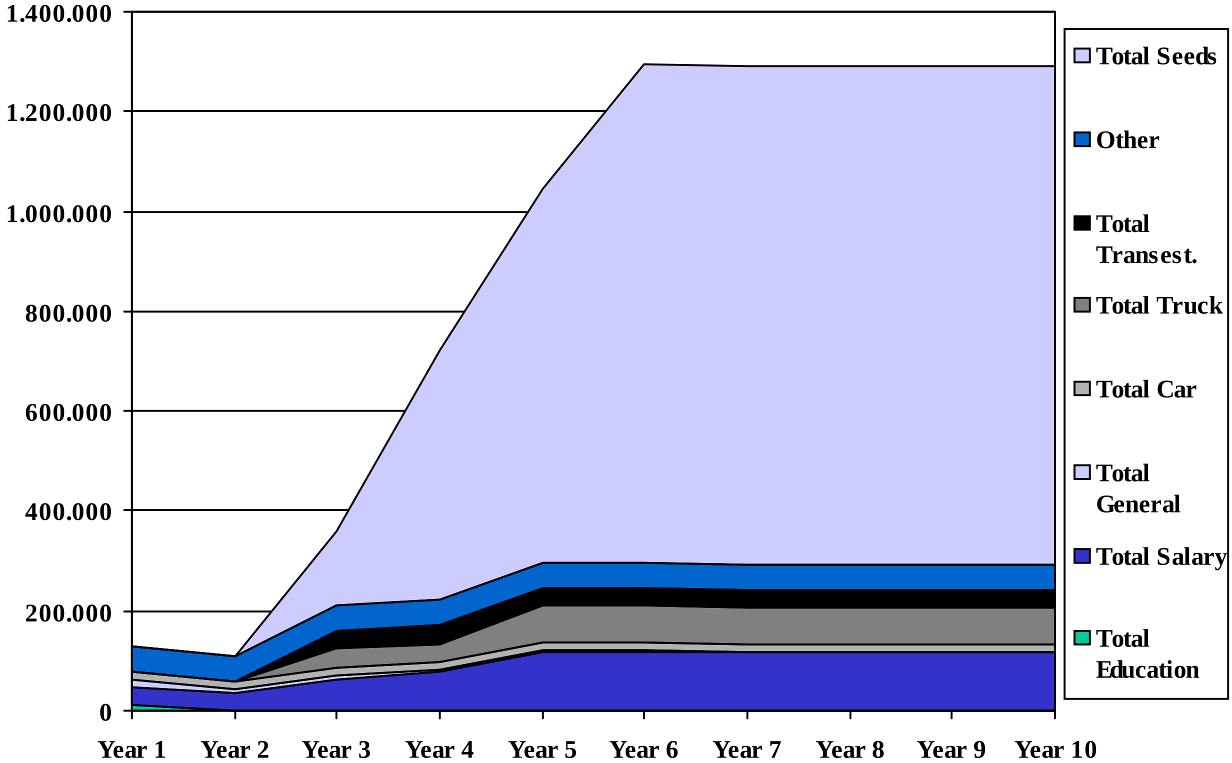
Remaining Questions:

- Specially press, transesterfication and transportation need some further research

6.8 SQ8: What are the costs of this project compared with fossil fuel?

Conclusions:

- Education: €24.000 for four years
- Seeds: 6500
- Solarix can produce a truck with press installation for €120.000,-.
- Solarix sells a conventional transesterfication machine the Sx 5 2.25 million liter bio diesel a year. Costs €250.000,-
- Transportation costs
- Distribution costs
- Farmers rewarding for the seeds
    - €8,- per 60 kilo (Diligent, Tanzania)
    - 9000 kilo per ha = €1200,- ha/ yr
    - 5 ha = €6.000,- = 2.6 GDP Cameroon
    - Total for 2 mil. Liter = €1 mil. (build up from 0 till 100% in 5 years)
- Other (€50.000)



Source:

- Diligent, Center for Jatropha Production, Eric Jan, Achten 2008, Nyamai and Omuodo, Zambian Agricultural Research Institute, Fact Foundation, Global Flora, Solarix, Paul

Remaining Questions:

- Transportation costs
- Distribution costs
- Maintenance costs
- Farmers rewarding
- Other transesterfication
- Truck ideal solution
- Other

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