



# Socio-Economic Impact Study of biofuel plantation on farm households in Mozambique

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Photo cover: Chilengue plantation Energem

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## **II Abstract**

In this thesis the socio-economic impact of jatropha plantations on surrounding villages has been assessed. The Farm Household Model as adopted by A. Low as well as the Sustainable Livelihood Framework are applied in order to make predictions about the direction of the impact. By means of a direct comparison of the mean between the treatment and control group as well as between the treatment group in the situation before and after the arrival of the plantation the impacts have been statistically analyzed. Three impact areas have been identified; namely an increase in income, an increase in expenditures and thirdly a decrease in leisure time. The impact also becomes visible when looking at the change in the labour pattern of the households, in the treatment group a shift has taken place from migration, other off-farm employment and own farm to work on the plantation. Related changes are a decrease in household food production, microenterprise activities and sale of cash crops in the treatment group. A natural relation exists between an increase in frequent cash income and an increase in expenditures, for this reason this variable has been identified as one of the main impact areas of the plantation. The results of the Independent T-test show indeed a higher level of expenditures on food and non-food items for the treatment group as compared to the control group. Both differences are highly significant. With respect to leisure, one would assume that due to increased job opportunities a shift might take place from working on own farm to work on the plantation. In general this does not necessarily have to lead to a change in leisure time available. However it has appeared that household members that were not working before now started working on the plantation leading to a direct decrease in leisure time. Next to that, the majority of the households and in particular the women have continued working on their own land additionally to working on the plantation.

Key words: impact assessment, Mozambique, biofuel plantation, off-farm employment

### **III Resumo**

Na presente tese o impacto sócio-económico das plantações de jatropha em aldeias vizinhas foi avaliada. O modelo “Farm Household” adoptado pelo A. Low, bem como o “Sustainable Livelihood Framework” são aplicados com o objectivo de fazer previsões sobre a direcção do impacto. Os impactos foram analisados estatisticamente por intermédio de uma comparação directa da média entre o tratamento e o grupo controle, bem como entre o grupo de tratamento antes da situação e depois da chegada das plantações. Três áreas de impacto foram identificadas, nomeadamente, um aumento na renda, um aumento de gastos e em terceiro lugar, uma diminuição no tempo de lazer. O impacto também se torna visível quando se olha para a mudança no padrão de trabalho das famílias, no grupo de tratamento uma mudança ocorreu a partir da migração, emprego agrícola e da própria fazenda para trabalhar na plantação. As alterações relacionadas são uma diminuição nas actividades de microempresas e da venda de culturas de rendimento do grupo de tratamento. Uma relação natural entre um aumento no rendimento em dinheiro frequentes e um aumento das despesas, por este motivo esta variável foi identificada como uma das principais áreas de impacto da plantação. Os resultados do T-teste independente demonstram de fato um maior nível de gastos com alimentos e itens não-alimentares para o grupo de tratamento, em comparação ao grupo controle. Ambas as diferenças são altamente significativas. Em relação ao lazer, supõem-se que devido ao aumento das oportunidades de trabalho a mudança poderia ocorrer de trabalhar na própria fazenda para trabalhar na plantação. Em geral, isso não necessariamente tem de conduzir a uma mudança no tempo de lazer disponíveis. No entanto, tem-se que os membros da família que não estavam a trabalhar até agora começaram a trabalhar na plantação conduzindo a uma redução directa no tempo de lazer. Em seguida a isso, a maioria dos agregados familiares e em especial as mulheres continuaram a trabalhar em sua própria terra além de trabalhar na fazenda.

Palavras-chave: avaliação de impacto, Moçambique, plantação de biocombustíveis, emprego não-agrícola

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## Abbreviations

CEPAGRI	Centro de Promoção da Agricultura
DUAT	Direito de Uso e Aproveitamento da Terra
FHM	Farm Household Model
GHG	Greenhouse Gases
Ha	Hectares
IIAM	Instituto Nacional de Investigação Agrária de Moçambique
INE	Instituto Nacional de Estatística de Moçambique
MINAG	Ministerio de Agricultura
MSU	Michigan State University
Mtc	Meticais
SLF	Sustainable Livelihood Framework
TIA	Trabalho do Inquérito Agrícola

# 1. Introduction

## 1.1 Background

With an annual growth rate of 6.5%, Mozambique has experienced a strong recovery of the civil war. However, with a per capita GNI of \$370 in 2008 (World Bank 2009), Mozambique still belongs to one of the poorest countries in the world. The country remains dependent upon foreign assistance for much of its annual budget, and the majority of the population remains below the poverty line. Poverty reduction is thus a major objective of the government as well as non-governmental organizations in Mozambique. As most Mozambicans live in rural areas with subsistence agriculture being their main livelihood strategy, any poverty reduction strategy in Mozambique must give priority to rural areas and address the household-level determinants of poverty (Datt *et al.*, 2000).

This thesis is part of the DGIS-WUR funded *Competing Claims, Competing Models* program. This program focuses on the impact of expansion of biofuel production systems on rural livelihoods and resource competition in southern Africa. Research is concentrated in Mozambique, where biofuel production initiatives are being developed in various agro-ecological zones in the country. Although biofuel production is promising and strongly promoted at various policy levels, little is known about its developmental and environmental impacts, and especially, their consequences for poor people's livelihoods (Competing Claims 2009). Within this program, part of the research is done in cooperation with the company Energem. Energem owns several plantations in Sub-Saharan Africa, and some of them are located in Bilene, Mozambique. Energem has formally been allocated by the Mozambican government the rights to 60,000 hectares of land in Gaza Province and is in discussions over the allocation over a further 60,000 hectares in other provinces in light of the progress the company has achieved to date. It is intended that the jatropha seeds will be processed to produce a crude oil, which will be exported to the project's target markets in the European Union (Energem 2009 a).

Mozambique is a land abundant country and has favorable climatic conditions for the cultivations of raw materials for biofuels production, namely, 36 million hectares (ha) of arable land, of which presently less than 10% is in use (Sitoe 2005). In Mozambique all land belongs to the government that gives it under concession for production or accepts that a family has always been using a certain plot of land and has land users right. Since mid 2008,

the government of Mozambique has pending use-rights requests for more than 12 million ha, with nearly all of the requests relating to biofuels (Arndt *et al.*, 2009).

This increase in biofuel investment can be attributed to a number of biofuel support policies that are being adopted by governments in the U.S., E.U., and Brazil as well as some lower income countries. Examples of these policies are producer tax incentives, national blending mandates, and import tariffs. However, these blending mandates are argued to put pressure on grain and oilseed markets, driving up international food prices and affecting human welfare (Ewing *et al.*, 2008). In the section below a brief review of the literature with respect to biofuels and its potential impact on developing countries will be provided.

## **1.2 Literature review**

The effect of increasing investment in biofuel production has been debated over the past few years and in particular its implications for low-income countries. Several reports have been found discussing the potential effects of biofuels on food security and its competition with land, water and food (Keyzer 2008, Mitchell 2008). These reports are quite critical in the sense that they hypothesize that the consequences of increased biofuel production are not necessarily positive. It is questioned whether the benefits of biofuel production are also reaped by the poor or whether they will only experience a decrease in food security due to a decrease in household food production and an increase in food prices. Another main focus in the reports is on the environmental implications of biofuel production. One of the reasons is that biofuels are seen as a means for reducing Greenhouse Gases (GHG), however scientific research leads us to believe that GHG emissions might actually increase with biofuel production (Gallagher 2008). Depending on the methods used to produce the feedstock and process the fuel, some crops can even generate more greenhouse gases than do fossil fuels. GHG can for example also be emitted by land use changes as clearing new land for biofuels may generate larger GHG emissions due to burning and composition of organic matter.

### **1.2.1 Jatropha Curcas L.**

*Jatropha Curcas L.* also called jatropha is a plant that produces seeds with high oil content. The seeds are toxic and jatropha is hence not used as a food crop. The plant can grow under (sub-) tropical conditions and can withstand conditions of severe drought and low soil fertility. Current interest by investors, farmers and NGOs in jatropha is mainly due to its potential as an energy crop. *Jatropha* seeds can be pressed into bio-oil that has good

characteristics for the production of biodiesel. On the other hand jatropha can also be integrated into traditional farming systems in developing countries. It can be planted as a living fence around agricultural fields or on marginal soils to control erosion (Putten *et al.*, 2009).

According to the jatropha handbook of the Fact Foundation the production of jatropha seeds and processing into biofuel provides extra job opportunities. The biofuel can be used for both transport and electricity production and can give local communities energy independence. The oil can also be used for soap production, providing a profitable rural village activity however jatropha production should only take place when there is sufficient land for local food production (Putten *et al.*, 2009). It is also noted that intercropping jatropha with food crops is a good option as well and that the extra investments in agriculture might lead to an increase food production.

A critical note on jatropha as a biodiesel crop is provided by Ribeiro and Matavel (2009). In their study, an evaluation of jatropha production and the most common claims made in favor of jatropha in Mozambique is made in order to delineate the differences between rhetoric and reality. It is widely assumed that jatropha is a crop that can be grown on marginal land due to its resistance to adverse weather conditions. However this ability to survive in these conditions does not necessarily imply that it can yield high quantities of oil. The productivity and profitability of the plant therefore depends on the agroclimatic conditions of the area where it is cultivated. In order to get a good quantity of high quality seeds, jatropha must be grown in fertile land or with additional nutrition, in areas with high rainfall or irrigation, and requires efficient pest control implementation (Ribeiro and Matavel 2009).

### **1.2.2 Biofuels in Mozambique**

In Mozambique, biofuels are being promoted by the government as a poverty-reduction strategy. Several jatropha production models have already been applied, from outgrower schemes, to farm-owned enterprises and plantations. A recent study done by (Arndt *et al.*, 2009) estimated the impact of large-scale biofuel investments on economic growth and income distribution using a dynamic Computable General Equilibrium model. In their research they compare plantation and outgrower approaches to producing biofuels. They consider ethanol produced from sugarcane using a plantation approach and biodiesel produced from jatropha using an outgrower approach. They find that the outgrower approach is much more strongly pro-poor due to the greater use of unskilled labour and the

accrual of land rents to smallholders rather than plantation owners. They also report that there is a lack of quantitative economic analyses in the field of estimation of growth and poverty impacts of biofuel investment in a low-income country.

The annual report of the State of Food and Agriculture of FAO also had an important focus on biofuels in its 2008 edition. Like the previous mentioned study the authors of this report are also in favor of outgrower schemes with respect to biofuel production in order to safeguard staple-food production and ensuring pro-poor growth. However in many cases, private investors interested in biofuel production in developing countries will look to the establishment of plantations to ensure security of supply. Next to that if investors have to build supporting infrastructure such as irrigations and roads, the scale of the operation necessary to offset the costs will be even larger and is therefore more likely to develop on the scale of plantations (FAO, 2008 a).

In Ewing *et al.* (2008) biofuel production models are reviewed and best-practices identified that can expand welfare gains for smallholders and the poor. The authors of the report find that countries with high reliance on biomass for energy and high incidence of hunger, such as Tanzania and Mozambique, should seek to maximize welfare either through investments in energy technologies that might have spillovers into food production or by designing investments in agriculture and energy such that they expand employment opportunities for the poor and food insecure, and thus lead to lower dependencies on biomass for energy. However further research into the effects on socio-economic welfare is needed in order to capture the agriculture-food security linkages. In this context, an analysis of the micro-level impact of these biofuels plantations on farm households is necessary and may contribute to the ongoing debate.

### 1.3 Research area

Mozambique consists of 10 provinces, namely, Cabo Delgado, Gaza, Inhambane, Manica, Maputo, Nampula, Niassa, Sofala, Tete and Zambezia. The fieldwork for this thesis has been conducted in the South-East of Gaza province. Gaza province consists of several districts, one of them being Bilene Macia. In this district the plantations of Energem are located and hence served purpose for this research. Bilene, officially Praia do Bilene, is home to many tourists due to its coastal location. The tourism and construction sector hence provide the main off-farm jobs in this village. The nearest main market is in Macia. Macia owes much of its economic vibrancy to its location on the intersection of the main highway of Mozambique (EN1). Several times a day there are transportation opportunities from Bilene to Macia by minibus. This facilitates the mobility for habitants near this road.

The district has an area of 2.157 km<sup>2</sup> and the population size is estimated at 165.104 habitants in the year 2005. Bilene district has a population density of 77 habitants per km<sup>2</sup> and the population is concentrated in Bilene Beach and Macia. Average farm size in Bilene Macia district is estimated at 1,5 hectares by the Ministry of State Administration of Mozambique (Perfis Distritais 2005). This roughly corresponds to the average of 1,66 ha estimated by the *Trabalho do Inquerito Agrícola (TIA) 2001-2002* for Mozambique. The main food crops produced in Bilene Macia district are cassava, maize, groundnuts, beans and sweet potato and form the basis of the diet of the farm households, next to that also production of cash crops is of importance, and in particular of banana, sugarcane and pineapple. The population in this district is relatively young, 43% has less than 15 years of age. The level of illiteracy is approximated by the *Instituto Nacional de Estadística (INE)* in the year 1997 to be 47,5% for men compared to 67,7% for women. Data on educational participation confirms this as well. In the case of Bilene beach the percentage of women compared to men attending school is lower, e.g. 17,3% of the men compared to 28,6% of the women never attended school (INE 1997).

This study uses data from a farm household survey that was held in three villages in the district Bilene Macia, namely Chilengue, Ngolene and Nzêve. The survey was carried out during the months February - May 2009. To measure the impact of the plantation a control and treatment group has been formed, hence the three villages are mainly selected based on their geographical position towards the plantation. In total 84 households were interviewed, 41 in Chilengue, 21 in Ngolene and 22 in Nzêve. The data collected includes information on demographic characteristics, agricultural and durable assets, employment and expenditures.

Below the research area is graphically displayed and a short description of each village is provided.

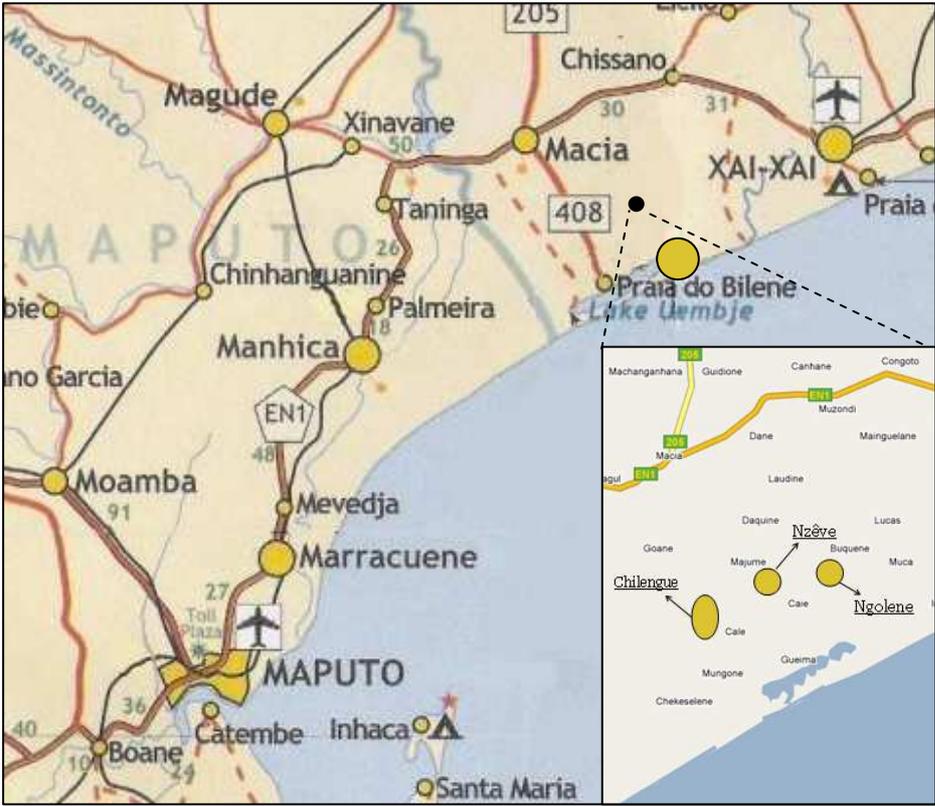


Figure 1.1 Research area

Source: Elaboration from Google maps

Chilengue is a village located on both sides of the main road Bilene-Macia. Due to its geographic location the habitants of this village participate quite actively in the nearby markets Bilene and Macia and many have off-farms jobs in tourism and construction in Bilene. Also many households have a stall near the road where they sell charcoal, firewood, honey, fruit and medicinal plants. In Bilene Macia district Energem has two plantations, one in Chilengue and one in Nzêve. The plantation in Chilengue was created in January 2007 and the one from Nzêve in January 2008 and with time both plantations increased in size. Many habitants from Chilengue hence started working on this plantation. Due to the arrival of the plantation many households had to give up part of their land that was located in the south-eastern part of the village where the plantation had started. According to the biofuel company, those households whose land would be used for jatropha production were informed in time; however some residents have lost part of their harvest. According to own estimates the village consists of approximately 150-200 households.

Ngolene is a small village just after Nzêve. It consists of 22 households, which is relatively small compared to Chilengue. The community is located in a more remote area with less market access and less off-farm job opportunities available. The majority of the habitants works on their fields and participates in microenterprise activities. There is one dirt road starting from the main road Bilene Macia through Nzêve and Ngolene continuing further up north. There is no transport available in Ngolene which is a constraint in active market participation.

The village characteristics of Nzêve are quite similar to those of Ngolene. Nzêve is also more remotely located and only accessible by dirt road. There live approximately between 20-30 households in Nzêve. Its population is slightly more scattered than in Ngolene. However the distance to the main road Bilene Macia is much closer and transportation is more in reach. The majority of the households living in Nzêve have at least one family member working on the plantation. Due to increased access to off-farm jobs, the standard of living in Chilengue and Nzêve appears to be of higher level. In all above mentioned villages there is no electricity or sewage system. The distance between the three villages is approximately 4 km. GPS measurements have been made of all homesteads of the interviewed households as well as of the plantation, water wells and primary school.

## 1.4 Objectives and research questions

The main objective of this thesis is to measure the impact of large-scale biofuel production on farm households. In order to measure the impact it is important to obtain insight into changes in land and labour allocation of the households surrounding these jatropha production sites. The research also aims to respond to the need for quantitative studies on impacts of biofuel plantations in developing countries.

In line with the research objective the main research question is as follows:

*What is the socio-economic impact of jatropha plantations on farm households in Bilene district, Mozambique?*

In order to answer the main research question, some of the most significant relationships in agricultural development in Southern Africa will be addressed, as specified by A. Low (1986), and formulated into sub-research questions:

- Has there been a change in the relationship between farm production and off-farm wage employment opportunities?
- Did the relationship between farm production for own-consumption and for sale change?

## 1.5 Thesis outline

The thesis is structured as follows; in chapter two, the analytical frameworks will be presented, namely the Farm Household Model and the Sustainable Livelihoods Framework. The Sustainable Livelihoods Framework is used to gain a better understanding of the range of possible impacts of the biofuel plantation on its environment. The Farm Household Model is used to show the direction of the impact. The methodology of this thesis will be presented in chapter three. This methodology includes information on the data collection techniques and the analysis of the data. Results and a discussion of the research will be provided in chapter four; first an explanation is given on the comparability of the treatment and control group to be followed by results from the direct comparison of the means between the control and treatment group as well as a comparison of the treatment group in the situation before and after the plantation. Additionally, the intra-village differences are analyzed. In chapter five a conclusion and discussion of the main socio-economic impacts of the plantation is presented and some suggestions for future research are given.

## **2. Analytical Framework**

In this chapter the analytical frameworks will be presented. Section 2.1 provides an overview of the Sustainable Livelihoods Framework. The Farm Household Model is explained in section 2.3 and an application of this model is provided in section 2.4 where predictions are made on the direction of the impact. In this model an in-depth focus is provided on the model of A. Low.

### **2.1 Sustainable Livelihoods Framework**

When measuring the impact of a program or a change in environment, similar studies frequently use the Sustainable Livelihoods Framework (SLF) as a main framework in their analysis. The important feature of this livelihood definition is to direct attention to the links between assets and the options people possess in practice to pursue alternative activities that can generate the income level required for survival (Ellis 2000). In order to understand the scope of the possible impacts of the plantation this framework can be a useful tool as it can describe and visualize the livelihoods of those affected households. A popular definition of a livelihood is the one provided by Chambers and Conway (1992) wherein a livelihood comprises the capabilities, assets and activities required for a means of living.

In the figure below the SLF is depicted and one can identify the various factors which constrain or provide opportunities and to show how these relate to each other. Hence the framework attempts to gain a realistic understanding of what shapes people's livelihoods and how the various influencing factors can be adjusted so that, taken together, they produce more beneficial livelihood outcomes (DFID 2007).

As can be seen in the figure below there are many different types of relationships which all are highly dynamic. The asset pentagon lies at the core of the livelihoods framework. The shape of the pentagon can be used to show the variation in people's access to assets however due to the nature of the SLF in this thesis it proves sufficient to give descriptive data instead of a visual representation. In chapter 4.2 an application of this framework is provided in order to show how the indicators in the framework have adapted to the arrival of the plantation. A short description of the assets and their importance for this research are provided below.

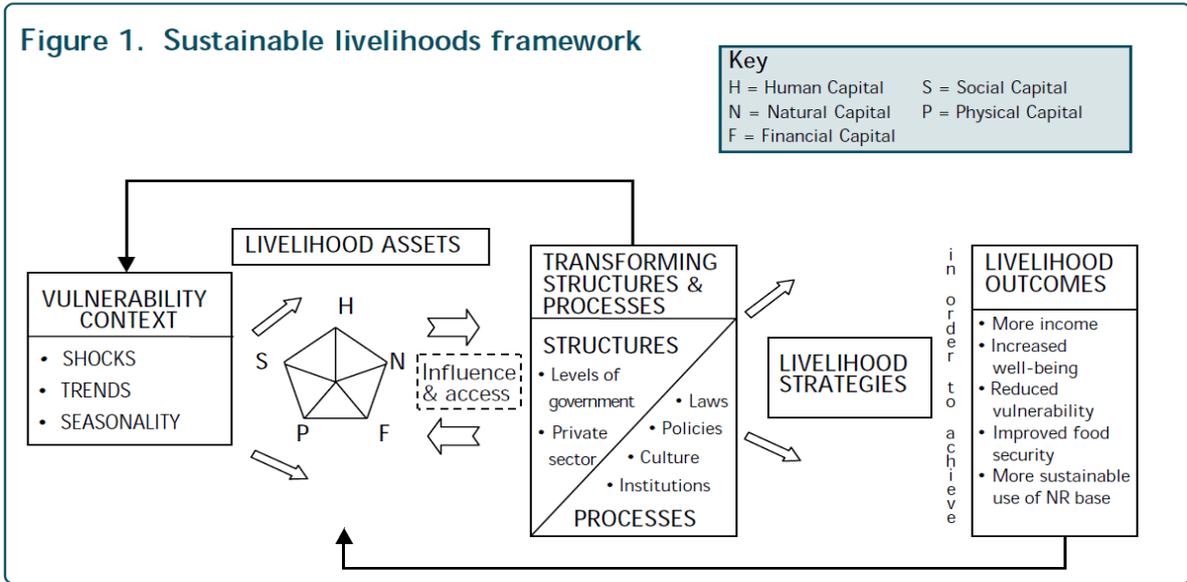


Figure 2.1 Sustainable Livelihoods Framework

Source: Sustainable Livelihoods Guidance Sheets (DFID 2007)

Human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives (DFID 2007). At the household level human capital is a factor of the amount and quality of labour available and hence plays a significant role in this research. Social capital next to its own intrinsic value, is particularly important as a ‘resource of last resort’ for the poor and vulnerable as it can provide a buffer that helps them cope with shocks and can act as an informal safety net to ensure survival during periods of intense insecurity. In an economic sense, by improving the efficiency of economic relations, social capital can help increase people’s incomes. Natural capital is the term used for the natural resource stocks from which resources flows and services useful for livelihoods are derived (DFID 2007). Examples are land, forests and water, and for all these it is important to consider access and quality and how both are changing. Natural capital is very important to those who derive all or part of their livelihoods from resource-based activities and is thus an important aspect that needs to be researched in Bilene Macia district. Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive. This last part may be especially true in the case of Bilene. Due to the arrival of the plantation new infrastructure might be created or improved which can benefit the whole community. Financial capital denotes the financial resources that people use to achieve their livelihood objectives (DFID 2007). This is also the asset that tends to be the least available to the poor and it can also be a reason that the other types of capital are so

important to them. It is expected that a considerable impact will take place in both financial and natural capital. The impact on financial capital might be due to a potential increase in off-farm wage income and with respect to natural capital, the plantation might occupy part of the land that was formerly used for household food production.

In order to obtain a holistic comprehension of the effect of large-scale biofuel production, both qualitative and quantitative methods are combined with the objective to show the diverse range of socio-economic impacts that biofuel production might have on Mozambican livelihoods.

## **2.2 Farm Household Model**

Many farm households are semi-commercialized in the sense that, even if all markets work, at least some of their production is kept for home consumption and some of their labour resources are directly used for home production. Food produced in excess of household consumption is sold on the product market, and family labour supplied in excess of use on the home plot is sold on the labour market. In the case that food production is less than consumption and/or labour supplied is less than the needs for the fields, the household is a net buyer of food and/or a net employer of labour. In this case, cash expenditures to buy food have to come from other sources of income such as the sale of cash crops or of labour. When not all markets work, some households may be completely autonomous in food and/or labour, even when they participate in markets for other goods such as cash crops and other factors such as fertilizers or credit (Sadoulet 1995). To graphically present the model in the figure below the total time available is displayed on the x-axis and income on the y-axis. The total time, the household has available is divided into three components, namely time on farm, wage work, and leisure. The figure contains a production function of farm output, TPP, when all labour is used on-farm and an indifference curve  $I_1$ , representing a given level of utility obtained by different combinations of leisure and income. Hence an increase in leisure will lead to a decrease in income and vice versa. Household full income is given,  $F$ , as well as a shifted real wage line  $ww'$ , that takes into account the net product of labour on own farm and thus representing the opportunity cost of time in terms of market prices (Ellis 1993).

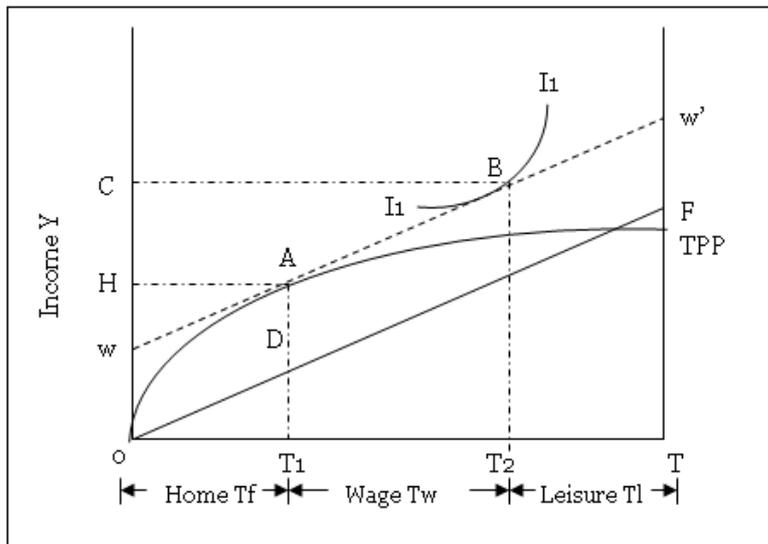


Figure 2.2 Farm Household Model

Source: Ellis, F., (1993) Peasant Economics: farm households and agrarian development

The Farm Household Model (FHM) can be used to determine the impact of many different changes in exogenous variables confronting the household and is hence a useful tool in this study. One household model will be discussed in more detail in the next section, namely the model of A Low.

### Farm Household Model A. Low

The focus of the Low Farm Household Model is on agricultural production in African countries bordering South Africa. The main assumptions of the model are the existence of a labour market where wage rates vary for different categories of labour and where some members have a higher wage than others. Secondly, flexible access to land is assumed for farm households according to their family size meaning that land input can be increased parallel with labour input. Next to that, another condition is the existence of semi-subsistence farm households for which the farm-gate price of food differs from the retail price at which food can be purchased at the market. Finally, the occurrence of food-deficit farm households with hiring out of family labour is of importance (Ellis 1993, Low 1986). According to the model of A. Low a two-stage process is involved, in the first, the household uses goods as inputs in a production process to generate basic commodities. In the second stage consumers choose the best combination of these commodities by maximizing a utility function. Those family members who have a comparative advantage in wage work tend to be male, so that subsistence production is carried out by women, children and elders. The farm

productivity of men and women may be just as high however adult women have a number of other tasks to perform which constrain the hours they can spend on farm work. Low's model demonstrates the flexibility of household theory to adapt to alternative assumptions and to yield predictions concerning the varying circumstances that farmers may confront (Ellis 1993).

In the figure below the farm household model of Low is presented. In this model it is assumed that the household contains three members of working age of whom the labour times are given by A, B and C. All members have the same productivity in farm subsistence production however they experience different wages in the labour market. Like in the previous graph, this graph also contains a production function for subsistence output, TPP, however in the Low model this function is linear, meaning that the marginal product of labour is constant and is the same for each household member.

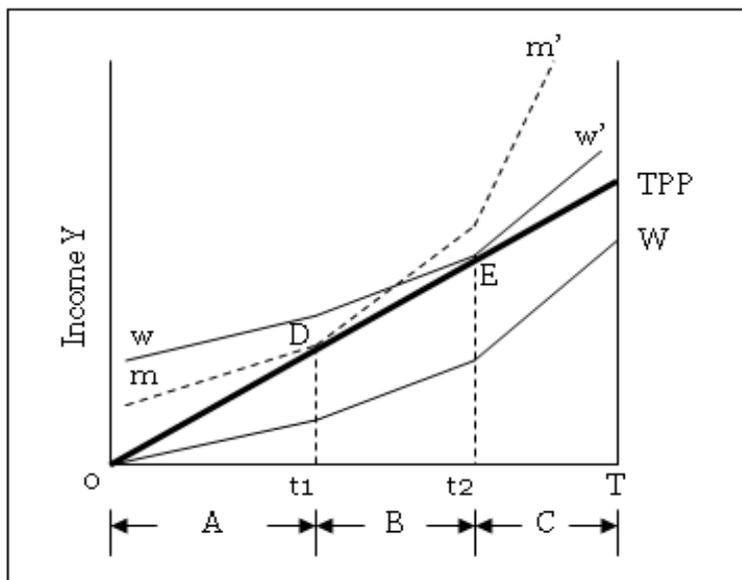


Figure 2.3 Low Farm Household Model

Source: Ellis, F., (1993) Peasant Economics: farm households and agrarian development

The line OW demonstrates the rise in total wage income occurring when the labour time of each household member is valued by the real wage that they could earn in the labour market. Corresponding to the line OW is the parallel opportunity cost of labour line,  $ww'$ , which touches the TPP curve at point E. This point is defined as the profit maximizing level of labour input for this household, hence only those household members whose real opportunity cost of time is lower than their marginal product of labour, work in household food production. Household members such as C, whose real opportunity cost of time is

higher than the marginal product of labour on the farm should engage in off-farm work in order to maximize household income (Ellis 1993). Hence what is of importance in the above figure is the slope of the real wage line ( $ww'$ ) compared to the slope of the production function (TPP). In the case that the slope of  $ww'$  is smaller than the slope of TPP the household member should engage in household food production, however when the opposite is the case then household members have an advantage working off-farm. In the next section the household model is applied to the arrival of a plantation and predictions are made on the direction of the impact.

### **Application of Farm Household Model A. Low**

Due to the research area of this thesis and the village characteristics, it is assumed that households have two main resources, namely land and labour. As mentioned before, the model of A. Low seems most applicable as in the local context the assumption that all household members face a fixed wage is not realistic and in general wage rates vary considerably by sector. Additionally, the size and composition of households are directly related to household food production in low-income countries (Low 1986). Other inputs (e.g. seeds, fertilizer) are excluded from the model as its use is negligible as also acknowledged in Siteo (2005) and Perfis Distritais (2005). Due to the flexibility of land access as in the model of A. Low the production function may have a linear or near linear portion (constant marginal returns to scale) before diminishing returns set in.

Taking the household model of section 2.2 as a starting point, several predictions are made in this section on how the arrival of the plantation can affect a rural household. Land in general is assumed abundant and access to land mainly depends on demographic characteristics of the household. Farm size increases proportionally with household size and is thus assumed to be not fixed but variable. However the plantation does occupy a considerable amount of land that was formerly used for household food production. Hence a constraint on land has been created. Looking at the labour use of the household and in particular in its time spent in food production it can be expected that a decrease will take place in time spent on food production and in low-paying piece jobs and an increase will take place in work at the plantation and consequently in household total income. These shifts are illustrated in the figures below.

In the situation before the plantation, as illustrated in figure 2.4, it is assumed that time available to a household will be spend on a combination of activities in different sectors. The household will give priority to the, often seasonal, activity that gives the highest return e.g.

tourism (household member A). In the figures below it is assumed that the household contains four members of working age of whom the labour times are given by A, B, C and D. As in the Low model, all members have the same productivity in farm subsistence production, TPP, however they face different wages in the labour market as can be seen in the line OW. Similar to the previous figures, what is of importance is the slope of the wage line compared to the slope of the production function. In the case of household member D, where the slope of OW is smaller than the slope of TPP the member should engage in household food production. The figure is constructed by starting with the activity that gives the highest return and building on earlier wages the activity with most diminishing returns given to the right.

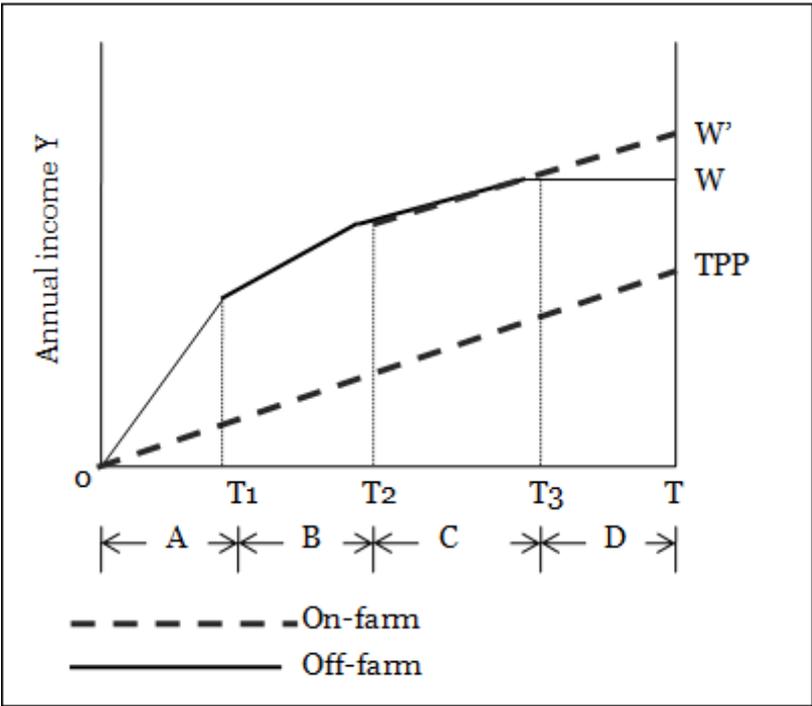


Figure 2.4 Labour supply - multiple off-farm jobs

With the arrival of the plantation a formal wage job has been created providing a fixed wage income throughout the year, which is illustrated in figure 2.5. It is expected that its returns might be relatively lower compared to work in the tourism sector and hence one household member might still work there (A), but that during the year the plantation will suppress all other inferior jobs that give diminishing returns and that annual income is higher. Questionable is whether workers will stay at the plantation or when another activity comes up providing higher returns they will shift to this activity accepting the temporary nature of it. The figure shows that full household income, W,' has increased, which might lead to an increase in expenditures as also hypothesized in the Sustainable Livelihood Framework.

Additionally, time on-farm and in low-paying piece jobs decreased and an increase took place in fixed off-farm work which is in this case the plantation.

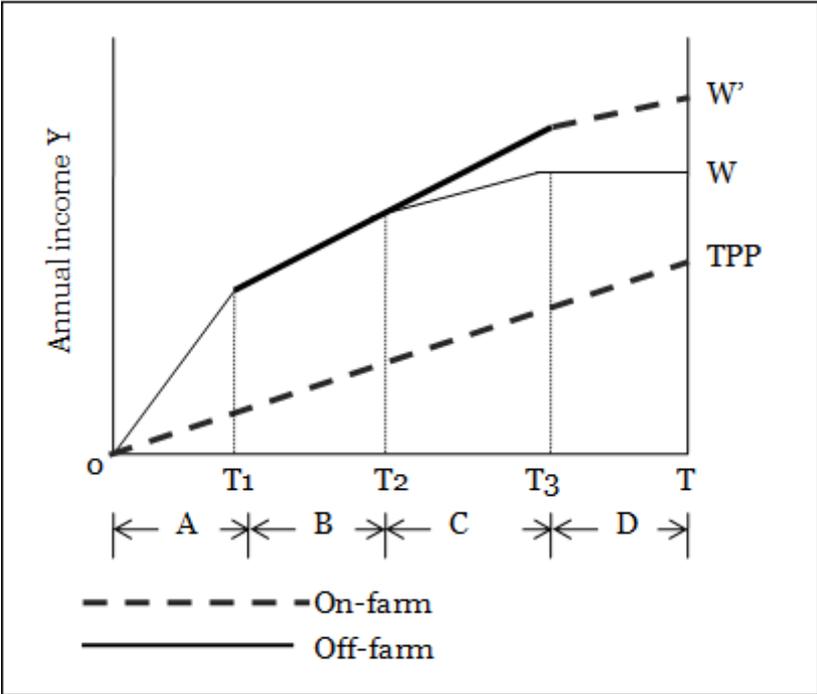


Figure 2.5 Labour supply – arrival of plantation

## **3. Methodology**

In this chapter the methodology will be discussed. In section 3.1 the various data collection techniques are presented including qualitative and quantitative research instruments as informal observations and interviews, semi-structured interviews and a household survey. Section 3.2 covers the data analysis, which consists of the data preparation, description of the variables and a direct comparison of the data.

### **3.1 Data Collection Techniques**

In this research the use of both qualitative and quantitative data has been one of the main strategies. The qualitative data was gathered via informal observations and interviews (3.1.1) and via semi-structured interviews with key-informants (3.1.2). The quantitative data come from the household survey (3.1.3). Data from household surveys as a base for research can be used for testing theories about household behavior by examining all the activities of the household and to trace the behavioral links between economic events and individual welfare (Deaton 1997). An important concept in this thesis is also that of methodological triangulation. According to O'Donoghue and Punch (2003), triangulation is a “method of cross-checking data from multiple sources to search for regularities in the research data”. This technique is often used in social sciences and mainly in qualitative research in order to present more reliable data. For this reason mainly several data collection techniques have been applied.

#### **3.1.1 Informal observations and interviews**

Informal observations and interviews have been conducted to gain insights into the livelihoods and its determinants for rural households. The observations were also of use in identifying the broad range of impacts. Next to this, the information obtained serves as an input into the Sustainable Livelihoods Framework. Striking was to notice the differences between observation and interview. It became clear that most of the interviewed people experience difficulties in time and scale. When asked what time people devoted to some activities, in most cases time was overstated to its reality. The same applies to scale; declared land size was often considerably higher than real land size.

### **3.1.2 Semi-Structured Interviews**

Most of the semi-structured interviews took place before commencing with the household survey, this in particular to improve the questionnaire. Interviews have been held with a variety of organizations, from socio-economic research institutions to governmental departments, though mainly from Ministerio de Agricultura MINAG (Ministry of Agriculture) such as Centro de Promoção da Agricultura CEPAGRI (Agricultural Promotion Center) and IIAM (Instituto Nacional de Investigação Agrária de Moçambique). Useful feedback was provided on the research proposal and methods to analyze the data.

### **3.1.3 Household Survey**

For this study a household survey has been conducted in three villages surrounding the plantation in order to quantitatively analyze its impact. An important feature of this thesis is the focus on changes in allocation of land and labour. Mainly because the first identified effect on the rural households is that the plantation occupies land that was formerly used for food production and secondly that the plantation provides employment opportunities for the surrounding communities. For this reason the households have been classified according to whether they have experienced an impact on land and/or labour. Based on this classification a control and treatment group was constructed. Unfortunately no baseline data was available which might lead to a bias in comparing the data. However a number of questions were asked to the treatment group referring to the situation before the arrival of the plantation. The situation in the treatment group before the arrival of the plantation should be quite similar to the current situation in the control group. A direct comparison is made between the means of the treatment group and the control group as well as a comparison for the treatment group in the situation before (T<sub>0</sub>) and after the arrival of the plantation (T<sub>1</sub>). This strategy enables to measure the differences in the socio-economic situation of both groups. To also have an understanding of the situation before the plantation, questions were asked on household composition and labour structure before the arrival of the plantation and also information on their former fields is obtained.

The respondents in many cases were the household heads (26% female, 74% male) but also often the interview was held with the spouse. In some cases respondents had difficulties in remembering the asked facts, in particular with respect to field size and farm output. The

principal survey instrument collected information at both the individual and household level. At the individual level, it obtained information for every household member on a range of topics, including age, education and occupation. At the household level, additional information was obtained on landholdings, agricultural production and livestock, housing characteristics, asset ownership, main non-food expenditures, food expenditures and sources of income. In addition to the data collected at individual and household levels, also detailed market price information was collected in the two main markets, namely Bilene beach and Macia. The interviews took approximately between 60-90 minutes mainly depending on the household size. For logistical reasons in most cases it was not possible to visit their fields however a good insight is gained by means of the informal observations.

In line with the two main effects identified, a household classification was made. Four subgroups have been created; a group that has experienced no impact on land nor labour, a group that has not experienced an impact on land but does provide labour to the plantation, a group which does not provide labour but did experience an impact on land, and at last a group who experienced an impact on both land and labour.

### **Sample Size**

In total 84 households were interviewed, 41 in Chilengue, 21 in Ngolene and 22 in Nzêve. A test survey was conducted in order to test the relevance and applicability of the questions. The household questionnaire, added to this report as Appendix 6.1, includes information on demographic characteristics, agricultural and durable assets, employment and expenditures. The data retrieved from the households are treated confidentially.

In the data analysis six observations have been deleted in the quantitative analysis due to the fact that these households were recently migrated in order to work for the plantation and hence data obtained on household food production and income pattern would be biased when comparing it to the local community. According to Sudman (1976) an adequate quantitative impact study contains at least 100 observations per independent group in the sample. Due to resource and logistical constraints it has not been possible to interview this amount of households and hence the possible relations that will be presented in the results may not be causal.

Table 3.1 Sample Size

	<b>Chilengue</b>	<b>Ngolene (C)<sup>1</sup></b>	<b>Nzêve (T)<sup>2</sup></b>	<b>Total</b>
No L*, no A**	7	<b>16</b>	2	<b>25</b>
Yes L, no A	5	5	4	<b>14</b>
No L, Yes A	10	0	0	<b>10</b>
Yes L, Yes A	13	0	<b>16</b>	<b>29</b>
<b>Total</b>	<b>35</b>	<b>21</b>	<b>22</b>	<b>78</b>
* Labour; ** Land (Area)				
<sup>1</sup> Control group, village Ngolene				
<sup>2</sup> Treatment group, village Nzêve				

Source: Household Survey

In the above table the situation as described in the chapter 1.3 becomes visible. In Ngolene (control group) approximately 75% of the households did not provide land nor labour to the plantation. This contrasts sharply with Nzêve (treatment group) where 72% of the households did provide land as well as labour. In Chilengue the distribution of the impact appears to be more balanced.

### **Sampling Method**

Due to the experimental nature of this study, a control and treatment group have been formed in order to measure the impact of the jatropha plantation. For this reason a two-stage sample design has been applied. In the first stage the villages were selected based on a geographical analysis. Two villages surrounding the plantation and one village more remotely located, Ngolene, as a control group. The second stage involved household sampling. The sample households are thus geographically grouped. Due to the small size and similarity of the communities in Ngolene and Nzêve all households in these two villages have been interviewed. That there are several households in each village has made it worthwhile to collect village-level information, later referred to as community characteristics. Households living in the same cluster are usually more similar to one another in behavior and characteristics than are households living in different clusters (Deaton 1997). With respect to Chilengue, which is a relatively larger village, a different sampling method has been applied. Originally it was intended to use stratified sampling as a beforehand classification was made, however due to similar research of colleague students, households who had been interviewed before, refused to participate in the survey and hence stratification was no longer possible. It

proved possible to conduct the interviews slightly more inland, while still in the same village and the sample can be said to be representative of inland Chilengue.

### **Survey Structure**

The questionnaire consists of eight parts; some data will be used in the qualitative part of this study however the majority can be used for quantitative analysis.

- Part I: Household Roster; socio-demographic data of the individual household members, including the notion of whether the household member is present now and was present before arrival of the plantation.
- Part II: Agriculture; information on farming system, auto-consumption and on income derived from cash crops.
- Part III: Labour Roster; specified by family and hired labour
- Part IV: Off-farm labour; information on income derived from wage labour before and after arrival plantation and income derived from microenterprise activities excl. cash crop income
- Part V: Inputs; data on livestock and agricultural inputs
- Part VI: Household assets; data on durables and housing characteristics and also on distances to fields, to collect water and firewood
- Part VII: (Non) food expenditures; specified by week, month, 3 months, 6 months, year and by market
- Part VIII: Consumption pattern; contains data on number of meals per day and periods of food scarcity.

### **3.2 Data Analysis**

In this section the main approach to analyze the data is highlighted, namely a direct comparison between the control and treatment group, respectively Ngolene and Nzêve. Before describing the way to analyze the data, a glance on the data preparation will be given followed by a description of the variables used in analysis.

### **3.2.1 Data Preparation**

Before conducting the statistical analysis extensive data verification was performed. The first step was made during the data collection process. The data was processed through manual editing during the household survey. Coding was applied after the survey in order to facilitate the interviews. During each interview, the answers were checked on reliability and inconsistency and a quick revision of the results was performed. When necessary, uncertainties were discussed with the respondent. To ensure the data to be valid and realistic in the analysis, it was crosschecked for logic links, missing values and outliers.

Even though the number of missing observations for a single variable does not have to be large, the set of households for whom there is missing data for at least one variable increases with the number of explanatory variables (Datt *et al.*, 2000). In this study the problem of missing values was solved by deleting six observations from analysis where the households do not originate from the district and where the household is thus not representative of the population. Appendix 6.2 provides a detailed list on the variables and its description. Also, reference is made to the household questionnaire as given in Appendix 6.1, in order to show how the variables were obtained. The variables are ordered per category.

### **3.2.2. Description of variables**

The set of variables derived from the questionnaire mainly belong to the following categories; demographic characteristics, agriculture, employment and income sources, household assets, and expenditures. In the subparagraphs below a short description will be provided per category. Data on agricultural inputs is excluded from analysis as its use proved to be negligible.

#### **Demographic characteristics**

Main demographic characteristics include household size and composition variables. Four age categories are distinguished, namely below 6 years of age, between 6-18 years, 18-60 years of age and 60 years and above. Number of dependents (age categories below 6 years, 6-18 and 60 years and above) is also included, as well as age, gender and marital status of the household head. Education also forms part of this category; variables measuring school

attendance by children (age category 6-18) and schooling level of household head and spouse are included. An important measure is also current household size and the size at To (before the arrival of the plantation).

### **Agriculture**

As stated before, it has been decided not to use declared farm size as a variable due to the immense variation in declared and measured farm sizes. However in this study number of fields will be used as a land-related variable, which might provide a more accurate measure as also acknowledged in Tschirley (2000) and Tschirley (2001). To obtain a variable farm size in hectares (ha), the declared number of fields is multiplied by average field size per location as measured by Mota (2009). The households are also distinguished by their current crop diversity and income derived from cash/food crops as well as the situation before the arrival of the plantation. Variables indicating the household's possession of livestock is included as well, in particular ownership of chicken and ducks as these proved to be the main livestock present in Bilene Macia district.

### **Employment and income sources**

In this category variables related to employment and different income sources are included. As in Datt *et al.* (2000) also variables are included related to diversification of income sources within the household. Also a dummy is included of whether a household member works at the plantation or not. Employment is further categorized in work on own farm, work on other farm, migration, microenterprise activity, other off-farm and not working. Hours working on farm and total hours in employment (both on- and off-farm) are also included as well as a dummy variable for the use of hired labour.

### **Household assets**

With respect to household assets, dummy variables are included which indicate whether the households owns a radio, bike, TV, DVD and cell phone. Number of dwellings is included as well and whether the main dwelling has a durable roof and durable walls. Durable walls include stone and wood walls and a durable roof includes concrete, tile, and zinc roofs. The

non-durable walls or roofs consist of natural materials such as reed and leaf. They also include the category 'other' (Fox 2005).

## Expenditures

In this section both food and non food-expenditures are included. Expenditures are grouped according to market and frequency where frequency is subdivided by year, six months, three months, month and week. Main non-food expenditures are clothing, transport and education. Some of the main food expenditures include rice, maize, peanuts, beans and Bambara groundnuts. A variable on number of meals per day for adults and children is included as well.

## Hypothesis direction impact

In the table below the main variables used in analysis are given as well as a hypothesis of the direction (positive/negative) of the impact of the plantation. The expected signs are equal for both the comparison control vs. treatment as well as for the treatment group before vs. after.

Table 3.2 Hypothesis direction impact

Variable	Expected sign	Explanation
Off-farm income	+	Higher level of off-farm income due to increased job opportunities and higher level of total household labour hours and in particular in off-farm employment
Income cash/food crops	-	Lower level of income derived from sale of cash and food crops due to a decrease in time spent on farm activities
Income microenterprise	-	Lower level of income derived from microenterprise activities due to a decrease in time spent on other cash generating activities due to increase in off-farm income
Value production	-	Lower value of food production due to decrease in time spent on farm and increase in food expenditures
Durable assets	+	Higher number of durable assets due to increase in off-farm income
Food expenditures	+	Higher level of food expenditures due to decrease in household food production and increase in cash income available to the household
Non-food expenditures	+	Higher level of non-food expenditures due to an increase in cash income available

Food share	-	Lower level of food expenditures on total expenditures due to increase in non-food expenditures and an increase in total income
Auto-consumption	-	Lower level of auto-consumption due to decrease in time spent on-farm
Household labour on farm	-	Decrease in time available to work on farm due to increase in hours in off-farm employment
Total household labour	+	Higher level of total hours worked due to increase in hours worked in off-farm employment
Farm size	-	Decrease in farm size due to less time spent on farm and because of the arrival of the plantation where some households lost part of their land.

A detailed description on these variables and on how they are constructed can be found in appendix 6.2.

### 3.2.3 Direct Comparison

In this study two ways to analyze the data are adopted, starting with a direct comparison of the mean outcomes of the treatment group to those of the control group. In this descriptive analysis a comparison is performed on the explanatory variables related to the impact areas as identified chapter 3. To compare the means between the two groups an Independent T-test is performed. This test is used when there are two experimental conditions and different participants were assigned to each condition (Field 2005). Data for this test comes from Ngolene and Nzêve. During the survey, data have also been gathered in the treatment group, Nzêve, on the situation before the arrival of the plantation,  $T_0$ , to compare the means of explanatory variables in  $T_0$  to the current situation,  $T_1$ , a Dependent T-test is used. This test is used when there are two experimental conditions and the same participants took part in both conditions of the experiment, this test is also called a paired-samples t-test (Field 2005). Under the null hypothesis the two mean values are not statistically different and this hypothesis is as follows;  $H_0: \mu_{\text{treatment}} = \mu_{\text{control}}$ .

In the table below an example of the results from the Independent T-test is presented. The number of observations,  $N$ , as well as the mean is given for both the control and treatment group. The mean difference refers to the difference in mean values of the outcome indicator of both the treatment and control group and between brackets the Standard Error (SE) of the

difference is provided. The degrees of freedom, df, and significance level, P, are given per explanatory variable.

Table 3.3 Example of presentation results Independent T-test (*treatment vs. control at T1*)

Variable	N		Mean		Mean diff. <b>T-C</b> (SE)	Df	P
	<b>C</b> <sup>1</sup>	<b>T</b> <sup>2</sup>	<b>C</b>	<b>T</b>			
X1							
X2							
* significant at 10%; **significant at 5%; ***significant at 1% <sup>1</sup> Control group, village Ngolene <sup>2</sup> Treatment group, village Nzêve							

The table for the Dependent T-test is slightly different in the sense that T<sub>0</sub> (before plantation) will be compared to T<sub>1</sub> (after plantation).

Table 3.4 Example of presentation results Dependent T-test (*treatment T1 vs. T0*)

Variable	N	Mean		Mean diff. <b>T1-T0</b> (SE)	Df	P
		<b>T0</b> <sup>1</sup>	<b>T1</b> <sup>2</sup>			
Pair X1- X2						
Pair X3-X4						
* significant at 10%; **significant at 5%; ***significant at 1% <sup>1</sup> Situation before arrival plantation <sup>2</sup> Situation after arrival plantation						

## **4. Results**

Section 4.1 gives an overview of the wage labour opportunities in Bilene Macia district by providing an introduction to the jatropha company Energem, elaborating on contracts and absenteeism as well as on labour prices in wage employment. In section 4.2 an application of the Sustainable Livelihoods Framework is provided. Section 4.3 presents the results of the direct comparison is presented. First the level of comparability between the treatment and control group is explained to be followed by a comparison of the means between these two groups as well as a comparison of the means in the treatment group of the situation before and after the arrival of the plantation. A link is created with the predictions made in the Farm Household Model and Sustainable Livelihoods Framework. In section 4.4 the intra-village differences in Chilengue are presented as this village is quite different from the two more remote villages and will hence be analyzed separately.

### **4.1 Wage labour**

Bilene Macia district is located in Gaza province just above the capital, Maputo. Due to its favorable location near the lagoon, Praia do Bilene is home to many tourists from primarily South Africa. The tourism and construction sector hence provide the main off-farm jobs in this village. The nearest main market is in Macia. Macia owes much of its economic vibrancy to its location on the intersection of the main highway of Mozambique (EN1). Several times a day there are transportation opportunities from Bilene to Macia by minibus which facilitates the mobility for habitants near this road. Holidays are in the months December and January and the majority of the tourists arrive at this time. With the arrival of the plantation an increase in job opportunities has been experienced by the surrounding communities. A more detailed description on the plantation is provided below.

#### **4.1.1 Energem**

In Mozambique all land belongs to the government that gives it under concession for production or accepts that a family has always been using a certain plot of land and has a land users right. In 1995 a new National Land Policy was approved. The policy intends to establish a clear rights-based approach to guaranteeing land for the poor; it also aims to be a development instrument designed to promote new investment in the country. The new land law introduced important provisions to secure land rights for the smallholder sector, by

recognizing customary rights of access and management as being equivalent to the state-allocated land use and benefit rights, called *Direito de Uso e Aproveitamento da Terra* (DUAT). A key element is that investors have to consult local people and secure their approval before they are able to obtain a DUAT. Local people can choose to keep their rights, or make deals that generate resources for local development. The main goal is to empower the local community to participate in natural resources management, including allocating rights to investors. At the same time, the DUAT is transferable. The transferability of the DUAT is regulated by article 16 of the law and articles 15 and 16 of the Regulations (Soares 2009).

Energem Resources Inc. is a renewable and alternative energy resources company engaged in 10 African countries and China in long term projects in the energy sectors. Energem Biofuels Limited is the alternative energy division of Energem Resources Inc. (Energem 2009 a). The first jatropha project in Bilene Macia district started in 2007 by the company Duelco. Duelco started with the establishment of two jatropha plantations, one in Chilengue and one in Nzêve. Duelco was responsible for the management and establishment of the plantations and Energem was one of the investors in this project. Per 2008 Energem bought out Duelco and took over the management (Energem 2009 b). The communities surrounding these plantations experience some confusion with respect to the ownership of the company as some think it is still Duelco that is operating the plantation. When Energem arrived, the plantation size was gradually scaled up and more employees were hired. At the time of the research the plantation in Chilengue occupied 305 ha and the plantation in Nzêve 420 ha. More land has been acquired however part of this land consists of high biodiversity areas which have been kept intact in order to minimize the environmental impact. The produce from the 2009 harvest will only be used for the generation of seeds as to start production on new land; however per 2010 the jatropha harvest will be used for commercial production (Energem 2009 b).

Both Duelco and Energem occupy land that was formerly used for household food production. At the time of the land acquisition no measurements of the individual plots and crop yields have been made and hence no individual compensation was provided. However some form of compensation was provided by the creation of water wells and by ploughing a new piece of land for the communities who had to give up part of their land. In Chilengue, Energem ploughed 200 hectares of land near the Aeródrome, a nearby aeronautical terminal owned by the Mozambican Airports Company (Soares 2009). According to the community of Chilengue this piece of land is located too far away and hence remains unused. In Nzêve the villagers are also compensated with a new piece of land. Each household that has lost part of

their land has received 0,5 hectares (ha) of ploughed land in return. Energem offers a fixed wage employment of 1650 Meticais (Mtc) per month. In the period of the research the plantation changed the work schedule from a fixed number of hours per day to a fixed number of tasks per day in order to see the change in productivity. It soon became clear that the workers indeed considerably increased their productivity to finish work sooner. Normal working hours are from 06.00-15.00 on weekdays and from 06.00-13.00 on Saturdays. With the new schedule the workers often finished before 12.00 on weekdays and hence could start working on their own farm or spend time on leisure. In the section below attention is given to the level of absenteeism on both plantations.

#### 4.1.2 Contracts and absenteeism

An interesting aspect in this study reflects the discussion with respect to absenteeism in chapter two where it is mentioned that it is questionable whether workers will remain working at the plantation when another activity comes up providing higher returns though being of temporary nature. In the table below the level of absenteeism is presented during a period of 6 months in the year 2009. Interesting to see is the difference between both plantations. The amount of absent days is more than twice as high in Chilengue as compared to Nzêve.

Table 4.1 Level of absenteeism

<b>Plantation</b>	<b>N<sup>1</sup></b>	<b>T<sup>2</sup></b>	<b>Absent days</b>	<b>Male/female ratio</b>
Chilengue	129	6 months	712	1.63
Nzêve	113	6 months	280	1.01
<sup>1</sup> Number of workers on the plantation				
<sup>2</sup> Time period				

Source: Energem

A possible explanation for the high level of absenteeism in Chilengue is the geographic location of the village which is nearby the main road Bilene Macia. This location leads to increased household mobility to and from markets and also to increased job opportunities. Households in Chilengue have already been working for an extensive period of time in off-farm jobs and access to jobs is higher. The Chilengue community is familiar with piece jobs and seasonality in the tourism sector. The plantation offers fixed wage employment and households are not familiar with this kind of contract. The work is relatively intensive and is continuous as compared to other 'flexible' jobs. These reasons might be leading to the high

level of absenteeism. Apparently in Nzêve the wage in most cases compensates for the opportunity costs of the worker's resources and time as access to other jobs is considerably less and it might be more appealing than work on own farm. The wage does not appear to be high enough in Chilengue to cover their opportunity costs. Of interest is also the male/female ratio, this ratio is much higher in Chilengue where there are 80 male and 49 female workers whilst in Nzêve there are 57 male and 56 female workers. Whether the balance between male and female workers has an effect on absenteeism is not analyzed in this study.

#### 4.1.3 Labour price in Bilene Macia district

In the table below a list of labour prices in wage employment is provided. As can be seen wages differ by sector as also assumed in the model of A. Low.

Table 4.2 Labour wages in wage employment

<b>Sector</b>	<b>Wage (Mtc/Month)</b>	<b>Seasonality</b>
Tourism	2275	Peak Dec./Jan.
Construction	1750	Piece jobs
<b>Plantation</b>	<b>1650</b>	Permanent
Guard	1500	Permanent/Temporary
Chissano (farm)	1490	Permanent/Temporary

Source: Household Survey

From the table above it can be deduced that the tourism sector provides the highest return on labour. However work in this sector is often from temporary nature and after these 2 months a considerable decrease in the hired labour force is experienced. Just below the tourism sector also the construction sector provides high returns to labour. There is less seasonality in this sector, however these piece jobs are of temporary nature and no fixed wage contract is provided leaving its workers in a state of insecurity. Energem on the other hand offers a permanent wage of 1650 Mtc per month providing security to its employees. Jobs in either of these sectors are valued highly as the level of unemployment is still high in the district and many families solely work in household food production and participate in microenterprise activities such as selling charcoal, firewood, honey and mats. Households working in off-farm employment have in general less time available to work on their fields and in some cases they will hire-in labour during agricultural peak seasons. The cost of hired (casual) labour ranges

between 25-30 Meticais (Mtc) per hour, hence for families where household members are working on the plantation it is more beneficial to both hire-out and hire-in labour. They hire themselves out to work on the plantation as the return (1650 Mtc) is higher than what they would receive working on their own land and it is relatively cheaper to hire-in labour during agricultural peaks. The hiring-in of labour also shows the still high importance of household food production for rural livelihoods.

In Chilengue the level of hired labour is relatively high. Of the total number of respondents, 11 households mentioned that they hire labour and particularly in the harvesting season. Of those households that hire labour, 63% also provides labour to the plantation. Hence it is plausible to assume that due to the increase in total household labour and decrease in household labour on farm, households in Chilengue, in order to keep some level of food production, need to hire labour. Unfortunately no data is available on the level of hiring-in of labour before the arrival of the plantation. In the more remotely located villages, Ngolene and Nzêve, the level of hired labour is low, where only one household in Ngolene mentioned to hire labour as compared to two households in Nzêve. The intra-village differences for Chilengue also become apparent when looking at the level of absenteeism in both plantations in section 4.1.2.

In the next section an application of the Sustainable Livelihoods Framework is provided which provides a holistic overview on the range of impacts after the arrival of the plantation.

## **4.2 Sustainable Livelihoods Framework**

In this paragraph an overview of the Sustainable Livelihood Framework and the impact areas are presented. In this framework only the socio-economic relations will be highlighted that were identified during this study. The qualitative data for this framework was gathered via a literature review, informal observations and interviews and via semi-structured interviews with key-informants. It should be mentioned that several socio-economic indicators (e.g. the intra-household allocation of resources) could not be analyzed due to the time constraint of this study.

### **4.2.1 Vulnerability context**

The vulnerability context is mainly dependent on trends and shocks. Vulnerability due to shocks mainly includes events as drought, floods, pests, diseases and civil war as well. These shocks destroy assets directly (Ellis 2000). Very low levels of savings, seasonality and livelihood dependency on crop agriculture compound these. Loss of access to land can also be perceived as a shock and is hence an immediate effect on the livelihood viability of the individuals and households to whom it occurs. With respect to trends, the arrival of the plantation did lead to a decrease in out-migration and an increase in population due to increased job opportunities. The duration and intensity of these trends depend on the permanent nature and the success of the plantation. Due to the increase in job opportunities and the provision of a fixed wage employment for the employees working at the plantation, a lower level of vulnerability is expected. Part of this can be explained by the fact that households have become less dependent on solely subsistence agriculture and seasonality. On the other hand, there might be a simultaneously occurring impact on the level of food prices, however no data has been gathered on food prices in the situation before the arrival of the plantation and hence this impact is not measured. It is possible that partly due to the increase in off-farm employment the level of household food production has decreased leading to a decrease in food supply to the market, which consequently might increase food prices. As has become clear in this research, the level of food production in the treatment group has decreased however households have not given up producing food entirely. Risk aversion and the history in food production play a role here as well as the increase in cash income available which enable households to hire-in labour as has been mentioned in section 4.1.

#### 4.2.2 Livelihood assets

**Human capital** proves to be one of the most important factors that have been subject to change due to the arrival of the plantation mainly because household labour power is the most important determinant of production capacity. Institutional capacity to increase farmers' skills is very low as there are no extension services in this district. What also became clear quite soon is that household size and composition are open to change as soon there is a change in the external environment of the household. In the light of increased job opportunities in the villages surrounding the plantations a surge of family members from other villages arrived. In some cases far relatives came to live with their families in Chilengue, Ngolene and in particular in Nzêve. In the last village almost 18% of the current habitants only moved there in the past year hoping to find work on the plantation. Another effect of the plantation related to human capital is that some household members in the age of 18 plus quit school in order to work on the plantation. This might have serious implications for future education levels of the communities. On the other hand, the plantation also offers training to its workers and some technologies they can adopt with respect to their own fields. However the plantation so far hasn't adopted an outgrower scheme and hence knowledge transfer with respect to production technologies might be limited.

**Natural capital** is of high importance to the rural Mozambican livelihoods, this in particular as they are both producers and consumers of food crops. The plantations occupy land that was formerly used for household food production and hence has resulted in a considerable impact. In Chilengue 66,7% of the interviewed households has lost part of their former land compared to 72,7% in Nzêve. However as also become clear in the results of my colleague M. Mota no change was found in cropping activities due to the jatropha plantation. Except their own fields, households surrounding the plantations also lost access to firewood collection sites. Hence natural capital has decreased, however the nature of the decrease might be temporarily as households will find new land suitable for cultivation.

**Financial capital** refers to the financial resources that people use to achieve their livelihood objectives (DFID 2007). Due to the arrival of the plantation an increase in off-farm job opportunities has been experienced by the local communities. Many households now obtain cash income from formal wage labour. Before the plantation a considerable part of cash income was obtained by microenterprise activities and sale of cash crops. Income derived from microenterprise activities is defined as income from all sources other than wage labor or agricultural production and the sale of that production (Tschirley 2000). However many men

already worked off-farm or in other agricultural wage employment and migration occurred frequently. The level of microenterprise activities and cash crop sales is still high in the control group as compared to the treatment group, where wage labour has become the main financial resource. Another reason for this might also be that several households lost part of their former land to the plantation and consequently lost some of their food crops and also income derived from cash-crop sales has been affected. In general savings in cash form is difficult, banks or other institutional savings schemes are generally not available to the local communities and the cash income from crop sales in particular for the control group is often a once-a-year event and may be insecure due to the volatile prices. Cash obtained from cash crop sales generally goes to meet immediate needs (Whiteside 2002).

**Physical capital** concerns the basic infrastructure and producer goods needed to support livelihoods. Due to the arrival of the plantation new infrastructure will be created or improved which can benefit the whole community. Some villages might become less remote due to more transport opportunities. Due to the geographic location of Chilengue near the main road Bilene Macia it can be seen that this community is more dynamic in its movements. Market access and participation is facilitated by access to transport. In Chilengue distances to main services as health clinics, banks and schools are significantly shorter than in the two more remotely located villages.

**Social capital** is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives. Key connections are through family and traditional leadership structures, through which land access, informal safety nets and contract labour is accessed. What can be observed in the research villages is that in the two smaller communities, namely Nzêve and Ngolene, there seems to be a more intrinsic network of connectedness amongst each other where cash transfers are common and where neighbours help each other on their fields, in particular in harvesting time. However social capital also proves to be very important in Chilengue where one of the village secretaries is in charge of recruitment for the plantation and hence keeping close relations with the secretary might prove worthwhile in obtaining a job, also reflecting on the leadership structures as mentioned above.

#### **4.2.3 Transforming Structures and Processes**

The transforming structures and processes are the organizations both private and public, policies and legislations that affect livelihoods. Structures exist at various levels. Analysis

should therefore be sensitive to the roles and responsibilities of the different levels of structures and seek to identify those that are of greatest importance to livelihoods.

Structures are important because they make processes function. An absence of appropriate structures can be a major constraint to development. This is a particular problem in remote rural areas. Many important organizations do not reach these areas and as a result services go undelivered and markets do not function (DFID 2007). This is also the case with extension services; from the 128 districts in Mozambique only 55 districts receive extension services (Siteo 2005). Bilene Macia district is not covered leading to a possible lack of knowledge with respect to agricultural practices (Perfis Distritais 2005). An important aspect is also that many local communities are not aware of their property rights as they lack information on land and labour laws and in particular on biofuel policies. This leads to the fact that the communities are unaware of the legal positions they have in the land acquisition process and this could have a considerable effect on the bargaining power related to the bio-energy company. The arrival of the plantation has additionally led to an important change in the environment and might have caused a change in both livelihood strategy and outcome.

#### **4.2.4 Livelihood strategies**

Households follow livelihood strategies based on the opportunities afforded by their livelihood assets, their vulnerability context and the transforming structures and processes they experience. According to (Scoones 1998) there are three broad clusters of livelihood strategies, namely: agricultural intensification/extensification, livelihood diversification and migration. These livelihood strategies are seen to cover the range of options open to rural people. Either rural households gain more of their livelihood from agriculture through processes of intensification or extensification, or they have the option to diversify via off-farm income earning activities. Another strategy is to migrate and seek a livelihood elsewhere. Often rural households pursue a combination of strategies.

Before the plantation the situation in most households was that of the men working in piece jobs in either construction or in the services sector or participated in microenterprise activities for those more remotely located villages. Often men also worked in South Africa in the mines or other businesses. The women mainly worked on their land to safeguard food production and they took care of the cooking, cleaning and nursing of children. After the arrival of the plantation, both men and women started working there. Clearly a decrease in time available for leisure as well as for food production occurred, however the extent of this decrease is not as conventional, in particular for women. After they finish work on the

plantation they will go directly to their fields as well as in the weekends. So on those hours they were normally spending on other household tasks they now work in household food production.

Hence in this study it has become clear that many households in the treatment group mainly had livelihood strategies of agricultural extensification and migration to South Africa. After the arrival of the plantation some men returned back home due to the increased job opportunities in their district. In the control group the main strategy is still agricultural extensification as many household members work on their own land and levels of cash crop sales are high, however where possible livelihood diversification is adopted. The reason for this is that the combination of lack of cash income and relatively high prices for inputs as fertilizer and seeds make intensification of food production for sale not a key strategy for most smallholders. However most of these smallholders try to produce as much food as possible for home consumption, and therefore to be less vulnerable to volatile food prices (Whiteside 2002).

#### **4.2.5 Livelihood Outcomes**

According to (DFID 2007) livelihood outcomes are the achievements or outputs of livelihood strategies. Several livelihood outcomes are identified for those households in the treatment group. The first and probably the most important one in this study concerns the increase in income. Although income measures of poverty have been much criticized, people certainly continue to seek a simple increase in net returns to the activities they undertake and overall increases in the amount of money coming into the household (DFID 2007). The increase in income also resulted in a decrease in other cash generating activities as microenterprise activities and cash crop sales. Probably because these activities are time-intensive and return to labour in wage work might be higher. This leads to another important outcome; with the cash income available the household has increased its (non-) food expenditures. With respect to the time available to the household, a decrease in leisure time is identified due to diversification of leisure time to wage work. This is in particular true for women as they keep working in food production on their fields and next to that engage in off-farm activities. These three livelihood outcomes will be analyzed in more detail in both the statistical analysis and Farm Household Model.

### **4.3 Results Direct Comparison**

Before starting the research it was assumed that in the control group, Ngolene, no labour market was present and hence could illustrate the situation in the treatment group if treatment had not occurred. However during the interviews it came to the fore that many habitants did participate in wage employment, though, in a nearby farm. Hence analysis based on the classical treatment and control group might provide biased results. However many households still not participate in wage labour and hence it has been decided to use this village as a control group and use all the data obtained and continue the experiment. Combining the predictions made by the Farm Household Model and the Sustainable Livelihood Framework, three main impact indicators have been identified. These include an increase in wage income and decrease in other cash generating activities, an increase in (non) food expenditures and thirdly a decrease in leisure time available to the household. In this chapter these impact indicators will be statistically analyzed and comparisons made between the control and treatment group and in the treatment group in the situation before and after the arrival of the plantation.

Off-farm employment opportunities have shown to be of great importance to rural households. This can also be confirmed by just looking at the number of households per village. Striking is that after the arrival of the plantation the total number of households has increased in the treatment groups. In Chilengue of the 41 interviewed households, three have arrived after the arrival of the plantation to look for work (7%), in Nzêve this is 4 out of 22 households (18%). In most cases household relatives or acquaintances have come to live in their village hoping to find work but in other cases people have migrated from more northern areas as they heard from the increased job opportunities in Bilene district.

People involved in local off-farm employment usually live and consume at home, and they can combine local off-farm employment with working on-farm due to small sizes of landholdings. The development of off-farm employment plays an important role in improving agricultural productivity and rural household incomes. Off-farm employment can absorb surplus labour from agriculture. Next to that off-farm employment can supplement rural household incomes and reduce poverty. Lastly off-farm employment can diversify rural household incomes and reduce the income risks of households (Feng 2006). In the tables below the current main activity of the household heads and the main activity before the arrival of the plantation in the three villages is presented.

Table 4.3 Main activity household head at To by village

		<b>Chilengue</b>	<b>Ngolene</b>	<b>Nzêve</b>	<b>Total</b>
<b>Main activity of household head</b>	Own farm	13	10	7	30
	Other on-farm	0	6	8	14
	Microenterprise	1	1	0	2
	Migration	5	2	2	9
	Other off-farm	11	2	5	18
	Not working	5	0	0	5
<b>Total</b>		35	21	22	78

Source: Household Survey

Table 4.4 Main activity household head at T1 by village

		<b>Chilengue</b>	<b>Ngolene</b>	<b>Nzêve</b>	<b>Total</b>
<b>Main activity of household head</b>	<b>Plantation</b>	<b>12</b>	<b>3</b>	<b>18</b>	<b>33</b>
	Own farm	10	8	1	19
	Other on-farm	0	8	2	10
	Microenterprise	1	1	0	2
	Migration	2	1	1	4
	Other off-farm	6	0	0	6
	Not working	4	0	0	4
<b>Total</b>		35	21	22	78

Source: Household Survey

From the tables above it can be seen that the main activity of the household head has changed in all three villages since the arrival of the plantation (To). Starting with Chilengue a shift has taken place from migration, other off-farm and own farm to work on the plantation. It should be taken into account that these results are for the household head and not for the household as a whole. However in most cases it appeared that first of all the household head started working on the plantation and then also some additional household members when possible. For this reason the analysis is representative to the household and other households. In Ngolene a small shift has occurred by a number of households who already supply some labour to the plantation however the majority of the population still participates in work on own or other on-farm activities. The most drastic changes have occurred in Nzêve where an enormous shift has occurred from other on/off-farm and own farm to work on the plantation.

The number of households participating in wage employment (categories: other on-farm, migration and other off-farm) at To was high in all villages, though noticeable is that

households in Ngolene and Nzêve primarily work in agricultural wage employment and that non-agricultural wage income is almost negligible. This result is in contrast to Chilengue where non-agricultural wage appeared to play an important role. A reason for this might be the more favourable geographic location of Chilengue as it is situated near the main road Bilene Macia. This might enable better access to off-farm employment opportunities. Striking is that more than 80% of the household heads in Nzêve give labour to the plantation, whereas in Chilengue this is only 33% of the interviewed households. This implies that the labour-related impact in Nzêve is considerable. By solely looking at the main activity of the household heads, no change is noticed with respect to microenterprise activities, however the income derived might have decreased as will become apparent in this chapter. Since the village characteristics and number of observations for Chilengue differ quite considerably from those in Ngolene and Nzêve, only the means between these last two villages will be compared. In Nzêve the entire community has experienced a direct impact whilst Ngolene is more remotely located and except for a few households there is no impact of the plantation. The intra-village differences in Chilengue will be discussed in more detail in chapter 4.2.

#### **4.4.1 Comparability control and treatment group**

In order to analyze the data by means of a direct comparison, the control and treatment group have been carefully selected so that the control group represents the treatment group in the situation before the treatment. Households in the treatment group come from the village Nzêve and households in the control group from Ngolene. Ngolene is a small village located four kilometers after Nzêve. Both villages have a similar number of households, between 20-25, and are both located in a remote area with limited market access and where before the arrival of the plantation limited off-farm job opportunities were available and this is still the case in Ngolene. In contrast, the majority of the households living in Nzêve have at least one household member working on the plantation.

Calculating the annual incomes and expenditures per activity, demographic equivalence scales have been used. These scales convert any demographic composition for a household into an equivalent number of adults (Ravallion 1995). Many equivalence scales exist in the literature and they often differ by country. In this study the square root scale will be used, this scale divides household income, expenditures and time by the square root of household size (OECD 2009). The variables represent annual data. Based on the geographical location of both villages, it is assumed that the village characteristics were quite similar before the arrival of the plantation. It is expected that the treatment group in the situation before the

plantation (To) is quite similar to the current situation (T1) in the control group. In the table below a comparison of the mean between the treatment group at To and the control at T1 is presented for a number of variables used in analysis, namely household labour on-farm, total household labour and level of off-farm income.

Table 4.5 Comparison treatment To to control T1

Variable (per adult equivalent)	Mean		Mean diff. T-C
	C T1 <sup>1</sup>	T To <sup>2</sup>	
Household labour on farm (hrs/yr)	528	492	-36
Total household labour (hrs/yr)	1362	1227	-135
Off-farm income (Mtc/yr)	7872	7159	-713
<sup>1</sup> Situation after arrival plantation in control group, village Ngolene			
<sup>2</sup> Situation before arrival plantation in treatment group, village Nzêve			

Source: Household Survey

From the above comparison it can be seen that the mean difference is relatively small for all variables. Noticeable is that the level of all variables in the situation before the arrival of the plantation was lower for the treatment group as compared to the control group. The reason for this might be that the control group already experienced a slight impact of the arrival of the plantation as some households already start providing labour to the plantation. However, due to the geographic location of both villages and their similarity, a direct comparison of the means between the treatment and control group as well as a comparison for the treatment group in the situation before and after the arrival of the plantation proves sufficient.

#### 4.4.2 Results direct comparison: control and treatment

In this section the impact indicators identified in the Sustainable Livelihoods Framework and Farm Household Model will be statistically analyzed by a direct comparison of the means between the control (Ngolene) and treatment (Nzêve) group as well as a before and after comparison of the means for the treatment group. In order to compare the means between the control and treatment group an Independent T-test will be used. The Independent T-test is used when there are two experimental conditions and different participants assigned to each condition. In the table below the explanatory variables for income, expenditures and leisure are compared and its significance is given.

One of the main impacts of the plantation on the surrounding villages is an increase in cash income available to the household. To demonstrate this increase in income from wage labour

the current annual income from off-farm employment is compared with the level of off-farm income in the control group. Next to that a comparison in income from microenterprise activities and cash crop sales is made between the control and treatment group. It is hypothesized in chapter 3.2.2 that income derived from these last two activities is higher for the control than for the treatment group, whilst income from wage labour is assumed to be higher for the treatment group than for the control group.

Table 4.6 Results Independent T-test Ngolene vs. Nzêve

Variable (per adult equivalent)	N		Mean		Mean diff. (SE)	Df	P
	C <sup>1</sup>	T <sup>2</sup>	C	T			
<b>Income</b>							
Off-farm income (Mtc/yr)	21	22	7872	19151	11279 (2434)	41	0,000***
Income cash crops (Mtc/yr)	21	22	239	11	-228 (71)	41	0,002***
Income microenterprise (Mtc/yr)	21	22	1025	760	-265 (538)	41	0,626
Value production (Mtc/yr)	21	22	1377	938	-439 (294)	41	0,142
<b>Expenditures</b>							
Food expenditures (Mtc/yr)	21	22	5562	7899	2337 (1011)	41	0.026**
Non-food expenditures (Mtc/yr)	21	22	873	1778	905 (267)	41	0.002***
<b>Time</b>							
Household labour on farm (hrs/yr)	21	22	528	297	-231 (83)	41	0,008***
Total household labour (hrs/yr)	21	22	1362	2587	1225 (263)	41	0,000***
* significant at 10%; **significant at 5%; ***significant at 1%							
<sup>1</sup> Control group, village Ngolene							
<sup>2</sup> Treatment group, village Nzêve							
<sup>3</sup> Weighted average							

Source: Household Survey

### Descriptive statistics income

From the above table it can be concluded that indeed there is a considerable increase in income derived from off-farm wage employment for the treatment group. On the contrary, income derived from sales of cash crops is considerably higher in the control group. Both variables are highly significant at the 1% level. The variables income microenterprise and value production however show no significant difference between the control and treatment group, though by looking at the means a general idea can be obtained on the direction of the difference. The sign for income derived from microenterprise activities and the value of production (C>T) are as expected. The variable value production is calculated by multiplying farm output by the going market price for each crop. As mentioned in chapter 3, there might

be a considerable bias in the variable value production, primarily because many households experienced difficulties remembering exact output, especially in the case of subsistence agriculture, and hence the values used in this study are possibly biased downwards. Market price data have been obtained by means of the household survey and via interviews with agricultural produce traders.

### **Descriptive statistics expenditures**

A natural relation exists between an increase in income available and an increase in expenditures for this reason this variable has been identified as one of the main impact areas of the plantation. It is expected that expenditures on food as well as non-food items are higher in the treatment group than the control group. The results of the Independent T-test show indeed a higher level of expenditures on food and non-food items for the treatment group as compared to the control group. Non-food expenditures for the control group mainly include transport to market, gasoline for lighting and educational expenses. This variable is also highly significant at the 1% level.

### **Descriptive statistics leisure time**

With respect to leisure one would assume that due to increased job opportunities a shift might take place from working on-farm to work on the plantation. This in general does not necessarily have to lead to a change in leisure time available. However it has appeared that household members that were not working before now started working on the plantation leading to a direct decrease in leisure time. Additionally, the majority of the households and in particular the women have continued working on their own fields besides working on the plantation as is also highlighted in the Farm Household Model.

As can be seen in the results of the Independent T-test the variable household labour on farm is much higher in the control group as compared to the treatment group. This variable is significant at the 5% level ( $p < 0,05$ ). The variable total household labour is on the contrary considerably higher in the treatment group and is highly significant at the 1% level. The variable total household labour is not directly a measure of hours of leisure time available however the enormous increase in hours worked either on- or off-farm does indirectly imply a decrease in leisure time available to the household.

#### 4.4.3 Results direct comparison: treatment before and after

Next to a comparison of the means between the control and treatment group also a comparison of the means is made for the treatment group (Nzêve) in the situation before and after the arrival of the plantation for a limited number of variables.

The variables included are household labour on-farm, household labour on farm per household member, total household labour (both on- and off-farm), off-farm income and the income derived from food crop sales. It is expected that household labour on-farm will decrease and a shift will take place to work on the plantation. For this analysis a Dependent T-test is used as it concerns two conditions where the same participants took part in.

Table 4.7 Results Dependent T-test Nzêve

Variable (per adult equivalent)	N	Mean		Mean diff. <b>T<sub>1</sub>-T<sub>0</sub></b> (SE)	Df	P
		<b>T<sub>0</sub><sup>1</sup></b>	<b>T<sub>1</sub><sup>2</sup></b>			
Household labour on farm (hrs/yr)	22	493	297	-196 (45)	21	0,00***
Total household labour (hrs/yr)	22	1228	2587	1359 (188)	21	0,00***
Off-farm income (Mtc/yr)	22	7159	19151	11992 (2056)	21	0,00***
* significant at 10%; **significant at 5%; ***significant at 1%						
<sup>1</sup> Situation before arrival plantation						
<sup>2</sup> Situation after arrival plantation						

Source: Household Survey

As can be seen in the table above indeed the variable household labour on farm has considerably decreased in size since the arrival of the plantation. On the contrary, total household labour has increased in more than twice the size, showing here again the decrease in leisure time available to the household. Income from off-farm activities has also increased considerably, showing the impact of the plantation.

A similar analysis is made for Chilengue in the following section, however here attention is given to the intra-village differences.

#### 4.4 Intra-village differences

The treatment and control group from the aforementioned analysis are representative as in Nzêve the majority of the habitants lost a part of their land and provide labour and in Ngolene no land is used by the plantation and only a small number of households already provide labour. For this reason no distinction is made according to the classification as described in chapter 3.1.3. Chilengue on the other hand is a more diverse village where 52% of the respondents (19 households) stated that they have at least one household member that is working on the plantation. This community has already been working for an extensive period of time in off-farm employment and hence, contrary to Nzêve, their levels of off-farm income might not have changed that much since the arrival of the plantation. Additionally as has become apparent in section 4.1.3 the Chilengue community tends to hire-in labour in agricultural peak seasons. To quantitatively show the intra-village differences in Chilengue again an Independent T-test will be used where treatment is defined as minimal one household member providing labour to the plantation. Again data on income and expenditures is estimated by adult equivalent. In Chilengue the hypothesis of the direction of the impact is the same as in section 3.2.2 however no significant change is expected in off-farm income due to the history in off-farm employment.

Table 4.8 Results Independent T-test Chilengue

Variable (per adult equivalent)	N		Mean		Mean diff. T-C (SE)	Df	P
	C <sup>1</sup>	T <sup>2</sup>	C	T			
Household labour on farm (hrs/yr)	16	19	1265	664	-601 (185)	33	0.003***
Total household labour (hrs/yr)	16	19	1804	2462	658 (307)	33	0.040**
Auto-consummation (Mtc/yr)	16	19	1078	513	-565 (324)	33	0.090*
Off-farm income (Mtc/yr)	16	19	3416	16449	13033 (2694)	33	0.000***
* significant at 10%; **significant at 5%; ***significant at 1% <sup>1</sup> Control group Chilengue where no members are working on the plantation <sup>2</sup> Treatment group Chilengue where minimum 1 member is working on the plantation							

Source: Household Survey

As can be concluded from the above table a significant difference is found for all variables used in analysis. The signs are as expected and again show the considerable decrease in household labour on farm and increase in total household labour due to work at the plantation. Particular interest is given to the variable off-farm income as it was expected that due to the history in off-farm employment, the mean difference would be small. However it is relatively large and the same results are obtained as in the analysis of section 4.3.

## 5. Conclusion and discussion

The effect of increasing investment in biofuel production has been debated over the past few years and in particular its implications for low-income countries. It is questioned whether the benefits of biofuel production are also reaped by the poor or whether they will only experience a decrease in food security due to a decrease in household food production.

By assessing the socio-economic impact of the biofuel plantations, three impact areas have been identified in the Sustainable Livelihoods Framework and have been analyzed by making a direct comparison of the means between the control and treatment group as well as in the treatment group in the situation before and after the arrival of the plantation. The first area concerns the increase in cash income obtained from off-farm employment. The increase in income consequently resulted in a decrease in other cash generating activities as microenterprise activities and cash crop sales. The second identified impact area is an increase in (non-) food expenditures. Both differences are highly significant. Looking at the increase in both cash income and expenditures it can be concluded that households working on the plantation are better off in socio-economic terms as households in the control group.

With respect to the time available to the household, a decrease in leisure time is identified due to replacement of leisure time by wage work. As can be seen in the results of the Independent T-test the variable household labour on-farm is much higher in the control group as compared to the treatment group. A consequence of the decrease in household labour on-farm is that the level of household food production has decreased. The impact of this decrease in food production is not visible yet, however in the long-term this might have a considerable effect on food prices and food availability. Even though household labour on-farm has decreased, the variable total household labour is considerably higher in the treatment group.

The focus of this study has been on the socio-economic impact of biofuel plantations however many other impact areas can be identified. An important area that has not been dealt with in this thesis is the environmental impact of the plantation and its implications for the livelihoods of farm households. Another highly relevant study area is the community consultation process. Private investors are obliged to consult the community on their plans and should come to an agreement with respect to compensation. In many cases plantations use land that was formerly used for household food production. In return for the use of land a plantation offers a compensation however this compensation is often under discussion and community consultations should be strictly followed according to protocol.

Due to the limited amount of time and resources available some aspects could not have been analyzed. Of main interest would be to analyze the situation in the research area in a few years time. The survey has been conducted two years after the arrival of the plantation and hence some impacts that become visible over time might not yet have been possible to identify. According to the conducted literature study, outgrower schemes in general provide higher advantages compared to the plantation approach. In the case of Energem, no outgrower scheme was adopted as the company was not yet producing for commercial purposes. It would be interesting to measure the possible increase/decrease in income when applying outgrower schemes in villages surrounding the plantation. Another aspect that has not been incorporated in this research is that of intra-household allocation of resources. This information could be of importance for policy making as it might highlight the distribution of cash income within the household and the gender-related spending pattern.

As mentioned before, an important note with respect to this research is related to the reliability of the obtained household data. Some of the conclusions of this research are based on the increase in total hours worked and a decrease in hours worked on-farm. It must be mentioned that during the survey some households had difficulties in time and scale which is of relevance for the time related variables as well as for the variable value production which includes a measure of scale (hectares). A related matter is also that those households who lost part of their land might give desirable answers as they would like to receive an additional compensation of Energem. So they might declare smaller farm size after the arrival of the plantation. Another important aspect is that in this study a control and treatment group has been created. The idea behind this concept is that the treatment group before the arrival of the plantation should be similar to the current situation in the control group. However the control group already did experience a slight impact of the plantation as a handful of habitants already started working there. The reason that the data has been used is mainly related to the geographic location of both villages and their similarity as presented in section 4.4.1.

This study can contribute to the ongoing discussion of impacts of large-scale biofuel production in developing countries and thereby creating a better understanding of the livelihood strategies farm households adopt when facing the arrival of a biofuel plantation. It should be mentioned that the outcome of this study should not be generalized to other biofuel initiatives in Mozambique.

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## 7. Appendices

### 7.1 Household Questionnaire



Estudo sobre famílias rurais em Mocambique 2009  
Questionnaire intrahousehold allocation study

Data .....  
Código Família .....

#### Section 1 - Caracterizacao Geral da Família

---

##### A – Local

1. Distrito .....  
2. Comunidade .....  
3. GPS .....  
4. Nome da pessoa entrevistada .....

##### B- Informacoes sobre família

5. Nome do Chefe de Família (CF) .....  
6. Idade do CF .....  
7. Educacao CF .....  
8. Sexo do CF .....  
9. Estado Civil do CF .....

10. Membros familiares (pessoas que comem e vivem nesta casa. Preencha a tabela seguinte.  
*Para crianças menores de 10 anos, diga so idade e sexo*

Relacao com CF	Sexo	Idade	Educacao	Principal actividade	Membros presente em To	Membros presente agora
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						

## Section 2 - Terra e uso de terra

### A - Terra actual

Machambas	Area (GPS)	Fertilidade	Arvores	Uso actual
1				
2				
3				
4				
5				
6				

1. Por favor, faça uma lista das culturas produzidas nas machambas

Machambas	Cultura 1	Cultura 2	Cultura 3	Cultura 4
1				
2				
3				
4				
5				
6				

2. Faça uma lista da quantidade produzida da ultima colheita e o seu destino

<b>Machamba 1</b>	Produtividade	Consumo Próprio	Vendido	
Cultura	Numero de sacos	Numero de sacos	Numero de sacos	Preco por sacco
1				
2				
3				
4				

<b>Machamba 2</b>	Produtividade	Consumo Próprio	Vendido	
Cultura	Numero de sacos	Numero de sacos	Numero de sacos	Preco por sacco
1				
2				
3				
4				

<b>Machamba 3</b>	Produtividade	Consumo Próprio	Vendido	
Cultura	Numero de sacos	Numero de sacos	Numero de sacos	Preco por sacco
1				
2				
3				
4				

## B - Terra anterior á plantacao de Jatropha

Caso nao consiga preencher a tabela Q3 e Q4, preencha somente a tabela seguinte

Machambas	Area (GPS)	Fertilidade	Arvores	Uso actual
1				
2				
3				
4				
5				
6				

3. Por favor, faca uma lista das culturas produzidas nas machambas em To

Machambas	Cultura 1	Cultura 2	Cultura 3	Cultura 4
1				
2				
3				
4				
5				
6				

4. Faca uma lista da quantidade produzida da ultima colheita e o seu destino em To

<b>Machamba 1</b>	Produtividade	Consumo Próprio	Vendido	
	Numero de sacos	Numero de sacos	Numero de sacos	Preco por sacco
1				
2				
3				
4				

<b>Machamba 2</b>	Produtividade	Consumo Próprio	Vendido	
	Numero de sacos	Numero de sacos	Numero de sacos	Preco por sacco
1				
2				
3				
4				

<b>Machamba 3</b>	Produtividade	Consumo Próprio	Vendido	
	Numero de sacos	Numero de sacos	Numero de sacos	Preco por sacco
1				
2				
3				
4				

### Section 3 - Uso de Mao de obra

---

Mao de obra familiar - estacao de chuvas

Código ID	Horas por dia	Dias por semana	Principal actividade
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Uso de mao de obra em To Estacao chuvas

Código ID	Principal Actividade
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Mao de obra familiar - estacao de Seca

Código ID	Horas por dia	Dias por semana	Principal actividade
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Estacao seca

Código ID	Principal Actividade
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Contratar mao de obra na estacao de chuvas

No. Pessoas	Horas por dia	Dias por semana	Actividade

Contratar mao de obra na estacao seca

No. Pessoas	Horas por dia	Dias por semana	Actividade

1. Quanto paga por dia a cada pessoa contratada?

2. O uso de mao de obra alterou-se desde To?

Sim....1

Nao.....2

#### Section 4 - Trabalhos exteriores a machamba

---

1. Em caso de existir outro trabalho alem da machamba por favor preencha a tabela seguinte

<b>Trabalho exterior</b>	<b>Salário (Met)</b>	<b>Em géneros</b>
Plantacao		
Turismo		
Guarda		
Emigrante AS		
Construcao civil		

2. Tem alguma actividade do tipo pequena empresa?

<b>Actividade</b>	<b>Tipo pagamento</b>	
	<b>Dinheiro (Met)</b>	<b>Em géneros</b>
Venda madeira		
Venda comida		
Venda de Carvao		
Venda frutos selvagens		
Venda bebidas caseiras		

3. Existem outras entradas de dinheiro (como receber dinheiro de algum familiar emigrante)?

<b>Tipo de pagamento</b>	<b>Quantidade recebida</b>	
	<b>Dinheiro (Met)</b>	<b>Em géneros</b>

#### Section 5 - Entradas e saídas de producao

---

1. Que tipo de despesas tem com a producao?

	<b>Custos</b>	
	<b>Quantidade</b>	<b>Preco por Unidade (km, kg)</b>
Fertilizantes		
Pesticidas		
Sementes		
Transporte		
Outra		

## A. Producao animal

<b>Tipo Animais</b>	<b>Número</b>	<b>Preco do animal no mercado</b>
Galinha		
Patos		
Cabras		
Outra		

2. Tem algum tipo de despesas com as seguintes actividades relacionadas com producao animal?

<b>Tipo despesa</b>	<b>Custos</b>
Pastoreio	
Alimentacao	
Veterinario/medicamentos	
Outra	

## Section 6 - Bens de Família

---

1. Possui algum dos bens listados na tabela seguinte?

Se sim, diga qual é o preco do mercado actual

<b>Item</b>	<b>Preco (Mtc)</b>
<b><i>Bens agricolas</i></b>	
Tractor	
Bomba/ Irrigacao	

<b><i>Bens de luxo</i></b>	
Radio	
Bicicleta	
Telemovel	
TV	
DVD	

## A. Habitacao

2. Quantas habitacoes tem? .....

3. Há quanto tempo tem esta habitacao? .....

4. A habitacao principal é feita de que tipo de material ?

<b>Parte da habitacao</b>	<b>Principal material usado</b>
Paredes exteriores	
Telhado	
Chao	

5. Esta a armazenar algum tipo de comida actualmente?

Item	Quantidade
Milho	
Mandioca	
Gergeli/Feijao jago	
Batata doce	
Cebolas	

6. Quanto tempo demora a chegar aos seguintes locais?

Locais	Agora	To
Estrada principal		
Mercado		
Escola Primaria		
Plantacao		

7. Quanto tempo demora chegar a cada uma destas fontes?

Fontes	Agora	To
Fonte agua		
Plantas medicinais		
Frutos selvagens		
Carvao / Lenha		

## Section 7 - Despesas com alimentacao

---

1. Quanto dinheiro gastou nas ultimas duas semanas com comida?

	Quantidade/unidade	Preco
Peixe		
Leite/ Iogurte		
Ovos		
Feijoes		
Carne Vaca		
Carne de Cabrito		
Galinha		
Vegetais		

### A - Despesas nao alimentares

2. A sua familia teve alguma despesa com artigos nao alimentares?

Ano	6 Meses	Mes	Semana	Dia

## Section 8 - Hábitos de consumo

---

1. No geral, quantas refeicoes fazem por dia? .....
2. No geral, quantas refeicoes as crianas fazem por dia? .....
3. Seguem este padrao durante todo o ano? .....
- Sim.....1
- Nao.....2      Se nao, especifique
  
4. Quantas pessoas comem normalmente em sua casa diariamente? .....
5. Em que periodos do ano ha carencia de alimentos? .....
- (estacao chuvas/ estacao seca)

## 7.2 List of variables and description

<b>Variables</b>	<b>Description</b>	<b>Measurement</b>
village	Village of household	Chilengue/Ngolene/Nzêve
hhzise_To	Household size at To	Numeric
hhsiz	Current household size	Numeric
agehhh	Age household head	Numeric
educhhh	Education household head	Primary/Secondary
genderhhh	Gender household head	Dummy male/female
marithhh	Marital status household head	Married/Divorced/Widow/ Polygamous
ageotill6	Age category 0-6	Numeric
age6till18	Age category 6-18	Numeric
age18till60	Age category 18-60	Numeric
age60plus	Age category 60 plus	Numeric
depend	Number of dependents	Age categories 0-6, 6-18 and 60+
educ6till18	Education category 6-18	Numeric
educ18plus	Education category 18 plus	Numeric
hirelabour	Hire in of labour	Dummy yes/no
costhired	Costs of hired labour	Aggregated (annual) in Meticais
mainacthhh	Main activity of household head	Dummy
mainacthhh_To	Main activity of household head at To	Dummy
mainactsp	Main activity of spouse	Dummy
mainactsp_To	Main activity of spouse at To	Dummy
hrsonfarm	Total household labour on own farm	Aggregated (annual) in hours
hrsonfarm_To	Total household labour on own farm at To	Aggregated (annual) in hours
hhmemfarm	Household members on own farm	Numeric
hhmemfarm_To	Household members on own farm at To	Numeric
hrsmemfam	Hours per household member on own farm	Aggregated (annual) in hours
hrsmemfam_To	Hours per household member on own farm at To	Aggregated (annual) in hours
plantation	Labour to plantation	Dummy yes/no
hhmemplant	Number of household members at plantation	Numeric
ownradio	Household owns a radio	Dummy yes/no
ownbike	Household owns a bike	Dummy yes/no
owntv	Household owns a tv	Dummy yes/no
owndvd	Household owns a dvd-player	Dummy yes/no
owhphone	Household owns a phone	Dummy yes/no
durassetadj	Number of durable assets	Numeric per adult equivalent
dwelling	Number of dwellings	Numeric
durablewall	The main dwelling has durable walls	Dummy yes/no
durableroof	The main dwelling has a durable roof	Dummy yes/no
foodexpadj	Annual value of food expenditures	Aggregated (annual) in Meticais divided by equivalence scale
nonfoodexpadj	Annual value of non-food expenditures	Aggregated (annual) in Meticais divided by equivalence scale

foodshare	Share of food expenditures	Percentage of food expenditures on total expenditures
mealday	Nr. of meals per day	Numeric
mealdaych	Nr. of meals per day for children	Numeric
incofffarm_To	Annual income from off-farm employment at To	Aggregated (annual) in Meticais divided by equivalence scale
incofffarm	Annual income from off-farm employment	Aggregated (annual) in Meticais divided by equivalence scale
incmicroentadj	Adjusted income microenterprise activities	Aggregated (annual) in Meticais divided by equivalence scale
incremit	Annual income remittances	Aggregated (annual) in Meticais divided by equivalence scale
costremit	Annual costs remittances	Aggregated (annual) in Meticais divided by equivalence scale
plots_To	Number of plots at TO	Numeric
plots	Number of plots	Numeric
sellerp_To	Household sells food/cash crops at To	Dummy yes/no
sellerp	Household sells food/cash crops	Dummy yes/no
inccasherpadj_To	Adjusted income cash crop income	Aggregated (annual) in Meticais divided by equivalence scale
inccasherpadj	Adjusted income cash crop income	Aggregated (annual) in Meticais divided by equivalence scale
incfoodcrpadj_To	Annual income from sales food crops at To	Aggregated (annual) in Meticais divided by equivalence scale
incfoodcrpadj	Annual income from sales food crops	Aggregated (annual) in Meticais divided by equivalence scale
cropdiv_To	Nr. of different crops at To	Numeric
cropdiv	Nr. of different crops	Numeric
nrichickens	Number of chicken	In hours
nrducks	Number of ducks	In hours
nrgoats	Number of goats	In hours
distwater	Distance to water source	In hours
distfirewood	Distance to firewood	In hours
distplot	Distance to plot	In hours
distplot_To	Distance to plot at To	In hours
distmainroad	Distance to main road	In hours
distmainmarket	Distance to market Bilene	In hours
offincadj	Adjusted off-farm income	Aggregated (annual) in Meticais divided by equivalence scale
offincadj_To	Adjusted off-farm income at To	Aggregated (annual) in Meticais divided by equivalence scale
valueprodadj	Annual value of production	Aggregated (annual) in Meticais divided by equivalence scale
farmsize	Farm size	Number of fields multiplied by average field size in ha
equivsc	Equivalence scale	Square root scale
equivsc_To	Equivalence scale at To	Square root scale
totanhrsmem	Total time of members working per year	Aggregated (annual) in hours
totanhrsmem_To	Total time of members working per year at To	Aggregated (annual) in hours
autocons	Auto-consummation per year	Aggregated (annual) in Meticais

### 7.3 Extended Tables Results Statistical Analysis

Table 7.1 Independent samples T-test Ngolene vs. Nzêve

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Adjusted off-farm income per adult equivalent (Mtc)	Equal variances assumed	,027	,870	-4,634	41	,000	-11279,437	2434,198	-16195,4	-6363,476
	Equal variances not assumed			-4,648	40,714	,000	-11279,437	2426,606	-16181,1	-6377,761
Adjusted income cash crop income per adult equivalent (Mtc)	Equal variances assumed	10,075	,003	3,224	41	,002	227,815	70,666	85,101	370,529
	Equal variances not assumed			3,152	21,014	,005	227,815	72,282	77,502	378,128
Adjusted income microenterprise activities per adult equivalent (Mtc)	Equal variances assumed	1,265	,267	,492	41	,626	264,810	538,652	-823,020	1352,639
	Equal variances not assumed			,488	36,912	,628	264,810	542,349	-834,183	1363,802
Annual value of production per adult equivalent (Mtc)	Equal variances assumed	3,863	,056	1,496	41	,142	439,316	293,729	-153,882	1032,513
	Equal variances not assumed			1,507	38,063	,140	439,316	291,477	-150,717	1029,348
Number of durable assets	Equal variances assumed	,494	,486	-1,051	41	,299	-,236	,224	-,689	,217
	Equal variances not assumed			-1,050	40,707	,300	-,236	,225	-,690	,218
Annual value of food expenditures per adult equivalent (Mtc)	Equal variances assumed	,564	,457	-2,310	41	,026	-2336,659	1011,492	-4379,409	-293,909
	Equal variances not assumed			-2,299	38,486	,027	-2336,659	1016,541	-4393,685	-279,632
Annual value of non-food expenditures per adult equivalent (Mtc)	Equal variances assumed	1,917	,174	-3,394	41	,002	-905,314	266,724	-1443,974	-366,653
	Equal variances not assumed			-3,429	35,806	,002	-905,314	264,041	-1440,915	-369,712
Total annual labour worked on farm per adult equivalent (hrs)	Equal variances assumed	,010	,919	2,773	41	,008	230,951	83,296	62,732	399,170
	Equal variances not assumed			2,788	39,723	,008	230,951	82,849	63,471	398,431
Total annual labour per adult equivalent (hrs)	Equal variances assumed	,031	,861	-4,652	41	,000	-1224,764	263,258	-1756,424	-693,104
	Equal variances not assumed			-4,664	40,883	,000	-1224,764	262,625	-1755,193	-694,336

Table 7.2 Independent samples T-test Ngolene vs. Nzêve

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Number of dependents	Equal variances assumed	,022	,884	-,754	41	,455	-,366	,485	-1,346	,614
	Equal variances not assumed			-,753	40,649	,456	-,366	,486	-1,347	,615
Number of plots at TO	Equal variances assumed	1,600	,213	3,312	41	,002	1,680	,507	,655	2,704
	Equal variances not assumed			3,298	39,154	,002	1,680	,509	,650	2,710
Number of plots	Equal variances assumed	9,002	,005	4,658	41	,000	2,043	,439	1,157	2,929
	Equal variances not assumed			4,597	30,406	,000	2,043	,444	1,136	2,950
Household sells food/cash crops at T0	Equal variances assumed	,737	,396	3,581	41	,001	,487	,136	,212	,762
	Equal variances not assumed			3,574	40,383	,001	,487	,136	,212	,762
Household sells food/cash crops	Equal variances assumed	28,870	,000	6,132	41	,000	,669	,109	,449	,889
	Equal variances not assumed			6,038	27,832	,000	,669	,111	,442	,896

Table 7.3 Dependent samples T-test Nzêve treatment before vs. after

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Total annual labour on farm per adult equivalent - Total annual labour on farm at T0 per adult equivalent	-195,645	211,61705	45,11691	-289,470	-101,819	-4,336	21	,000
Pair 2	Total annual labour per adult equivalent - Total annual labour at T0 per adult equivalent	1359,696	883,28751	188,31753	968,06862	1751,324	7,220	21	,000
Pair 3	offincadj - offincadj_T0	11992,71	9643,94025	2056,095	7716,826	16268,59	5,833	21	,000
Pair 4	inccashcrpadj - inccashcrpadj_T0	11,36364	53,30018	11,36364	-12,26834	34,99561	1,000	21	,329
Pair 5	incfoodcrpadj - incfoodcrpadj_T0	-89,46273	237,52633	50,64078	-194,776	15,85055	-1,767	21	,092
Pair 6	sellcrp_T0 - sellcrp	,18182	,50108	,10683	-,04035	,40399	1,702	21	,104

Table 7.4 Group statistics Ngolene vs. Nzêve

Group Statistics					
	Village of household	N	Mean	Std. Deviation	Std. Error Mean
Number of dependents	Ngolene	21	1,95	1,627	,355
	Nzeve	22	2,32	1,555	,332
Number of plots at T0	Ngolene	21	3,95	1,802	,393
	Nzeve	22	2,27	1,518	,324
Number of plots	Ngolene	21	3,95	1,802	,393
	Nzeve	22	1,91	,971	,207
Household sells food/cash crops at T0	Ngolene	21	,71	,463	,101
	Nzeve	22	,23	,429	,091
Household sells food/cash crops	Ngolene	21	,71	,463	,101
	Nzeve	22	,05	,213	,045
Age household head	Ngolene	20	50,50	15,676	3,505
	Nzeve	22	43,64	14,184	3,024
Education household head	Ngolene	21	2,33	2,689	,587
	Nzeve	22	2,27	2,292	,489
Household size at T0	Ngolene	21	3,19	2,015	,440
	Nzeve	22	3,95	2,360	,503
Current household size	Ngolene	21	3,52	2,040	,445
	Nzeve	22	4,41	2,039	,435
Average adult age	Ngolene	21	47,38	16,277	3,552
	Nzeve	22	38,91	11,804	2,517
Education category 6-18	Ngolene	21	,33	,658	,144
	Nzeve	22	,82	,907	,193
Labour to plantation	Ngolene	21	,24	,436	,095
	Nzeve	22	,91	,294	,063
Nr. of household members at plantation	Ngolene	21	,24	,436	,095
	Nzeve	22	1,77	1,020	,218
Number of durable assets	Ngolene	21	,81	,750	,164
	Nzeve	22	1,05	,722	,154
Number of dwellings	Ngolene	21	2,38	,740	,161
	Nzeve	22	2,55	1,711	,365
The main dwelling has durable walls (Mtc)	Ngolene	21	,10	,301	,066
	Nzeve	22	,05	,213	,045
The main dwelling has a durable roof (Mtc)	Ngolene	21	,00	,000	,000
	Nzeve	22	,05	,213	,045
Nr. of meals per day	Ngolene	21	2,10	,301	,066
	Nzeve	22	2,23	,429	,091
Annual income remittances (Mtc)	Ngolene	21	,00	,000	,000
	Nzeve	22	545,45	1765,470	376,399
Annual costs remittances (Mtc)	Ngolene	21	,00	,000	,000
	Nzeve	22	1863,64	3758,108	801,231
Nr. of different crops at T0	Ngolene	21	4,67	1,528	,333
	Nzeve	22	2,55	1,870	,399
Nr. of different crops	Ngolene	21	4,67	1,528	,333
	Nzeve	22	3,50	1,535	,327
Number of chicken	Ngolene	21	3,57	4,686	1,023
	Nzeve	22	2,59	3,554	,758
Number of ducks	Ngolene	21	,05	,218	,048
	Nzeve	22	,91	2,136	,455
Number of goats	Ngolene	21	,10	,301	,066
	Nzeve	22	,05	,213	,045
Farm size (ha)	Ngolene	21	,3357	,16866	,03680
	Nzeve	22	,4605	,26832	,05721
Number of durable assets per adult	Ngolene	21	,4633	,50023	,10916
	Nzeve	22	,5741	,48210	,10278
Autoconsummation per year per adult equivalent	Ngolene	21	1137,83	675,927	147,499
	Nzeve	22	926,33	1079,180	230,082