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Evaluation of socio-economic sustainability indicators at Jatropha projects

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Abstract

Biofuels are a possible solution to increase the worldwide energy source diversification in renewable energy of which Jatropha has been marked as a high potential crop. Recently concerns have arisen about the sustainability of the biofuel production process. Therefore there has been a stronger focus on the development of sustainability certification schemes, that can be used to determine and guarantee the sustainability of a biofuel project. The objective of this research is to contribute to the further development of sustainability certification schemes and to determine what indicators can be used for this. Within sustainability certification schemes there is a focus on the socio-economic areas of concern. First, a literature review was conducted to determine the areas of concern to be included. The areas of concern that are included are food security, land rights, rural and social development, labour rights and economic feasibility. These areas of concern have been specified into criteria, indicators and data requirements, which have been put into a data format. During field work in Mozambique the data format was applied to evaluate the sustainability of the projects, but most importantly the practicability and accuracy of the indicators. During the field work 6 Jatropha projects were involved in this research and visited throughout Mozambique. The results of the sustainability of the projects showed that there were no major issues concerning food security, land rights, rural and social development and labour rights. The most concerns were regarding economic feasibility. The still limited knowledge on Jatropha cultivation causes the performance to be below expectations, which causes difficulties for financial projections. The assessment of the indicators' practicability and accuracy was precarious. Some indicators show good results and could be implemented, especially indicators aimed for individual projects. Indicators aimed for national or regional data are more difficult to implement, partly because of the immature stage of the Jatropha industry currently in Mozambique, and should now be revised or altered.

Preface

Dear reader,

During the process of preparing, executing and writing this research I have received support from many people who I would like to express my gratitude to.

First of all my daily supervisor, Janske van Eijck, who has supported me throughout the entire process. Janske initially offered me the opportunity to take on this research and has been closely involved from the start. She has always been available for useful discussion, helpful feedback and advice and other support of any kind.

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NL Agency, for co-facilitating this research, for providing me with network opportunities to get in touch with and learn from other people in this research field and for funding IIAM, which made it possible for me to execute my field work in Mozambique.

The process of this research has been demanding, but therefore also very rewarding and has improved and expanded my capabilities in many ways. My stay and field work in Mozambique have been a unique experience and very enriching. In the end, I am very grateful that I have received the opportunity to take on this research and happy that I grasped it with both hands.

Yours sincerely,

Jouke Rom Colthoff

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Abbreviations

EPFL	École Polytechnique Fédérale de Lausanne
EU	European Union
FAO	Food and Agriculture Organization
GBEP	Global Bioenergy Partnership
GDP	Gross Domestic Product
IIAM	Instituto de Investigação de Agrária de Moçambique
NL	Netherlands
NPSB	Netherlands Programs Sustainable Biofuel
RED	Renewable Energy Directive
RSB	Roundtable on Sustainable Biofuels
UNDP	United Nations Development Program
US	United States

Definitions

Sustainable – To meet present needs without compromising the ability of future generations to meet their needs.

Renewable energy resource – A natural resource that can replenish itself over time.

Biodiesel – Biodiesel is a renewable fuel for diesel engines derived from vegetable oils.

Biofuels – A gaseous, liquid, or solid substance of biological origin that is used as a fuel.

Biomass – Renewable organic materials, such as wood, plant material, vegetation, agricultural crops or wastes, and municipal wastes, especially when used as a source of fuel or energy.

Sustainability certification scheme – A method to provide a sustainable standard through independent verification.

1. Introduction

The global energy demand is increasing and will remain to increase in the future, while the global reserves of fossil fuels are diminishing. In order to keep the global energy supply in line with the global energy demand there is a need for diversification of energy sources. One of the solutions is to make use of renewable energy sources. Renewable energy sources include solar power, wind power and hydro power and also bioenergy; power generated from sustainable biomass.

Sustainable biomass represents the use of crops and plants or their residues to produce electricity or biofuels. An important aspect of the production of bioenergy is the question whether this can actually be executed sustainable (Amigun, Musango et al. 2011). Recently there has been criticism on the use of biomass for the production of biofuels, questioning the sustainability (Ariza-Montobbio and Lele 2009). One of the most consistent arguments against biomass as being sustainable, follows from the food versus fuel debate. The large scale cultivation of biomass crops is by some considered to have a negative impact on food security and is said to increase food prices (ActionAid 2009). The sustainability of bioenergy production is an important aspect, for example for the European Commission, requesting compliance with the new renewable energy directive and also for the Dutch government, that has to comply with the established targets (European Commission 2009). The Dutch government has also shown interest by developing sustainability guidelines and targets, which shows the importance of the sustainability of bioenergy production (Cramer, Wissema et al. 2007).

As a result of the uncertainty regarding the sustainability of the use of bioenergy there is globally an increased focus on the development of sustainability certification schemes (van Dam, Junginger et al. 2008; van Dam, Junginger et al. 2010). These sustainability certification schemes are focused on developing indicators and the operationalization thereof, which can be used to measure, analyze and guarantee the sustainability of bioenergy production (van Dam, Junginger et al. 2008). This means that bioenergy projects that comply with these certification schemes can contribute to improve the sustainability of biomass production chains. However, most of the existing sustainability certification schemes are not in advanced enough stage, yet, to be fully operational.

Over the last few years, approximately since 2005, research on biomass sustainability certification schemes has intensified (Vissers, Paz et al. 2011). This trend was stimulated by the fact that the worldwide trade in biomass has increased exponentially. The production of biodiesel has increased from less than 30PJ in 2000 to 572PJ in 2009 and the production of ethanol has increased from 340PJ in 2000 to 1540PJ in 2009 (Lamers, Hamelinck et al. 2011). Taking into account the possible negative impacts of biomass production, sustainable bioenergy production, and therefore the establishment

of sustainability criteria for biofuels, has become a key concern in EU biofuels directives (Zarrilli 2006; European Commission 2011). However, there are a number of complications for the implementation of a sustainability certification scheme (van Dam, Junginger et al. 2008). Multiple organizations are developing various certification schemes, but there is a lack of unity and consensus among the different certification schemes (Vissers, Paz et al. 2011). Also, criteria and indicators may sometimes be too general, vague and leave room for different interpretations (Lewandowski and Faaij 2006). Research has been carried out on appropriate sustainability criteria and on the further harmonization of the various certification schemes to come to a more comprehensive and unanimous certification system (van Dam and Junginger 2011). Furthermore, the development of methodologies, to measure impacts of biofuel production under specific circumstances, such as for a specific region, is recommended (Smeets, Junginger et al. 2008). Examples of studies that quantify the impacts of bioenergy production are Arndt (2009) and Herreras (Herreras 2011), who respectively use a CGE analysis and an input/output analysis as methods. However, these methods have a stronger focus on comprehensiveness than on practicability, where exactly practicability is important for certification. When it comes to the content of the several certification schemes, it appears that most of them mainly argue about environmental principles (van Dam, Junginger et al. 2010). Even though there are serious concerns about socio-economic impacts of bioenergy production activities, they were generally being left out of certification initiatives (van Dam, Junginger et al. 2010). Recently certification schemes have been developed that also include socio-economic aspects. Examples of sustainability certification systems that include socio-economic aspects are the *Sustainability Indicators for Bioenergy*, developed by the Global Bioenergy Partnership (GBEP 2011), the *Principles and Criteria for Sustainable Biofuel Production*, developed by the Roundtable of Sustainable Biofuels (RSB 2010), and the *NTA8080* (Netherlands Technical Agreement), developed by the Nederlands Normalisatie-institute (Dutch Normalization institute) (NEN 2011).

To deal with the energy demand issue and to accomplish in meeting renewable energy targets the Dutch government aims at sustainable biomass as a large contributor. However, the production potential of biomass in the Netherlands is limited, since available land for cultivation is scarce. Therefore the Netherlands has to rely for a large share on imported biomass to increase the renewable energy share.

To stimulate the import of biomass, NL Agency has established the Netherlands Programmes Sustainable Biomass (NPSB). This program is intended to stimulate the sustainable production and import of biomass produced abroad (Agency NL 2011). This way the Netherlands can meet their energy needs and meet the sustainable energy targets set. The NPSB project portfolio consists of the programs Sustainable Biomass Import, Global Sustainable Biomass and projects of the Daey Ouwens

Fund that are relevant (Agency NL 2011). The NPSB focuses on the evaluation of the impact of biomass production, on the sustainability certification of biomass production and on making production chains more sustainable (Agency NL 2011). Since 2008, the program has issued funding to 45 projects to stimulate the production of sustainable biomass in developing countries and increase the export to the Netherlands (van Eijck, Smeets et al. 2010; Heinze and Kwant 2011).

A crop that has the potential to be used for the production of biofuels is Jatropha curcas (Wiskerke, Dornburg et al. 2010; van Eijck, Smeets et al. 2011; Wicke, Smeets et al. 2011; van Eijck, Smeets et al. 2012). The Jatropha curcas plant is able to grow on marginal land and is therefore suitable for cultivation in many areas. The seeds of the Jatropha contain on average 34.4% oil (Achten, Verchot et al. 2008), which can be used as diesel substitutes in engines, either directly in blends with diesel or to produce biodiesel. A large share of the projects that are part of the NPSB, 12 out of 45, are Jatropha projects (Agency NL 2011).

The objective of this study is to contribute to further clarification and development of sustainability certification schemes with a focus on socio-economic aspects of Jatropha projects. A review of literature is conducted on sustainability certification schemes in order to distinguish the areas of concern. These areas of concern are further specified in criteria and indicators, and are further operationalized. A point of interest hereby is the consideration between accuracy and practicability. Acquiring all possible data in detail results in a high degree of accuracy, but that would imply low practicability, so there is a tradeoff between these two aspects.

In section 2 the research question and research boundaries are stated. In section 3 the methodology is explained, while in section 4 the Jatropha projects that are involved are introduced. In section 5 the results are explained and finally section 6 and 7 contain the discussion and conclusion respectively.

2. Research question

This research aims to contribute to further development and specification of the operationalization of socio-economic aspects of sustainability certification schemes that can contribute to the assessment of bioenergy projects, such as Jatropha. This leads to the following research question:

Which indicators can be used for the socio-economic areas of concern in sustainability certification schemes, what is the practicability and accuracy of the indicators used, and do they provide a good overview of the sustainability of a biofuel project?

2.1 Research boundaries

First, as already mentioned, there is a focus on socio-economic aspects of certification schemes, thereby disregarding other aspects such as environment and agronomy. Second, this research is focused on Jatropha for the production of biofuels. There are various crops that can be used for the production of biofuels, of which Jatropha is marked as a crop with a large potential. Also, Jatropha has a lot of interest worldwide and in the Netherlands (NL Agency 2011). Third, Mozambique has been marked as a region with a large potential for the production of biofuels (NL Agency 2011; Van der Hilst et al. 2012), where also multiple Jatropha projects are located. Moreover, there is access to data in Mozambique through cooperation with the local institute *Instituto de Investigação Agrária de Moçambique* (IIAM). Therefore, this research is region specific; only Jatropha projects in the country of Mozambique are incorporated. Fourth, when it comes to data collection an important distinction can be made between plantations and outgrowers. The data collection from plantations can be more detailed and easier to obtain than from outgrowers (Van Eijck et al. 2011). Although the latter is a notable issue for the operationalization of indicators, this will not be a point of focus in this research. Fifth, this research does not intend to compose an infinite and comprehensive overview concerning sustainability criteria, but instead considers both accuracy and practicability. Last, there is a focus on the impacts of the production of biofuels and feedstock and not on the use of biofuels, which narrows down the scope of certain areas of concern.

3. Methodology

3.1 Identification of areas of concern, criteria, indicators and data requirements

There is a focus on two existing sustainability certifications systems and in addition, other certification schemes and literature on this topic are used. The first certification scheme is the *Sustainability Indicators for Bioenergy*, which is developed by the Global Bioenergy Partnership (GBEP 2011). The second certification scheme is the *Principles and Criteria for Sustainable Biofuel Production*, which is developed by the Roundtable of Sustainable Biofuels (RSB 2010). These two certification schemes are selected, since both are already in an advanced development stage and both provide considerable attention to socio-economic indicators. Furthermore, the set of areas of concern, criteria and indicators that is identified is checked for accuracy with the data format that has been developed for data collection during the Jatropha assessment that was commissioned by NL Agency (van Eijck, Smeets et al. 2011).

Box 1: Terminology

A distinction is made between four layers. First, there are the areas of concern, which explain the general aspect on which bioenergy production may have an impact. The second layer consists of the criteria. The criteria represent the areas of concern in more focused and concise terms and form the core of the goal that is to be reached for each area of concern. The third layer consists of the indicators. The indicators are measurable for which data can be collected and these arise from the methods that are used. The fourth and final layer consists of the data requirements that are needed to cover the indicators.

The identification of the areas of concern, the criteria's, the indicators and the data requirements represent the operationalization of the socio-economic aspects of bioenergy production. The details can be found in appendix B.

3.2 Outcome literature review

In this section an overview is given of the areas of concern, criteria and indicators that have been identified through the literature review. In addition an overview is given of the data requirements for the indicators that have been identified. The details of the literature review can be found in appendix B. The overview is shown in table 3 and 4 below.

Area of concern	Criteria	Indicator
Food security	• The bioenergy production shall not threaten food security • The bioenergy production shall ensure the human right to food access	• Availability of main staple crops [tonnes/year] • Change in yields of main staple crops [tonnes/hectare] • Land converted from food crops for bioenergy feedstock production [hectares] • Change in prices of the 5 main staple crops [€/tonnes] • Change in share of expenditures households spent on food [%] • Competition for labour [yes/no] • Change of perception by people affected by bioenergy production regarding food security [positive/negative] • Change in undernourishment [%]
Land rights	• Biofuel production activities shall respect land rights and land use rights. • Existing land rights will be assessed, documented and established. This holds both for formal and informal land rights. The allocation of land for biofuel production will only be established when these rights are determined. • Acquisition or voluntary resettlement of land for biofuel production will always be compensated	• Land acquisition process [positive/negative] • Land compensation [positive/negative] • Change in access to land [positive/negative] • Share of land acquisitions that have complied with formal or socially accepted procedure regarding absolute numbers and area [%]
Rural and social development	• The socio-economic position of local stakeholders shall be improved	• Comparison wages Jatropha projects to comparable sector/national average [Mtc]

	through the impact of biofuel operations	• Change in share of people below the poverty line [%] • Change in GDP [USD/year] • Purchasing power [USD/year] • Life expectancy [years] • Literacy rate [%] • GINI-index [-] • Regional unemployment rate compared to national average [%] • Contribution to education, health care and infrastructure investments [-] • Share of total regional investments by Jatropha projects [%] • Net Job creation per hectare [jobs/hectare] • Ratio skilled/unskilled jobs [%] • Ratio permanent/temporary jobs [%]
Labour and working conditions	• Bioenergy production activities shall not violate labour rights • Bioenergy production activities shall ensure decent work and the well-being of workers • No forced labour or child labour shall occur on bioenergy production activities • Workers shall have the right to organize, collectively bargain and the right to associate • Workers shall not be discriminated in any way, including gender	• Amount of forced labour [positive/negative] • Amount of child labour [positive/negative] • Rate of discrimination [positive/negative] • Formation of unions [positive/negative] • Number of work related accidents and health issues [positive/negative]
Economic feasability	• Bioenergy production activities shall be financially viable	• NPV [€ or USD] • IRR [%] • PBP [years] • Production costs [€ or USD/tonne SVO] • Profitability [€ or USD/year] • Competitiveness Jatropha biofuel compared with alternatives such as fossil diesel [Mtc]

Table 1: Overview areas of concern, criteria and indicators (GBEP 2011; RSB 2010).

Area of concern	Data requirements	Data source
Food security	• 4 main staple crops [type of crop] • Production of main staple crops nationally/regionally [tonnes/year] • Exports and imports of main staple crops [tonnes/year] • Changes in stockpiles of main staple crops [tonnes/year] • National yield averages of main staple crops [tonnes/hectare] • Regional yield averages of main staple crops [tonnes/hectare] • Hectares under cultivation for main staple crops nationally [hectares] • Hectares under cultivation for main staple crops regionally [hectares] • Land converted from food crops for bioenergy feedstock production for individual projects and on a regional and national scale [hectares] • Change in nominal prices of the main staple crops nationally [€ or USD/tonne] • Change in nominal prices of the main staple crops regionally [€ or USD/tonne] • Price inflation % • Change in price indices of main staple crops nationally/regionally [index] • Change in total expenditures households [Mtc/month] • Change in expenditures food households [Mtc/month] • Time spent on biofuel feedstock production per person/household [hours/week] • Change in time spent on food production per person/household [hours/week] • Perception of food security before bioenergy activities [A lot worse, a little worse, unchanged, a little improved, a lot improved, don't know] • Perception of food security after bioenergy activities initiated [A lot worse, a little worse, unchanged, a little improved, a lot improved, don't know] • Change in undernourishment [%]	• Statistical databases • Interviewing at Jatropha projects • Interviewing at community • Interviewing at authorities • Literature review
Land rights	• Land transferred in terms of ownership [yes/no] • Previous land ownership [private/government/community]	• Interviewing at Jatropha projects • Interviewing at local authorities

	• Assessment of previous land rights [yes/no/outcome] • Assessment of informal use of the land [yes/no/outcome] • Land conflicts [yes/no/type of conflict] • Transparency in process through language use [English/Portuguese/local/other] • Use of documentation on the land acquisition process [yes/no] • Engagement in stakeholder analysis [yes/no] • Stakeholders [private/authorities/community] • Compensation of previous users of the land [yes/no] • Type of land compensation [monetary/qualitative] • Amount of land compensation [Mtc] • Price paid for land [Mtc/hectare] • Change in access to land for secondary land users [yes/no] • Land compensation secondary land users [Mtc or qualitative] • Involvement of secondary land users [yes/no] • Identification of secondary land users [yes/no] • The number of land transfers for the production of bioenergy [absolute number] • The land area transferred for the production of bioenergy [hectares] • The number of land transfers that have complied with formal or socially accepted procedure [absolute number] • The land area that has been transferred compliant to formal or socially accepted procedure [hectares]	
Rural and social development	• Wages Jatropha projects [Mtc/month] • National wage averages [Mtc/month] • Wage averages agricultural sector [Mtc/month] • Legal minimum wage agricultural sector over 2011 [Mtc/month] • National poverty line [USD/day] • International poverty line [USD/day] • People below the national poverty line [%] • GDP per capita [USD] • GDP per capita (PPP) [USD] • Life expectancy [years] • Literacy rate [%] • GINI-index [-]	• Statistical databases • Interviewing at Jatropha projects • Interviewing at community • Interviewing at local authorities • Literature review

	• Unemployment rate [%] • Contribution to education, health care and infrastructure investments [yes/no] • Total project investments in education, health care and infrastructure [monetary or qualitative] • Total regional investments in education, health care and infrastructure [monetary or qualitative] • Total number of jobs currently and expected [absolute number] • Number of skilled and unskilled jobs created [absolute number] • Number of permanent and temporary jobs created [absolute number] • Number jobs have been taken away by replacing previous activities on the plot of land [absolute number] • Land area of the project currently and expected [hectares]	
Labour and working conditions	• The policy on forced labour [-] • The policy on child labour [-] • The policy on gender discrimination [-] • The right for employees to form unions [yes/no] • Number and type of work related accidents [number and type] • Identification of different types of work [manual/mechanical/other] • Exposure of employees to chemicals or other hazardous materials [yes/no] • The average working hours [hours/day and week] • Breaks [time/day] • International legal minimum age [years] • National legal minimum age [years]	• Interviewing at Jatropha projects • Literature review
Economic feasability	• NPV [€ or USD] • IRR [%] • PBP [years] • Production costs [€ or USD/year] • Turnover [€ or USD/year] • Costs [€ or USD/year] • Profit [€ or USD/year]	• Interviewing at Jatropha projects • Statistical databases • Local data sampling • Expert consultation • Literature review

	• Future expectations profit [€ or USD/year] • Future expectations production costs [€ or USD/year] • Investment costs [€ or USD/hectare] • Production costs [€ or USD/hectare] • Yield [kg dry seeds/ha/yr or kg dry seeds/tree/yr] • Selling price [Mtc/L SVO] • Price Jatropha SVO and biodiesel [Mtc/L] • Price fossil diesel nationally/regionally [Mtc/L] • Price other biodiesels nationally [Mtc/L]

Table 2: Overview of areas of concern, data requirements and data sources (GBEP 2011; RSB 2010).

3.3 Methodology of data collection

Primary data has been collected from March to May 2012. During this period 6 Jatropha projects were visited as well as various institutions in Maputo, Mozambique. At the Jatropha projects data has been collected through interviews. This also includes interviews with communities in the direct vicinity of the Jatropha projects and local authorities that are directly involved with the projects.

Secondary data is partially collected using online public sources such as FAOstat and countrystat. Furthermore government institutes were visited in Maputo.

3.3.1 Primary data

To create a practical questionnaire of the data requirements that were applied during the field work four different versions were created that were used in interviews with four different target groups. Some data collection was identical for different target groups, but there were also specific questions that were only relevant for one specific target group. The four versions are:

- Data project: this questionnaire was used for interviews with project general managers or other people that were involved with project management.

- Data community: this questionnaire was used for interview with people from the local community close to a certain Jatropha project. Usually this meant interviews with community leaders, since the community leaders were often involved with negotiations with the Jatropha projects and the authorities and were most aware of the situation.

- Data workers: this questionnaire was used for interviews with people that work at the Jatropha projects. For the majority unskilled workers were interviewed, but sometimes also higher skilled workers with more responsibility or supervising positions.

- Data local authorities: this questionnaire was used for interviews with local authorities. There are two levels, the provincial and district administration. Because the provincial administration is only involved locally on an administrative level and are not involved in negotiations with the Jatropha projects directly, only the district administration has been involved.

The four different versions are used for all Jatropha projects that were involved in the data collection. The overview below shows the quantity of questionnaires conducted for each Jatropha project:

Interviews Jatropha projects	Data project	Data community	Data workers	Data local authorities
AVIAM	2	2	5	2
ADPP	1	5	5	1
Niqel	1	1	5	-
MoçamGALP	1	-	-	1
SAB	1	1	4	-
Sun Biofuels	2	1	4	1

Table 3: Quantity of questionnaires conducted in each category and for each Jatropha project.

The table shows that for MoçamGALP the acquired data is limited. The visit at MoçamGALP was not planned beforehand, since the general manager could not be contacted properly. Therefore, onsite there was only spoken to a local technician, who was only able to provide some basic information about the location in Chimoio, but very little about the GALP project in general. For the other Jatropha projects, the visits were planned with project management.

3.3.2 Secondary data

Secondary data was collected through online sources such as FAOstat, countrystat, IMF, WFP and Mozambican governmental databases. Also, secondary data was collected through available reports at governmental institutes such as the ministry of agriculture, the national institute of statistics, CEPAGRI. Contacts with the relevant people within these institutes were established in cooperation with IIAM. This way, additional data could be collected that was not publically available.

3.4 Data analysis and evaluation

An important aspect of the evaluation of the indicators is the assessment of the practicability and accuracy. Practicability meaning the readily availability of data from a data source and/or the possible measurement of an indicator over a specified period of time and furthermore the amount of time, effort and input it takes to be able to extract the desired output. Accuracy meaning the degree of closeness of the collected data to the impact that the indicator aims to measure, the reliability and consistency of the collected data and the whether the indicator is easy to comprehend.

The data format is intended to be a tool for data collection and should be practical in use and thus easy to apply. The results of the data collection during the field work in Mozambique show information on both the practicability and accuracy. Related to the practicability and accuracy is the fact whether the data format gives a good overview of the sustainability of a Jatropha project regarding the relevant areas of concern.

4. Projects

Six Jatropha projects are analyzed in this research; the projects are introduced below.

4.1 AVIAM

AVIAM is located near the village of Micolene in Nacala a Velha district. It is an Italian funded project that has started their activities in 2009 and has 250 hectares of Jatropha planted so far and they are aiming for 10.000 hectares in 2017. At the moment, AVIAM is still in the start-up phase and has not reached its goal for the amount of hectares they want to plant each year. Also, they are not operating commercially yet, not having produced or sold oil yet, except for some trials. The aspect on which they can improve the most is said to be the agronomic knowledge about Jatropha, best cultivation practices, yield optimization and planting seed quality. So, how to cultivate Jatropha in the best way possible, gaining the best yields possible by using e.g. optimal quality of planting-seeds. However, management is positive and hopeful for the future. They plan on going into the industrial phase this year, which means they will start planting on a larger scale and start producing oil. They expect to reach the break-even point 8 years from the start of the industrial phase, so in 2020 (AVIAM-Management 2012).

4.2 ADPP

ADPP's main office is located in Bilibiza district. ADPP has been active on this site since 2006 and started Jatropha activities in 2009 and has received funding from FACT up to 2 years ago. ADPP works with outgrowers that are paid for Jatropha seeds. They also have their own plantation field, but this is on a very small scale and only meant for trials. At the moment they have a network of 1800 outgrowers and they intend to continue the expansion without a fixed goal. ADPP wants to produce and sell oil and also by-products, such as soap. However, at the moment they have not engaged in any commercial activities yet, nothing has been sold. They intend to start selling for local use this year (ADPP-Management 2012).

4.3 Niqel

Niqel is located near the village of Grudja in Buzi district. Niqel is a private initiative of Nick Gagiano, who will remain to be the general manager, but was recently taken over by Dutch investors and now belongs to the 'Dutch Jatropha Consortium'. Niqel started operations in 2007 and currently has 1.500 hectares of Jatropha planted and is aiming for about 5.000 hectares in 2014. Niqel has not produced or sold any oil yet, except for some trials. They have been bulking up all the seeds that they harvested over the last few years and, together with seeds bought from Sun Biofuels, will send all those seeds to the Netherlands for processing soon. The new owners of the Dutch Jatropha Consortium have facilities in the Netherlands to extract and process the oil (Niqel-Management 2012).

4.4 Sun Biofuels

Sun Biofuels, a plantation company, is located near the city of Chimoio in Manica province. Sun Biofuels was previously a UK based company, but changed ownership in august 2011 and was taken over by other investors. The general manager is South African. The Sun Biofuels Jatropha plantation, located on the site of a former tobacco plantation, is the biggest in Mozambique with 2500 hectares planted. However, since the ownership changed project management has decided not to focus on Jatropha any longer, due to disappointing results. They will maintain the Jatropha that is already there but will not expand. Instead, they will go into food crops. The Jatropha that they still have and the oil that might be produced could be used for their own use their machinery (Sun Biofuels-Management 2012).

4.5 MoçamGALP

MoçamGALP is located near the city of Chimoio in Manica province. It is a combined initiative from Petromoc, Ecomoz and GALP Energia. There are multiple locations of this project. They are also located in Buzí, using the name GALPBuzi, and also in Inchope and Mocuba. Apparantly, Mocuba is supposed to become a large plantation in the future, but there is nothing there yet. The location in Chimoio has about 165 hectares planted. They are aiming for an area of 15.000 hectares on this location, but they have troubles acquiring more land (MoçamGALP-Management 2012).

4.6 SAB

SAB, which stands for SECI API Biofuels is located near the village of Inhassune within Panda district in the province of Inhambane and is Italian. SECI and API are two Italian companies that are backing this project. SAB has acquired a DUAT for 6000 hectares and they have a business plan for 7000 hectares. The land previously belonged to another Jatropha project and before that there was a community farm located. SAB currently has about 240 hectares planted, but have slowed down its progress. They do not want to keep on planting at the same pace, because they want to wait until they have a good enough variety that will give them constant quality. So they are working on trials and are also cooperating with a university in Israel. When they have found seeds of high enough quality they will resume planting (SAB-Management 2012).

5. Results

First, the results of the indicators concerning the sustainability of the Jatropha projects. Second, an assessment of the indicators' practicability and accuracy based on the application of the indicators during preparatory- and field-work in Mozambique. The results are structured individually for all five areas of concern and the accompanying indicators: food security, land rights, rural and social development, labour and working conditions and economic feasibility.

5.1 Food security

5.1.1 Results sustainability

The most notable findings from the results of the indicators regarding food security sustainability are presented in the tables below. This concerns the data requirements and indicators aimed at individual projects and not the indicators aimed for national overview data and national impact from secondary data.

Project	Ave. houshold exp. Before (Mtc)	Ave. food exp. Before (Mtc)	Ave. share food exp. Before (%)	Ave. houshold exp. After (Mtc)	Ave. food exp. after (Mtc)	Ave. share food exp. after (%)
AVIAM	2500	1225	50,0	1500	1000	33,3
ADPP	3480	933	52,9	2739	1440	55,5
NIQEL	2150	1438	71,7	5400	2563	45,7
Sun Bio	2667	2313	78,1	6175	4138	66,4
SAB	2500	1500	60,0	3150	2075	70,1

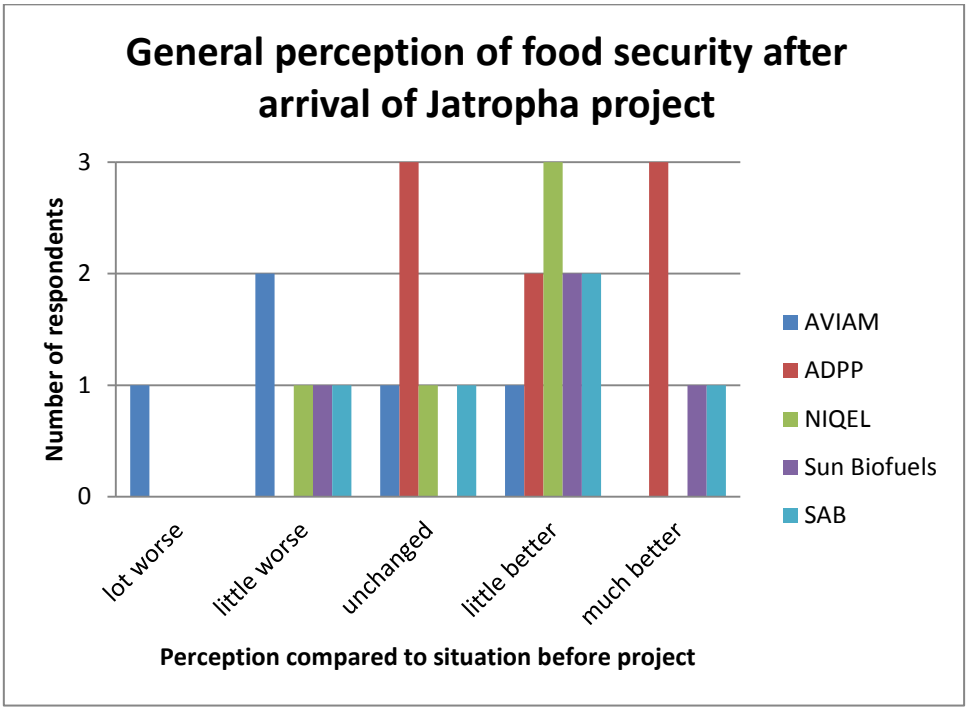
Table 4: Difference in average share of food expenditures before and after Jatropha projects have started.

The results show that the change in share of food expenditures vary per project between positive, negative and relatively equal. A dropping percentage means that the people spend a smaller share on food, which means they either make more money or the absolute amount they spend on food is lower. For an increasing percentage the opposite is valid.

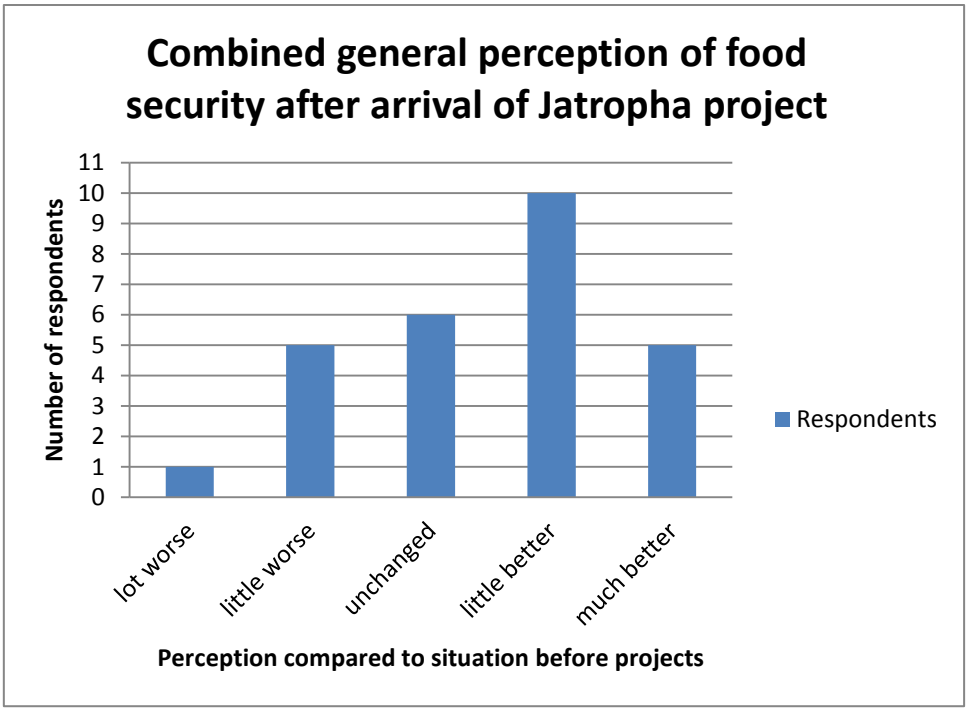
Project	Ave. Time spent on food prod. Before (h/week)	Ave. time spent on food prod. after (h/week)
AVIAM	33,3	33,3
ADPP	23,4	3,9
NIQEL	24,8	9,00
Sun Bio	24,0	13,8
SAB	19,3	3,8

Table 5: Difference in average time spent on food production before and after Jatropha projects have started.

The above results show that the average time spend on food production has significantly dropped for most projects. This means people either do not have to work on food production any longer, because they can afford to buy it, or that they have enough money to pay other people to work on the land for them, or that they do not have enough time anymore, because they are working at the Jatropha projects.



Graph 6: General perception of food security after the arrival of Jatropha project for each project individual



Graph 7: Combined general perception of food security after the arrival of Jatropha project

Both graph 6 and 7 show the results of the general perception of the communities regarding food security. The results vary per project as can be seen in graph 5, but when combining the results in graph 7 it shows that the overall trend is slightly more on the positive side, which means a better food security.

The abovementioned results are now combined in the table below. The results are rewarded either a negative, neutral or positive score, which are combined in the end to give an impression of the sustainability of food security of a project:

Project	Land conversion from food crops to Jatropha	Change in share food expenditures	Labour competition	General perception	Overall
AVIAM	+	0	+	-	+
ADPP	+	0	+	+	+++
Niqel	+	0	+	+	+++
Sun Biofuels	-	0	+	+	+
SAB	+	0	+	+	+++

Table 8: Project specific sustainability regarding food security, separate for each indicator and an overall combined score. '+' meaning no issues or a positive influence, '0' meaning no noticeable influence, '-' meaning the occurrence of issues or a negative influence.

5.1.2 Assesment indicators

The evaluation of the practicability and accuracy of the indicators is summarized in the table below. Following, the results of practicability and accuracy of the indicators are further explained.

Indicator	**Practicability**	**Accuracy**
The availability of main staple crops	-	-
Change in yields of main staple crops	-	-
Land converted	+	+
Change in prices of the 5 main staple crops	0	-
Change in share of household expenditures	+	0
Competition for labour	+	+
Change in perception of food security	+	+
Change in undernourishment	-	-

Table 9: indicator specific practicability and accuracy regarding the availability of main staple crops. '+' meaning positive, '0' meaning neutral, '-' meaning negative.

Both availability, change in yields and change in prices of main staple crops do not score good on either practicability and accuracy. Data on national production, yields and prices of main staple crops are available for most years, however different sources show contradicting results. Besides this, the data on regional production, yields and prices is very limited. The main issues are that either the data is not available at all, has many gaps and is old and outdated. These are quite common problems for a developing country such as Mozambique. Regarding accuracy it is difficult to extract good output on the level that is desired, for individual projects, and consequently to reflect the impact of individual projects on the availability of main staple crops locally, regionally or nationally. For change in prices, the national price data can be used as a guideline to determine trends, but not so much to reflect the impact of individual projects.

Land conversion can be used properly on a project scale. The project itself can provide data on what the previous occupation was of the land that was taken over. This can often be confirmed by local authorities, such as the district administration. The accuracy of the indicator depends on the reliability of the data source. Regarding the local community the data is often based on memory. Regarding the Jatropha project and the local authorities the information is based on documentation during the land consultation period. However, because all parties are involved with this indicator the general picture of the land conversion can almost certainly be recovered and data can be cross checked.

For household expenditures and competition for labour the results from the data collection at the individual projects and the community are valuable for use. People from local communities are asked about their household expenditures and working hours with an emphasis on the change before and after a project started operations. Regarding accuracy these indicators are good in targeting individual households and workers and acquiring direct results and differences between past and present. It reflects the impact of an individual project and show a clear change in expenditures and working hours. For household expenditures on food a downside could be that other influences such as a bad harvest due to drought can also interfere with food prices. Also, for both indicators an insecurity is the reliability of the answers. Mostly, the questions can be answered sufficiently, but sometimes the questions are not fully understood, especially regarding the difference between past and present to indicate a difference.

For change in perception the results from the data collection show a direct impact of projects on the food security of people from the community or workers. In this case the time frame of the data collection is between right before the start of the projects and the present. However, if projects have existed for a longer period, the time frame could be reconsidered in order to take into account the passage of time and the accompanying changes as well. Regarding accuracy, there could also be other factors that influence the food security situation. And also, like the indicator already states, it concerns a perception and not hard data. However, this indicator does target individual households directly with a simple and clear answer on a set scale, which contributes to the accuracy.

Undernourishment data is irregular and only available on a national level. Detailed undernourishment figures for regions or districts are not available. It is not possible to reflect the impact of an individual project on undernourishment data. It could be used as a benchmark on the long term and in a situation/country where there is a large and established biofuel market.

5.2 Land rights

5.2.1 Results sustainability

The most notable findings from the results of the indicators regarding land rights sustainability are presented in the tables below. This concerns the data requirements and indicators aimed at individual projects and not the indicators aimed for national overview data and national impact from secondary data.

Data requirements	AVIAM	ADPP	NIQEL	Sun Biofuels	MoçamGALP	SAB
Land transferred in terms of ownership	no	no	no	no	no	no
Previous land ownership/user	-	-	-	Tobacco company	State cotton farm	State cotton farm
Assessment of previous land rights	yes	-	yes	yes	-	yes
Assessment of informal use of the land	yes	-	yes	yes	-	yes
Land conflicts	4 families relocated	no	no	After stopping Jatropha activities	no	no
Transparency in process through language use	Portuguese, Makua	-	English, local	Portuguese	-	local
Documentation on the land acquisition process	Only for relocated families agreement	-	no	yes	-	yes
Engagement in stakeholder analysis	yes	-	yes	yes	-	yes
Stakeholders	Project, local government, community	-	Project, local government, community	Project, local government, community	-	Project, local government, community

Table 54: Overview of the results of the data requirements for the indicator land acquisition process.

The results of the land acquisition process in table 54 above shows that there have been no major difficulties taking into account the data that was available at this point. There was a minor conflict with the relocation of 4 families and the payment thereof. Also, it show that problems can occur after a Jatropha project ceases its activities and people lose jobs.

Data requirements	AVIAM	ADPP	NIQEL	Sun Biofuels	MoçamGALP	SAB
Compensation of previous users of the land	yes	-	yes	yes	-	no
Type of land compensation	Monetary	-	material	intangible and material	-	-
Amount of land compensation	3000 - 11000 Mtc	-	construction material and land clearance	job creation and community development	-	-
Price paid for land	-	-	-	-	-	-

Table 55: Overview of the results of the data requirements for the indicator land compensation.

The results from land compensation show there is a broad array in compensation, ranging from financial compensation to material and physical compensation and also community development and job creation was in some cases considered as compensation. In one case there was no land compensation according to project management, not taking into account other services to the community and also job creation.

Data requirements	AVIAM	ADPP	NIQEL	Sun Biofuels	MoçamGALP	SAB
Change in access to land for secondary land users	no	no	no	yes	-	no
Land compensation secondary land users	-	-	-	-	-	-
Involvement of secondary land users	yes	-	yes	no	-	yes
Identification of secondary land users	yes	-	yes	no	-	yes

Table 56: Overview of the results of the data requirements for the indicator change in land access.

The results from change in land access show there was no big change in land access to secondary land users. It also appeared that this was not a key part of the land acquisition process, which explain the data gaps. For most projects, secondary land users had unchanged land access.

The indicator 'share of land acquisitions that have complied with formal or socially accepted procedure regarding absolute numbers and area' has not been taken into account, because no national data was available. Only an overview of the six projects that are included in this research can be made. Out of six projects, of which one project did not do land acquisition and for another project there was no data, four remain. Out of these four projects, there were three without notable issues, which is 75%.

The abovementioned results are now combined in the table below. The results are rewarded either a negative, neutral or positive score, which are combined in the end to give an impression of the sustainability of land rights of a project:

Project	Land acquisition	Land compensation	Land access	Overall
AVIAM	+	+	0	++
ADPP	/	0	0	0
Niqel	+	0	+	++
Sun Biofuels	0	-	-	--
MoçamGALP	/	0	0	0
SAB	+	0	+	++

Table 10: Project specific sustainability regarding land rights, separate per category as used in the literature review and an overall combined score. '+' meaning no issues or a positive influence, '0' meaning no noticeable influence, '-' meaning the occurrence of issues or a negative influence, '/' meaning irrelevant or no data.

5.2.2 Assessment indicators

The evaluation of the practicability and accuracy of the indicators is summarized in the table below. Following, the results of practicability and accuracy of the indicators are further explained.

Indicator	Practicability	Accuracy
Land acquisition process	+	+
Land compensation	+	0
Change in access to land	-	-
Share of land acquisitions complied to accepted procedure	-	-

Table 11 indicator specific practicability and accuracy regarding land rights. '+' meaning positive, '0' meaning neutral, '-' meaning negative.

For the land acquisition process and land compensation data can be acquired at three different sources; at the local authorities (district administration), at the project management and at the local community. Data such as previous occupation, possible conflicts and the execution of a land rights assessment are straightforward and available. However, land compensation is not always relevant, because land compensation does not always occur. More emphasis on alternative ways of compensation next to monetary compensation will be useful. A downside is that it can be time consuming to collect the data since field work is necessary and the data is not always documented. Regarding accuracy, it is possible to cross check data through the multiple data sources. Data on the land acquisition process is gathered for individual projects, which is the only usable method, because national data on Jatropha project land acquisitions does not exist. In some cases documentation about the land acquisition process can be better, because agreements with communities are not always documented, but merely oral agreements. For land compensation, the indicator is focused on

possible monetary compensation, but compensation is not always monetary and therefore in some situation data varies widely and may be difficult to interpret. Therefore, a strict definition is important regarding the different forms of compensation that are suggested in the questionnaires.

Change in access to land is not always relevant, since secondary land users are not always involved. If they are, the effects on secondary land use is only in some cases retrievable since community leaders cannot provide detailed information about every member in the community. Involving more community members would significantly increase the time input necessary for field work. Regarding accuracy, secondary land users are difficult to define and to determine in what way their land access is affected, which results in very limited data. If secondary land use is relevant, these aspect have to be defined more specific.

For share of land acquisitions only Jatropha projects that are directly involved during field work can be included in this indicator, since there is no secondary data available. Also at individual projects data is difficult to gather due to poor accuracy of the indictor. There are multiple parts difficult to define, such as ‘complied with’ and ‘social accepted procedure’, which deteriorates the accuracy.

5.3 Rural and social development

5.3.1 Results sustainability

The most notable findings from the results of the indicators regarding land rights sustainability are presented in the tables below for all the projects involved. The data for expected jobs and land area and the data for the replacement of jobs on the acquired land have been left out, because of insufficient results.

Project	Jobs	Hectares	Jobs/hectares	Skilled	Unskilled	Ratio	Permanent	Temporary	Ratio
AVIAM	205	200	1,03	1	204	0,00	55	150	0,37
ADPP	12	-	-	12	0	1,00	12	0	12,00
NIQEL	280	1500	0,19	10	270	0,04	230	50	4,60
Sun Bio	80	2311	0,03	11	69	0,16	80	0	1,00
MoçamGALP	45	165	0,27	12	33	0,36	12	33	0,36
SAB	170	240	0,71	80	90	0,89	120	50	2,40

Table 12: Overview of the indicators ratio job creation/hectares, ratio skilled/unskilled and ratio permanent/temporary

The table above shows that the results vary widely for job/hectare, ranging from 0,03 up to 1,03 jobs per hectare. A high ratio means relatively high job creation. The skilled versus unskilled jobs ratio show that the majority of the jobs at Jatropha projects are unskilled, with an exception for ADPP, which does not cultivate Jatropha itself but only employs extension workers. For the permanent versus temporary jobs there are varying results. For example, AVIAM employs more temporary workers, while Niqel employs more permanent workers. Permanent workers are preferred, because it ensures more security for the workers. However, for the projects labour costs are an important factor.

Project	Average wage (Mtc/month)
AVIAM	2005
ADPP	4000
NIQEL	2300
Sun Bio	2500
MoçamGALP	2005
SAB	2626

Table 13: Overview of the average wages paid at the Jatropha projects based on both statements from project management and project worker respondents.

The wage for a normal worker at every project is given in the table above. All wages are equal to or higher than the legal minimum wage in the agricultural sector, which is 2005 Mtc/month. Only ADPP sticks out, because they mostly employ extension workers, which are skilled jobs and paid more. The wages could only be compared to the minimum wage in the agricultural sector, because secondary data for other comparisons was not available.

The indicator contribution to education, health care and infrastructure can only be expressed in material contributions, as described in appendix D for each project. The value of the investments could not be determined. Also, the comparison between project contributions and total investments in the region, e.g. by government, could not be made.

The results from the projects on rural and social development are now combined in the table below to distinguish how the projects score on each area/indicator :

Project	Wage comparison	Contribution to educ/health/infra	Job creation/hectare	Ratio skilled/unskilled	Ratio temporary/permanent	Overall
AVIAM	+	0	+	-	-	0
ADPP	+	0	+	+	+	++++
NIQEL	+	+	+	-	+	+++
Sun Bio	+	+	-	-	+	+
MoçamGALP	+	+	+	+	-	+++
SAB	+	+	+	+	+	+++++

Table 14: Project specific sustainability regarding rural and social development, separated per category as used in the literature review and an overall combined score. '+' meaning a positive, '0' meaning a neutral score, '-' meaning a poor score.

5.3.2 Assessment indicators

The evaluation of the practicability and accuracy of the indicators is summarized in the table below. Following, the results of practicability and accuracy of the indicators are further explained.

Indicator	Practicability	Accuracy
Wage comparison	+	+
Contribution to education, health care and infrastructure	+	0
Job creation	+	0
Background living conditions	+	-

Table 15: indicator specific practicability and accuracy regarding land rights. '+' meaning positive, '0' meaning neutral, '-' meaning negative.

Data on wages at individual Jatropha projects can be acquired from project management as well as from employees. A comparison with the legal minimum wage can be made. The legal minimum wage in agriculture is available from online public sources. A comparison to other sectors or average wages in the country is difficult, because detailed data on wages per sector is not available. Regarding accuracy, the wages retrieved from project management and project workers are straightforward and can be cross checked. The legal minimum wage in agriculture is a legal standard, which is unambiguous.

Data on contribution to the local community is available from both project management and the community leaders. However, the contribution of Jatropha projects to a local community does often not consist of quantitative agreements, but often qualitative agreements, which the indicator should be adapted to. For example it does not entail a fixed financial sum, but rather the 'restoration of a medical center', with no strict definition of 'restoration'. Also, it is not always clear whether a certain contribution is already realized, or not executed yet, but merely promised, and also how agreement were made, through contracts or merely oral agreements.

Data about job creation at individual projects is available from project management and also from the local communities, where workers usually come from. National data on unemployment rates is poorly available and outdated. When it is available, the impact of an individual project cannot be reflected on it, due to the difference in scale. Data on job creation of individual projects is reliable and straightforward. There is a division between skilled and unskilled jobs, however when a project shows a more complicated organizational structure with multiple job levels this can become more difficult. Furthermore unemployment rates at local communities can often not be specified, however the effect of a project on employment in a local employment can be clearly indicated, positive or negative.

Data on background living conditions can be retrieved from online public sources, but there are data gaps for some requirements. Using national figures as background living conditions is not useful at the moment, since the impact of Jatropha projects on national data is negligibl. However, some facts, such as overall poverty, could be used to support other results in the evaluation of a Jatropha project.

5.4 Labour and working conditions

5.4.1 Results indicators

For this area of concern there were no quantitative indicators. For the description of the results of all the qualitative indicators, see appendix D.

The results are rewarded either a negative, neutral or positive score, which are combined in the table below to give an impression of the sustainability of labour and working conditions of a project:

Project	Forced labour	Child labour	Discrimination	Union	Accidents	Overall
AVIAM	+	+	+	+	0	++++
ADPP	+	+	+	+	0	++++
NIQEL	+	+	+	+	0	++++
Sun Bio	+	+	+	+	0	++++
MoçamGALP	+	+	+	0	0	+++
SAB	+	+	+	+	0	++++

Table 16: Project specific sustainability regarding labour and working conditions, separated per indicator from the literature review and an overall combined score. '+' meaning no issues or a positive influence, '0' meaning no noticeable influence, '-' meaning the occurrence of issues or a negative influence.

5.4.2 Assessment indicators

The evaluation of the practicability and accuracy of the indicators is summarized in the table below. Following, the results of practicability and accuracy of the indicators are further explained.

Indicator	Practicability	Accuracy
Forced labour	+	+
Child labour	+	0
Discrimination	+	0
Workers union	+	+
Accidents and health issues	-	-

Table 17: indicator specific practicability and accuracy regarding land rights. '+' meaning positive, '0' meaning neutral, '-' meaning negative.

The data for all indicators in this area of concern is available from both project management and workers at the project. Project management can provide their policy regarding forced and child labour, discrimination, workers unions, and accident and health records and the workers can verify this. Data on the international and national child labour standards can be acquired from public online sources. Regarding discrimination, during fieldwork gender differences were not considered to be an issue, which made the data for this indicator somewhat irrelevant, but upon request, the data was available. For workers unions, data was available not only about the existence of workers unions, but also about topics that were discussed within the unions. For accidents and health issues data was only available if records are kept, which was not always the case during field work in Mozambique. Regarding accuracy, the occurrence of forced labour and child labour is straightforward, it is either yes or no. Workers can elaborate on the project management's policy by explaining why they started working for the project, what their age is, what they get rewarded, their working hours and breaks and how operations are executed. The definition of child labour is straightforward. However, the results of the data collection do show some variations due to misinterpretation of the question by the workers. The workers often indicate the age of the youngest person working at the project in contrary to the minimum age to be allowed to work at the project, though the indicated age was never below the legal minimum age. So this should be further specified, there is room for improvement in data collection and communication. The definition of accidents and health issues are not strict and therefore different interpretations are possible, which leads to biased data. Also, the boundary between work related accidents and other accidents is not always clear. On these aspects improvements have to made.

5.5 Economic feasability

5.5.1 Results sustainability

The results of the indicators regarding economic feasibility are presented in the tables below.

Project	NPV (USD)	IRR (%)	PBP (years)
AVIAM	-	50%	8
ADPP	-	-	-
NIQEL	-	27%	7
Sun Bio	15.900.000	7%	4
MoçamGALP	-	-	-
SAB	-	-	-

Table 18: Overview of the data for the financial projection indicators NPV, IRR and PBP.

The table above show there is very little data readily available for NPV, IRR and PBP. When these are available they often come from the business plan. However, the business plans are in some cases outdated and/or based on wrong assumptions.

Instead of readily available NPV, IRR or PBP figures, more financial data was collected for the indicator profitability.

Project	Turnover 2011 (USD)	Costs 2011 (USD)	Investment costs (USD)	Yield (t/ha/y)	Intended selling price (USD/t oil)	Prod costs USD/t oil	Break even projected in (y)	Oil content
AVIAM	0	-	2.000.000	1,75	625	2041	2020	35%
ADPP	0	6.400	-	0,17	7	667	2013	20%
NIQEL	0	1.000.000	5.000.000	3,00	850	690	2015	29%
Sun Bio	18.000	2.140.000	12.000.000	0,50	1193	417	2014	30%
MoçamGALP	-	-	-	-	-	-	2020	18%
SAB	0	2.000.000	4.800.000	0,05	-	24000	2020	40%

Table 19: Overview of the data requirements for the indicator profitability.

The indicator profitability itself consists of a profit calculation, which is irrelevant at this stage for all the projects, since none of the projects have a continuous turnover yet. Furthermore the data requirements include projections on profitability through the break-even point, their intended yield , production costs and oil content. These figures vary widely for the different projects. One of the reasons for this is that these figures are often merely assumptions yet.

Project	Local price fossil diesel (Mtc/L)	Intended selling price Jatropha oil (Mtc/L)
AVIAM	38	19
ADPP	41	35
NIQEL	35	26
Sun Bio	38	36
MoçamGALP	38	-
SAB	40	-

Table 20: Overview of the data requirements for the indicator competiveness.

The table above shows the local fossil diesel prices compared to the intended selling price of Jatropha oil for each project. Looking at these figures it seems that the competitive positions would be very good. However, again these numbers are only assumptions, no oil is being produced yet.

The results are rewarded either a negative, neutral or positive score, which are combined in the table below to give an impression of the sustainability of the economic feasibility of a project:

Project	NPV, IRR, PBP	Profitability	Competitiveness	Overall
AVIAM	-	-	+	-
ADPP	-	-	+	-
NIQEL	0	0	+	+
Sun Bio	-	-	0	--
MoçamGALP	/	/	/	/
SAB	-	-	-	---

Table 21: Project specific sustainability regarding financial feasability, separated per category as used in the literature review and an overall combined score. '+' meaning positive score, '0' meaning no noticeable influence, '-' meaning a negative score. '/' meaning no data.

The overall score of the economic feasibility of the Jatropha projects is quite low, since most financial data are based on projections that have not been achieved yet. Also, some operations have already shut down or are slowing down, showing that the economic feasibility is still a big issue.

5.5.2 Assessment indicators

The evaluation of the practicability and accuracy of the indicators is summarized in the table below. Following, the results of practicability and accuracy of the indicators are further explained.

Indicator	Practicability	Accuracy
NPV, IRR, PBP	0	-
Profitability	+	0
Competitiveness	+	+

Table 22: indicator specific practicability and accuracy regarding land rights. '+' meaning positive, '0' meaning neutral, '-' meaning negative.

In some situations the data for NPV, IRR and PBP is easy to collect, when it is readily available from project management and up to date. However, if this is not the case a more extensive financial analysis has to be conducted which is very time consuming. The data needed to analyze the profitability of a project is also available from project management. The only constraint is that some data requirements concerning the production process are not relevant yet, because of the developing stage that many projects are still in. Regarding accuracy, NPV, IRR, PBP and profitability data are often outdated and based on wrong assumptions, because of a gap between theory and reality regarding expectations of Jatropha cultivation, making the future expectation inaccurate. Therefore these are often useless and can only be used if accompanied by the assumptions they are based on. Also data used for a financial analysis is difficult to gather, since many projects do not have a full production process yet and many aspects of a production process are still irrelevant, but are straightforward and can be used, once they become relevant for a certain Jatropha project. Profitability is evaluated higher than NPV, IRR, and PBP for both practicability and accuracy, because profitability is to a lesser extent based on assumptions and financial projections and more on data from current operations. Another point of attention is the wide variety of units used for the date requirements. A more unified unit scale would improve the general accuracy.

For competitiveness the selling price or intended selling price of Jatropha oil can be acquired from project management. At first, many projects want to sell to the local markets, which means to compete with local fuel prices. The local fossil diesel prices can be acquired by sampling. A comparison with other biofuels is difficult, because there are no clear markets for these either. Regarding accuracy, the selling price of Jatropha oil can be easily compared to local fossil diesel prices in order to establish the competitive pricing position. However, at the moment the Jatropha oil

selling prices are still estimates, since nothing is being produced or sold yet. Other biofuel prices are not taken into account, since just like for Jatropha there are no local or national markets for those.

*A more elaborate description of the results of the indicators concerning the sustainability of the Jatropha projects for all areas of concern can be found in **appendix D**.*

*A more elaborate description of the assessment of the indicators for all areas of concern concerning the practicability and accuracy can be found in **appendix E**.*

6. Discussion

For the data requirements of this research there was also qualitative data. Quantitative data may be preferred over qualitative data, but this was not always possible in this research. Therefore it was not always the best option in this situation. Quantitative data is often difficult to gather, non-existent, or not detailed enough in a developing country like Mozambique. When this is the case, qualitative data can bring a solution. Also, much of the data is directly acquired during field work at projects and communities, where the same reasoning is valid. Moreover, qualitative data can also emphasize certain aspects that are important, such as people's opinions. For this purpose open questions were also used, with good results.

The quantitative data that was used for this research did not always show congruence. For example, when acquiring data for food production, there were several different data sets, even within the same data source (e.g. FAOstat and COUNTRYstat). Therefore, a choice had to be made of which data set to use, but it is difficult to determine which is best.

The level of access and/or authorization to data sources, such as at governmental organizations, but also at Jatropha projects was problematic. Being connected to an external institute like Utrecht University means that access to these data sources does not come automatically. This issue was partly solved by collaborating with IIAM, but the Mozambican bureaucracy still proved to be difficult to navigate through. At Jatropha projects it proved difficult to acquire specific financial data, being an individual researcher. It could be possible that these issues would be less a problem for larger research organizations.

There is a language barrier that makes it in some situations difficult to gather the right data. Specifically during field work when dealing with local communities, communicating through two different translators from English to Portuguese to the local language it proved difficult to gather the right data and transfer the questions adequately to the interviewee. Besides, the content is in some cases quite detailed and/or technical, which was difficult to comprehend in some situations for the interviewees or even the translators.

During the literature review and the preparations for the field work choices had to be made for the data formats. The choice was made for the most relevant areas of concern and indicators according to previous research on this topic. However, it is difficult to have an comprehensive overview that is perfect for each situation. Areas of concern such as migration, legality, gender, access to energy and

human health and safety were not included specifically (see the literature in Appendix B for more details).

A number of Jatropha projects that were involved in this research were still in an immature stage. This caused several indicators and data requirements to be irrelevant, because not all processes were up and running yet. Therefore the data collection was not fully completed. This is the same for the Jatropha industry as a whole in Mozambique.

An issue that came forward during this research is the possible interdependency of different indicators. Some indicators used in this research are likely interdependent, while they are evaluated individually. The possible interdependency between indicators was not a focus point in this research and therefore also not elaborated on. However, this might affect the evaluation of indicators concerning either the sustainability or the practicability and accuracy. Further research into the interdependency of indicators is therefore recommended.

7. Conclusion and recommendations

7.1 Results sustainability

Food security is not an issue related to Jatropha production at the communities involved in this research. The food security issues that do arise cannot be related to the Jatropha project, but are more related to general national poverty issues. The reduced time spent on food production by project workers was in almost all cases compensated by their salary, which was then used to pay others to work on their land for them.

Land rights are mostly not an issue at the six Jatropha projects that were included in this research, with the study constraints taken into account. Generally, the land acquisition went according to the Mozambican legal procedures to obtain a DUAT. This happened in consultation with the local authorities and communities to come to an agreement. Only in one case, the local community said to be disadvantaged by the presence of a Jatropha project, because of the loss of their land, which should be avoided. This occurred after the project slowed down or even stopped its Jatropha production activities. Failure of Jatropha activities could therefore be risky for the effect on land rights.

Rural and social development show positive results on all aspects. Income, communal facilities and job creation are all positively influenced by the presence of Jatropha projects without exception. Income increased for people working at the projects and also unemployment rates have dropped. However, these effects are sensitive to the success and/or failure of the Jatropha production. A project where progress in production was slowed down due to disappointing results induced a decrease of the number of jobs and a decrease of income. Communal facilities are funded by the projects to gain good will during the land consultations and to support communities on social development.

Labour and working rights are not an issue at the Jatropha projects included in this research, which is confirmed by both the projects and the workers. There are no mishaps of forced labour, child labour or discrimination whatsoever. All work is according to Mozambican law and workers are content with their job at Jatropha projects that offers them financial security and an occupation.

Economic feasibility is the biggest issue among the five areas of concern. At the moment none of the Jatropha projects are profitable and only some are positive about their financial projections for the near future. Sun Biofuels already halted its Jatropha activities and will only do it on the side, while SAB is also slowing down its activities due to poor results and then there are also projects that could not be included in this research, because they were already out of business. The main reason for the

difficult economic feasibility is the agronomic knowledge and yield of the Jatropha plant. Yields are not what they were expected to be, there is a big gap between theory and reality. The Jatropha plant so far has not delivered the high expectations, but this is also where a lot can still be gained; agricultural knowledge about how to cultivate Jatropha the best way possible in order to increase yields. Cooperation between different projects is also desirable, to share best case practices, which is also many projects were interested in.

7.2 Assessment indicators

For the conclusion of the assessment of the indicators, the indicators from all different areas of concern can be split up in three groups. The good scoring indicators that can be implemented right away, the intermediate scoring indicators that have to be revised before they can be implemented and the poorly scoring indicators that cannot be implemented without major revisions. The three groups are shown in the tables below.

Indicator	**Practicability**	**Accuracy**
Land converted	+	+
Competition for labour	+	+
Change in perception of food security	+	+
Land acquisition process	+	+
Wage comparison	+	+
Forced labour	+	+
Workers union	+	+
Competitiveness	+	+

Table 23: Good scoring indicators that can be implemented.

The indicators in table 23 have scored good on both practicability and accuracy, which mean they can be implemented right away. The indicators are spread over all areas of concern. They have in common that they target projects specifically. Therefore it is important to focus on the project level for the data collection instead of looking for general national data, that either do not exist, are outdated or inaccurate, especially in a developing country such as Mozambique background information on the setting in which a biofuel project operates. Moreover, when projects and the entire industry are still in a developing stage it is important to focus on individual projects instead of, non-existing, national databases. Targeting individual projects requires time intensive field work; if national data does exist it could provide easier access to valuable data.

Indicator	Practicability	Accuracy
Change in prices of the 5 main staple crops	0	-
Change in share of household expenditures	+	0
Land compensation	+	0
Contribution to education, health care and infrastructure	+	0
Job creation	+	0
Background living conditions	+	-
Child labour	+	0
Discrimination	+	0
NPV, IRR, PBP	0	-
Profitability	+	0

Table 24: Intermediate scoring indicators that need revision before implementation

The indicators in table 24 have scored intermediate on both practicability and accuracy, which mean they have to be revised before they can be implemented. These indicators are also spread over all areas of concern. Overall, practicability is less of an issue than accuracy, which is for more indicators either intermediate or poor. There are several aspects that can contribute to a better accuracy of indicators. First, it is necessary to utilize stricter definitions, which will improve the method to collect and qualify data. Second, communication is very important during data collection. Data formats should be as clear as possible with no room for different interpretation. This to ensure that the respondents comprehend the requested data perfectly. The number and type of respondents can also be improved. There are different kind of people at a local community and different kind of workers at Jatropha projects and there should be a clear format of what data to collect from which respondents and in what quantity. Moreover, a more equal use of units throughout the data collection diminishes the chance on error and thus improves accuracy. Finally, some data, such as financial projections, are based on wrong assumptions, which leads to biased results that cannot be used. Assumptions regarding Jatropha cultivation and the accompanying business plans should be corrected.

Indicator	Practicability	Accuracy
The availability of main staple crops	-	-
Change in yields of main staple crops	-	-
Change in undernourishment	-	-
Change in access to land	-	-
Share of land acquisitions complied to accepted procedure	-	-
Accidents and health issues	-	-

Table 25: Poorly scoring indicators that cannot be implemented yet.

The indicators in table 25 have scored poorly on both practicability and accuracy, which mean they cannot be used in the current form. These indicators are limited to the areas of concern food security, land rights and labour and working conditions. What the top three indicators in the table have in common is that they are aimed at national data, while national data is poorly available in Mozambique and not at the right scale to measure the impact of individuals projects. On the other hand, the indicator change in access to land of secondary land users is more difficult, since secondary land users are often not involved in the land consultation, which makes them difficult to pursue. The indicator 'share of land acquisitions' is difficult, since there is no strict definition and also unclear where data should come from and who should be included. The last indicator does not score good, because accidents and health issues are either not monitored properly or simply not a relevant issue at the projects involved. Definitions should be better explained, for instance there is a big difference between bruises and fatalities. Therefore a more concise explanation is advisable.

Overall, it is advisable to evaluate Jatropha projects individually, instead of looking for a national impact, since that is not feasible yet at the current development stage of the projects and industry as a whole. National data can only be used as background information at this moment, but developments in the biofuel industry are currently not reflected. Also qualitative data can be an outcome, when quantitative data is difficult to reach, such as the indicator concerning the change in perception of food security. Especially, for example, when financial data is difficult to acquire from local communities about expenditures, people's opinions can be helpful whether their situation improved or not. The data that can be collected on site is the most valuable and practical to evaluate a project and when including all the stakeholders (authorities, projects, communities), it is possible to gain an overview of the socio-economic performance of the Jatropha projects.

The indicators, aimed at individual projects, can therefore be implemented without much difficulty. The indicators aimed at national data and impact are more difficult to implement. For instance, several background indicators can provide very suitable information under the right circumstances, meaning the national data are available with the right accuracy, but when this is not the case these indicators do not contribute to measuring impacts. The methodologies used for the implementation of the data format were mainly interviews and observations for the indicators aimed at individual projects. These were satisfactory in results, but time consuming. It is also important to consider the respondents and how to approach them, since there is a difference between e.g. a (foreign) project managers and local community members. Also, since interviews are subject to a difference in interpretation it is very important to have a clear structure and strict definition of the data that is to be acquired.

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9. Appendix A

9.1 Context

This chapter provides background information for this research on Jatropha sustainability assessment. First, the region where this research will be conducted, Mozambique, will be elabourated on. Second, following the section on Mozambique, more information will be given about Jatropha.

9.2 Region

The country in which this research will be conducted is Mozambique. The climatic and political circumstances are found to be beneficial for the cultivation of the Jatropha in Mozambique (Froger, Paz et al. 2010). In this section there will be elabourated on the region of Mozambique, where data will be collected by means of field visits. First, some general background information on the country of Mozambique will be given. Second, the local policy concerning the production of biofuels in Mozambique will be discussed. Third, an overview will be given of the biophysical potential for the production of biofuels in Mozambique.

Mozambique is one of the poorest and most underdeveloped countries in the world (Froger, Paz et al. 2010). Nevertheless, Mozambique has one of the fastest growing economies with a high annual growth rate. Since, the 1990's the growth rate averages around 7% annually (World Bank 2009), and similar growth rates are estimated for the short term. In 2009, Mozambique ranked 172 out of 182 countries on the United Nations Human Development Index (UNDP 2009). This also reflects on the low income level, with an estimated GDP level of US$1000 per capita in 2010 (CIA World Factbook 2011). Mozambique has a population of approximately 22,9 million people (CIA World Factbook 2011). The average life expectancy at birth is low at approximately 52 years with a high estimated infant mortality rate of 80 deaths out of 1000 births (CIA World Factbook 2011).

Although the growth rate of the Mozambican economy is at a promising high, Mozambique faces serious issues concerning the prevalent poverty throughout the country. Causes of the widespread poverty can be partly traced back to the Portuguese colonization and the subsequent armed conflict, that harmed Mozambique's economy, infrastructure, educational and health systems (Schut, Slingerland et al. 2010). Furthermore, the country is vulnerable to natural disasters, such as floods and droughts, and to food insecurity (Schut, Slingerland et al. 2010). Food insecurity affects 35% of

population through low availability and ineffective access, storage and distribution of food (Batidzirai, Faaij et al. 2006; DeMatteis, DeOliveira et al. 2006).

The Mozambican coast stretches for over 2500km along the Indian ocean and the Mozambique channel. Of the total land area, approximately 36 million ha is arable, of which an estimated 10% is cultivated. Agricultural activities employ 85% of the active work force of the population (Schut, Slingerland et al. 2010). Mozambique is endowed with large natural and energy resources, such as the hydropower potential from the numerous rivers, coal, fisheries, forests and gas (AFD 2009). Despite the available resources, Mozambique is fully dependent on oil imports (FAO 2008), which results in a high and increasing percentage of the GDP that is being spent on energy and fuel (World Bank 2009). The dependency on oil imports and the high expenditures on energy and fuel explains the interest of the Mozambican government in alternative energy sources such as biofuels.

The government actively stimulates the promotion of Jatropha in Mozambique (Froger, Paz et al. 2010; Schut, Slingerland et al. 2010). The biofuel discussion became prominent in Mozambique in 2004, when during the elections the government encouraged the Mozambican farmers to produce Jatropha in order to relieve the dependency on oil (Frontier Markets 2008). In 2009, the National Biofuel Policy and Strategy was approved by the Mozambican government, in which the strategic objectives concerning biofuel production were defined. In this policy framework Jatropha and coconut are considered to be strategic feedstock for the biodiesel production and sorghum and sugar cane for the production of ethanol (Froger, Paz et al. 2010). The new policy framework was a result of an intense discussion between the government, farmers, NGO's, the private sector and academics about the Mozambican approach towards biofuels. This discussion was evoked by serious concerns regarding potential pressure on land, water, food production and lack of control in this process (Schut, Slingerland et al. 2010).

Beneficial agricultural conditions and an ample labour force gives Mozambique a large economic potential to overcome the current state of underdevelopment (Rebello Da Silva and Da Silva Garrilho 2003; Diao, Hazall et al. 2007). Moreover, Mozambique could use its large biophysical potential for the production of biofuels, for which Jatropha is one of the options. A recent assessment of Mozambique's biophysical potential identified up to 7 million ha to be available for bioenergy crop production in the business as usual scenario in 2030 and even up to 16 million ha to be available in a progressive scenario in 2030 (IIAM and DNTF 2008; van der Hilst, Verstegen et al. 2012).

9.3 Jatropha

In this section there will be elabourated on the crop on which this research is based, Jatropha curcas. First, a brief botanical description and the characteristics of the Jatropha plant will be given. Next, the cultivation of the Jatropha plant will be discussed followed by an elabouration on the oil content and the use of the Jatropha oil.

Jatropha curcas Linnaeus is a large shrub or large tree. It is commonly known as Jatropha, which will be used during the continuation of this research, or Physic nut. Jatropha grows up to 5 -7 meters tall, has a life expectancy of up to 50 years and belongs to the Euphorbiaceae family (Achten, Verchot et al. 2008). The main reason for the interest in Jatropha for biofuel production is the fact that Jatropha grows oil-bearing fruits (Achten, Verchot et al. 2008). The plant is native to the American tropics with a distributional range in Mexico, Central America, Bolivia, Peru, Argentina and Paraguay (USDA 2000). Nowadays, the Jatropha plant is distributed across tropical and subtropical regions around the world. The leaves and nut of Jatropha are poisonous and therefore not edible. Also, some studies say that Jatropha is drought resistant and is able to grow on marginal land (Benge 2006; van Eijck and Romijn 2008), which leads us to the cultivation of Jatropha.

Jatropha is said to be able to grow well on semi-arid and arid land, does not need a lot of water and can therefore grow without irrigation (Achten, Verchot et al. 2008). Also, Jatropha is able to grow on marginal land and does not absorb much of the nutrients from the soil. Jatropha can therefore grow on land that is not suitable to grow many other (food) crops (Benge 2006), although yields will not be high on these lands. Furthermore, Jatropha has the capacity to control soil erosion and to reclaim land and can also be used by farmers as a live fence to contain or exclude farm animals (Henning 2000; Openshaw 2000). Besides these capacities, Jatropha can be used as a commercial crop to produce biodiesel from the oil that is contained in its seeds (Openshaw 2000). These capacitites make the Jatropha an easy growing, relatively low cost and low maintenance crops. Because of these characteristics there was a growing interest in use of Jatropha to help alleviate the imminent energy crisis. The Jatropha curcas was therefore also often labeled as a wonder crop (Benge 2006), and the optimism surrounding the beneficial characteristics of the plant is further stimulating the Jatropha biodiesel hype (Achten, Verchot et al. 2008).

Other research tempers the optimization concerning Jatropha. For instance, Benge (2006) says that when Jatropha grows on marginal land, there will be marginal yields as well. Studies show that there is a significant variation in the potential oil yield of Jatropha, with a much higher indicated yield when grown on soil of better quality (Burley and Griffiths 2009). Also, the claim that Jatropha is drought resistant and does not need to be irrigated is contradicted by complaints of farmers who say that Jatropha will not thrive unless irrigated, which competes directly with water use for domestic purposes (Burley and Griffiths 2009). From these contradicting claims and assumptions can be deducted that Jatropha is still a wild plant of which the basic agronomic properties are not thoroughly understood and of which the environmental impacts have not yet been sufficiently investigated (Achten, Verchot et al. 2008).

Finally, an important reason for the growing interest in Jatropha as one of the possible solutions for the diminishing fossil fuel reserves is the oil content of its seeds. The seeds of Jatropha have an oil content of approximately 27% to 40% (Achten, Mathijs et al. 2007), with an average of 34,4% (Achten, Verchot et al. 2008). The seed yields also vary widely. A review of several studies showed an estimated seed yield in different countries and regions between 0.1 and 15 t/ha/yr (van Eijck 2007). If cultivation of Jatropha is seen as the first step in the production chain of biodiesel, the second step is the extraction of oil from the Jatropha seeds. The extraction can be done either mechanical or chemical (Achten, Verchot et al. 2008). The extracted Jatropha oil can then be used as a base for liquid fuel in several ways. The vegetable oil can be used directly, in blends with fossil fuels or can be further processed by means of pyrolysis, micro-emulsification or trans-esterification (Achten, Verchot et al. 2008). The different products of Jatropha oil have various uses. It can be used in combustion engines, but also for cooking and lighting and the production of soap and pesticides (Benge 2006).

10. Appendix B

10.1 Literature review

In this section the GBEP and RSB certifications schemes are reviewed. Moreover, the socio-economic criteria that are included in these certification schemes are analyzed. First, the GBEP system is reviewed on both the social and economic aspects, followed by the RSB system. In addition, other relevant literature are also briefly mentioned.

Furthermore, a remark has to be made about the practical side of the literature review. For different certification schemes there is a difference in the terminology used, which could lead to confusion. The terminology for certification schemes includes amongst others: areas of concern, themes, criteria, indicators, methods, principles, aspects, pillars and requirements and these are used interchangeably. During the review of the GBEP and RSB certification schemes the terminology that is used by the schemes themselves are maintained. During the identification of the areas of concern, criteria, methods and indicators a more organized terminology is used to create a clear structure. The explanation of this terminology can be found in section 4.1.2. The difference is that the terminology used in this research is consistent, which contributes to the practicability, in contrary to the terminology used in several certification schemes and other literature sources.

10.1.1 GBEP

The Global Bioenergy Partnership is an organization that is "committed to promote the global dialogue on bioenergy and is active in the strategic areas of sustainable development, climate change and food and energy security" (GBEP 2011). As a part of their activities GBEP has developed a sustainability certification scheme, the *Sustainability Indicators for Bioenergy*, to further promote the sustainable development of the bioenergy sector (GBEP 2011). The certifications system consists of 24 sustainability indicators that are that are divided up in three different pillars. These are the environmental pillar, the social pillar and the economic pillar. In this review, only the indicators that belong to the social and economic pillar will be included.

10.1.1.1 Social pillar

For each pillar, GBEP has identified a selection of relevant themes, that then served as a guideline for the development of the indicators. These themes can be considered to be the equivalent of the term 'areas of concern', which was discussed earlier. Based on these six themes eight indicators (term used by GBEP) were developed, that represent the themes. Each indicator relates primarily to one or more of the themes. For the social pillar the themes and accompanying indicators are shown in table 1 below. Note that some indicators appear twice, since they are related to more than one theme.

Theme	Indicator
1. Price and supply of a national food basket	• Price and supply of a national food basket
2. Access to land, water and other natural resources	• Allocation and tenure of land for new bioenergy production
3. Labour conditions	• Jobs in the bioenergy sector • Incidence of occupational injury, illness and fatalities
4. Rural and social development	• Jobs in the bioenergy sector • Change in income • Change in unpaid time spent by woman and children in collecting biomass
5. Access to energy	• Bioenergy used to expand access to modern energy services
6. Human health and safety	• Change in mortality and burden of disease attributable to indoor smoke • Incidence of occupational injury, illness and fatalities

Table 26: GBEP social themes and indicators (GBEP 2011).

The indicators will now be described in further detail.

Allocation and tenure of land for new bioenergy production – This indicator aims to investigate in the percentage of land that is used for new bioenergy production. Furthermore, the allocation of the land for bioenergy production should happen according to the current domestic legal system or socially accepted practice and established procedures should be followed for determining legal property rights.

This indicator relates most to the theme of access to land, water and other natural resources, since land tenure facilitates land access. Access to arable land is essential for the development of bioenergy production, since it will encourage land owners and users. Furthermore, respect for land tenure rights, which includes both formal and informal land rights, is essential for a fair and justifiable allocation of land resources.

An increasing trend of land transfer processes that comply to formal or socially accepted practice will represent a positive development in the quality of land transfer processes that is related to new bioenergy production investments.

For the data requirements then, the indicator will be based on the following data collection:

- The land area, both absolute in hectares and as a percentage of the total land areas, that is currently either used as common land by the local population or privately owned by the local population.
- Formal registration of land tenure, such as titles and contracts, that is held by biofuel investors and companies that have been registered in a national or local registry.
- The existence of local population land rights and the amount, ha and %, of lands that are legally recognized as community lands.
- Information about qualitative aspects concerning the issuing of new biofuel land use concessions, regarding land rights.

These data can be collected by a combination of referring to documents of land rights or land registry records at a national level and through interviews and surveys at the household, villages or local governmental units level.

Price and supply of a national food basket – This indicator aims to measure the effect of domestic bioenergy production on the price and supply of a nationally defined food basket. The food basket being a collection of nationally representative foods. Furthermore, changes should be taken into

consideration in demand of food, import and export of food, agricultural production and agricultural costs.

The food basket is defined on a regional or national level and includes the crops that make up the major part of the diet and supply a dominant proportion of the energy and nutrient needs for an individual in a particular country. In addition to the impact of bioenergy production on the food price and supply, this indicator aims to measure the impact of changes in food prices on the national, regional and household welfare levels.

Bioenergy production could affect the agricultural production positively, increasing the supply (Diaz-Chavez, Mutimba et al. 2010). On the other hand, bioenergy production could also affect the supply negatively, when a larger share of the crops are being used as a feedstock for the biofuel production. Furthermore, increased biofuel production activities could affect the demand for cultivation inputs, such as land, water and fertilizer, which could influence their prices and in the end could affect food prices.

For the data requirements then, the indicator will be based on the following data collection:

- Calorie contribution by crop.
- Production of staple crops.
- Exports and imports of staple crops.
- Energy costs and their impact on agricultural production and distribution costs.
- Impacts of weather on crop production.
- Price inflation.
- Change in demand for foodstuffs.
- Shares of staple crops used for food, feed, fiber and fuel.
- Prices of staple crops.
- Household income and expenditure by crop.

These data can be collected for both the national and regional level from national or international statistical records. Organizations such as USDA and FAO provide global databases that provide data relating to food and agriculture. If necessary, additional data can be gathered through interviews and surveys.

Change in income – This indicator aims to measure the contribution of wages paid for employment in the bioenergy sector to the change in income and also the contribution of net income from the sale and own consumption of bioenergy products by self-employed household.

This indicator relates most to the theme rural and social development. Employment and wages in the biofuel production sector can be important drivers for the rural and social development, especially in developing countries. Furthermore, wages are an important indicator for labour conditions in relation to comparable sectors. Next to wage income, self-employment is another important source of income that can be linked to biofuel production, which can affect rural and social development positively.

Income generation is an important indicator of the sustainability of the biofuel production sector through income effects on economic and social development.

For the data requirements then, the indicator will be based on the following data collection:

- Wages in the biofuel production sector in relation to comparable sectors.
- Income from sale or barter of bioenergy products by self-employed households/individuals.
- Types, quantities and prices of products substituted by self-employed production of bioenergy products.
- Cost of own-production of bioenergy products.
- Average household income level in currency and equivalent good, before bioenergy production starts.
- Persons per household in bioenergy production.

These data can be collected by using existing national/international statistical accounts and also documents, such as employment contracts and sales contracts. If necessary, additional data can be gathered through interviews and surveys.

Jobs in the bioenergy sector – This indicator aims to measure the net job creation through bioenergy production and also the total number of jobs in the bioenergy sector and the percentage thereof that adheres to labour standards in comparison to other sectors. This indicator is primarily related to the themes rural and social development and labour conditions.

Net job creation can have a significant positive influence on sustainable development on the national and regional level. Furthermore, if the percentage of jobs that adheres to labour standard increases over time this shows a positive impact on sustainable development.

For the data requirements then, the indicator will be based on the following data collection:

- Number of jobs created annually along the bioenergy production chain, dis aggregated by skilled/unskilled and temporary/indefinite.
- Total number of jobs along the bioenergy production chain.
- Number of jobs that comply with labour standards in the bioenergy production chain.

These data can be collected by using existing national/international statistical accounts and industry information. If necessary, additional data can be gathered through interviews and surveys.

Change in unpaid time spent by woman and children in collecting biomass – As a result of the switch from traditional use of biomass to modern bioenergy services.

This indicator relates most to the theme rural and social development. In many developing countries, firewood collection is a highly time- and energy-intensive activity, for which woman and children are generally responsible. A switch to modern bioenergy can therefore be considered a clear indicator of improvement in sustainable development.

The activity of firewood collection brings along a number of health risks and by measuring the time saved, this indicator provides information on the contribution to sustainable development.

For the data requirements then, the indicator will be based on the following data collection:

- Hours per week saved collecting biomass at the household level.

To collect these data national statistics can be used and additional data sources from organizations such as FAO and UNDP.

Bioenergy used to expand access to modern energy services – This indicator aims to determine the total amount and percentage of increased access to modern energy services gained through modern bioenergy.

This indicator relates most to the theme of access to energy. In practice, access to energy involves offering affordable access to modern energy services, such as electricity for lighting and communication, modern fuels for cooking and heating and mechanical power for productive purposes. Modern bioenergy may play an important role in providing these energy services. By measuring the increased access gained through modern bioenergy, this is an important indicator for the contribution of modern bioenergy to energy access.

This indicator provides an overview of the contribution of modern bioenergy to access to modern energy services and therefore helps assess the contribution of modern bioenergy to sustainable development in a country.

For the data requirements then, the indicator will be based on the following data collection:

- Amount of additional electricity generated and provided to the grid from bioenergy and non-bioenergy sources.
- Amount of additional energy used by households and businesses that previously did not have adequate access to modern energy services from bioenergy and non-bioenergy sources.
- Number of households and businesses gaining increased access to modern energy services through bioenergy and non-bioenergy sources.
- Amount of energy used by households and business from modern bioenergy services and through traditional use of biomass.
- Average energy consumption per household and business
- Number households and businesses using energy through traditional use of biomass.

To collect these data national and international statistical accounts can be used or through market and/or household surveys. This can be done at a national, regional and household level.

Change in mortality and burden of disease attributable to indoor smoke – This indicator aims to investigate in the effects of the use of modern bioenergy instead of solid fuel on the mortality rate and disease. This also includes the effects of the use of improved biomass-based cook stoves.

This indicator relates most to the theme of human health and safety. Lack of access to clean, efficient and modern sources of energy within a home can impact human health. The most important direct health effects are caused by air pollution from burning solid fuels. Switching to cleaner biofuels can reduce health risks.

A shift towards cleaner and more efficient modern fuels could dramatically reduce health risk. This indicator helps to assess the role of biofuels in the transition towards the use of modern energy services.

For the data requirements then, the indicator will be based on the following data collection:

- Number of households that depend on traditional use of biomass or other solid fuels within the home.

- Number of households that use modern (bio)energy services within the home.
- Statistics on respiratory diseases.

To collect these data, databases from organizations such as the WHO and UNDP can be used.

Incidence of occupational injury, illness and fatalities – This indicator aims to register the number of accidents, injuries, illness and fatalities related to the production of bioenergy, in relation to comparable sectors.

This indicator relates most to the theme of human health and safety. It refers to safety and health at work and can help to assess the extent to which workers are protected from work-related hazards in the bioenergy production chain. A safe work-environment contributes to sustainable production in general.

By comparing rates of work-related hazards in bioenergy production to comparable sectors, it is possible to assess the sustainability of the bioenergy sector in terms of safety and labour conditions.

For the data requirements then, the indicator will be based on the following data collection:

- Hectares used for bioenergy production and total biofuel production.
- Number of work-related hazards reported in bioenergy production and other (agricultural) sectors.
- Number of days missed in bioenergy production and other (agricultural) sectors.
- Type of work related-hazards in bioenergy production and other (agricultural) sectors.

These data can be collected by using existing national/international statistical accounts. If necessary, additional data can be gathered through interviews and surveys.

10.1.1.2 Economic pillar

Similar to the social pillar, six themes were developed for the economic pillar, which served as guidelines for the accompanying indicators. Based on these six themes eight indicators were developed, that represent the themes. Each indicator relates primarily to one or more of the themes. For the social pillar the themes and accompanying indicators are shown in table 2 below. Note that some indicators appear twice, since they are related to more than one theme.

Theme	Indicator
1. Resource availability and use efficiencies in bioenergy production, conversion, distribution and end-use	• Productivity • Net energy balance
2. Economic development	• Gross value added • Change in consumption of fossil fuels and traditional use of biomass
3. Economic viability and competitiveness of bioenergy	• Productivity • Net energy balance • Gross value added
4. Access to technology and technological capabilities	• Training and requalification of the workforce
5. Energy security and diversification of sources and supply	• Energy diversity
6. Energy security and infrastructure and logistics for distribution and use	• Infrastructure and logistics for distribution of bioenergy • Capacity and flexibility of use of bioenergy

Table 27: GBEP economic themes and indicators (GBEP 2011).

The indicators will now be described in further detail.

Productivity – This indicator aims to measure the productivity of bioenergy feedstock, the processing efficiencies, the amount of production per hectare per year and the production costs.

This indicator relates most to the theme of *resource availability and use efficiencies in bioenergy production.* It focuses on the productivity of the land used to produce bioenergy, as well as the overall economic efficiency of the production.

An increased productivity could represent either a higher efficiency or an increased availability of land and other resources. A lower need for inputs reduces costs and increases profits. Both are important for the economic sustainability.
For the data requirements then, the indicator will be based on the following data collection:

- Average production yields of bioenergy feedstocks by feedstock
- Processing efficiencies of bioenergy feedstocks into end products.
- Amounts of bioenergy produced and the land area used to produce this.
- Bioenergy production costs per energy unit.

These data can be collected by using existing national/international statistical accounts or by gathering existing data at the national level or at farms and processing plants.

Net energy balance – This indicator is meant to measure the energy ratio of the bioenergy value chain in comparison to other energy sources.

This indicator relates most to the theme of *resource availability and use efficiencies in bioenergy production.* Energy is required as an input at several steps of the production chain of bioenergy. The net energy ratio, the energy output in comparison to the energy input, is an important indicator of the relative energy efficiency of bioenergy production chain.

A positive energy ratio indicates that the production is sustainable from an energy perspective. This indicator can be used to identify the most energy efficient method of producing bioenergy among several options.

For the data requirements then, the indicator will be based on the following data collection:

- Ratio of energy inputs required for the production of harvested feedstock and the energy content of one unit of feedstock.
- Ratio of the energy content of biofuel produced to the energy content of feedstock input.
- Average energy efficiency of combustion engines and bioenergy powerplants.

These data can be collected by using existing national/international statistical accounts or surveys at the national level or at farms and processing plants.

Gross value added – This indicator measures the gross value added per unit of bioenergy and also as a percentage of GDP.

This indicator relates most to the theme of economic development. It is a monetary value for the amount of bioenergy that has been produced minus the cost of all inputs. This indicator is also a measure of the contribution to GDP of the bioenergy production.

The gross value added and the percentage of the GDP thereof, shows the contribution of the bioenergy sector to the economy.

For the data requirements then, the indicator will be based on the following data collection:

- Total output value
- Intermediate input value

These data can be collected by using existing national/international statistical accounts or through surveys and interviews.

Change in consumption of fossil fuels and traditional use of biomass – This indicator aims to capture the substitution of fossil fuels with modern domestic bioenergy and also the substitution of the traditional use of biomass with modern bioenergy.

This indicator primarily relates to the theme of economic development. The use of modern bioenergy can displace the use of fossil fuels and traditional biomass, which would have a positive impact on the economy. Large savings can be obtained by reducing the import of fossil fuels.

The reduction of the use of fossil fuels and traditional use of biomass gives a perception of the rate of the transition towards modern bioenergy.

For the data requirements then, the indicator will be based on the following data collection:

- Consumption of domestically produced bioenergy.
- Energy sources displaced due to bioenergy consumption.
- Energy import prices.
- Cost of inputs imported for the production of bioenergy.

These data can be collected by using existing national/international statistical accounts.

Training and requalification of the workforce – This indicator aims to determine the percentage of trained workers out of the total labour force in the bioenergy sector.

This indicator primarily relates to the theme of access to technology and technological capabilities. It provides information about the level of training of the work force. Moreover, it reflects the skills and training provided to the bioenergy workforce and also the ability of workers to be re-employed in other sectors.

The indicator helps to give an overview of the share of the workforce that has had access to education or training for labour activities in the bioenergy sector.

For the data requirements then, the indicator will be based on the following data collection:

- Number of workers in the bioenergy sector.
- Number of skilled and/or trained workers in the bioenergy sector.
- Number of re-employed workers from the bioenergy sector.
- Number of jobs lost from the bioenergy sector.

These data can be collected by using existing national/international statistical accounts or through surveys and interviews at the national level or at farms and processing plants.

Energy diversity - This indicates the change in diversity of the total primary energy supply due to bioenergy.

This indicator relates most the theme of *energy security and diversification of sources and supply*. Energy security is defined by several interrelated aspects. This indicator focuses on the diversity of the energy supply. The more diverse the energy sources and supply, the higher the energy security.

The indicator offers a measure of the influence of bioenergy on energy diversity and therefore also energy security.

For the data requirements then, the indicator will be based on the following data collection:

- TPES from each energy source, including bioenergy production.
- Number of bioenergy sources and the associated amount of energy in MJ.

These data can be collected by using existing national/international statistical accounts or trough using existing data at a national level.

Infrastructure and logistics for distribution of bioenergy – This indicator aims to measure the number and capacity of routes for critical distribution systems.

This indicator relates most to the theme of *energy security and infrastructure and logistics for distribution and use.* For improving energy security, diversifying energy distribution routes is also an important aspect.

Safe, reliable, appropriate and available infrastructure will help ensure energy security and contributes to sustainable development.

For the data requirements then, the indicator will be based on the following data collection:

- Number of port facilities capable of handling biofuels
- Capacity for handling and storage of biofuels compared with actual level of biofuel utilization
- Capacity and reliability of blending facilities and terminals
- Number and capacity of pipelines for bioenergy import

These data can be collected through interviews and surveys at the national level.

Capacity and flexibility of use of bioenergy – This indicator aims to measure the ratio of capacity and the ratio of flexibility of the use of bioenergy.

This indicator relates most to the theme of *energy security and infrastructure and logistics for distribution and use*. Unused or flexible capacity in using biofuels helps to increase energy security and is one of the goals for infrastructure development for biofuel production. A flexible system helps to decrease risks and further reduce operational costs.

Areas that have a limited or inflexible bioenergy capacity risk supply irregularities. The ratio for capacity indicates the level of capacity for using the bioenergy compared to the actual utilization for each critical sector. The ratio for flexibility indicates the flexibility of utilization systems to switch between bioenergy and alternative fuels sources.

For the data requirements then, the indicator will be based on the following data collection:

- Capacity for main biofuel distribution routes
- Share of capacity that is fuel or feedstock flexible

These data can be collected through interviews and surveys at the national level.

10.1.2 RSB

The Roundtable on Sustainable Biofuels is an international initiative that is coordinated by the Energy Center at the École Polytechnique Fédérale de Lausanne (EPFL). The RSB "provides and promotes the global standard and certification scheme for socially, environmentally and economically sustainable production of biomass and biofuels" (RSB 2010). As part of their activities the RSB has developed a sustainability certification scheme, the *Principles and Criteria for Sustainable Biofuel Production*, to further promote the sustainable development of biofuel production. The certification scheme consist of 12 main principles. These principles can be considered to be the equivalent of the areas of concern for sustainability used in our research. In contrary to the GBEP system, these principles are not allocated to a specific category such as social and economic. Therefore, a consideration is made upon which principles touch on the socio-economic aspects. The following principles will be included in this review.

- Principle 1: Legality
- Principle 4: Human and labour rights
- Principle 5: Rural and social development
- Principle 6: Local food security
- Principle 12: Land rights

The above mentioned principles will now be described in further detail. Each principle consists of one or more criteria.

Legality – The legality principle states that all biofuel operations shall comply with all applicable laws and regulations of the country in which the operations takes place. Also, biofuel operations shall apply with international laws and agreements. The operators include feedstock producers, feedstock processors and biofuel producers.

Human and labour rights – This principle states that biofuel operations shall not violate human rights and labour rights, and shall promote decent work and the well-being of workers. This principle consists of several criteria.

- The first criterium is that workers shall have the right to organize, the right to collectively bargain and shall enjoy freedom of association.
- The second criterium is that no forced labour or slave labour will take place.
- The third criterium is that no child labour shall occur. An exception is made for work on family farms, under the condition that work does not interfere with the child's schooling and does not harm its health.

- The fourth criterium is that workers shall not be discriminated in any way. This includes gender, wages, working conditions and social benefits.
- The fifth criterium is that wages and working conditions shall comply with all applicable laws and international agreements and also collective agreements with workers. Minimum wages shall be respected or, in absence thereof, the wages shall be negotiated on an annual basis with the workers.
- The sixth criterium is that safety conditions and health for workers shall comply internationally recognized standards.
- The seventh criterium is that operators shall regulate that all the criteria mentioned above shall also be applied when labour is contracted through external parties.

Rural and social development – This principle states that in regions of poverty, the production of biofuel shall contribute to the social and economic development of local and rural people and communities. This principle consists of several criteria.

- The first criterium states that the socio-economic position of local stakeholder shall be improved through the impact of biofuel operations.
- The second criterium states that the special measures shall be implemented in order to benefit and stimulate the participation of women, youth and indigenous communities in biofuel operations.

Local food security – This principle states that the production of biofuels shall ensure the human right to adequate food access and improve food security. This principle consists of two criteria.

- The first criterium states that an assessment of risks to food security should be engaged in and that any negative impacts of biofuel operations shall be mitigated.
- The second criterium states that in regions of lower food security, biofuel operations should improve the local food security of the directly affected stakeholders.

Land rights – The last principle states that biofuel production activities shall respect land right and land use rights. This principle consists of two criteria.

- The first criterium states that existing land rights will be assessed, documented and established. This holds bother for formal and informal land rights. The allocation of land for biofuel production will only be established when these rights are determined.
- The second criterium states that acquisition or voluntary resettlement of land for biofuel production will always be compensated.

10.1.3 Other literature

In addition to the GBEP and RSB systems, there is also made use of other studies on the sustainability of bioenergy production and the accompanying areas of concern (Lewandowski and Faaij 2006; RSB 2010; Amigun, Musango et al. 2011; Arndt, Benfica et al. 2011; Broadhurst 2011; Chum 2011; GBEP 2011; Global Biopact 2011; van Eijck, Smeets et al. 2012). There are other socio-economic aspects concerning the sustainability of bioenergy production that are not explicitly mentioned in the GBEP and RSB systems, but that are mentioned in other studies. Examples of these are gender and migration (Arndt, Benfica et al. 2011; Global Biopact 2011). From these sources, a selection of areas of concern is made in the next section.

10.2 Identification of areas of concern

In this section the socio-economic areas of concern that are included in this research are explained. Using the findings of the literature review from the previous section (Lewandowski and Faaij 2006; RSB 2010; Amigun, Musango et al. 2011; Arndt, Benfica et al. 2011; Broadhurst 2011; Chum 2011; GBEP 2011; Global Biopact 2011; van Eijck, Smeets et al. 2012), the areas of concerns that are widely represented are selected. The included areas of concern are food security, land rights, rural and social development, labour and working conditions and economic feasibility. These are selected for their consensus throughout the reviewed literature, and for which also data is available regarding criteria, methods and indicators. Therefore, deducted from Jatropha literature these areas of concern are important.

In more detail, all areas of concern that are included are covered by both the GBEP and RSB systems, with the exception of economic feasibility. Economic feasibility is not covered by RSB, but is an important aspect throughout other Jatropha literature (van Eijck, Romijn et al. 2012), and therefore still included. Food security is included, since it is among the most important issues concerning sustainability (van Eijck, Romijn et al. 2012) and it is covered by theme 1 of the GBEP social pillar and principle 6 of RSB. For the same reason, land rights is included, and it is covered by theme 2 of the GBEP social pillar and principle 12 of RSB. Rural and social development is covered by theme 4 of the GBEP social pillar and principle 5 of RSB and is an important aspect throughout Jatropha literature (van Eijck, Romijn et al. 2012). Labour and working conditions is covered by theme 3 of the GBEP social pillar and principle 4 of RSB. Last, the economic aspect is not covered by RSB. However it is extensively covered by the GBEP economic pillar, but for practicability reasons is reduced to economic feasibility, which is also an important aspect in other Jatropha literature (Chum 2011; Global Biopact 2011; van Eijck, Romijn et al. 2012; van Eijck, Smeets et al. 2012).

Other socio-economic areas of concern that will not be included are migration, legality, gender, access to energy and human health and safety. Migration will not be included, since it has not been a dominant area of concern in several certification schemes and other literature. Legality will not be included individually, because it will be partly covered within the areas of concern land rights and labour and working conditions, concerning compliance to law and regulations. Gender will not be included as such, since it has a more general character that is covered by multiple other areas of concern. However it will be partly covered within labour and working conditions, concerning discrimination. Access to energy will not be included, because there is a focus on the production of biofuels and not on the use of biofuels. Last, human health and safety will also not be included individually, but will be partly covered by labour and working conditions and also rural and social development.

10.2.1 Food security

An important aspect of the production of bioenergy is the discussion concerning food security. The possible positive economic impacts that the production of biofuels could bring is partly overshadowed by the impact that the production of biomass, more precisely the large scale cultivation of biomass crops, has on national and regional food security. It appears that large scale biofuel production and the accompanying large scale cultivation of biomass crops could have significant consequences on all four aspects of food security; availability, access, stability and utilization (BEFSCI 2011), which are shown in figure 1 below.

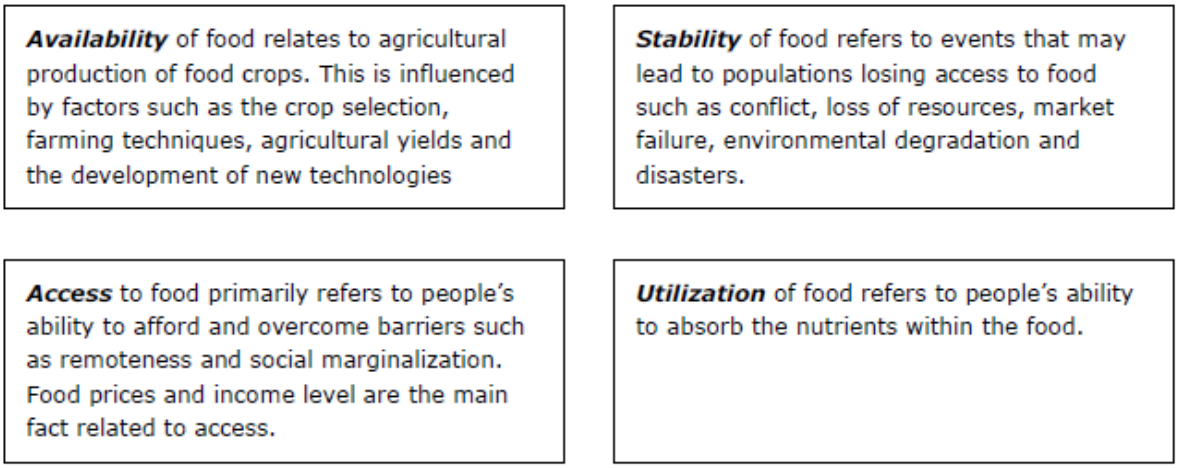


Figure 1: Aspects that influence food security (Van Eijck 2010;(UN 2008)

The production of bioenergy crops could replace the production of food crops in the agricultural sector. Bioenergy production could therefore lead to a shortage of regional food supply, if land owners earn higher profits from selling biomass for export than from selling food to the local market (Lewandowski and Faaij 2006). If bioenergy feedstocks are grown on land that previously had no economic value no additional pressure would be created on food security, which is rarely the situation. Even though Jatropha possesses the capability of growing on poor soil, the higher yields that can be accomplished by growing Jatropha on fertile grounds could be a reason for farmers to grow Jatropha on grounds that were previously allocated to food production (ProForest 2008; Global Biopact 2011). If this the case, then the cultivation of bioenergy feedstocks could increase the demand for food and agricultural commodities, which puts additional pressure on natural resources such as land and water, which eventually could lead to an increase in food commodity prices (Chakravorty 2009; Wright 2009; Chum 2011). However, on the other hand these negative impacts could be avoided if the agricultural output per land area unit would be increased. Agriculture yields in developing countries have a large potential for progression compared to western yields. If agricultural yields for food crops would be increased, the demand for agricultural land would

decrease, since less land is required. This land could then be used for bioenergy production without compromising food production (BEFSCI 2011; van der Hilst, Verstegen et al. 2012). Based on these possible implications this research will focus on the aspects food access and food availability of the food security framework. The availability of food relates to the agricultural production of food crops. Food access is mainly relates to the ability of people to afford food. These two aspects are closely related to agricultural yields and food prices (BEFSCI 2011(van Eijck, Smeets et al. 2010).

10.2.2 Land rights

Another important aspect regarding the production of biofuels is the issue of land rights, or more extensively the issue of land rights, land tenure, land ownership and also land access. Access to arable land is important for the development of bioenergy production (GBEP 2011). However, the access to arable land, for large scale plantations in particular, could have a negative impact on local land allocation and could induce land conflicts. Land conflicts are a common occurrence in Africa, especially when large plots of land are being allocated to large scale commercial projects, such as the cultivation of Jatropha for bioenergy production for example (Global Biopact 2011). The main reason for this is that the boundaries of property are often not clearly demarcated and land title ownership is often not clearly defined or registered and documented. In developing countries, such as Mozambique, and rural areas in particular, land title ownership may be informal and only exist as common historical knowledge among the elders of the community. Moreover, another issue then is the threat to land access by the poor in rural areas due to the acquisition of large plots of land by private entities, since economies of scale are beneficial for biofuel production. Land right conflicts is therefore one of the main issues a large scale commercial plantation may have to face (ProForest 2008; Brittaine and Lutaladio 2010; Global Biopact 2011). Respect for land tenure rights, which includes both formal and informal land rights, is essential for a fair and justifiable allocation of land resources (GBEP 2011).

10.2.3 Rural and social development

The third area of concern is rural and social development. The growing demand for biofuels and the growing activities in the production of biofuels could bring a number of benefits, such as a contribution to economic growth (Arndt, Benfica et al. 2009). However, these benefits should not be reserved for a select few larger, possibly non-domestic, biofuel companies, that dominate the production of biofuels. The areas where the production of biofuels takes place are often developing countries, such as Mozambique. These countries then, should not be exploited by biofuel production activities, but stimulated in their rural and social development. The growing demand for biofuels can

present an opportunity to stimulate the social and rural development in developing countries (Chum 2011). Increased investments in rural areas will be an important factor in making the biofuel production a force that positively stimulates development. Increased agricultural commodity prices can attract greater public and private investments for infrastructure, education and health care for example (Chum 2011). Furthermore, the ripening of Jatropha is variable and harvesting the seeds therefore occurs by hand, which results in high labour costs and substantial job creation. Biofuel production could therefore help alleviate poverty through job creation and income generation (Global Biopact 2011).

10.2.4 Labour and working conditions

The fourth area of concern regards to the labour and working conditions amongst jobs involved with the bioenergy production chain. The production of biofuels often takes place in developing countries, where labour and working conditions may be not very formal, far-reaching or complied with. However, next to the creation of jobs it is important that jobs are of sufficient quality to contribute to the sustainability of the industry. This means that biofuel operations should not violate human rights or working rights and that it should ensure decent work and stimulate the well-being of workers (RSB 2010; van Eijck, Smeets et al. 2012). Furthermore, jobs in rural areas will be mainly low-skilled and seasonal with workers having the possibility to face poor labour and working conditions. Also, smaller out-growers that are contracted to larger processors may face unfair business practice, since smaller farmers will have little negotiating power concerning the determination of sales terms and conditions with large commercial private companies. This however could be counteracted to ensure the smaller farmers have the right to cooperate and form unions (Global Biopact 2011).

10.2.5 Economic feasibility

Another area of concern regards to the economic feasibility of the production of biofuels by making use of Jatropha. The production of biofuels has to be economically feasible and should be able to be competitive with other sources of energy, such as fossil fuels. The competitiveness of biofuels is amongst others heavily dependent on both the production costs and the world wide fossil fuel prices.

10.3 Identification of criteria, indicators, methods and data requirements

In this section the areas of concern that were discussed in the previous section are formed into several criteria. The next step is distinguishing indicators that are used to implement the several criteria and make them measurable. To measure and/or calculate the indicators several methods are used. The specific methods can both be qualitative or quantitative, dependent on the criteria and indicators. To calculate the indicators there are various data requirements, which are also outlined. Also, the level on which the methods and indicators can be applied is of importance. This could be on a national level, but also on a regional/local level. Preferably they are applied on a regional level, which makes it possible to evaluate individual Jatropha projects. However, in some cases data is only available on a national level.

For the data requirements several data sources are used, such as literature, databases and data through interviewing. For each data requirement a distinction is made between whether data requirements could already be fulfilled beforehand using literature and databases and whether data requirements had to be fulfilled by using data through interviewing and local databases in Mozambique.

Another important aspect is the availability, accessibility and quality of data. Data collection are difficult in a development country such as Mozambique. The issues range from the availability of data to the accessibility and quality of data. To improve accessibility, there is a cooperation with the national Mozambican institute 'Institute for Agricultural Research Mozambique (IIAM)', but it remains a challenge. Even data on Mozambique from an established organization like the FAO is in some cases contradicting, which reflects the difficulty of data collection.

10.3.1 Food security

For the area of concern food security the following criteria are selected (RSB 2010):

- The bioenergy production shall not threaten food security
- The bioenergy production shall ensure the human right to food access

As discussed in the area of concern for food security; out of the food security framework, that consists of availability, access, utilization and stability, this research will focus on the first two. Food availability and access are strongly related to agricultural production/yields and food prices. To cover these two aspects of food security and to implement the criteria there will be made use of several methods and indicators.

10.3.1.1 Food availability

For food availability there are several indicators used to cover the topic. The first indicator to be used is (Global Biopact 2012; GBEP 2011):

- Availability of main staple crops

The production of the main staple crops is of importance for the food security of a region and should not be affected by bioenergy feedstock production in the region. The availability of the main staple crops consists of the production, exports, imports and changes in stockpile. The domestic supply of the main staple crops can be calculated by summing the domestic production and the import minus the export. Also changes in possible stockpiles of certain crops should be included, since stockpiles could both increase or decrease and therefore alter the final availability. Regional statistics can then be compared to national statistics to check whether regional availability trends are not out of line with national availability trends. The comparison between regional and national data reduces the influence of external factors such as rain fall. Moreover, the comparison between regional and national data shows which areas have a relatively high or low staple crops availability. This leads to the following data requirements (GBEP 2011):

Data requirement	Unit	Data	Data source
• **4 main staple crops**	Type of food crops	Cassava, maize, rice, sorghum	(Donovan and Tostão 2010; FAO/WFP 2010)
• **Production of main staple crops nationally/regionally**	Tonnes/year	Nationally available (2001-2010), regionally partially. See appendix C, section 12.1.1 and 12.1.2	FAOSTAT, INE, MINAG
• **Exports and imports of main staple crops**	Tonnes/year	Partially available. See appendix C, section 12.1.1	FAOSTAT, INE, MINAG
• **Changes in stockpiles of main staple crops**	Tonnes/year	Partially available. See appendix C, section 12.1.1	FAO/WFP, INE, MINAG

Table 28: Data requirements availability main staple crops

The four major staple crops in Mozambique, in terms of production quantities, are maize, cassava, rice and sorghum. Out of these four, maize and cassava are the most important followed by the other two (Donovan 2012; FAO/WFP 2012). For data gaps that have not been fulfilled yet, data will be collected locally in Mozambique in cooperation with IIAM and other institution such as the ministry of agriculture (MINAG) and the national institute for statistics (INE).

A second indicator that will be used to cover the food availability aspect is:

- Change in yields of main staple crops

The yield of main staple crops is of importance to assess the influence of bioenergy feedstock production in a certain region. Bioenergy feedstock production could affect regional demand for agricultural input commodities, such as water and fertilizer, which can result in higher commodity prices. This could finally lead to lower yields for main staple crops and thus affecting food availability. If not available as such, yields can be calculate by using hectares used for the cultivation of the main staple crops and the production of the main staple crops. On the other hand the yield could also be positively influenced by bioenergy feedstock production. Through spill-over effects from the bioenergy production to smallholders by means of agricultural training. Smallholders often do also cultivate food crops next to Jatropha, which then could be positively influenced. Furthermore, a comparison can be made between national yield averages and regional yields, which reduces the influence of external factors such as rain fall. Moreover a comparison between the regional and national data shows the development of a region's yield relatively to the national average, the change thereof, and preferably the influence of bioenergy projects in the region. Data on yields can be directly available. If not, yields can be calculated by using crop production data and area under cultivation. This leads to the following data requirements:

Data requirement	Unit	Data	Data source
• **National yield averages of main staple crops**	Tonnes/hectare	Available. See appendix C, section 12.2.1	FAOSTAT
• **Regional yield averages of main staple crops**	Tonnes/hectare	Partially available. See appendix C, section 12.2.2	FAO/WFP, MINAG, SIMA
• **Hectares under cultivation for main staple crops nationally**	hectares	Available. See appendix C, section 12.2.3	FAOSTAT
• **Hectares under cultivation for main staple crops regionally**	hectares	Partially available. See appendix C, section 12.2.4	FAO/WFP, MINAG, SIMA

Table 29: Data requirements yields main staple crops

A third indicator that will be used for food availability is:

- Land converted from food crops for bioenergy feedstock production

The amount of land that is being used for bioenergy feedstock production can have an influence on local food availability, especially when land for this purpose is converted from food crops production. Therefore the amount of land that is converted from food crops for bioenergy feedstock production is of importance. A connection can be made with the previous indicator, yields. If land is converted from food crops, the yields of the remaining food crops production should go up in order to compensate the lost land on food crops. This indicator will be measured on a local scale through interviewing at Jatropha projects, which will show whether individual projects have converted land from food crops for bioenergy feedstock production. Furthermore, if available, data will be collected from authorities for more comprehensive numbers, preferably on both a regional and national scale. This leads to the following data requirements:

Data requirement	Unit	Data source	Data aim
• **Land converted from food crops for bioenergy feedstock production for individual projects and on a regional and national scale**	hectares	Interviewing at Jatropha projects and authorities (CPI, CEPAGRI)	Interviews at 6 Jatropha projects

Table 30: Data requirements for land conversion

For data collection on land conversion interviews will be conducted with approximately 6 Jatropha projects. Contacts with these Jatropha projects will be established through private networking (Janske van Eijck) and through collabouration with IIAM.

10.3.1.2 Food access

For food access there are several indicators used to cover the topic. The first indicators to be used is (GBEP 2011):

- Change in prices of the 5 main staple crops

This indicator aims to measure the price changes of the 5 main staple crops. The prices of the main staple crops are of influence of food access. Higher food prices induce decreased food access. The change in real food prices can be calculated by using the nominal prices of the main staple crops and the level of inflation. Preferably, food price indices are also collected regionally. If so, a connection can be made to the other indicators staple crop production and land converted from food crops for bioenergy feedstock production. This leads to the following data requirements (GBEP 2011):

Data requirement	Unit	Data	Data source
• **Change in nominal prices of the main staple crops nationally**	€/tonne	Available. See appendix C, section 12.3.3	FAOSTAT
• **Change in nominal prices of the main staple crops regionally**	€/tonne	Partially available. See appendix C, section 12.3.4	GIEWS
• **Price inflation**	%	Available. See appendix C, section 12.3.1	IMF
• **Change in price indices of main staple crops nationally/regionally**	Index	Partially available. See appendix C, section 12.3.2	FAOSTAT

Table 31: Data requirements change in prices

The second indicator that will be used to cover food access is (GBEP 2011):

- Change in share of expenditures households spent on food

This indicator aims to measure the share of household expenditures spent on food. If food prices are increasing it is likely that the share spent on food increases. The share of expenditures can by calculated be determining the total expenditures of households and the household expenditures on food. A connection there can be made to the previous indicator change in prices of the 4 main staple crops. Also a comparison can be made to the situation before biofuel feedstock production was present in the region and after. Furthermore, a comparison can also be made with results from a survey executed by INE in 2009 also on the share of household expenditures (INE 2009). This leads to the following data requirements:

Data requirement	Unit	Data	Data source	Data aim
• **Change in total expenditures households**	€/month	Available for 08/09. See appendix C, section 12.4.1	INE, interviewing at community	5 interviews per Jatropha project
• **Change in expenditures food households**	€/month	Available for 08/09. See appendix C, section 12.4.1	INE, interviewing at community	5 interviews per Jatropha project

Table 32: Data requirements share of expenditures households spent on food

For the data collection for this indicator, 5 interviews will be conducted for each Jatropha project that is involved. These interviews will be held at the community, with for example community leaders, but also with regular people. A distinction will be made between people that are related and people that are unrelated to the Jatropha project. Related meaning workers at the project or

villagers from a village nearby. Unrelated meaning villagers from a village not directly in the vicinity of a Jatropha project, but in the same province.

10.3.1.3 Competition for labour

Another aspect of food security is the competition for labour. Therefore, the indicator used is (GBEP 2011):

- Competition for labour

Bioenergy feedstock production can generate work, which is positive. However, when workers start working in bioenergy feedstock production instead of in food production this could negatively influence the food security in the region, since workers are being pulled away from food production. This goes for both plantations and smallholders. Workers at plantations could have previously been engaged with food production and smallholders can be engaged in intercropping, thus combining Jatropha production with food production. Therefore there should be looked at the time spent by workers on bioenergy feedstock production and the change in time spent on food production. The level on which this happens is on both the individual level and the household level, since change in time spent on food production could be compensated by other household members. This leads to the following data requirements (GBEP 2011):

Data requirement	Unit	Data source	Data aim
• **Time spent on biofuel feedstock production per person/household**	Hours/week	Interviewing at Jatropha projects (plantations and smallholders)	Interviews with 5 workers at Jatropha projects
• **Change in time spent on food production per person/household**	Hours/week	Interviewing at Jatropha projects (plantations and smallholders)	Interviews with 5 workers at Jatropha projects

Table 33: Data requirements competition for labour

10.3.1.4 Perception

Besides quantitative data there will also be made use of the qualitative perception of people regarding food security. The indicator that will be used is:

- Change of perception by people affected by bioenergy production regarding food security

This indicator aims to reflect upon the qualitative perception that people have on their own food security and specifically the change of their perception before and after bioenergy production in the area. A distinction will be made between people that are related and people that are unrelated to the Jatropha project. Related meaning workers at the project or villagers from a village nearby. Unrelated meaning villagers from a village not directly in the vicinity of a Jatropha project, but in the same province.. The perception will be classified from 'a lot worse' to 'a lot improved'. This is a classification also used by INE for household surveys (INE 2009). This leads to the following data requirements.

Data requirement	Unit	Data source	Data aim
• **Perception of food security before bioenergy activities**	A lot worse, a little worse, unchanged, a little improved, a lot improved, don't know	Interviewing at Jatropha projects and INE	5 interviews per project
• **Perception of food security after bioenergy activities initiated**	A lot worse, a little worse, unchanged, a little improved, a lot improved, don't know	Interviewing at Jatropha projects and INE	5 interviews per project

Table 34: Data requirements perception

10.3.1.5 Background

The final aspect of food security that is covered concern background indicators, that provide an overview of the status of the country/region with regard to food security. The indicators that will be used are (Van Eijck 2012):

- Change in undernourishment

The food security index is a measure for the food security situation nationally or regionally. Decreased access and availability of food can lead to undernourishment, which is therefore also an indicator for food security. This leads to the following data requirements:

Data requirement	Unit	Data	Data source
• **Change in undernourishment**	%	Partially available. See appendix C, section	FAOSTAT

Table 35: Data requirements background indicators.

10.3.2 Land rights

For the area of concern land rights the following criteria are selected (RSB 2010):

- Biofuel production activities shall respect land rights and land use rights.
- Existing land rights will be assessed, documented and established. This holds both for formal and informal land rights. The allocation of land for biofuel production will only be established when these rights are determined.
- Acquisition or voluntary resettlement of land for biofuel production will always be compensated

There are two analytical methods that will be used for the area of concern land rights. The first method will be an analysis of the land acquiring process for which data will be collected through interviewing and can be performed for individual projects and/or plantations (van Eijck 2012). The second method will be an analysis of the share of land acquisitions that have complied with the established domestic legal procedures to determine legal title of land (GBEP 2011). These methods will be executed as follows.

10.3.2.1 Land transfer

The aspect of land transfers will be covered by several indicators. The first indicator that will be used is (RSB 2010; GBEP 2011; Data format 2012; van Eijck, Smeets et al. 2012):

- Land acquisition process

The land acquisition process is an important part of the initiation of bioenergy feedstock production activities. The land acquisition concerns the various stakeholders involved, such as the previous land owner, the community and the authorities. It is important that the land acquisition process has followed formal or socially accepted procedure. This includes an assessment of the previous situation and occupation of the land, which includes previous ownership and use of the land, and whether these findings have been taken in consideration in the land acquisition process. An approach to measurement is to refer to documents of land rights or land registry records. However, in developing countries this approach has the disadvantage that only few documents or registers exist, that they are not up to date and incomplete and that they do not reflect the variety of both formal and informal land rights that exist through custom and tradition (GBEP 2011). Therefore, this is a qualitative indicator for which data will be collected through interviewing. Interviews will be conducted at Jatropha projects and with institutions involved with the land acquisition process, CPI

and CEPAGRI , as distinguished by Soares (2012), and also with community members. This leads to the following data requirements (Data format 2012):

Data requirement	Unit	Data source
• **Land transferred in terms of ownership**	Yes/no	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Previous land ownership**	Private/government/community	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Assessment of previous land rights**	Executed yes/no	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Assessment of informal use of the land**	Executed yes/no	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Land conflicts**	Yes/no/type of conflict	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Transparency in process through language use**	English/Portuguese/local/other	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Documentation on the land acquisition process**	Available yes/no	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Engagement in stakeholder analysis**	Yes/no	Interviewing at Jatropha projects, CPI, CEPAGRI, community
• **Stakeholders**	Private/authorities/community	Interviewing at Jatropha projects, CPI, CEPAGRI, community

Table 36: Data requirements land acquisition process

The second indicator that will be used is:

- Land compensation

Following a possible transfer of land ownership and an assessment of previous rights and informal use it is important to know if and in what way stakeholders have been compensated for the land. This indicator is therefore connected to the land acquisition process indicator. The land compensation is relevant for all stakeholders involved that have been identified during a possible stakeholder analysis. The compensation can both be monetary or qualitative. Qualitative compensation is a broad concept and can range from agricultural training to a new school for example. This leads to the following data requirements:

Data requirement	Unit	Data source	Data aim
• **Compensation of previous users of the land**	Yes/no	Interviewing at Jatropha projects, community, CPI, CEPAGRI	Interviews with all stakeholder groups involved with land compensation for each project involved
• **Type of land compensation**	Monetary/qualitative	Interviewing at Jatropha projects, community, CPI, CEPAGRI.	Interviews with all stakeholder groups involved with land compensation for each project involved
• **Amount of land compensation**	€	Interviewing at Jatropha projects, community, CPI, CEPAGRI	Interviews with all stakeholder groups involved with land compensation for each project involved
• **Price paid for land**	€/hectare	Interviewing at Jatropha projects, community, CPI, CEPAGRI	Interviews with all stakeholder groups involved with land compensation for each project involved

Table 37: Data requirements land compensation

The third indicator that will be used is (GBEP 2011):

- Change in access to land

When a certain plot of land transfers ownership there could also be a change in access to land for secondary land users. Secondary land use is also called informal land use. For example land that is being used by a community for certain ecosystem firewood, such as collecting firewood. This is also an important aspect of a land transfer. Therefore secondary land users, if applicable, should also be identified and involved in the land transfer process , including land compensation. The secondary land users are identified during an assessment of informal use of the land, which follows from the indicator 'land acquisition process'. This leads to the following data requirements:

Data requirement	Unit	Data source
• **Change in access to land for secondary land users**	Yes/no/how?	Interviewing at Jatropha projects and community
• **Land compensation secondary land users**	€ or Mtc	Interviewing at Jatropha projects and community
• **Involvement of secondary land users**	Yes/no	Interviewing at Jatropha projects and community
• **Identification of secondary land users**	Yes/no/who?	Interviewing at Jatropha projects

Table 38: Data requirement change in access to land.

10.3.2.2 Background

The second aspect that will be covered is a back ground aspect that does not apply for individual Jatropha projects but for the data collection at various projects as a whole. The indicator that will be used is (GBEP 2011):

- Share of land acquisitions that have complied with formal or socially accepted procedure regarding absolute numbers and area

This indicator concerns an analysis of the share of land acquisitions that have complied with the established domestic legal procedures to determine legal title of land (GBEP 2011). A data sample of land transfers for bioenergy production can be collected through a series of interviews of those involved in land transfers. In practice, a formal and socially accepted procedure would mean that all transactions processes have been free and voluntary for all the stakeholders involved and that all agreements have been negotiated. This will be identified through interviewing and the aspects are also represented by the data requirements in section 4.4.2.1. An increasing percentage of land acquisitions that have followed formal or socially accepted procedure will show a positive trend in land transfer processes related to bioenergy production (GBEP 2011). However, it is difficult to establish a reference for this indicator, since data collection is only performed at one moment in time. This leads to the following data requirements:

Data requirement	Unit/Example	Data source
• **The number of land transfers for the production of bioenergy**	Absolute number	Interviewing at Jatropha projects, community, CPI, CEPAGRI
• **The land area transferred for the production of bioenergy**	Hectares	Interviewing at Jatropha projects, community, CPI, CEPAGRI
• **The number of land transfers that have complied with formal or socially accepted procedure**	Absolute number	Interviewing at Jatropha projects, community, CPI, CEPAGRI
• **The land area that has been transferred compliant to formal or socially accepted procedure**	hectares	Interviewing at Jatropha projects, community, CPI, CEPAGRI

Table 39: Data requirements share of land acquisitions

10.3.3 Rural and social development

For the area of concern rural and social development the following criteria is selected (RSB 2010):

- The socio-economic position of local stakeholders shall be improved through the impact of biofuel operations

To come to an analysis of rural and social development then a set of various indicators will be included that vary from qualitative to quantitative of which some may be more general, concerning national figures, and some may apply more to individual projects and/or regions. In this research, there will be focused on the impacts of the production of Jatropha and not on the use of Jatropha biofuels.

10.3.3.1 Income

The first aspect that will be used to cover rural and social development concerns income. For income there will be made use of the following indicator:

- Comparison wages Jatropha projects to comparable sector/national average/minimum wage

The wages that are paid for workers at Jatropha projects compared to the national average analysis will show how wages from the bioenergy sector compare to other comparable sectors and also the national average and thus show whether or not bioenergy production activities stimulate rural and social development. For the wage level at Jatropha projects a distinction will be made between management, high-skilled and low-skilled and permanent and temporary jobs. Furthermore, the legal minimum wage will be taken in consideration for the wage comparisons as well, since all wages should be above the legal minimum wage. This leads to the following data requirements:

Data requirement	Unit	Data	Data source
• **Wages Jatropha projects**	€ or Mtc per day/week/month	-	Interviewing at Jatropha projects, literature
• **National wage averages**	€ or Mtc per week or month	-	Database, literature review
• **Wage averages agricultural sector**	€ or Mtc per week or month	-	Database, literature review
• **Legal minimum wage agricultural sector over 2011**	€ or Mtc per week or month	2005 Mtc/month	(Wageindicator 2011)

Table 40: Data requirements income

10.3.3.2 Background living conditions

The second aspect that will be covered concern more general background living conditions and statistics. These do not necessarily directly reflect the impact of an individual Jatropha project, but do provide valuable background information on the general welfare and therefore also rural and social development. There will be made use of the following indicators (Global Biopact 2012; van Eijck, Smeets et al. 2012):

- Change in share of people below the poverty line
- Change in GDP
- Purchasing power
- Life expectancy
- Literacy rate
- GINI-index
- Regional unemployment rate compared to national average

These indicators could be influenced by bioenergy production and are preferably analyzed regionally to be able to make a connection with possible bioenergy production in a region. However, this will be dependent on data availability. A result of increased economic activities and therefore possible rural and social developments is the number of people that live below the poverty line. Two poverty lines will be used: the national poverty line and the international poverty line (Van Eijck 2012). This leads to the following data requirements:

Data requirement	Unit	Data	Data source
• **National poverty line**	US$/day	18 Mtc/day, $0,50/day	(IMF 2011)
• **International poverty line**	US$/day	$1,25/day	(World Bank 2012)
• **People below the national poverty line**	%	54%	(WFP 2012)
• **GDP per capita**	US$	473 US$/year/capita (2010)	(FAO/WFP 2010)
• **GDP per capita (PPP)**	US$	1100 US$/year/capita (2011)	(CIA World Factbook 2011)
• **Life expectancy**	years	52	(CIA World Factbook 2011)
• **Literacy rate**	%	47%	(CIA World Factbook 2011)
• **GINI-index**	-	45,6 (2008)	(CIA World Factbook 2011)
• **Unemployment**	%	17% (2007)	(TradingEconomics 2012)

Table 41: Data requirements background living conditions

10.3.3.3 Investments

Third, there will be looked at the contribution of Jatropha projects to infrastructure, health and education on a regional scale for individual Jatropha projects. The indicator that will be included is (GBEP 2011; Van Eijck 2012):

- Contribution to education, health care and infrastructure investments
- Share of total regional investments by Jatropha projects

By contributing to education, health care and infrastructure investments Jatropha projects can locally have positive influence on rural and social development. Moreover, investing in these public facilities could compensate for example loss of access to land. These contributions can both be monetary or qualitative. Furthermore, an analysis of the share of total local investments in these public facilities that is accounted for by Jatropha projects will be executed. The data will be collected by interviewing and will be mainly qualitative, but quantitative where possible. The level of data collection will be as detailed as possible, which means down to region, province, district. Interviews will be held at the Jatropha projects and at local authorities and will consist of the following data requirements:

Data requirement	Unit	Data source	Data aim
• **Contribution to education, health care and infrastructure investments**	Yes/no	Interviewing at Jatropha projects and local authorities	Interviews at 6 Jatropha projects and accompanying local authorities
• **Total project investments in education, health care and infrastructure**	€ or qualitative	Interviewing at Jatropha projects and local authorities	Interviews at 6 Jatropha projects and accompanying local authorities
• **Total regional investments in education, health care and infrastructure**	€	Interviewing at Jatropha projects and local authorities	Interviews at 6 Jatropha projects and accompanying local authorities

Table 42: Data requirements investments

10.3.3.4 Job creation

The fourth aspect that will be used to cover rural and social development will be job creation. The following indicators will be used (GBEP 2011):

- Net Job creation per hectare
- Ratio skilled/unskilled jobs
- Ratio permanent/temporary jobs

If bioenergy production activities create a positive net job creation it can have a positive impact on rural and social development on the regional and national level (GBEP 2011). The net job creation consist of jobs that have been taken away, by for example buying agricultural land, but also of new jobs that are being created. An important consideration within job creation is the distinction between skilled and unskilled jobs, with skilled jobs contributing more to the development. The same goes for the distinction between permanent and temporary jobs. Many workers may be employed during harvesting, but that does not involve permanent jobs. Using this data it is possible to calculate ratios of skilled/unskilled, permanent/temporary and jobs/ha ratios in order to be able to make a comparison among different Jatropha projects. The data collection will be done through interviewing on individual projects and will consist of the following data requirements:

Data requirement	Unit	Data source	Data aim
• **Total number of jobs currently and expected**	Absolute number	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Number of skilled and unskilled jobs created**	Absolute number	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Number of permanent and temporary jobs created**	Absolute number	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Number jobs have been taken away by replacing previous activities on the plot of land**	Absolute number	Interviewing at Jatropha projects and local authorities, expert consultation	Interviews at 6 Jatropha projects, previous land occupiers, authorities, experts.
• **Land area of the project currently and expected**	hectares	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects

Table 43: Data requirements job creation

10.3.4 Labour and working conditions

For the area of concern labour and working conditions the following criteria have been selected (RSB 2010):

- Bioenergy production activities shall not violate labour rights
- Bioenergy production activities shall ensure decent work and the well-being of workers
- No forced labour or child labour shall occur on bioenergy production activities
- Workers shall have the right to organize, collectively bargain and the right to associate
- Workers shall not be discriminated in any way, including gender

10.3.4.1 Labour and working conditions

The analytical method that will be used for labour and working conditions is an analysis of the labour and working conditions at Jatropha projects, for which data will be collected through interviewing and is qualitative. The questions in the interview will cover issues that deal with labour rights and working conditions concerning jobs created by bioenergy production activities. The interviews will be conducted for individual biofuel projects. The following indicators will be included (GBEP 2011):

- Amount of forced labour
- Amount of child labour
- Rate of discrimination
- Formation of unions
- Number of work related accidents and health issues

Labour that is carried out at Jatropha projects should not be involved with forced labour or child labour of any sort. The same goes for discrimination. There should be no gender discrimination concerning hiring workers. Nor should there be any gender discrimination concerning wage levels. Also, workers should have to right form unions, to associate themselves and make collective agreements with the employer. Finally an assessment will be made of work related accidents and health issues, which relates to the type of work, the work pressure and possibly chemicals workers use. This leads to the following data requirements (Data format 2012; GBEP 2011):

Data requirement	Unit	Data	Data source
• **The policy on forced labour**	-	-	Interviewing at Jatropha projects
• **The policy on child labour**	-	-	Interviewing at Jatropha projects
• **The policy on gender discrimination**	-	-	Interviewing at Jatropha projects
• **The right for employees to form unions**	Yes/no	-	Interviewing at Jatropha projects
• **Number and type of work related accidents**	Amount/hectare/ year	-	Interviewing at Jatropha projects
• **Identification of different types of work**	Manual/mechanic al	-	Interviewing at Jatropha projects
• **Exposure of employees to chemicals or other hazardous materials**	Yes/no	-	Interviewing at Jatropha projects
• **The average working hours**	Hours/day	-	Interviewing at Jatropha projects
• **Breaks**	Minutes/hour	-	Interviewing at Jatropha projects
• **International legal minimum age**	years	15 years	(ILO 2012)
• **National legal minimum age**	years	15 years	(Right to Education 2012)

Table 44: Data requirements labour and working conditions

10.3.5 Economic feasibility

For the area of concern economic feasibility the following criteria have been selected (Van Eijck 2012):

- Bioenergy production activities shall be financially viable

10.3.5.1 Financial projections

The method to be used for economic feasibility will be a financial projections analysis, which analyses the potential economic feasibility of Jatropha biofuel production projects (Van Eijck, 2012). The economic feasibility is evaluated by assessing the NPV, the IRR, the PBP and the production costs and this automatically leads to the following indicators:

- NPV
- IRR
- PBP
- Production costs

Preferably the data collection for these indicators can be done directly by interviewing. If these indicators are not readily available, they will be calculated using the following formulas, considering financial data of the Jatropha projects is available.

NPV

The NPV represents the total amount of profit or loss that is being generated over the lifetime of a project (or a fixed period of time). A positive NPV indicates a profit, which means that the expected net benefits over the fixed period of time are higher than the expected net costs. A negative NPV indicates a loss, when the costs exceed the benefits. The break-even point is reached when the NPV equals zero. The NPV is calculated by using the following formula (I) (Van Eijck, 2012):

$$NPV = \sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^i} \qquad \text{(I)}$$

NPV Net Present Value [€]

B_i benefits in year i [€]

C_i costs in year i [€]

r discount rate [%]

n lifetime of project [years]

IRR

The IRR is used as an indicator for the rate of the profitability of a project. The IRR is calculated by using the NPV formula. To calculate the IRR, the NPV in the formula should be set to zero with the discount rate as the variable. In more precise terms, the IRR is equal to the discount rate at which the NPV equals the break-even point. An IRR higher than the actual discount rate then indicates potential profit. This means a high IRR is desirable for project investments. (Van Eijck, 2012)

PBP

The PBP represent the number of years that are required to recover the initial investments that are needed for a projects (Van Eijck, 2012). The PBP depends on the initial investment costs and the expected discounted annual profits. The PBP is calculated by equalizing the initial investment costs to the summed discounted annual profits.

Production costs

The production costs can be used to compare the Jatropha biofuel production costs to a reference energy source, which in this case is diesel from fossil oil. The price of Jatropha biofuel per energy unit has to be competitive with diesel from fossil oil. The production costs are calculated using the following formula (II) (Van Eijck, 2012):

$$C = \frac{\sum_{i=1}^{i_t} \left(ecc_i \sum_{y=1}^{n} \frac{f_i(y)}{(1+r)^y} \right)}{yld \sum_{y=1}^{n} \frac{f_{yld}(y)}{(1+r)^y}} \qquad \text{(II)}$$

C Cost of biomass [€ kg^{-1} or € t^{-1} or € m^{-3}]

i_t number of cost items with different time pattern

ecc_i cost of energy crop cost item [€ ha^{-1}]

n number of years of plantation lifetime [yr]

$f_i(y)$ number of times that cost item i is applied on the plantation in year y [dimensionless]

r discount rate [dimensionless]

yld yield of the energy crop [kg ha^{-1} yr^{-1} or t ha^{-1} yr^{-1} or m^3 ha^{-1} yr^{-1}]

$f_{yld}(y)$ binary number, harvest (1) or not (0) in year y [dimensionless]

10.3.5.2 Profitability

In the event that such specific financial data are not available there will be made use a more general method to assess the profitability of a Jatropha project. Then, the following indicator will be used:

- Profitability

For this indicator the following data requirements will be used (Data format 2012):

Data requirement	Unit	Data source	Data aim
• **Turnover**	€/year	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Costs**	€/year	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Profit**	€/year	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Future expectations profit**	€/year	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Future expectations production costs**	€/year	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Investment costs**	€/ha	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Production costs**	€/ha	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Yield**	kg dry seeds/ha/yr or kg dry seeds/tree/yr	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects
• **Selling price**	€/kg	Interviewing at Jatropha projects	Interviews at 6 Jatropha projects

Table 45: Data requirements profitability

10.3.5.3 Competitiveness

The last method is a comparison between the prices for Jatropha SVO or biodiesel and fossil diesel. This leads to the following indicator:

- Competitiveness Jatropha biofuel compared with alternatives such as fossil diesel

It is very important for Jatropha biofuel to be competitive with alternative fuels. If Jatropha biofuel is not competitive it will not be the preferred option which will lead to a not or slow growing market. Alternatives for Jatropha biofuel are fossil diesel and possibly other biofuels. Data on fuel prices will be collected through a literature review and through local data sampling at fuel selling points. Through data sampling a comparison can also be made between different regions. Also experts can be consulted on prices of other biofuels. For this indicator the following data requirements apply (Data format 2012):

Data requirement	Unit	Data	Data source
• **Price Jatropha SVO and biodiesel**	€/L or Mtc/L	-	Interviewing at Jatropha projects and literature review
• **Price fossil diesel nationally/regionally**	€/L or Mtc/L	36,81 Mtc/L (2011)	(All Africa 2011), literature review, local data sample
• **Price other biodiesels nationally**	€/L or Mtc/L	-	Literature review, local expert consultation

Table 46: Data requirements competitiveness

11. Appendix C

11.1 Main staple crop production

11.1.1 National main staple crop production, import, export and change in stockpile

Maize	tonnes x1000			
Year	**Domestic production**	**Import**	**Export**	**Change in stockpile**
2001	1143	300	0	-
2002	1115	373	6	-
2003	1179	206	3	-
2004	1060	56	12	-40
2005	942	179	1	-
2006	1418	239	103	-
2007	1152	28	19	-
2008	1285	101	29	-
2009	1932	82	15	-
2010	1878	163	180	-30

Table 47: Maize national availability data. Source: (FAO/WFP 2005; FAO/WFP 2010; FAOSTAT 2012)

Cassava	tonnes x1000			
Year	**Domestic production**	**Import**	**Export**	**Change in stockpile**
2001	5975	-	-	-
2002	5925	-	-	-
2003	6150	-	-	-
2004	6413	-	-	0
2005	4782	-	-	-
2006	6659	-	-	-
2007	5039	-	-	-
2008	4055	-	-	-
2009	5672	-	-	-
2010	5700	-	-	0

Table 48: Cassava national availability data. Source: (FAO/WFP 2005; FAO/WFP 2010; FAOSTAT 2012)

Sorghum	tonnes x1000			
Year	**Domestic production**	**Import**	**Export**	**Change in stockpile**
2001	160	0	0	-
2002	138	0	1	-
2003	191	0	0	-
2004	153	16	0	0
2005	115	10	1	-
2006	205	14	1	-
2007	170	2	0	-
2008	187	0	0	-
2009	384	0	0	-
2010	395	0	0	0

Table 49: Sorghum national availability data. Source: (FAO/WFP 2005; FAO/WFP 2010; FAOSTAT 2012)

Rice	tonnes x1000			
Year	**Domestic production**	**Import**	**Export**	**Change in stockpile**
2001	167	-	-	-
2002	93	-	-	-
2003	117	-	-	-
2004	91	-	-	0
2005	65	-	-	-
2006	99	-	-	-
2007	105	-	-	-
2008	102	-	-	-
2009	179	-	-	-
2010	180	-	-	0

Table 50: Rice national availability data. Source: (FAO/WFP 2005; FAO/WFP 2010; FAOSTAT 2012)

11.1.2 Regional main staple crop production

Maize production	**tonnes x1000**						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	140	135	-	161	171	184	208
Niassa	244	199	-	264	261	291	323
Nampula	148	134	-	165	175	200	222
North	**532**	**468**	-	***591***	***607***	***675***	***753***
Zambezia	263	253	-	304	314	345	310
Tete	191	178	-	237	245	261	270
Manica	221	219	-	269	295	317	325
Sofala	82	84	-	82	80	93	72
Centre	**757**	**734**	-	***892***	***933***	***1 017***	***977***
Inhambane	38	48	-	34	53	82	54
Gaza	49	127	-	52	67	101	55
Maputo	28	36	-	12	16	56	39
South	**115**	**212**	-	***99***	***136***	***240***	***148***
Mozambique	**1 403**	**1411**	**1534**	**1 582**	**1 676**	**1 932**	**1 878**

Table 51: Maize regional production data. Source: (FAO/WFP 2005; FAO/WFP2010)

Cassava production	tonnes x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	-	2 080	-	-	-	-	-
Niassa	-	380	-	-	-	-	-
Nampula	-	4 800	-	-	-	-	-
North	-	**7 260**	-	-	-	-	-
Zambezia	-	2 970	-	-	-	-	-
Tete	-	15	-	-	-	-	-
Manica	-	25	-	-	-	-	-
Sofala	-	178	-	-	-	-	-
Centre	-	**3 188**	-	-	-	-	-
Inhambane	-	600	-	-	-	-	-
Gaza	-	350	-	-	-	-	-
Maputo	-	60	-	-	-	-	-
South	-	**1 010**	-	-	-	-	-
Mozambique	-	**11 458**	-	-	-	-	-

Table 52: Cassava regional production data. Source: (FAO/WFP 2005)

Sorghum production	tonnes x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	49	56	-	-	-	-	-
Niassa	28	32	-		-	-	-
Nampula	85	92	-	-	-	-	-
North	***162***	***180***	-	**-**	**-**	**205**	**210**
Zambezia	50	47	-	-	-	-	-
Tete	30	19	-	-	-	-	-
Manica	32	27	-	-	-	-	-
Sofala	45	23	-	-	-	-	-
Centre	***157***	***116***	**-**	**-**	**-**	**160**	**163**
Inhambane	13	10	-	-	-	-	-
Gaza	4	1	-	-	-	-	-
Maputo	1	0	-	-	-	-	-
South	***17***	***11***	**-**	**-**	**-**	**12**	**12**
Mozambique	**337**	**307**	**339**	**348**	**366**	**378**	**384**

Table 53: Sorghum regional production data. Source: (FAO/WFP 2005; FAO/WFP2010)

Rice production	tonnes x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	17	17	-	-	-	-	-
Niassa	5	5	-	-	-	-	-
Nampula	36	37	-	-	-	-	-
North	***58***	**59**	-	**-**	**-**	**60**	**59**
Zambezia	73	81	-	-	-	-	-
Tete	0	0	-	-	-	-	-
Manica	1	1	-	-	-	-	-
Sofala	34	21	-	-	-	-	-
Centre	***108***	**103**	-	-	-	**152**	**69**
Inhambane	2	1	-	-	-	-	-
Gaza	6	8	-	-	-	-	-
Maputo	4	3	-	-	-	-	-
South	***12***	**12**	-	-	-	**48**	**50**
Mozambique	**178**	**174**	-	-	-	**260**	**179**

Table 54: Rice regional production data. Source: (FAO/WFP 2005; FAO/WFP2010)

11.2 Main staple crop yield and area harvested

11.2.1 National yield averages

National yield average	tonne/hectare			
Year	Maize	Cassava	Sorghum	Rice
2001	0,96	7,16	0,57	0,96
2002	0,88	5,81	0,55	0,93
2003	0,87	5,88	0,58	0,98
2004	0,81	6,00	0,57	0,96
2005	0,77	4,33	0,55	0,97
2006	0,85	7,77	0,50	0,94
2007	0,85	7,75	0,57	1,00
2008	0,92	7,72	0,59	0,98
2009	1,20	6,03	0,62	0,98
2010	1,19	6,00	0,64	0,97

Table 55: National main staple crop yield data. Source: (FAOSTAT 2012)

11.2.2 Regional yield averages

Maize regional yield averages	tonnes/hectare			
Province	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	1.67	1.64	1.64	1.62
Niassa	1.61	1.55	1.67	1.63
Nampula	1.25	1.28	1.40	1.44
North	***1.50***	***1.48***	***1.57***	***1.57***
Zambezia	1.30	1.31	1.40	1.27
Tete	1.24	1.22	1.25	1.21
Manica	1.17	1.24	1.27	1.21
Sofala	0.76	0.74	0.85	0.76
Centre	***1.17***	***1.19***	***1.24***	***1.17***
Inhambane	0.35	0.47	0.66	0.64
Gaza	0.34	0.41	0.63	0.50
Maputo	0.34	0.34	0.73	0.60
South	***0.35***	***0.48***	***0.66***	***0.57***
Mozambique	**1.10**	**1.13**	**1.20**	**1.19**

Table 56: Regional maize yield data. Source: (FAO/WFP 2010)

Sorgum regional yield averages	tonnes/hectare			
Province	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	-	-	-	-
Niassa	-	-	-	-
Nampula	-	-	-	-
North	-	-	**0.72**	**0.71**
Zambezia	-	-	-	-
Tete	-	-	-	-
Manica	-	-	-	-
Sofala	-	-	-	-
Centre	-	-	**0.55**	**0.56**
Inhambane	-	-	-	-
Gaza	-	-	-	-
Maputo	-	-	-	-
South	-	-	**0.41**	**0.37**
Mozambique	-	-	**0.62**	**0.62**

Table 57: Regional sorghum yield data. Source: (FAO/WFP 2010)

Rice regional yield averages	tonnes/hectare			
Province	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	-	-	-	-
Niassa	-	-	-	-
Nampula	-	-	-	-
North	-	-	**0.93**	**0.93**
Zambezia	-	-	-	-
Tete	-	-	-	-
Manica	-	-	-	-
Sofala	-	-	-	-
Centre	-	-	**1.13**	**0.72**
Inhambane	-	-	-	-
Gaza	-	-	-	-
Maputo	-	-	-	-
South	-	-	**2.40**	**2.26**
Mozambique	-	-	**1.19**	**0.98**

Table 58: Regional rice yield data. Source: (FAO/WFP 2010)

No regional yield data available for cassava.

11.2.3 National area harvested

National area harvested	hectares x1000			
Year	Maize	Cassava	Sorghum	Rice
2001	1193	834	280	174
2002	1271	1020	250	100
2003	1356	1046	330	120
2004	1312	1069	270	95
2005	1230	1105	210	67
2006	1664	857	406	105
2007	1350	650	300	105
2008	1400	525	320	104
2009	1612	940	617	182
2010	1573	950	620	185

Table 59: National main staple crop area harvested data. Source: (FAOSTAT 2012)

11.2.4 Regional area harvested

Maize regional area harvested	hectares x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	90	92	-	96	105	112	128
Niassa	143	147	-	165	168	174	198
Nampula	119	125	-	133	137	143	154
North	***352***	***365***	***-***	***394***	***410***	***429***	***481***
Zambezia	221	221	-	234	240	247	245
Tete	175	176	-	192	200	209	224
Manica	177	178	-	230	238	255	268
Sofala	69	68	-	106	108	110	95
Centre	***642***	***644***	***-***	***762***	***786***	***821***	***832***
Inhambane	90	87	-	97	111	125	85
Gaza	143	78	-	152	127	160	110
Maputo	45	57	-	36	46	77	65
South	***278***	***222***	***-***	***285***	***284***	***362***	***260***
Mozambique	**1271**	**1230**	**1471**	**1 441**	**1 480**	**1 612**	**1 573**

Table 60: Regional maize area harvested data. Source: (FAO/WFP 2005; FAO/WFP2010)

Cassava regional area harvested	hectares x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	176	180	-	-	-	-	-
Niassa	26	27	-	-	-	-	-
Nampula	449	463	-	-	-	-	-
North	***652***	***671***	-	-	-	-	-
Zambezia	287	297	-	-	-	-	-
Tete	2	2	-	-	-	-	-
Manica	2	3	-	-	-	-	-
Sofala	13	15	-	-	-	-	-
Centre	***303***	***316***	-	-	-	-	-
Inhambane	69	72	-	-	-	-	-
Gaza	39	39	-	-	-	-	-
Maputo	5	7	-	-	-	-	-
South	***113***	***118***	-	-	-	-	-
Mozambique	**1069**	**1105**	-	-	-	-	-

Table 61: Regional cassava area harvested data. Source: (FAO/WFP 2005; FAO/WFP2010)

Sorghum regional area harvested	hectares x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	70	71	-	-	-	-	-
Niassa	41	41	-	-	-	-	-
Nampula	127	133	-	-	-	-	-
North	***238***	***245***	***-***	***-***	***-***	***287***	***294***
Zambezia	73	71	-	-	-	-	-
Tete	61	58	-	-	-	-	-
Manica	51	38	-	-	-	-	-
Sofala	64	58	-	-	-	-	-
Centre	***250***	***225***	***-***	***-***	***-***	***293***	***293***
Inhambane	24	17	-	-	-	-	-
Gaza	15	2	-	-	-	-	-
Maputo	1	0	-	-	-	-	-
South	***41***	***19***	***-***	***-***	***-***	***30***	***31***
Mozambique	**528**	**488**	**-**	**-**	**-**	**610**	**617**

Table 62: Regional sorghum area harvested data. Source: (FAO/WFP 2005; FAO/WFP2010)

Rice regional area harvested	hectares x1000						
Province	**2003 - 2004**	**2004 - 2005**	**2005 - 2006**	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**
Cabo Delgado	16	16	-	-	-	**-**	**-**
Niassa	5	5	-	-	-	**-**	**-**
Nampula	36	38	-	-	-	**-**	**-**
North	***55***	***58***	-	-	-	***64***	***64***
Zambezia	82	83	-	-	-	**-**	**-**
Tete	0	0	-	-	-	**-**	**-**
Manica	1	1	-	-	-	**-**	**-**
Sofala	31	29	-	-	-	**-**	**-**
Centre	***115***	***114***	-	-	-	***134***	***95***
Inhambane	4	3	-	-	-	**-**	**-**
Gaza	2	4	-	-	-	**-**	**-**
Maputo	2	2	-	-	-	**-**	**-**
South	***7***	***8***	-	-	-	***20***	***22***
Mozambique	**178**	**180**	-	-	-	**218**	**182**

Table 63: Regional rice area harvested data. Source: (FAO/WFP 2005; FAO/WFP2010)

11.3 Main staple crop economics

11.3.1 Inflation rate

Inflation	
Year	%
2000	12,7
2001	9,1
2002	16,8
2003	13,5
2004	12,6
2005	6,4
2006	13,2
2007	8,2
2008	10,3
2009	3,3
2010	12,7

Table 64: Annual inflation Mozambique data. Source: (IMF 2011)

11.3.2 National consumer food price index

National consumer price indices	Food price index	General price indix
Year	Index: 2000 = 100	
2000	100	100
2001	111	111
2002	132	130
2003	149	145
2004	165	162
2005	174	173
2006	204	197
2007	225	215
2008	267	247
2009	286	255
2010	329	287

Table 65: Price index data Source: (FAOSTAT 2012)

11.3.3 National producer food prices

National producer food prices	US$/tonnes			
Year	**Maize**	**Cassava**	**Sorghum**	**Rice**
2000	51,8	32,4	51,8	90,6
2001	91,8	38,6	79,7	94,2
2002	126,7	33,8	105,6	105,6
2003	105,1	42	92,5	84,1
2004	122,4	66,7	111,2	144,6
2005	154,5	132,4	141,3	163,3
2006	139,9	157,6	177,3	157,6
2007	145,4	213,3	174,5	193,9
2008	279,4	249,4	205,8	300,6
2009	298,3	310	216,4	322,3
2010	-	-	-	-

Table 66: National producer food price data. Source: (FAOSTAT 2012)

11.3.4 Regional retail food prices

This is an example of regional food price statistics. These are available for several regions in Mozambique, mostly for the main staple crops maize and rice.

Figure 2: Maize price data for Maputo. Source: (GIEWS 2012; SIMA 2012)

11.4 Rural and social development

11.4.1 Share of expenditures

Share of household expenditures spent on food	
2008 - 2009	**%**
Total Mozambique	51,4
Residential area	
Urban	35,2
Rural	65,7
Region	
North	56,7
Centre	64
South	34,5
Province	
Cabo Delgado	63,6
Niassa	52,6
Nampula	55
Zambezia	63,7
Tete	70,9
Manica	65
Sofala	54,1
Inhambane	52,1
Gaza	48,6
Maputo province	38,4
Maputo city	21,5

Table 67: Household expenditures data. Source: (INE 2009)

11.4.2 Undernourishment

Percentage of population Mozambique undernourished

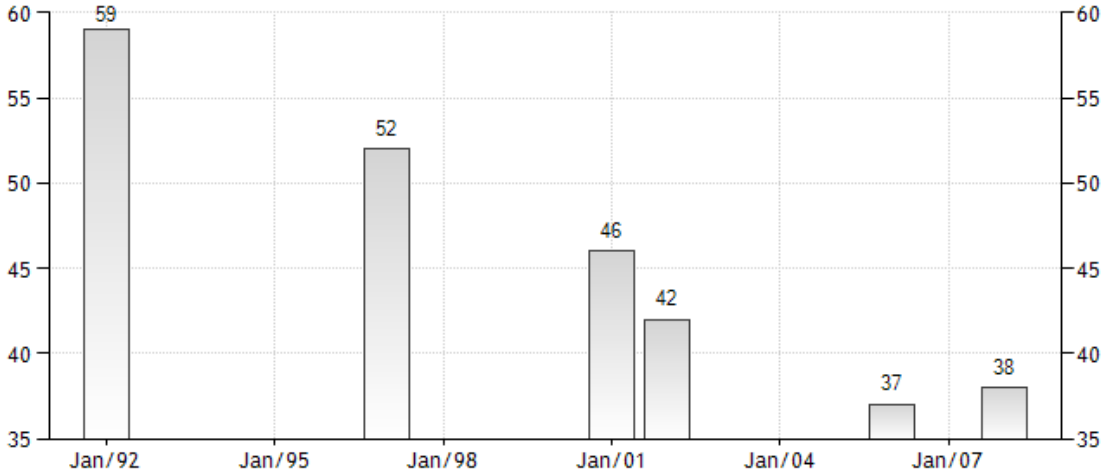


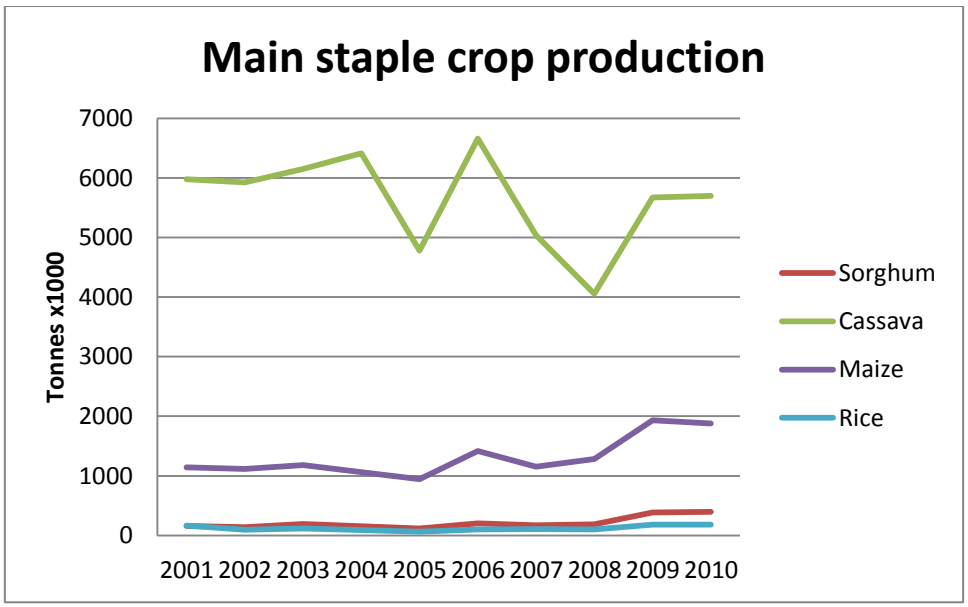
Figure 3: Mozambique undernourishment data. Source: (FAOSTAT 2012; TradingEconomics 2012)

12. Appendix D: results sustainability

12.1 Food Security

12.1.1 Secondary data

To get an overview of food availability and the possible impact of Jatropha projects on this multiple data requirements were used. These include the main staple crop production, the national yield averages and the national area harvested. The national data is shown in the graphs below. The more detailed regional data is scarcely and irregular available and therefore cannot be used. Theoretically these statistics could be used to reflect the impact of an individual Jatropha project on, but in practice this is very difficult. However, some statistics can be used to support some other claims that have arisen from the data collection during the field work.

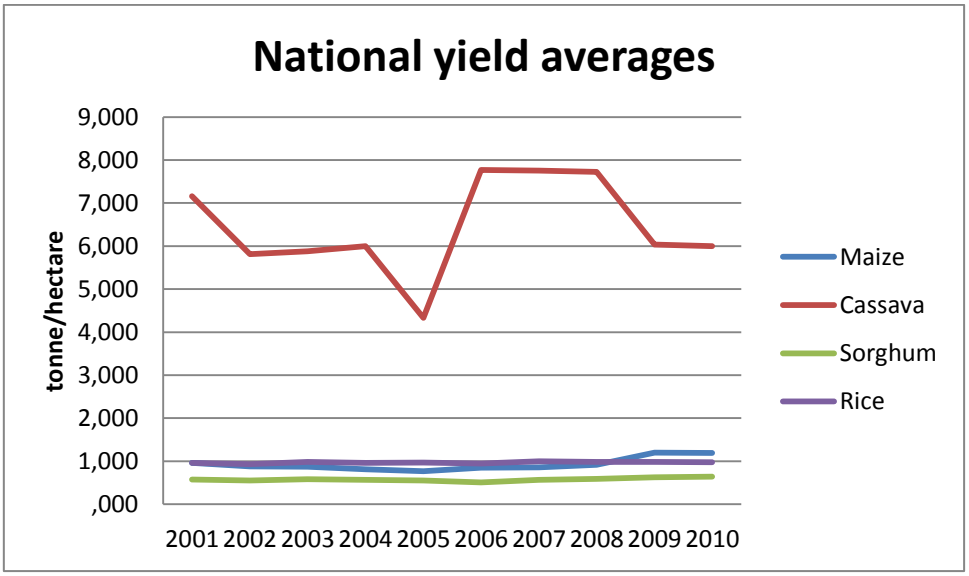


Graph 1 : Main staple food crop production in Mozambique (FAO/WFP 2005; FAO/WFP 2010; FAOSTAT 2012).

The main staple crop production figures show a very small increase for both rice and sorghum over the last decade. Maize shows a considerable increase, almost doubling over the span of 10 years. Cassava shows big fluctuations and even a small decrease in production in the end. This means that the overall main staple crop production has only slightly increased, which does not improve the food availability much, also taking into account the growing population.

The national yield averages shows the performance of the Mozambican agriculture. (Ideally, the influence of Jatropha projects could benefit local communities in a way that they would learn from the project in using improved agricultural techniques and are possibly supported with land

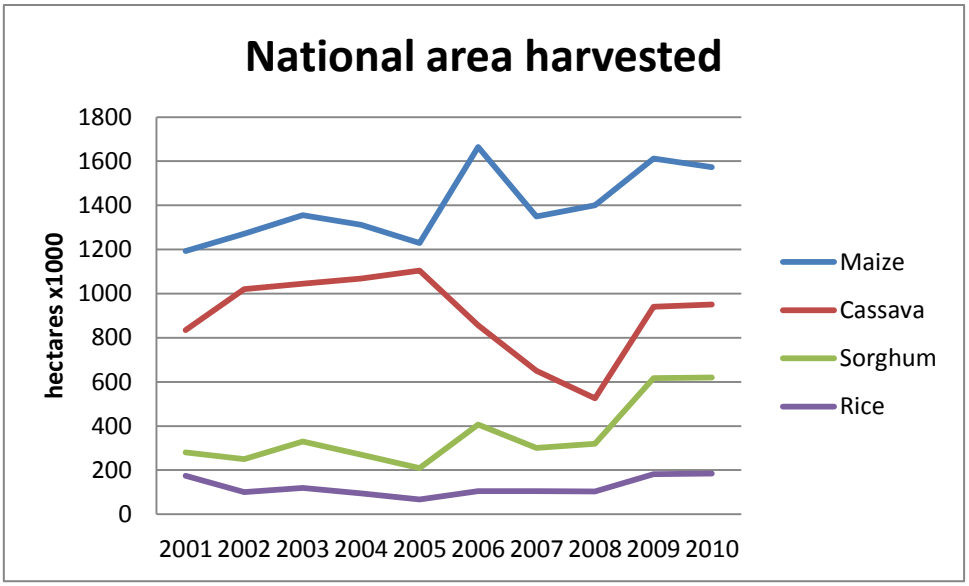
preparation and/or fertilizer for example.) Jatropha projects could have an influence on national yield averages, but to reflect the impact of individual projects is a bridge too far still and might only work for a very large and settled industry. Even then, it would be difficult to exclude other influences.



Graph 2: National yield averages of staple food crops in Mozambique (FAOSTAT 2012).

The national yield averages show that there is hardly any progress for either maize, sorghum and rice. Only cassava shows a stronger fluctuation, but only has a decreased yield average over the last decade. This shows that there has not been progress in the agricultural sector in Mozambique. A reason could be that there is no considerable increase in knowledge or the use of improved techniques. Also, the profit based agricultural sector is only small in Mozambique, with a majority of the food production being done by individual people, which could influence the lack of growth.

The national area harvested theoretically shows the impact of Jatropha projects taking over crop land that was previously used for main staple crop food production. However, again, the data is not detailed enough to reflect the impact of a single project. To compensate for this, the previous land occupation has been used during the data collection for individual projects. This way it becomes clear, whether crop land was taken over.

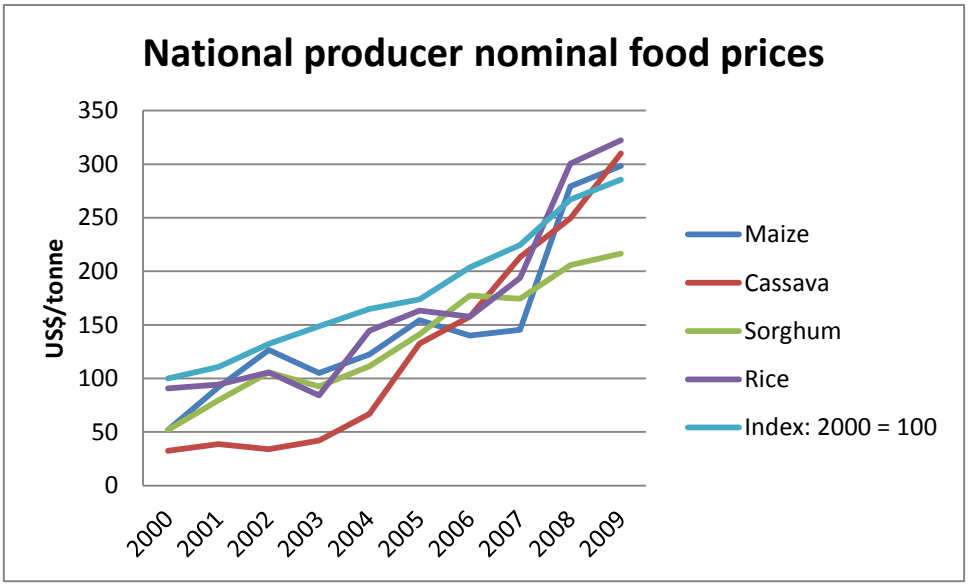


Graph 3: National area harvested of staple food crops in Mozambique (FAOSTAT 2012).

The national area harvested remains about equal for both rice and cassava, neglecting strong fluctuations for cassava. Sorghum and Maize show a considerable increase in national area harvested.

Combining the slight increase in the national area harvested and the status quo for national yield averages, this explains the small increase in national main staple crop production figures.

The data requirements for the indicator food access includes food prices, inflation and indices. In this situation the national food prices are intended to show the impact of Jatropha projects on food prices, since Jatropha projects could increase food prices by taking over land and resources, but could also decrease food prices by increasing food crop yields. However, again the data is not detailed enough to reflect the impact of individual impacts at the moment. On the other hand, food prices can be related to change in household expenditures.



Graph 4: National producer nominal prices of staple food crops in Mozambique (FAOSTAT 2012).

The graph above show a strong increase in the prices of all four main staple crops. The fifth line shows the general consumer food price index. Even when the price inflation is taken into account, the real price increase is still strong. This supports the claim that people at all projects say that food has become a lot more expensive, which could lead to a more difficult food security situation.

12.1.2 Data Jatropha projects

12.1.2.1 AVIAM

Most of the land that is used for Jatropha at the moment was not used before for food production, it was mainly uncultivated according to the project and the community . AVIAM tries to avoid conflict by going around the places where people live. In some cases however, people did have to be relocated. Four families were relocated and in return they were compensated for their loss of crop land and trees that produce cash crops. This compensation was determined by the district administration based on the amount and type of crops and trees, which was satisfying for the concerning families as well, according to the community leader, who was involved with the negotiations (AVIAM-Authorities 2012; AVIAM-Community 2012; AVIAM-Management 2012).

A small issue was when people in the local community started to make more money in general, the local food shop tended to increase its prices. In response to that, AVIAM talked to the people that sell food and asked them to keep food prices the same. If they refuse to listen it could be a possibility for AVIAM to start produce food crops themselves on a relative small scale for the local community and sell it for a lower price (AVIAM-Management 2012).

Food expenditures from people in the community and people that work at the project have not changed much. A reason for changes in food expenditures is generally is that people earn more money now and therefore spend more money. Also a general increase in food prices are said to be a cause. However, sometimes also a decrease in food expenditures is registered. It is unlikely that the increase in prices are related the project itself, regarding raw food crops, since hardly any crop land was taken over. However, there has been an effect on food prices related to increased income, which was described above, and where measures were considered (AVIAM-Community 2012; AVIAM-Workers 2012).

Labour competition is present at this project. People that work at the project have less time to work on their own crop land to cultivate food crops, than before the people worked at the project, because they spend most of their time working at the project now. This does not count for all workers. Most workers did not have other regular work before and had food production as their main activity. Some workers already had other work before and for them there was not much change in time spent on food production. However, this does not seem to be a constraint for most workers. The labour competition is usually compensated for by family members that still work on the crop land. Also, the people working at the project pay other people to work on their land for them to cultivate food. They pay them with the money that they earn at the project, which is sufficient to compensate the amount of lost time in food cultivation in most cases (AVIAM-Workers 2012).

The general perception of their food security situation of workers is slightly negative, with some people saying their situation has improved and other people saying their situation is worse than before. Causes vary from having a better income before, to not having enough money to compensate for lost time in food production (AVIAM-Workers 2012).

12.1.2.2 ADPP

Regarding land take over, Jatropha is almost always grown as a hedge around existing farm land, so it does not replace food crops, but grows around it (ADPP-Management 2012).

Food expenditures of the people that cultivate Jatropha as outgrowers and people that work for the project have generally increased, but also some unchanged and some decreased. Reasons for this are that food has become more expensive in general or there is less time for food cultivation (ADPP-Community 2012; ADPP-Workers 2012).

Labour competition is generally not a problem for the outgrowers. The outgrowers only grow relatively small quantities of Jatropha, which do not take up a lot of time, that could have been

spend on food production instead. This is different for people that work at the project full time. They generally have less time for food production than before, if they did not have other work before. This loss in food production time is compensated by paying people to work on their land for them (ADPP-Community 2012; ADPP-Workers 2012).

The general perception of workers at the project and outgrowers is very positive. For outgrowers, the food security situation is either unchanged, when they only just started cultivating Jatropha, or a lot better. For workers, the food security situation is generally a lot better, since they have better paid jobs now than they did before. Therefore, they can afford more food (ADPP-Community 2012; ADPP-Workers 2012).

12.1.2.3 NIQEL

Niqel does not take over land that is used for food crop production, but work around it in order to avoid conflict. During negotiations with the community it was decided that Niqel was allowed to use the land, only if they would leave the local people alone. So the land that was converted for Jatropha was either uncultivated yet or in some cases community/crop land if people themselves wanted to move. In that case the people would be assisted by the project with the relocation. Therefore, all conflict was avoided, and everyone in the community still has enough land for food production. This has worked to everybody's satisfaction, according to the community leader and the project manager. According to the community leader, the food security has not been affected at all by the project. The only negative influences come from nature. Besides, Niqel has allocated some of its land to food production for the local population. The project prepares the land, which can then be used for food production (Niqel-Community 2012; Niqel-Management 2012).

Food expenditures of the workers at the project have generally increased. However, according to themselves, this is mostly because of the current draught and therefore bad yields of the food crops. Also an increased salary makes the people spend more money on food or having less time to work on their own farm land (Niqel-Workers 2012).

Labour competition is slightly present among the workers at the project. Some workers have less time to work at their own farm land. However, other workers have an unchanged time spent on food production or even an increase (Niqel-Workers 2012).

The general perception of the workers is positive about the change in their food security situation since before the project was there. Possible discrepancies of this are blamed on the influence of nature, like drought., which can change every year (Niqel-Workers 2012).

12.1.2.4 Sun Biofuels

Regarding the land take over, since the area of Sun Biofuels is rather large there are several villages involved with the project that are not all in the same situation. The village that was visited, Quinta da Laranjeira, did not have very big problems regarding the land conversion. However, it was said that there was another village that was affected more by the project. Food crop land of that village was taken over by the project, which the village had agreed with. In return the project would offer employment to people in the village, which happened according to plan. The jobs would provide the people with money to buy food instead of cultivating it themselves. However, since the project was taken over by other investors, most of the project's activities have come to a halt, which meant that almost all employees were fired. Therefore the people in this village now no longer have work, nor food crop land. This makes the situation difficult for them. (community) The information from the project itself is contradicting however. The project states that they have taken over the land from a tobacco company and have only used land that was already cultivated with tobacco. This means that the project did not take over any community land. This can also be confirmed by the district administration (Sun Biofuels-Authorities 2012; Sun Biofuels-Management 2012).

The food expenditures have generally increased for the community and also the workers at the project. The reasons for this are that food prices have gone up, the amount of food production in a certain season and also increased salary (Sun Biofuels-Community 2012; Sun Biofuels-Workers 2012).

Labour competition is not a big issue at this project. Workers generally have an unchanged amount of time spent on their own farm land. Some have a small decrease in time spent, but others even an increase due to good working hours (Sun Biofuels-Workers 2012).

The general perception of the workers of their food security situation is positive. However, this concerns the few people that still work at the project. For the community and other people that used to work at the project is it different. Their situation was also good when they were still working at the project, but this changed when the project failed and was taken over. Now their situation is a lot worse (Sun Biofuels-Community 2012; Sun Biofuels-Workers 2012).

Combining these aspects, Sun Biofuels seemed to have a positive influence on food security when the project was still actively involved with Jatropha production. However, now the project has recently removed its focus from Jatropha and has slowed operations down, the food security situation of the local community has deteriorated. Whether this can improve again depends on whether the project is able to start up again and in what way. The focus will no longer be on Jatropha.

12.1.2.5 SAB

Food crop land of the local community is not affected but worked around. During the community consultation the community agreed with the arrival of SAB in the area and made clear what land they could not use and what land they could use, and these agreements where made to everybody's satisfaction. The land that was taken mainly belonged to an old state farm before, but that was a long time ago. In between another Jatropha project had used the land. An English company called ESV, which also planted Jatropha. However, SAB states that all the Jatropha had been removed again except for only a few hectares. No food crop land of the community was taken over, but worked around (SAB-Community 2012; SAB-Management 2012).

The food expenditures of the people working at the project and people in the community generally have slightly increased. The main reasons for this is that food has become more expensive over the recent years. Also, when people earn more money with a secure job, they also spend more money in general, and on food. This is also because of the fact that more people can now afford more food that they need quantitatively. Whether the qualitative aspect of food, better food and more variability, is also involved is unsure (SAB-Community 2012; SAB-Workers 2012).

There is some labour competition among the workers at the project. For some there is no change in time spent on food production. The people that do see a difference in the time they can spend on food production, the reasons vary from different working hours than a previous job and a switch food production as a main activity to a job at the project. This is compensated for by paying people to work on their farm land for them on food production (SAB-Workers 2012).

The general perception about the food security situation is positive in both the community and with workers at the project. The project is said to have a good influence and that there is enough food production besides Jatropha. Another reason is that people have a more secure and higher salary now, which improves their food security. On the other hand, some people still have a difficult food security situation, because of the ever increasing prices of food products, which causes them not be able to buy all the food they want (SAB-Community 2012; SAB-Workers 2012).

12.2 Land rights

In Mozambique there is never private land ownership by companies that want to acquire land. Land will always stay owned by the government. Instead the Mozambican governments gives out permits that give companies the right to use land for an certain amount of time. These land use permits are called 'DUAT'. This construction is land lease, however the lease fees are extremely low and thus appealing to companies.

12.2.1 Secondary data

For the focus area land rights there is not made use of any secondary data. All data is directly acquired during the field work in Mozambique.

12.2.2 Data Jatropha projects

12.2.2.1 AVIAM

For AVIAM's situation, there has been no transference of land ownership, but AVIAM has acquired a DUAT instead to be able to use the land. The stakeholders in the case of AVIAM are the Jatropha project itself, the district administration, the community leaders and the entire community itself. An assessment of previous land rights and occupation has been executed by the project management. The Jatropha project representatives consulted the community leaders from the local community to assess the possibility of acquisition of the land. The community leaders then consulted with the entire community and the land acquisition by AVIAM was approved. These consultations happen in collabouration with the local district administration, which also includes a previous land use assessment. Previously four families lived on the land, but otherwise it was mainly uncultivated. These four families had to be relocated and for that they had to be compensated. There was only one issue, because one family did not actually receive the payment yet, because their trees were not removed yet, though located in the midst of the Jatropha plantation. The transparency of the project was good, both Portuguese and the local language Makua were used during the land consultation and there was made use of translators. Most agreements between AVIAM and the community were oral agreements, however also made official documentation was used in the case of the four families that had to be removed and compensated (AVIAM-Authorities 2012; AVIAM-Community 2012; AVIAM-Management 2012).

There was compensation for the relocated families. The compensation was determined by the district administration and consisted out of a financial compensation based on the number of people

in the family, their land and on the type and amount of food crops and trees the families had on their land. The compensation was only monetary, the families were paid for their land and their crops. The financial compensation for the 4 families ranged from 3000,- to 11000,- MZM and was said to be satisfactory (AVIAM-Authorities 2012; AVIAM-Community 2012; AVIAM-Management 2012).

An assessment of secondary land users has also been executed. There were secondary land users that used the land that was acquired by AVIAM to collect firewood. However, it is said that here has been no change in the land access for secondary land users and that these activities are still possible, since trees are conserved across the plantation. Secondary land users have therefore not been taking in further consideration concerning the land acquisition (AVIAM-Community 2012; AVIAM-Management 2012).

12.2.2.2 ADPP

The ADPP Jatropha project works with an outgrowers model. This means that ADPP did not have to acquire land specifically for Jatropha cultivation. ADPP added Jatropha cultivation later to their activities as an agricultural school and they only have a minimal amount of the land dedicated to Jatropha trials. Therefore the indicator land acquisition and land compensation are not relevant for ADPP (ADPP-Authorities 2012; ADPP-Management 2012).

The indicator change in access to land is also irrelevant. The outgrowers that work with ADPP for the production of Jatropha seeds cultivate Jatropha on their own land, on the land they already used before. Usually the outgrowers grow Jatropha as a fence around their food crops. So, there is no change in their access to land.

12.2.2.3 Niqel

For the land acquisition Niqel has also obtained a DUAT, which allows them to use the land. The previous occupation of the land was mainly uncultivated bush and some population and their accompanying agricultural plots. The stakeholders during the land acquisition were Niqel, the local community and the authorities. An assessment of the land rights and informal land use was executed beforehand. The project consulted the community leaders, who agreed with the arrival of Niqel under the circumstance that the community would not be affected. This resulted in no conflicts concerning the land acquisition. Niqel works around the populated areas including the agricultural plot and does not interfere. Also, enough land is being untouched for activities such as firewood collection and other ways of informal land use. In some cases, people want to be relocated

themselves, because they do not want to become surrounded by the Jatropha plantation. Niqel then assists in relocating by providing building materials and clearing the new location. This is always voluntarily. Only a small issue is that the local people seem not to be able to understand the magnitude of 10.000 ha for example. Therefore, when the project wants to expand again, the people start to complain again, resulting in many more negotiations in order to avoid conflicts, even though the community accepted the land acquisition in the first place. There has not been a language barrier. Primarily English was used, but later on also translators were involved to translate to the local language. There has not been any official documentation between the project and the community, only oral agreements (Niqel-Community 2012; Niqel-Management 2012).

There has been land compensation for the people that voluntarily moved. Niqel decided to work around the local community instead of relocating them. In some cases though, people deliberately wanted to move themselves, always voluntarily. In that case, Niqel assisted by providing building material and clearing their new location of choice, where they could build a new house. This land compensation is not monetary but in labour and supplies (Niqel-Community 2012; Niqel-Management 2012).

The results for the indicator access to land for Niqel show that there has been no change in access to land, also not for secondary land users. Niqel has left enough land untouched for the local community to use in their daily life. This is also confirmed by the community. Since there is no change in access to land there is also no land compensation for secondary land users. If Niqel sticks to their current policy, this will likely not change in the future, even though they want to continue expanding (Niqel-Community 2012; Niqel-Management 2012).

12.2.2.4 Sun Biofuels

Concerning land acquisition, Sun Biofuels obtained a DUAT to use land that was previously used by a Tobacco company. The stakeholders during the land acquisition were the project, multiple local community leaders in the area and the local authorities. An assessment of previous land rights has been executed and Sun Biofuels has only taken over the land that was already being used by the Tobacco company before, so they did not acquire and cultivate any other land. However, according to the local communities there actually was agricultural land acquired by the Jatropha project. There were negotiations between the community leaders and the project and in return for letting the Jatropha project use their agricultural land the people from the communities would get employed and in that way have the financial capability to purchase food instead of cultivating it. This worked without any conflict until the moment Sun Biofuels ceased its Jatropha activities and fired a majority

of the workers. As a consequence of that, people from the community were now out of agricultural land and also out of a job and there without any income. This conflict is contradicting with the fact that only land was acquired that was already used by a tobacco company before. The language used during the land consultation was not a problem. There were translators involved, so that the local language could be used for the communities. Official documentation was used with the agreements between the community leaders and the project. The documentation was in Portuguese (Sun Biofuels-Authorities 2012; Sun Biofuels-Community 2012; Sun Biofuels-Management 2012).

Regarding land compensation, there has been compensation in the form of employment and community development, which will be elabourated in the section rural and social development. There has been no monetary compensation. The compensation of employment was satisfying according to the communities, but not any longer since the employment was cancelled (Sun Biofuels-Community 2012; Sun Biofuels-Management 2012).

Regarding the change in access to land the community says that they have less access to land now and have difficulties with collecting firewood. The land that is used for Jatropha cultivation was used for firewood collection before. However, secondary land use was not compensated either (Sun Biofuels-Community 2012).

12.2.2.5 MoçamGALP

For the land acquisition MoçamGALP also took over land from another agricultural company that was located there before. On the location of MoçamGALP there used to be a cotton producer called Testa Africa. MoçamGALP still does not have the DUAT yet for the location in Chimoio. They are trying to take over the DUAT of Testa Africa, but this is not finalized yet. The previous land occupation was cotton cultivation and some food crops. So far no issues with the local community have been encountered during the land acquisition (MoçamGALP-Authorities 2012; MoçamGALP-Management 2012).

12.2.2.6 SAB

For the land acquisition SAB acquired a DUAT for the area they intended to use for their Jatropha activities. Previously, a part of the land they acquired belonged to an old cotton state farm, so not all the land that was acquired was uncultivated land. There also used to be another Jatropha company (ESV), but all the Jatropha that used to be there was removed before SAB acquired the land. The stakeholders during the land acquisition were SAB, the community leaders and the local authorities.

During the land consultation it was made very clear between the project and the community which land was available for the project to use and which land not, because it was used by the local community. Because of the agreements, there were no conflicts during the land acquisition. The only issue is that SAB could not use all the land they would have liked to use, because they had to leave a part untouched for the community. Now they have to expand again through the acquisition of another DUAT in another area, which takes much time and effort. During the land consultation the local language was used. Also, agreements were documented for everyone (SAB-Community 2012; SAB-Management 2012).

There has been no monetary land compensation, since the local community has not been affected by the Jatropha activities of the project (SAB-Management 2012).

There has been no change in access to land for the local population. During the land consultation it was decided which land not to use and therefore there is still much land available for the local population to use, both for food production and secondary use such as cattle grazing and firewood collection (SAB-Community 2012; SAB-Management 2012).

12.3 Rural and social development

12.3.1 Secondary data

The secondary data that is collected for rural and social development can be found in the table below.

Data requirement	Unit	Data	Data source
• **National poverty line**	US$/day	18 Mtc/day, $0,50/day	(IMF 2011)
• **International poverty line**	US$/day	$1,25/day	(World Bank 2012)
• **People below the national poverty line**	%	54%	(WFP 2012)
• **GDP per capita**	US$	473 US$/year/capita (2010)	(FAO/WFP 2010)
• **GDP per capita (PPP)**	US$	1100 US$/year/capita (2011)	(CIA World Factbook 2011)
• **Life expectancy**	years	52	(CIA World Factbook 2011)
• **Literacy rate**	%	47%	(CIA World Factbook 2011)
• **GINI-index**	-	45,6 (2008)	(CIA World Factbook 2011)
• **Unemployment**	%	17% (2007)	(TradingEconomics 2012)

Table 68: Data requirements background living conditions

Given the wage for normal workers at all the projects that were involved, it is clear that all employees live above both the national and international poverty line with a minimum of 2005/31=64,7 Mtc/day. With the growth of these Jatropha projects and the development of new projects and the accompanying increase in job creation can therefore help reduce the percentage of people that live below the poverty line. With a larger share of the population earning a salary above the poverty line will also increase the GDP. A higher GDP relates to better living conditions in general and hopefully to a longer life expectancy and a higher literacy rate. At the moment the influence of the relative small scale Jatropha projects is still negligible on national data figures, and even if the magnitude of projects increases it is difficult to separate it from other influences. The effect of individual projects has already showed that unemployment is decreased in communities close by. Eventually this may effect national unemployment figures.

12.3.2 Data Jatropha projects

12.3.2.1 AVIAM

The wage at the project for regular workers is equal to the legal minimum wage in the agricultural sector, which is 2005 Mtc/month. This is confirmed by both the project and the workers. Half of the workers say they earned more money before they worked at the project with other unspecified

business, but they work for the project now because of the increased financial security and the permanent contract. The other half of the workers say they earn more money now than before (AVIAM-Management 2012; AVIAM-Workers 2012).

Regarding the contribution to education, health care and infrastructure AVIAM has the plans to build a new hospital/maternity center, but there has been no progress yet. The same goes for a new school and a football field. These have been promised according to the community leader, but nothing has happened yet and the community leader doubts whether this will still happen. The total investments of these contributions cannot be retrieved, since the plans have not been executed yet (AVIAM-Community 2012; AVIAM-Management 2012).

At the moment AVIAM employs 55 permanent workers and 150 temporary workers for harvesting for an area of 200ha. Out of these 205 jobs, there is one skilled job. AVIAM expects to double the number of permanent jobs next year to 110 and eventually expect to have 2000 temporary jobs for harvesting for a total area of 10.000ha (AVIAM-Management 2012).

12.3.2.2 ADPP

The ADDP Jatropha project is bases on the outgrowers model. This means they pay small farmers for the production of the seeds. The farmers receive 7,50 Mtc/kg seeds. For the farmers this is additional income that they did not have before and therefore beneficial. ADPP also employs people directly, most of which are extensions workers to assist the outgrowers. The salary range from 3000 Mtc/month up to 10.000 Mtc/month according to the project. The workers that were interviewed earned 3900 – 4267 Mtc/month, which is more than the legal minimum wage in this sector. For 3 out of 5 workers that were interviewed this is less than what they earned before, but it is not always clear what they earned their salary with before. For the other 2 it is more than what they earned before (ADPP-Community 2012; ADPP-Management 2012; ADPP-Workers 2012).

Regarding the contribution to education, health care and infrastructure ADPP helped build a bathroom in a local school. Also, ADPP educates teachers, who can teach at local schools. ADPP works with outgrowers and the extension workers that work for ADPP train the outgrowers how to cultivate Jatropha and also how to cultivate food crops. ADPP also said to provide the outgrowers with supplies needed for the cultivation of Jatropha, but this has not been followed up on in every case (ADPP-Community 2012; ADPP-Management 2012).

At the moment ADPP directly employs 12 people. These 12 are all permanent and skilled jobs. ADPP expects continuous growth, but they do not have a specific goal for the future. When they expand

their network of outgrowers an increase in direct employees is also expected. However, the expansion depends on the success of the project and the related income (ADPP-Management 2012).

12.3.2.3 Niqel

The wage for normal workers is 2300 Mtc/month, which is above the legal minimum wage. Security workers earn 2800 Mtc/month. Other workers higher in the hierarchy with more responsibility earn more up to 10.000 Mtc/month. A majority of the workers that were interviewed claim they earned more money before they worked at Niqel. However, an explanation can often not be given. Therefore, it seems that this statement is related to status (Niqel-Management 2012; Niqel-Workers 2012).

Regarding the contribution to education, health care and infrastructure Niqel constructed over 70km of roads and bridges. Niqel states they also have plans to build a school, a police station, a medical clinic and new houses. The community confirms this, but also says none of these plans have been executed yet. However, renovations on a hospital have been done and also a football team was created. Furthermore, Niqel has created more jobs in the region; unemployment in continuously decreasing (Niqel-Community 2012; Niqel-Management 2012).

At the moment Niqel employs 280 people. This number consists of 230 permanent and 50 temporary jobs and 270 jobs are unskilled and 10 are skilled. Eventually Niqel wants to grow to an area of 5000ha and employ 30 workers/ha for all maintenance, however this number seems extremely high (Niqel-Management 2012).

12.3.2.4 Sun Biofuels

The wage for normal workers is 2500 Mtc/month, which is above the legal minimum wage. Security guards earn 3000 Mtc/month and other employees with more responsibility earn up to 20.000 Mtc/month, excluding management. All workers that were interviewed were satisfied with their wage and in all cases they said they earn more money now than before they worked at the project (Sun Biofuels-Management 2012; Sun Biofuels-Workers 2012).

Regarding the contribution to education, health care and infrastructure Sun Biofuels restored a police station, fixed a medical clinic and built a community office. Also, they provide water through piping and a school was built. Furthermore a church was promised, but that did not go through (Sun Biofuels-Community 2012; Sun Biofuels-Management 2012).

At the moment Sun Biofuels employs 80 people, of which the majority is security and some people for maintenance of the Jatropha. Previously, before Sun Biofuels cut back on their Jatropha activities, they employed around 900 people. Out of the 80 currently employed,11 are skilled management staff and all jobs are permanent at the moment. In the near future Sun Biofuels intends to start hiring more employees again, but most likely not as many as in the past, because they want to work more efficiently with more heavy machinery to replace intensive labour (Sun Biofuels-Management 2012).

12.3.2.5 MoçamGALP

The wage for normal workers is 2005 Mtc/month, which is equal to the legal minimum wage in this sector (MoçamGALP-Management 2012).

Regarding the contribution to education, health care and infrastructure MoçamGALP purchased 20 computers for a local school (MoçamGALP-Management 2012).

At the moment MoçamGALP employs 45 people. Out of 45 there are 33 unskilled jobs and these are also temporary, which means there are 12 skilled and permanent jobs. However, the temporary workers also work at the project full time, but they only do not have a permanent contract (MoçamGALP-Management 2012).

12.3.2.6 SAB

The wage for normal workers is 2626 Mtc/month, which is above the legal minimum wage in agriculture. For other functions, such as mechanics, agronomists and administration staff the salary goes up to 40.000 Mtc/month for well educated people. All the workers that were interviewed were content with their salary and said they earn more money now than before they worked at the project (SAB-Management 2012; SAB-Workers 2012).

Regarding the contribution to education, health care and infrastructure SAB built a hospital and a water pump to provide the community with water. Furthermore, SAB sprayed the village against mosquitoes and they created a football team. SAB also said to build a school, but it unsure whether this will go through (SAB-Community 2012; SAB-Management 2012).

At the moment SAB employs 170 people of which 120 jobs are permanent and 50 jobs are temporary for harvesting. In total 80 jobs are skilled (SAB-Management 2012).

12.4 Labour and working rights

12.4.1 Secondary data

The only secondary data used for this area of concern is the legal minimum working age, which is 15 years old for both national and international standards.

12.4.2 Data Jatropha projects

12.4.2.1 AVIAM

At the AVIAM project there does not occur any forced labour, nor is there any child labour. The minimum age to work at AVIAM is 18 years. There is no gender discrimination regarding wage or positions. However, there are more men working at the project (AVIAM-Management 2012; AVIAM-Workers 2012).

The workers have the right to form a union and they have done so. The union discusses about issues, such as working hours, lunch time and the weekend (AVIAM-Management 2012; AVIAM-Workers 2012).

Work related accidents are tracked, but so far only a minor injury has occurred, a cut in the leg of a worker. Workers also say there only have been minor injuries, but they do have to take care of it themselves. When working with chemicals, protective equipment is used, such as an overall, boots, mask and gloves. However, sometimes workers do not have access to all this protective equipment. Besides the normal workers, there is a foreman, a technician and an agronomist. Normal workers usually work on plowing, harvesting, weeding, clearing land, transplanting, applying pesticides and shelling. The average working hours are 8 hours per day and 6 days per week with a 30 minute lunch break every day (AVIAM-Management 2012; AVIAM-Workers 2012).

12.4.2.2 ADPP

At the ADPP project there does not occur any forced labour, nor is there any child labour. The minimum age to work at ADPP is 22 years. There is no gender discrimination regarding wage or positions (ADPP-Management 2012; ADPP-Workers 2012).

The workers have the right to form a union and they have done so. The extension workers discuss all issues with the management monthly (ADPP-Management 2012; ADPP-Workers 2012).

Work related accidents are not tracked, because no real accidents have happened, only some minor injuries such as cuts and bruises. When working with chemicals in the factory, protective masks are used. Outside the factory no chemicals are used, only organic materials. Besides extension workers, there are factory workers and agronomists. Extension workers teach farmers about cultivating Jatropha and other food crops. The average working hours are 8 hours per day and 5,5 days per week with a 30 min. lunch break, but the hours are flexible for extension workers (ADPP-Management 2012; ADPP-Workers 2012).

12.4.2.3 Niqel

At the Niqel project there does not occur any forced labour, nor is there any child labour. The minimum age to work at Niqel is 22 years. There is no gender discrimination regarding wage or positions. Women work mostly in the nursery and in pruning. There are 50 women working at Niqel out of 230 (Niqel-Management 2012; Niqel-Workers 2012).

The workers have the right to form a union and they have done so. Around 60% of the workers belong to the union and they talk to the human resources manager about possible issues (Niqel-Management 2012; Niqel-Workers 2012).

Records of accidents are kept. Over the last 4 years, there has been one serious injury with a broken arm. This was reported to the insurance and government. When working with chemicals, workers use overall, masks, glasses, hats and boots. Besides normal workers, there are security and supervisors. The average working hours are 9 hours per day and 5 days per week with 30 min. breakfast break and a 1 hour lunch break (Niqel-Management 2012; Niqel-Workers 2012).

12.4.2.4 Sun Biofuels

At Sun Biofuels there does not occur any forced labour, nor is there any child labour. The minimum age to work at Sun Biofuels is 18 years. There is no gender discrimination regarding wage or positions. Women are encouraged to work (Sun Biofuels-Management 2012; Sun Biofuels-Workers 2012).

The workers have the right to form a union and they have done so. There is a syndicate representing the workers, which discusses with management about salary, clothing and equipment for example (Sun Biofuels-Management 2012; Sun Biofuels-Workers 2012).

Records of accidents are kept. There have been a few accidents, with one big accident where a lorry toppled over and several people past away. Insurance covers all work related accidents. When working with chemicals, workers use overall, masks, gloves and boots and fresh milk afterwards. Besides normal workers, there is a lot of security, maintenance and management. The average working hours are 8 hours per day and 5-6 days per week with a 1 hour lunch break (Sun Biofuels-Management 2012; Sun Biofuels-Workers 2012).

12.4.2.5 MoçamGALP

At MoçamGALP there does not occur any forced labour, nor is there any child labour. The minimum age to work at MoçamGALP is 25 years. There is no gender discrimination regarding wage or positions (MoçamGALP-Management 2012).

The workers do not have the right to form a union according to a managing technician, who states that this is not necessary, because everything is okay (MoçamGALP-Management 2012).

When working with chemicals, workers use masks, gloves and boots and fresh milk afterwards. Besides normal workers, there are technicians and supervisors. The average working hours are 5 hours per day and 6 days per week with a 20 min. lunch break (MoçamGALP-Management 2012).

12.4.2.6 SAB

At SAB there does not occur any forced labour, nor is there any child labour. There is no official minimum age to work at SAB, but they never hire below 20 years old. There is no gender discrimination regarding wage or positions (SAB-Management 2012; SAB-Workers 2012).

The workers have the right to form a union and they have done so. The union discusses with management about salary and working hours. Also, SAB works together with the local governmental work inspectors (SAB-Management 2012; SAB-Workers 2012).

Records of accidents are kept. The only situation that occurred was that the chief agronomist was declared unable to work, because of unknown reasons. When working with chemicals, workers use overall, masks, glasses and fresh milk afterwards. The average working hours are 8 hours per day and 6 days per week with a 30 min. lunch break every day according to law (SAB-Management 2012; SAB-Workers 2012).

12.5 Economic feasibility

12.5.1 Secondary data

For this area of concern no other secondary data was used, except for the average national fossil diesel price of 36,81 Mtc in 2011 (All Africa, 2011). This can be compared to the data for the local fossil diesel prices during the field work.

12.5.2 Data Jatropha projects

12.5.2.1 AVIAM

At the AVIAM project the NPV was not available from project management, yet the net annual cash flow is valued at 8 M €. The IRR is rated at 50%, which is very high and the payback period is 8 years from 2012. These number are given from the business plan by project management. The production costs are 1000-1500 US$/ha/y. With an intended yield of 1.75 t/ha/y for trees in their 3rd season and an oil content of 35% this results in 2041 US$/t oil (AVIAM-Management 2012).

At the moment there is no turnover yet for AVIAM. The total costs over 2011 were unknown, but there was no profit. AVIAM expects to start making a profit in 2020, which is conflicting with the payback period of 8 years from now, because it seems impossible to pay back the total investments with the profit of only the first profitable year. The production costs are likely to go down after 2015, but it is unsure how. The total investment costs have been 2M US$ so far. The yield after three years is intended to be on average 1750 kg/ha/y. At the moment there is no selling price yet, since no oil is being produced, but the selling price will probably be linked to the palm-oil market price and is estimated at 600-650 US$/t oil, which results in a local price of 19 Mtc/L (AVIAM-Management 2012).

The local diesel price is 38 Mtc/L, which is where the Jatropha oil would have to compete with, so the competitive position would be good. However, there is still a large gap between the intended production costs and intended selling price (AVIAM-Management 2012).

12.5.2.2 ADPP

For ADPP the financial projections for NPV, IRR and PBP were unknown. The production costs at the moment are 20 Mtc/L SVO, which is equal to 1167 USD/t oil. ADPP only uses the SVO directly, also in their own vehicles (ADPP-Management 2012).

ADPP does not have any turnover yet, so there was no profit. The total costs over 2011 were 192.000 Mtc or 6400 USD. ADPP intends to start selling this year and start making a profit in 2013. The production costs will maintain or decrease but it is unknown how. The total investment costs so far are unknown. The yield is 167 kg/ha/y, but this is merely the yield of a trial field and not the commercial Jatropha fields, because the commercial Jatropha fields are located at individual farmers. The yield among farmers is not known yet, since most farmers only just started cultivating Jatropha. The intended selling price is 35 Mtc/L SVO (ADPP-Community 2012; ADPP-Management 2012).

The local diesel price in the Bilibiza district is 41 Mtc/L, which is where the Jatropha oil would have to compete with, so the competitive position would be good (ADPP-Management 2012).

12.5.2.3 Niqel

At the Niqel project, the NPV was not available from project management. The project management business plan states that the IRR is rated at 26% and the payback period is 7 years as from full production, which is in 2012. The production costs are currently 200 USD/t seeds. With an oil content of 29%, this results in 690 USD/t oil (Niqel-Management 2012).

Niqel does not have any turnover yet. The total costs over 2011 were 1 M USD and there was no profit. Niqel expects to start making profit in 2015. Eventually the production costs will have to go down to 70 USD/t seeds to be able to be profitable. The total investment costs were 5 M USD so far. Until now the best yield achieved is 750 kg/ha/y. The intended yield with matured trees is 3000 kg/ha/y, but it is unsure whether this is achievable. The intended selling price will be 850 USD/ t oil, which results in a local price of 26 Mtc/L, however the intention is to export oil (Niqel-Management 2012).

The local diesel price is 35 Mtc/L, which is where the Jatropha oil would have to compete with, so the competitive position would be good for the Jatropha oil (Niqel-Management 2012).

12.5.2.4 Sun Biofuels

At Sun Biofuels, Jatropha cultivation is no longer the main focus. Therefore the financial projections are also partially covering their new activities in food production. The NPV is 15,9 M USD with a lifespan of 40 years and a discount rate of 5%. The IRR is 7% after 4 years from now. The payback period is 4 years from now on. These estimations include food crops besides Jatropha. The

production costs for Jatropha are 176 USD/ha or 125 USD/t seeds. With an oil content of 30% this results in 417 USD/t oil (Sun Biofuels-Management 2012).

The turnover was 18.000 USD in 2011 due to one transaction with Lufthansa. The total costs over 2011 were 2,14 M USD and there was no profit. Sun Biofuels expects to break even and start making profit in 2014. The total investment costs have been 12 m USD. The average yield is 500 kg/ha/y. There is no selling price yet, but the price is intended to be linked to the price of crude palm oil, which results in a selling price around 1193 USD/t oil, which results in a local price of 35 Mtc/L (Sun Biofuels-Management 2012).

The local diesel price is 38 Mtc/L, which is where the Jatropha oil would have to compete with, so the intended price of Jatropha oil is just below that of regular diesel (Sun Biofuels-Management 2012).

12.5.2.5 MoçamGALP

At MoçamGALP the data regarding economic feasibility could not be retrieved, except for the average oil content of the seeds of 18% (Sun Biofuels-Management 2012).

12.5.2.6 SAB

At the SAB project the NPV, IRR and PBP could not be retrieved. The projects stated that the financial projections that were included in the original business plan are outdated and irrelevant. According to the business plan SAB should be profitable in 8-10 years from the start, but these numbers are useless. This is because the big gap between theory and reality. The production costs are around 400 €/ha/y. Ideally this should go down to 200-220 €/ha/y (SAB-Management 2012).

There is no turnover yet. The total costs over 2011 are 2 M € according to the business plan and this also includes some food crop cultivation. However, SAB is slowing down their Jatropha activities, so therefore the business plan should be reviewed again, since the numbers are no longer accurate. When using the business plan as a guideline, SAB states that they expect to start making a profit in 2020. The total investment costs have been 4 M €. At the moment the yield is still very low at 50 kg/ha/y, which is why we are slowing down operations. The business plan is based on 5000 kg/ha/y, but this is unrealistic, so SAB is aiming for 1000-2000 kg/ha/y now. At the moment there is no selling price, nor a market. SAB intends to export the oil to Italy eventually, but will probably start selling locally first (SAB-Management 2012).

The local diesel price is 40 Mtc/L, which is where the Jatropha oil would have to compete with. However, SAB does not have an intended selling price yet, so a comparison cannot be made (SAB-Management 2012).

13. Appendix E: assessment indicators

13.1 Food security

13.1.1 The availability of main staple crops

Practicability – This indicator does not score good on practicability. National production of main staple crops figures are available for most years, however different sources show contradicting results. Besides this, the data on regional production of main staple crops is very limited. The main issues are that either the data is not available at all, the data has many gaps, the data is old and outdated and the data is irregular regarding the years for when it has been collected. These are quite common problems for a developing country such as Mozambique. Data is not readily available and not of good enough quality.

Accuracy – It is difficult to extract good output on the level that is desired, for individual projects, and consequently to reflect the impact of individual projects on the availability of main staple crops locally, regionally or nationally. Firstly, this is because the available data is not very detailed. Most of the available data is only national and already very limited regionally, and nonexistent on the district level. Secondly, especially with the relative small and starting Jatropha projects it is difficult to link a possible impact to the production of main staple crops.

13.1.2 Change in yields of main staple crops

Practicability – For this indicator the same explanation is valid as for the indicator 'the availability of main staple crops'.

Accuracy – For this indicator the same explanation is valid as for the indicator 'the availability of main staple crops'.

13.1.3 Land converted from food crops for bioenergy feedstock production

Practicability – This indicator can be used properly on a project scale. The project itself can provide data on what the previous occupation was of the land that was taken over. This can often be confirmed by local authorities, such as the district administration.

Accuracy – The data needed to analyze the land conversion comes from either the local community, the Jatropha project or the local authorities or a combination of the three. The accuracy of the indicator depends on the reliability of the data source. Regarding the local community the data is often based on memory. Regarding the Jatropha project and the local authorities the information is based on documents made up during the land consultation period. The accuracy depends on how well this is analyzed and documented beforehand and how well everything can be traced. However, because all parties are involved with this indicator the general picture of the land conversion can almost certainly be recovered.

13.1.4 Change in prices of the 5 main staple crops

Practicability – This indicator shows reasonable practicability. Main staple crop price data is better available than production or yield figures, but again data is only nationally available and already very limited per region. Data on the district level is not available. This data is mostly available through public online sources, which contributes to the practicability, however there are data gaps and it is not as detailed as desired.

Accuracy – It is very difficult to focus in on a local project, since data is only available nationally, partly regionally and not for districts. The impact of a small projects on a large regions is insignificant and not yet possible to determine. The price data can be used as a guideline to determine trends, but not so much to reflect the impact of individual projects. Price changes can be presented on a national and sometimes regional scale. However, this scale is too big to reflect the impact of individual projects. Mozambique is a very large country with large provinces and the province level is the highest level of detail for which data exists. It is therefore important to focus more on individual projects and the impact on food prices in the local community. This makes the practicability more difficult, since extensive field work is required, but the accuracy will improve.

13.1.5 Change in share of household expenditures

Practicability – For this indicator there is research by the Mozambican government, which can be used. However, this research is only conducted every 5 or 6 years and thus not up to date and perhaps could only be used as a benchmark. On the other hand, the results from the data collection at the individual projects and the community are valuable for use. People from local communities are asked about their household expenditures with an emphasis on the change before and after a project started operations. Field work is necessary, but respondents have this information available.

Accuracy – The accuracy is good in targeting individual households and acquiring direct results and differences between past and present. It reflects the impact of an individual project and show a clear change in expenditures. However, a downside could be that other influences such as a bad harvest due to drought can also interfere. This results in the necessity of the use of open questions for data collections. Open questions however can be interpreted in different ways and since it concerns money issues, answers can also be socially desirable. Therefore, the accuracy is intermediate.

13.1.6 Competition for labour

Practicability – This indicator shows good practicability. Even though this indicator requires field work, the data is readily available from workers at the project. The results from the data collection at the Jatropha projects and workers show a clear difference in time spent on food production and/or time spent on Jatropha cultivation before and after a project started operations. Also, the impact of an individual project can be reflected on individual workers since individual workers for each project are directly targeted.

Accuracy – This indicator represents a direct impact with no further interferences. Therefore the accuracy is good. The only insecurity is the reliability of the answers. Mostly, the questions can be answered sufficiently, but sometimes the questions are not fully understood, especially regarding the difference between past and present to indicate a difference. Therefore it is important the questionnaires are as simple as possible to not be misunderstood and either use the right language or involve translators during field work.

13.1.7 Change in perception by people affected by bioenergy production regarding food security

Practicability – This indicator required field work, but the information is available from the respondents, which are workers at Jatropha projects and people from the local community. The results from the data collection show a direct impact of projects on the food security of people form the community or workers. Another point of interest is the number of respondents to ask about their perception and also the time frame over which the question is asked. In this case the difference is between right before the start of the projects and the present. However, if projects have existed for a longer period, the time frame could be reconsidered in order to take into account the passage of time and the accompanying changes as well.

Accuracy – When asking for a perception, there could also be other factors that influence the food security situation. And also, like the indicator already states, it concerns a perception and not hard data. However, this indicator does target individual households directly with a simple and clear answer on a set scale, which contributes to the accuracy. Open questions like these can provide valuable information in contrary to other statically indicators that are not detailed or complete.

13.1.8 Change in undernourishment

Practicability – The undernourishment data is irregular and only on a national level. Detailed undernourishment figures for regions or districts are not available. Also undernourishment data that is available from public online sources is only available from certain years when a survey was conducted with large gaps.

Accuracy – It is not possible to reflect the impact of an individual project on undernourishment data. It could be used as a benchmark on a long term and perhaps in a situation/country where there is a large and established biofuel market. At the moment this indicator does not show the accuracy to contribute to the evaluation of a Jatropha project.

13.2 Land rights

13.2.1 Land acquisition process

Practicability – The data can be acquired at three different sources; at the local authorities (the district administration), at the project management and at the local community. These parties are all involved in the land acquisition process, which contributes to the practicability, since the same data is available from three different sources. Data such as previous occupation, possible conflicts and the execution of a land rights assessment are straightforward and available. A downside is that it can be time consuming to collect the data since field work is necessary and the data is not always documented.

Accuracy –The data needed for this indicator can be retrieved from three different sources, which contributes to the accuracy, since gathered data can be double checked. Also, the data on the land acquisition process is retrieved for individual projects, which is the only usable method. General data on Jatropha project land acquisitions do not exist. In some cases documentation about the land acquisition process can be better, because agreements with communities are not always documented, but merely oral agreements.

13.2.2 Land compensation

Practicability – Land compensation data can also be retrieved from three different sources that are involved in determining this indicator. Either the local authorities, the project or the local community can be consulted for this information, which contributes to the practicability. This makes it possible to cross check data. However, land compensation is not always relevant, because land compensation does not always occur. More emphasis on alternative ways of compensation next to monetary compensation will be useful.

Accuracy – The indicator is focused on possible monetary compensation, but compensation is not always monetary and therefore in some situation data varies widely and may be difficult to interpret. The overall accuracy is neutral, since the indicator should offer other possibilities too, such as material compensation. Wider interpretation makes the indicator more accurate, and strict definition is important regarding the different forms of compensation that are suggested in the questionnaires. Also, compensation is often not calculated per hectare, but a single financial or material offer. During field work, financial compensation was based on the type and amount on crops.

13.2.3 Change in access to land

Practicability – The involvement of secondary land users is not always relevant, since they are not always involved. If they are, the effects on secondary land use is only in some cases retrievable since community leaders cannot provide detailed information about every member in the community. Involving more community members would significantly increase the time input necessary for field work. Therefore this indicator shows average practicability.

Accuracy – The involvement of secondary land users is very small and thus also the available data on this topic. If there is any data available it is often in general terms and vague. Also, the secondary land users are difficult to define and to determine in what way their land access is affected. Is secondary land use is relevant, these aspect have to be defined more specific. In its current form, this indicator shows poor accuracy.

13.2.4 Share of land acquisitions that have complied with formal or socially accepted procedure regarding absolute numbers and area

Practicability – There is no secondary data available from governing institutes, which makes it difficult to show a statistic of a national overview. Only Jatropha projects that are directly involved during field work can be included in this indicator. Since there is no secondary data available, this indicator scores poorly on practicability.

Accuracy – The only results that can be generated for this indicator are very general and are related to issues of any kind at Jatropha projects. In this indicator there are multiple parts difficult to define, such as ‘complied with’ and ‘social accepted procedure’, which deteriorates the accuracy. Only qualitative results may be of some value concerning issues in general at Jatropha projects. Overall, this indicator shows poor accuracy.

13.3 Rural and social development

13.3.1 Wage comparison

Practicability – Data on wages at individual Jatropha projects can be acquired from project management as well as from employees and is readily available. A comparison with the legal minimum wage can be made. The legal minimum wage in agriculture is available from online public sources. A comparison to other sectors or average wages in the country is difficult, because detailed data on wages per sector is not readily available. Overall, this indictor show good practicability, because the first two aspects described above are the most important.

Accuracy – The wages retrieved from project management and project workers are straightforward and reliable, which contributes to the accuracy. Also, the minimum wage in agriculture is a legal standard, which is unambiguous. Therefore, this indicator shows positive accuracy. However, an improvement can be made in the specification of different functions amongst project workers, since there are different wages for different job levels. While making an overview of wages at a project or making a comparison the type of jobs and accompanying wages and the spread of those among the respondents should be taken into account.

13.3.2 Contribution to education, health care and infrastructure

Practicability – Data on contribution to the local community is available from both project management and the community leaders. These parties can provide information in which agreements where made regarding community development. The availability of this data form two parties makes it possible to cross-check the data. Overall, this indicator show good practicability, only time consuming field work should be taken into account.

Accuracy – The contribution of Jatropha projects to a local community does often not consist of quantitative agreements, but often qualitative agreements. For example it does not entail a fixed financial sum, but rather the ‘restoration of a medical center’, with no strict definition of ‘restoration‘. Also, there should be a strict difference between whether a certain contribution is already realized, or not executed yet, but merely promised. As well as a difference between documented agreements or merely oral agreements. The latter two aspects are not in order yet. However, also taking into account the possibility to cross-check data on community development provides this indicator overall with a neutral evaluation.

13.3.3 Job creation

Practicability – Data about job creation at individual projects is readily available from project management and also from the local communities, where workers usually come from. National data on unemployment rates is poorly available and outdated. When it is available, the impact of an individual project cannot be reflected on it, due to the difference in scale. However, through field work data is readily available for individual projects, which is the most important and contributes to good practicability.

Accuracy – Data on job creation of individual projects is reliable and straightforward. There is also a division between skilled and unskilled jobs that can be properly used, however when a project shows a more complicated organizational structure with multiple job levels this can become more difficult. Further specification of skilled and unskilled jobs is therefore advisable. Furthermore unemployment rates at local communities can often not be specified, however the effect of a project on employment in a local employment can always be clearly indicated, positive or negative. Furthermore, data on expected job creation at projects might be uncertain, due to the volatility in the development of Jatropha projects. Overall, this indicator shows average accuracy.

13.3.4 Background living conditions

Practicability – The data on background living conditions can be retrieved from online public sources, which contributes to the practicability. Attention should be paid to the fact that some data requirements demonstrate gaps. Overall, this indicator has good practicability.

Accuracy – Using national figures as background living conditions is not useful at the moment, since the impact of Jatropha projects on national data is negligible yet. It is not possible to reflect the impact of an individual Jatropha project on national living conditions data. However, some facts, such as overall poverty, could be used to support other results in the evaluation of a Jatropha project. Overall, this indicator shows poor accuracy.

13.4 Labour and working conditions

13.4.1 Forced labour

Practicability – The data for this indicator is available from both project management and workers at the project. Project management can provide their policy regarding forced labour and the workers can verify this. Practicability is therefore good, but again field work is required.

Accuracy – The occurrence of forced labour is straightforward, it is either yes or no. Workers can elabourate on the project management's policy by explaining why they started working for the project, what they get rewarded, their working hours and breaks and how operations are executed. Overall, this indicator shows good accuracy.

13.4.2 Child labour

Practicability – Data of the individual projects is available from project management and project workers. For this field work is required. Data on the international and national child labour standards can be acquired from public online sources. This indicator shows good practicability.

Accuracy – The definition of child labour and therefore also this indicator is straightforward. However, the results of the data collection do show some variations due to misinterpretation of the question by the workers. The workers often indicate the age of the youngest person working at the project in contrary to the minimum age to be allowed to work at the project, though the indicated age was never below the legal minimum age. So this should be further specified, there is room for improvement in data collection and communication. A positive aspect is that the data from project management can always be verified by the workers. Overall, this indicator shows neutral accuracy.

13.4.3 Discrimination

Practicability – This indicator focuses on gender discrimination for which the data about the difference between male and female workers can be checked with both the project management as with the workers themselves and is available. During fieldwork gender differences were not considered to be an issue, which made the data for this indicator somewhat irrelevant, but upon request, the data was available. Again, field work is necessary to acquire the data. Overall, this indicator show good practicability.

Accuracy – In its current state the indicator shows good accuracy, since the policy on gender equality from project management can be verified by the workers. However, there is room improvement on the further specification of gender discrimination/equality in the area of specific job functions and salaries. In its current state the indicator is too general. Therefore, the overall accuracy of this indicator is average.

13.4.4 Workers union

Practicability – Data on the possibility to form and the actual existence of a workers union is readily available from both project management and workers. Also data about topics, on which the workers union is involved, is available. Therefore, this indicator scores good on practicability, but field work is required.

Accuracy – The possibility to verify data with the use of two different sources, project management and workers, contributes to the accuracy of this indicator. There is also data available on the topics that are discussed through the workers union and also some results. On this part there is still some room for improvement, a bigger focus achieved results. Overall, this indicator shows good accuracy.

13.4.5 Accidents and health issues

Practicability – Data is only available if records are kept, which was not always the case during field work in Mozambique. Also, if there have been no accidents or health issues to record yet, possible processes to deal with this might not be implemented yet. Therefore, this indicator does not show good practicability.

Accuracy – The definition of accidents and health issues are not strict and therefore different interpretations are possible, which leads to biased data. Also, not all accidents or health issues are recorded, which makes it difficult to provide an overview. Moreover, the boundary between work related accidents and other accidents is not always clear. On these aspects improvements have to made. Overall, this indicator shows poor accuracy.

13.5 Economic feasability

13.5.1 NPV, IRR, PBP

Practicability – In some situations the data for these indicators is easy to collect, when it is readily available from project management and up to date, which contributes to a positive practicability. However, if the data for these indicators are not readily available a more extensive financial analysis has to be conducted which is very time consuming and requires many data, which puts a constraint on the practicability. This is supported by the fact that during field work these indicators were, more than once, not readily available or irrelevant, because based on wrong assumptions. Time constraints prevented to conduct the alternative and non-practical approach. Combining the two possibilities, this indicator shows average practicability.

Accuracy – Often data on the NPV, IRR and PBP are not available. If they are available, they are often outdated and based on wrong assumptions, because of a gap between theory and reality regarding expectations of Jatropha cultivation. Therefore these are often useless and can only be used if accompanied by the assumptions they are based on. Also data used for a financial analysis is difficult to gather, since many projects do not have a full production process yet and many aspects of a production process are still irrelevant. Overall, these indicators show poor accuracy.

13.5.2 Profitability

Practicability – The data needed to analyze the profitability of a project is available from the project management and is often available. At this moment in time the only constraint is that some data requirements concerning the production process are not relevant yet, because of the developing stage that many projects are still in. Overall, this indicator shows good practicability.

Accuracy – For this indicator any future expectations are usually based on the business plan, which again is often based on wrong assumptions, making the future expectation inaccurate. Other data requirements on the production process such as costs and turnover are straightforward and can be used, once they become relevant for a certain Jatropha project. Another point of attention is the wide variety of units used for the date requirements. A more unified unit scale would improve the general accuracy. Overall, this indicator show average accuracy.

13.5.3 Competitiveness

Practicability – The selling price or intended selling price can be acquired from project management. At first, many projects want to sell to the local markets, which means to compete with local fuel prices. The local fossil diesel prices can be acquired by sampling, and a comparison can be made. A comparison with other biofuels is difficult, because there are no clear markets for these either. Overall, this indicator show good practicability.

Accuracy – The selling price of Jatropha oil can be easily compared to local fossil diesel prices in order to establish the competitive pricing position. However, at the moment the Jatropha oil selling prices are still estimates, since nothing is being produced or sold yet. Other biofuel prices are not taken into account, since just like for Jatropha there are no local or national markets for those. Overall, this indicator shows good accuracy, but is dependent on the start of the sale of commercial Jatropha oil.