

**SCHOOL OF GRADUATE STUDIES
ADDIS ABABA UNIVERSITY
COLLEGE OF
DEVELOPMENT STUDIES (CDS)**

**The Challenges and Opportunities of
Developing Biodiesel in Ethiopia: The
case of castor seed in Eastern Hararge**



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Title

The Challenges and Opportunities of Developing Biodiesel in Ethiopia.
The case of Castor Seed in Eastern Hararge

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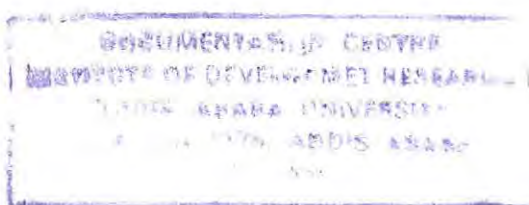
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Acronyms

C	Celsius
CGIAR	Consultative Group on International Agricultural Research
CO ₂	Carbon dioxide
EIA	Environmental Impact Assessment
EIAR	Ethiopian Institute of Agriculture and Research
EPA	Environmental Protection Authority
EU	European Union
FAO	Food Aid Organization
FEP	FloraEco Power
FGD	Focus Group Discussion
GHG	Green House Gases
Ha	Hectare
KII	Key Informants Interview
Kg	Kilogram
M	Meter
Mm	Millimeter
MoME	Ministry of Mines and Energy
MoARD	Ministry of Agriculture and Rural Development
N ₂ O	Nitrous oxide
OECD	Organization for Economic Development
Q	Quintals
R&D	Research and Development
US	United States
USSR	Republic of Russia

ABSTRACT

Biofuels are believed to be reducing GHG emissions, contributing to energy security for fossil fuel importing countries, generating new income opportunities in rural areas, and improving energy access for the poor, with positive implications for the environment and poverty reduction. However there are other negative consequences that question the viability of producing biofuels, which includes conversion of land and other productive resources from food to biofuels that could reduce food availability and increase food prices, and contribute to depletion of natural resources when done in a non-sustainable manner.

In order to assess the challenges and opportunities of developing biodiesel in Ethiopia, farmers who are working with FloraEco Power Company by producing castor in Eastern Hararge were taken as a case study. These farmers receive seeds, fertilizers and pesticides from the company and grow castor on their own land. Finally they sell the harvested seeds to this company at a fixed price set at the contract signed between them.

The methodology used was both qualitative and quantitative. Babilie woreda was selected from the three woredas that the company is working on due to its road accessibility and road availability. The study employed two-stage sampling procedure where at the first stage two kebeles were selected randomly from Babilie woreda and at the second stage 90 farmers were selected by systematic random sampling.

Farmers have benefited from this project in the case that new jobs have been created for them, which has brought additional source of income. In addition job opportunities were available for non-producers and agronomists in the woreda. Increase in price of food crops and decrease in food supply has occurred in the area due to the new practice of castor production to a certain degree in addition to shortage of rainfall. Farmers have allocated portion of their land to castor production but since they were able to intercrop castor with other food crops it has not compromised other food production. Farmers use fertilizers and pesticides monitored by agronomists who work with them which will not affect the environment.

However projects like this need proper monitoring to ensure sustainable development and to make small farmers higher beneficiaries.

1 Chapter One

1.1 Introduction

Energy is an essential factor to a nation's successful economic development. "Most of the energy in Ethiopia is derived from traditional sources (wood fuel, agricultural residue, charcoal and cattle dung) and this accounts for 95.8 % of the total energy supply. The remaining supply, which is about 4.2%, is contributed from fossil fuels" (Asress, 2002: 84).

"Ethiopia on average spends 8.6 billion birr annually on importing petroleum which consumes about 87 percent of the hard currency the country earns from foreign trade each year" (Wudneh, 2007). Ethiopia spends a large amount of money importing modern energy sources and if fossil fuels can be substituted with biofuels, lots of money can be saved and the saved amount can be allocated to other development investments.

The demand for fuel is increasing because of expansion of infrastructures and also the growing economy and as a result, the money spent to import the fuel is also rising (Alemayehu, 2007). Due to the rising oil prices, environmental concerns and interests in energy security, different countries of the world have taken biofuel production as a potential solution (Walter, 2006). Since the use of modern energy is highly dependant on non-renewable resources, using these resources appropriately and effectively has become very important and this has helped in considering the substitution of fossil fuels with biofuel. By doing this, natural resources can be transferred from generation to generation without being fully exhausted while ensuring sustainable development.

"Biofuels are renewable liquid fuels made from plant matter rather than fossil fuels. Today's primary biofuels are ethanol and biodiesel. Biofuels can help reduce air toxics emissions, greenhouse gas buildup, and dependence on imported oil" (www.mtpc.org/cleanenergy/energy/glossarytechfuels.htm).

Biofuels have a great potential for a number of countries worldwide and have a number of benefits economically, environmentally and socially. On the other hand, it has created a large degree of controversy relating to the issues of its usage and the likely consequences such as loss

of biodiversity, deforestation, increased use of fertilizers, which results in green house gas emissions, and also its effect on food security.

When looking into the history of liquid biofuels, they have been used since the early days of the car industry. Different inventors have been trying to use liquid biofuels since 1900. Nikolaus August Otto, a German who invented the combustion engine, conceived his invention to run on ethanol. Rudolf Diesel, who is also German invented the Diesel engine, to run on peanut oil. Henry Ford originally designed the Ford Model T, a car produced from 1903 to 1926, to run completely on ethanol. However, when crude oil became cheaply available cars began using fuels derived from mineral oil: petroleum or diesel ([http:// en.wikipedia.org/wiki/Biofuel](http://en.wikipedia.org/wiki/Biofuel)).

Rudolf Diesel has seen the future of biomass fuel utilization as he has indicated in his 1912 speech “the use of vegetable oils for engine fuels may seem insignificant today but such oils may become, in the course of time, as important as petroleum and the coal-tar products of the present time” (<http://en.wikipedia.org/wiki/Biodiesel>).

After the Second World War, cheap Middle Eastern oil lessened interest in biofuels. However, the oil shocks of 1973 and 1979 increased interest from governments and academics to use fossil fuels appropriately. The incidence of the counter-shock of 1986 again reduced oil prices and interest. Different countries of the world have taken measures towards the use of biofuel in the 1980s. For instance in United States all cars manufactured since 1988 are required to be compatible with fuels containing at least 20% ethanol E20 fuel, and with minor modifications these cars can use 85% ethanol blended with petroleum E85 fuel. The recently environmental impact concerns and the increasing cost of these fuels have made biomass fuels such as biodiesel a growing alternative ([http:// en.wikipedia.org/wiki/Biofuel](http://en.wikipedia.org/wiki/Biofuel)).

Biofuels have different types but the commonly known and used are biodiesel and ethanol. “Biodiesel is a diesel fuel substitute produced from renewable sources such as vegetable oils, animal fats, and recycled cooking oils. Biodiesel can be used in neat form, or blended with petroleum diesel for use in the diesel engines”. “Ethanol is the most common biofuel worldwide. It is an alcohol fuel. It is produced by fermentation of sugars derived from wheat, corn, sugar beet and sugar cane” (<http://en.wikipedia.org/wiki/Biodiesel>).

Many countries of the world are using biofuels substituting fossil fuels as a source of energy. Developing countries like Malaysia and Brazil could be good examples of those who have become successful in the production and use of biofuels. Since biofuel is the only alternative fuel approved by the Environmental Protection Authority, Ethiopia is taking measures to maximize the available potentials of biofuel. Ethiopia with an aim to shift from high-cost fossil to cost-effective bio-fuel has developed and approved a new Biofuel development strategy last September 2007. Currently, the government is working to expand the three existing sugar factories to produce ethanol and on the private sector not less than 20 companies have been registered to produce vegetable oils for biofuel, of which five have already gone operational (Wudneh, 2007).

Among these private companies that have started working in the production of biofuel, the specific work of one company with farmers in the area was taken as a case study. FloraEco Power is a company that started operating in Babille, Fedis, and Midaga, which are parts of the “*Misraq Hararge*” (East Hararge), in the zone of Oromia. The company has coverage of around 13,000 hectares of lands in eastern Oromia, including a land for an oil mill factory. Of the total hectares the 8,000 are used for growing castor provided by the government, and more than 4400 hectares coming from the community of farmers. It represents about 4000 farmers involved in the project. The factory crushes the seeds and extracts the oil by different technical processes and this oil is sent to European refineries to be turned into biodiesel (FEP, 2007).

1.2 Statement of the Problem

Ethiopia is a developing country, struggling to fight poverty to achieve the Millennium Development Goals by the year 2015. Ethiopia has taken measures to reduce poverty and has developed a Sustainable Development and Poverty Reduction Program in 2002 and recently has a Plan for Accelerated and Sustained development to End Poverty (PASDEP) in 2006. In order for the economy to grow, Ethiopia needs to open doors to investment so that a good return could be achieved especially in earning foreign currency, and also help the citizens to benefit socially as well as economically ensuring sustainable development.

“Sustainability is premised on decision-making which reflects a balance among economic efficiency, ecological integrity and human well being including equity considerations” (Costantinos, 2005:17). Any development work or investment should be based on achieving

sustainable development taking issues of being socially accepted, economically viable, and environmentally sound into consideration. The use of the available resources to make a living or for any investment or development work needs to be efficient and appropriate without compromising the future generation.

The case of biofuels has become a very hot issue, raising controversy which has made academicians, investors, environmentalists and also policy makers give it due consideration. Even if most consider it as a positive potential solution to energy security ensuring sustainable development, others argue about its negative consequences it will bring to the society such as loss of biodiversity, deforestation, increased use of fertilizers, which results in green house gas emissions, and also its effect on food security.

Since the development and expansion of biofuels could bring both positive and negative effects to the society and the environment it is a very sensitive issue that needs to be assessed thoroughly. Thus, the assessment of the challenges and opportunities of developing biodiesel and the socio-economic and ecological dimensions will have significant importance. To this end a case study of farmers who produce castor seed and sell their products to FloraEco Power Company so that plant oil could be extracted from the castor seed in Eastern Hararge and export the plant oil to other countries to be converted into biodiesel will be considered.

It is also believed that the study will fill the research gap since nothing much has been done regarding this issue and the concern of the proposed study in the specific area has not been directly addressed.

1.3 General Objectives of the Research

The general objective of the research is to investigate the challenges and opportunities of developing biodiesel in Eastern Hararge.

Specific Objectives

- To investigate the socio-economic benefits and challenges concerning the development of biodiesel
- To investigate the ecological benefits and challenges concerning the development of biodiesel

- To recommend the kind of interventions to ensure sustainable development while using biodiesels

1.4 Research Questions

With aims of addressing the major objective and specific objectives of the study, the research work was guided by the following questions: -

- What are the socio-economic benefits in developing biodiesel?
- What social implications does developing biodiesel have in the area?
- Has the income of farmers improved?
- What happened to the price and supply of other food crops since the bio-farm is introduced in the area?
- Have farmers cleared land in the area for castor production?
- What are the likely effects of developing biodiesel on the environment?

1.5 Significance of the Study

The findings of the research will serve as a springboard to other researchers who are interested to conduct further studies in the area. In addition, it could be used to build a knowledge base for investors who are interested in investing on biodiesel, and also for the academic and research community. Other development practitioners and the *woreda*¹ people could also benefit from the research.

1.6 Scope and Limitations of the Study

The scope of the study is limited to the randomly selected two *kebeles*² from one *woreda* out of the three *woredas* that the company is working on. This is due to limited time and money resources. The scope is also limited to the socioeconomic and ecological dimensions of developing biodiesel from castor seed.

Even though the challenges and opportunities of developing biodiesel has a broader dimension at a national level, however only the socio-economic and ecological dimensions to the specific

¹ *Woreda*- an Amharic equivalent to a district

² *Kebele*- an administrative sub division of a district (*woreda*)

project and local community are considered. Other aspects, which require laboratory analysis (soil and water analysis) are not addressed in this study.

1.7 Organization of the paper

This research paper comprises six chapters. Chapter one presents introduction and statement of the problem including objectives, significance, scope and limitation of the study. The second chapter provides review of related literatures pertaining to the problem under investigation. Various publications were exhaustively reviewed and diverging and converging views of different scholars and researchers that are pertinent to the problem are presented.

In chapter three, description of the study area and the study population, the location and physical settings of the study area is presented. Chapter four presents the research methodology, which includes the study design, types and methods of data collection and sampling method and procedures. The methods of data analysis that were adopted to investigate the answers for the research questions are also included in this chapter.

Chapter five presents results and discussion of the data investigated and analyzed. Besides, the socio-economic and demographic background of the study population is presented in this section. The last chapter provides summary of the report: conclusion and recommendation. Each of these is presented independently as a heading. At the end of this chapter, appendices and list of references are attached.

2 Literature Review

In this section, attempt is made to briefly describe some of the contemporary writings of biofuel/ biodiesel, particularly on issues related to the types, benefits, and facts and opinions. In view of the studies conducted in the field, effort is made to review the most relevant literatures, which are directly related to the main focus of the study.

2.1 What is Biofuel?

Non- renewable resources, which, are found in the form of non-living materials and fossil fuels, are in fixed quantity with the future of being depleted. Resources of this kind are organic and for all practical purposes they are not added to by nature, nor can be manufactured by mankind. Non-renewable resources can be divided into two. Recycled non-renewable resources include gold, copper, lead, that are largely retained for further use and disposed non-renewable resources include the cheaper metals, oil and coal, and mineral construction materials (Riddell, 1981).

Petroleum is the largest non- renewable source of energy consumed by the world's population, and this global demand for petroleum is predicted to increase 40% by 2025 (Johnston et al., 2006). Concerns about non-renewable resources, the rising prices of oil and energy security have motivated many countries to consider alternatives to imported petroleum, liquid biofuels being the major ones.

“Biofuel is a fuel produced from dry organic matter or combustible oils produced by plants. Examples of biofuels include alcohol (from fermented sugar), biodiesel from vegetable oil and wood” (www.esd.rgs.org/glossarypopup.html).

Biofuels, which are usually obtained from feedstocks, are forms of energy that are easily transported and stored, thus tradable, and believed to be environmentally preferable products. “Due to concerns about high dependence on oils, reduction of carbon emissions and the sky rocketing prices of oils biofuels have become a high priority issue in the US, the EU and in a number of other countries around the world” (Coelho, 2005: 20).

Sustainable development could be achieved by substituting fossil fuel with biofuel because its production permits the use of renewable resources without compromising the availability of resources for the next generation. That is why the United Nations Foundation launched the initiative

to promote sustainable production and use of biofuels in developing countries and has gained a lot of interest in many countries of the world (Walter, 2006).

“In this “aggressive biofuel growth” scenario, biofuels account for 10 percent of transport fuel production by 2010, 15 percent by 2015, and 20 percent by 2020 throughout most of the world” (Braun et al., 2006:10). Biofuels are expected to substitute at least some percentage of petroleum use in the next few years, if the current interest and production continues.

2.2 Types of Biofuel

Even though there are different types of biofuels the most widely used are ethanol and biodiesel.

2.2.1 Ethanol

“Ethanol is derived from the fermentation of mainly sugar and starch crops and, in the future, from cellulosic materials” (Matthews, 2007). For bioethanol production, maize, sugarcane, sugar beet, cassava, and wheat are considered feedstock crops (Rosegrant, et al., 2006).

Ethanol is considered to be highly beneficial because it uses the molasses that would have gone to waste while using sugarcane providing additional revenue for the agricultural sector. Liquid biofuels are produced in some countries, Brazil and United States are the largest ethanol producers that account for 90% of the world production producing 16 billion liters annually and substituting 40% of gasoline use in Brazil but only 3% in the United States. The primary feedstock for ethanol is sugarcane in Brazil and maize in the United States. Other than Brazil, developing countries are increasing their interest and producing biofuel including China, Colombia, India, Indonesia, Malaysia and Thailand (Hazell et al., 2006).

South Africa is the largest ethanol producer in Africa accounting for 70% of the continent’s total production. Other African countries such as Zimbabwe, Mauritius, Malawi, Zambia and Swaziland also produce ethanol (Karekezi et al., 2007). Other recent reports also indicate that Tanzania and Mozambique have been identified as having the potential and being suitable for growing biofuels (Oxfam, 2007). Currently, Ethiopia produces 8 million liters of ethanol annually (Wudneh, 2007).

2.2.2 Biodiesel

“Bio-diesel is an alternative diesel fuel that is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable, non-toxic and has low emission profiles and is an environmentally friendly fuel” (Karekezi et al., 2007: 3). Biodiesel, which can be blended with petroleum diesel, could be made from oilseed crops, as well as from waste oils and greases (Braun et al., 2006). It is also possible to make pure biodiesel for purposes of industrial input, agricultural activities and electric power (Wudneh, 2007). Biodiesel can be made from all plant oils, and is so far derived principally from canola (rapeseed), palm or soybean oils, sunflower, mustard seed oil, groundnut, castor seed, jatropha, animal fats, waste vegetable oils, or micro-algae oils (Bioenergy, 2007).

Biodiesel is described as, a light to dark yellow liquid, biodegradable, and practically does not mix with water, has a high boiling point and low vapour pressure. With a thickness similar to petro-diesel, it can be used in diesel engines (cars, trucks, buses, construction equipment), jet engines, and heating and electricity generating systems. It blends easily with petro-diesel and can be used as an additive to ultra-low sulphur diesel to increase lubricity (Arungu-Olende, 2007).

Biodiesel is highly produced in Europe, which accounted for 89% of the world's production in 2005 (Braun et al., 2006). “Germany and France are the largest producers of biodiesel from European countries, rapeseed being the primary feedstock accounting for 88% of the world's production followed by United States producing 8%” (Hazell et al., 2006:3). Globally, biodiesel production is only about one-tenth of total ethanol production and is more land-intensive than ethanol production. Although there is significant potential for biodiesel production in Africa still not much has been done (Braun et al., 2006).

2.3 Controversies- Concepts

These are some of the controversies or the concepts that are raised with the issue of biofuel:

- Crop production for biofuels competes with food production, thereby increasing food insecurity and threatening food supplies for the poor.
- Biofuels, much of it promising a source of environment friendly energy that would also be a benefit to the world's farmers.
- A large degree of biofuel production will threaten food supplies for the poor and fail to achieve the environmental benefits claimed.

- Large tracts of land being allocated for planting bio crops will cause deforestation, loss of biodiversity and divert land away from food production.

2.4 Benefits of Biofuel and/or Biodiesel

Various researchers have tried to indicate the different benefits of biofuels generally. Here are some of the benefits:

- Biofuels have the potential to alleviate poverty, create sustainable rural development opportunities, reduce reliance on imported oil, and increase access to modern energy services,
- Biofuel production offers a high potential to create jobs, especially in rural areas,
- Biofuels use can bring the combined benefit of enhancing energy security and reducing high foreign currency outlay,
- Biofuels production would induce economic growth and would certainly create jobs in a new producer country,
- Biofuel production help mitigate climate change by reducing green house gases meeting rural energy needs while protecting the environment.

However, the challenges and opportunities of developing biofuels are determined by where, how and from which feedstocks they are produced.

2.5 Biodiesel's Crops

In order to extract biodiesel a number of crops could be used. Some of these crops are castor, jatropha, rapeseed, palm, soybeans, and sunflower. This section will focus only on some of the major crops for producing biodiesel.

2.5.1 Jatropha

“Jatropha belongs to the family of *Euphorbiaceae*. Its original habitat is Central America, but Jatropha has spread out and it is now very common in Africa, India and Brazil.” Each tree’s lifespan can be up to 40 years and is believed that each hectare planted will produce over 3,000 liters after the tree reaches maturity, which commonly takes about 4 years (FEP, 2007).

Jatropha curcas could grow in infertile soil, in drought prone areas, can stand harsh and dry conditions, beneficial for restoring soil erosion, combating desertification, animals do not graze on it and is not edible. Therefore, it has a high potential in Sub-Saharan Africa, which has a large area of

degraded or marginal land that is not suitable for producing food and if good conditions are set quality oil can be achieved all year round. The above stated qualities including its cost of producing biodiesel being reasonably low, makes *Jatropha* desirable (Karekezi et al., 2007).

2.5.2 Castor Seed

Castor belongs to the family of *Euphorbiaceae* and genus *Ricinus*. The Amharic word for castor is known as “*gullo*” and “*kobo*” is the commonly Afan Oromo word used for castor in Eastern Hararge. “Castor is a stout, shrub-like perennial plant with reddish stems and long, broad green leaves. It’s seeds have been sought after a long time because of their oil and are mainly used as an anti-freeze for special aircraft lubricants, and cosmetics. Its oil is not employable for food and it can grow on desolate lands” (FEP, 2007).

Castor started getting more attention recently when new cultivation methods were introduced to develop varieties that could grow as a seasonal crop producing high yields. Nowadays, India, China, Brazil, France and the former USSR block are the leading castor producers. India is the largest producer and exporter of castor oil, with a share of 60 to 70% of world trade (Lele, 2006).

Castor oil has a variety of uses, including the production of nylon, motor oils, plastics, electrical insulation, paints and other industrial applications and is also used as a raw material for colours and soap. Castor has medicinal (laxative, dressing of wounds, chemotherapy for cancer), contraceptive and cosmetic uses. The oil can also be used in oil lamps and the cake or the residue can be used as a fertilizer (MoME, 2007).

A new research regarding the challenges and opportunities of some oilseed crops as sources of biodiesel has been conducted by the EIAR (The Ethiopian Institute of Agricultural Research). Castor seed was one of the potential oil seed crops for biodiesel production in Ethiopia’s case in this research.

Castor bean is native to Ethiopia and is widely distributed in the country due to its diverse adaptability. Castor plant varies in size from small annuals to small tree like perennials reaching up to ten meters. In Ethiopia, it is found in hedges, stream banks and roadsides and can be intercropped with maize, peanut, sorghum and maize. Castor is tolerant to moisture stress due to its deep root system but dwarf varieties require adequate moisture and are also suitable for irrigation (Getinet et al., 2008).

Weiss (2000) in the study of oil crops has indicated that castor grows well within temperatures of 20-26° C in clear and sunny days. However, cloudy and humid days irrespective of temperature reduce yield and temperatures of above 35° C and below 15° C reduce oil content and alter composition. Diverse studies have shown differing reports regarding the amount of rainfall needed to harvest castor and the amount of seed to be harvested per hectare due to the difference in seed variety and weather conditions. The recent study at the EIAR shows that the oil content of castor seed is over 50% with seed yield of 30 q/ha and even a higher potential depending on the environment. Highest seed yield of 33 q/ha and 59 % of oil content was obtained in Arbaminch. Lowest seed yields and oil contents were reported from higher altitudes (Getinet et al., 2008).

Other study in India indicates that 1,000 to 1,500 kgs of castor seeds can be cultivated from 1 hectare of rain fed good quality soil and 800 to 1,000 kgs from medium quality soil. If it is irrigated, it can yield up to 2,000 to 2,500 kgs of seeds. Comparison with other crops: It can yield crop in 5 to 6 months, seeds can be stored for two years, less probability of being attacked by pests and can sustain changes in weather easily. Castor can be cultivated round the year and 7.5 to 10 kgs of seeds are required for plantation in 1 hectare (Lele, 2006).

The EIAR study has also revealed some of the opportunities with castor production for biodiesel as being tolerant to moisture stress and since it is not an edible crop can be grown in marginal and idle lands without affecting food production. It appears that Ethiopian seed varieties are higher in oil content than any hybrid variety but are taller and later maturing than dwarf imported varieties. Regarding the challenges of using castor for biodiesel the research shows that some investors are importing hybrid seed, which is lower by 10-12 % in oil content than the Ethiopian variety, which results in lower yield. Currently the areas used for castor production are highly populated and if farmers continue using the small land they own for castor could compromise other food production and could cause clearing of dry forests and grazing lands (Getinet et al., 2008).

2.5.3 Other crops

Rapeseed/Canola

Rapeseed, and its Canadian brand canola oil, is grown and used for biodiesel mostly in Europe. The average yield is about 2.8 ton per hectare. Since these crops can grow well in cold regions such as the northern USA, Canada, and northern Europe, the expansion of its cultivation is limited to these countries (FEP, 2007).

Sunflower

Biodiesel could also be extracted from sunflower, which can be cultivated almost anywhere, but mainly in the former USSR. It can yield up to 2.5 ton of seeds per hectare, if cultivated under high-standard agriculture condition. However, this crop is not highly recommended because of its sensitivity to soil diseases and needs good care such as crop rotation in about 4 years interval (Ibid).

2.6 Socio-Economic Dimensions of Biofuel Production

The recent rise of oil prices and concerns for the environment has made use of biofuels popular all over the world. Biofuels are subsidized in most countries, since their production cost is higher than the price at which they are traded on the energy market (Treguer et al., 2006).

The sections below incorporate the socio-economic and ecological dimensions concerning the development of biofuel that also applies to biodiesel since it is one type of biofuel. When looking at these dimensions of developing biodiesel, there could be many issues and points to be raised, both negative and positive. However, this section will only try to focus on the major dimensions that are related to this particular study.

2.6.1 Socially Raised Controversial Issues: Trade off Between Food Production vs Castor Production

According to FAO, “food security exists when all people, at all times, have physical, social and economic access to sufficient amounts of safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (<http://www.fao.org/nr/ben/befs/key.html#1>).

The effects of biofuel production may be positive or negative depending on the situation of the producer country whether it is a net buyer or seller of energy services and food products which determines whether it is beneficial or detrimental to them (UN-Energy, 2007).

Top international experts from around the world had a meeting last April 2007 in Rome to consider the environmental and food security impact of the rapidly expanding bioenergy industry. At the meeting some experts argued that biofuel production could increase food security for farmers if they engage in the production of biocrops. Joseph Schmidhuber has commented that the impact on food security depends on the country's economic level of being a net exporter or importer of food and energy and also making a point that the crops should not be planted in areas which are food security

sensitive. He also noted that if managed well it could also turn out to be an agricultural renaissance for some developing countries by producing and exporting biofuels profitably (Matthews, 2007).

Others also argue that biofuel production does not necessarily lead to food insecurity rather could create rural jobs, increase incomes and thereby improving their food security (CGIAR, 2008). Some biocrops such as castor can be intercropped with other food crops and this will significantly increase the farmer's income without compromising other food production while ensuring farmers' food security.

There are other studies that stress on the fact that biofuel development may compromise food security resulting in the rise and instability of crop prices. The current price increase in food prices was mainly attributed to the expansion of biofuels in the world and market forces. A report of 'Agricultural Outlook 2007–2016', claims that increasing demand for biofuels is causing fundamental changes to agricultural markets driving up world prices for many farm products (Xiaohua, 2007). This rapid development of biofuels, which are produced from food crops, has already made huge changes in the international food crop prices especially maize.

A World Bank study has estimated that corn prices rose by over 60 percent from 2005-07, largely because of the U.S. ethanol program combined with market forces. A soon to be released International Food Policy Research Institute analysis blames 30 percent of the overall food price rise from 2000-2007 on biofuels (Borenstein, 2008). Joachim Von Braun, the director of the US-based International Food Policy Research Institute, said that if the production of biofuels is to be halted in 2008, it is expected that the price of maize will decline by about 20 percent and wheat by about 10 percent in 2009 and 2010 (AFP, 2008). Other recent studies have also shown that the increase in demand for biofuels may result in an increase in bioenergy crop prices and also other crop prices (FAO, 2007). This increase of food crops' prices is expected to continue in the future due to the growing use of cereals, sugarcane, oilseeds and vegetable oils to satisfy the needs of a rapidly increasing biofuels industry.

In addition, it is believed that the expansion of biofuels affects food aid. Developed countries such as the US being the world's largest donor of food aid, contributes an average of six million tons of cereal food aid annually since 1970 (IRIN, 2007). However, since farmers in the US have started selling the surplus crops to the ethanol production market and other biofuel production, food aid contributions may start declining. The increasing use of some crops to biofuel production has resulted in a decline of surplus crops in many parts of the world and in turn has made prices of some

crops to go up and decline in food exports.

Therefore developing countries will be affected more from this rise of food prices who are importers of food crops and dependants on food aid. In addition, this could arise food riots and conflicts, food crisis and threats of starvation in these developing nations even though they have not engaged in biofuel production. As a result of the high rise of food prices, food riots have already occurred in some parts of the world.

Major agricultural producers, such as Brazil, the United States, the EU and Canada are expected to reduce exports of basic feedstock commodities such as cereals or oilseeds for use in domestic biofuels industries and/or increase imports of biofuels (FAO, 2007). Others also emphasize that the rising prices of biocrops will draw attention of the existing farmers to change the crops they used to produce to biocrop and result in the production of monocrop (Northoff, 2007). Biofuels could have an impact on the availability of adequate food supplies when they are planted in arable land that could have been used for other crop production.

Biofuels could also have an indirect impact on food security reducing the availability of water for domestic use. Some biocrops require large quantities of water for both raw material production and the conversion process. Crops used for ethanol (sugar cane) and biodiesel (palm oil) production have high water requirement between 1,500 and 2,5000 mm/year respectively. Whereas, other crops such as maize, cassava, soybean, castor bean and cotton can be produced with moderate water requirement (between 500 and 1,000 mm/year) (FAO, 2007). When the production of biofuel crops compete with available water supplies, it could make water less readily available for household use, threatening the health status and thus the food security status of the farmers.

On the other hand, Braun et al. (2006) argue that other countries could learn from the Brazilian experience that biofuel's development does not lead to the spread of a monoculture or single-crop plantations nor does it compete with food production activities. They have given two major reasons for biofuel not compromising food security one being that biocrops could be planted in marginal lands leaving the favorable lands for food production and also rotating crops. The other reason was indicating the fact that food insecurity is not simply lack of food availability but rather not enough income to buy the available food. According to Alemayehu Tegenu, Minister of Mines and Energy of Ethiopia, the development of biofuel will not have negative impacts on the crop production of the country since the land allocated for biofuel will neither be convenient for farming nor grazing (Andualem, 2007).

2.6.2 Income Generation

Increased biofuel production can raise the incomes of small farmers and rural laborers in developing countries. Gustave Best advocates for biofuel stating that it holds out enormous opportunities for farmers especially in the developing world (Matthews, 2007). In the 'First High-level Biofuels Seminar in Africa' (2007) Thomson Sinkala, Chair of the Biofuels Association of Zambia stressed on the importance of biofuels development for the empowerment of marginalized rural communities, the promotion of family cohesion and the development of skills and technologies. Given that biofuel industries increase employment, generate income, provide energy security, infrastructure and training, and develop human resources and skills it can result in social and rural development (Wilson, 2007).

Since biofuel production is highly labour intensive, it creates new employment opportunities for unskilled workers in rural areas (GBP, 2007). Poor rural residents, including the food insecure, may benefit from new opportunities in biofuel development. This could be either through increased and profitable own production, new employment opportunities in larger biofuel enterprises in rural areas and/or additional services and businesses. Additionally, if biofuel production results in increased availability of local energy services, new business opportunities will be created based upon improved energy infrastructure.

Experiences in other countries have shown that community-based biofuel production has benefited the larger community. The jatropha project in Mali has directly benefited the poor by increasing their access to an affordable and clean energy source as well as providing off-farm rural livelihood to farmers, especially women (Alazar, 2008). In addition when looking at Brazil's experience, in 1997 the ethanol sector in Brazil employed about 1 million people, 35 percent of these jobs were temporary harvesting jobs employing many poor migrant laborers, but 65 percent were permanent. The number of jobs in manufacturing and other sectors created indirectly by the ethanol sector was estimated at 300,000 and many of these jobs were unskilled which benefited the larger rural residents. Some (60,000) small farmers also produce about 30 percent of the sugarcane in Brazil (CGIAR, 2008). These examples clearly indicate that new job opportunities can be created both for skilled and unskilled labours in the rural areas when they are engaged in biofuel production.

Increasing crop prices in addition to raising producers' incomes draw capital into rural areas. Positive impacts will go to those directly involved in the production and processing of biofuels, through higher feedstock (commodity) prices and higher volumes of marketable produce. The

rising commodity prices could benefit many farmers in both developed and developing countries, to the extent that developing country farmers have access to markets and are therefore able to respond to higher prices. However, this rise in prices could be a threat for small-scale producers who are net purchasers of food and the urban poor in developing countries who spend more than half of their income on food (Ibid). Moreover, if farmers are engaged in monocrop plantation it would not automatically improve their working and living conditions (Alazar, 2008).

2.6.3 Economic Benefits

Since most African regions depend on imported fuel, and spend huge amounts of money to import the fuels from other oil producing countries it has a negative impact on the regional economic development (Braun et al., 2006). Among the world's 50 poorest countries, 38 are net importers of petroleum and 25 import all of their petroleum requirements from abroad (UN-Energy, 2007). Biofuels production would induce economic growth and would certainly create jobs in a new producer country (Walter, 2006) and could provide positive opportunities that would help improve the wellbeing of rural people (FAO, 2007).

The use of biofuels locally would reduce import bills for energy-deficient countries and offer improved balance of trade and balance of payments (Arungu-Olende, 2007). If non-oil producer countries are able to substitute the imported fossil fuels with the domestically produced biofuels to a certain degree they could benefit highly. Countries, when using the locally produced biofuels, could divert portion of money that used to be allocated for importing oil to local agricultural and other development projects which could strengthen the country's economy and generate employment.

Experiences in countries such as Brazil, France, Germany, Mauritius and the US have shown that biofuel production that are small and locally owned tend to bring about higher local revenues and lower spending (UN-Energy, 2007). Locally produced biofuels can also increase access to energy for marginalized communities, taking the Brazilian social biodiesel programme as an example has resulted in off-grid electricity generation (CGIAR, 2008). Other studies have also shown that biofuel provides an opportunity for countries to utilize their own natural resources and attract potential foreign and domestic investors (Cloin et al., 2007).

In addition, it has the potential to reduce dependence on oil imports at the national level and to create readily available supplies of energy at the local level. However, with the exception of Brazil, biofuels currently in use generate comparatively little substitution effect for fossil fuels and are not

economically competitive. Different studies show that biofuels are currently heavily dependent on government support and protection for continued development in both developed and developing countries, via sales and excise tax exemptions, loan guarantees and high import tariffs (CGIAR, 2008).

The development of biofuels has potentially important role to play in poverty reduction through employment effects, economic growth and energy price effects (Peskest et al., 2007). According to a biofuel research by CGIAR (2008), under the right conditions, biofuels offer important opportunities for poverty reduction by stimulating stagnant agricultural sectors, thus creating jobs for agricultural workers and markets for small farmers bringing a rural economic development. It was also mentioned that biofuels industry has the potential to generate rural development and develop new roads and other infrastructures.

2.6.4 Issues about Land Use

Land use issue is very critical and currently with the increased production of biofuels use of lands appropriately has become very important. Professor Walter, (2007) in his study of Brazil's experience as a reference for other developing countries has stressed that even in areas with available large land, regulation of land is very important. Competition for more arable land and water resources directed to biofuel production may lead to some serious challenges over time (FAO, 2007). The UN frame work also stated that with the competition for land biofuels, as the 'next big cash crop', will be grown on the best lands, leaving cereals and subsistence crops to the low-quality lands (IRIN, 2007).

Priority at the moment must be to ensure that any rural land acquired for biofuel production had not previously been used for growing other food crops. It is a key to get it right at this stage, i.e. make sure farmers are not left landless (Ibid). The land that is given for planting biocrops should not compromise with other crop production. According to Alemayehu Tegenu on his speech at the 'First High-level Biofuels Seminar in Africa' (2007) Ethiopia's potential land for the production of crops for biodiesel alone is estimated to be 23,305,890 hectares.

However, in Africa or other developing nations the rural poor who do not have a secure land may be threatened by large scale feedstock production for biofuels which could even cause displacement. Due to the limited size of land owned by rural farmers there is a potential conflict between using land and water for growing livestock feed, food for human consumption and biofuels (Cloin et al., 2007). Furthermore, the so called "abandoned" or marginal lands that countries are proposing for biofuels development often provide some livelihood benefits to the most vulnerable living in the

area, who may be prevented from continued utilization if commercial biofuel plantations are developed.

2.7 Ecological Dimensions of Biofuel Production

Nowadays, biofuels are taken as a potential solution for energy security, reducing the environmental effects while sustaining the natural resources by using renewable resources. The use of biofuels has both positive and negative effects on the environment depending on the type of crop produced, what it is replacing, and the methods of cultivation and harvesting. While some argue that biofuels have greater social and environmental benefits, others including environmentalists argue that it results in environmental damage. A report commissioned on behalf of the OECD concluded that the potential of the current technologies of choice to produce biofuels and deliver a major contribution to the energy demands of the transport sector without compromising food prices and the environment is very limited (CGIAR, 2008).

The negative and positive effects of biofuels on the environment includes reduction of green house gas emissions, loss of biodiversity, deforestation, increased use of agro-chemicals and fertilizers which in turn causes environmental effects, and effects on soil and water quality. This section has tried to incorporate some of these environmental effects.

2.7.1 Green House Gas Emissions

“Biofuels provide an opportunity for the provision of the modern fuels and services required for development, whilst at the same time avoiding fossil-fuel derived CO₂ emissions” (Woods et al., 1994:53). This indicates that substituting fossil fuels with biofuels lowers the carbon emissions and hence reduce the green house gas emissions as compared to the use of fossil fuels. Biofuels have the ability to reduce green house gas emissions (Braun et al., 2006). A different study has also suggested that in order to mitigate the climate change and its effects on the environment the use of biofuels should be taken into consideration (Jatropha, 2006).

In order to conclude whether biofuels reduce green house gas emissions there are certain critical issues that need to be considered. “Emission reduction must be assessed considering the full life-cycle: The life-cycle includes production (choice of feedstock, agricultural practices, land use change etc.), refining and conversion processes and end-use practices” (GBP, 2007: 3). Sivan Kartha’s study (2006) also argues that in order to assess the net impact of displacing fossil fuels, the relative carbon intensity must be assessed on the basis of the emissions associated with the biofuel

crop production and the efficiency of the energy technology in which the biofuel is used. Taking into account these factors, it has been indicated in other studies that biofuels produced from feedstocks grown in tropical regions offer better carbon savings and cost efficiencies than those grown in Europe (Oxfam, 2007).

Fossil fuels in addition to being non-renewable have a problem of generating a dangerous and unwanted accumulation of CO₂ in the atmosphere. To this respect, supporters of biofuel claim that this alternative solution would not generate CO₂ accumulation. However the life-cycle assessment of the full process should be considered (Giampietro et al., 2005). Furthermore, the potential of reducing GHG emissions from liquid biofuels vary widely by region and the technology available. With the current commercial technologies, Brazilian ethanol produces the largest savings estimated to be up to 90% of GHG emissions compared to fossil fuels. Maize based ethanol production produces far lower reductions of around 13% (GBP, 2007). CGIAR's research on biofuels (2008) shows that ethanol from sugar beets and biodiesel reduce (40% to 50%), followed by soybean-based biodiesel and ethanol from starchy grains yields about 12% reduction.

To the contrary, others argue that if forests are removed for planting biocrops, reduction of greenhouse gases becomes unreal because the carbon-capturing forests are lost (Altieri et al., 2007). Two other studies have shown that changes in land use to produce crop-based biofuels can actually result in more greenhouse-gas emissions than burning fossil fuels. The studies estimate the impact of converting forests and grasslands into cropland for the production of biofuels. Both conclude that the resulting carbon emissions, released through decomposition or burning of biomass, create a 'carbon debt' that takes decades or even centuries to pay back. This finding undermines previous claims that substituting fossil fuels with biofuels should offset greenhouse gas emissions because biofuels restore carbon while they grow (Almeida, 2008).

Jack Riley, University of Nottingham, (2008) has commented that by harvesting biofuels, 30 times more carbon dioxide is released than will be regained when burning the biofuel produced. The ability of various biofuel types to reduce GHG emissions varies widely, and where forests are cleared to make way for new energy crops, the emissions can be even higher than those from fossil fuels (UN-Energy, 2007). Other studies have shown cases where fire has been used to clear new land for biofuels in China, Indonesia and Brazil resulting in reduced air quality, and fossil fuels are often used to generate process heat in the production of biofuels (Peskett et al., 2007). Situations such as conversion of forests and peatlands to biocrop lands would actually create huge 'carbon

debt' that will take many years to centuries to repay.

Due to the above stated reasons, it has been suggested that the EU's governments should not apply tax incentives to biofuels if their production involves the emission of more greenhouse gases than using pure fossil fuels (Cronin, 2007).

2.7.2 Deforestation and Loss of Biodiversity

Biofuels could have various benefits such as serving as windbreaks, restoration of degraded areas by planting biocrops in the marginal areas (Matthews, 2007). When looking at it from a different angle other studies indicate that plantation of biocrops could lead to deforestation by degrading the land and water that most poor people depend on (Braun et al., 2006).

In order to substitute at least some amount of fossil fuel with biofuels over millions of acres of land are required. This issue has arisen the question where to grow these biocrops? Land that should have otherwise been used for other crop plantation will be used for planting biocrops that are used for producing biofuels (Ibid). The case of South America can be taken as a good example that has caused the destruction of 91 million acres of forests and grasslands in Brazil, Argentina, Paraguay and Bolivia to plant soybeans for the production of biodiesel displacing large numbers of small scale farmers. In order to satisfy the world's market demands, Brazil alone will need to clear 148 million additional acres of forest (Altieri et al., 2007).

In order to increase the production of biofuels vast agricultural lands are needed and to provide the required land forests will be removed to change them into industrial farms, which causes deforestation affecting the natural ecosystem. Even if to plant shrubs such as castor seed there is a need to clear forests and make way (Berhe, 2007).

Biofuel areas could serve as the habitat for native biodiversity and a range of ecosystem services (Matthews, 2007). In addition, if the crops are planted in marginalized lands it could improve the biodiversity bringing out positive effects on the environment (Woods et al., 1994). In another study, it has also been mentioned that the use of perennial species such as trees for bioenergy may create more favorable habitats for biodiversity compared to conventional crop production (GBP, 2007). On the other hand, in another research Braun et al., (2006) argued that it causes loss of biodiversity. Even taking the case of Ethiopia, environmentalists argue that to develop the biofuel sector in a vast chunk of land, there will be the destruction of biodiversity, the flora and fauna (Wudneh, 2007).

David Hill (2008) has stressed that growing biofuels take a lot of land and huge amount of water neither of which the world has to spare.

CGIAR's research (2008) on biofuels states that the expansion of cropping to marginal lands results in a significant increase in erosion, ecosystem degradation and loss of biodiversity. Moreover, other studies have shown that biofuels could have negative environmental impacts if they replace wild forests or grasslands. These potential negative impacts include eutrophication of water bodies, acidification of soils and surface waters, and ozone depletion as well as the loss of biodiversity. The loss of pastoral life styles and loss of feed production for domesticated and wild animals that depend on these lands, could have significant negative economic and social impacts (UN-Energy, 2007).

When situations such as displacement, deforestation and loss of biodiversity occur people who are mostly at risk are the ones who are the poorest and the most marginalized in the world. The export-oriented expansion of palm oil production in Indonesia that takes out natural vegetation could be taken as an example of deforestation (Hill, 2008). Others also argue that in Africa, Asia and South America, people are being driven from their land and forests as it is being cleared to make room for the booming biofuel industry (CNN, 2008). The chair of the UN Permanent Forum on indigenous issues recently warned that 60 million indigenous people worldwide face clearance from their land to make way for biofuel plantations. Five million of these are in the Indonesian region of West Kalimantan. In Colombia military groups are forcing people out from their land at gunpoint, torturing and murdering those that resist, in order to plant oil palms, often for biofuels (Oxfam, 2007).

2.7.3 Increased Use of Fertilizers

To grow the biocrops in the selected areas, farmers will be forced to use some amount of fertilizers to get the maximum yield from the crops. In some cases there will be excessive use of fertilizers and pesticides, thereby degrading the land and also affecting the environment (Braun et al., 2006). However the current rapidly increasing price of fertilizers can negatively impact on the optimum application, which will prevent the proper growth and development of the plant (Cloin et al., 2007).

Some studies show that many of the crops that are currently used as biofuel feedstock require high-quality agricultural land and significant inputs of fertilizers, pesticides and water (UN-Energy, 2007). In another study it was specified that the growing plantation of biocrops in the United States requires the use of fertilizers and processing as other food crops (Hill, 2008).

CGIAR's research on biofuels (2008) has indicated that reduction in water quality will occur because of the increased fertilizer and pesticide use with the currently available technologies and greater soil erosion from maize and other crops. In addition, it was mentioned that the increased levels of nitrous oxides released into the atmosphere from fertilizer use, is the single most important GHG output in the biofuels process. In addition a recent study shows emissions of N₂O from fertilizer use to grow energy crops were heavily underestimated previously. Even though biofuels are said to be environmental friendly, the increased use of fertilizers and pesticides could actually be a threat to the environment increasing the GHG emissions.

2.8 The New Biofuel Development Strategy for Ethiopia

The Government of Ethiopia has given due attention to develop biofuels in Ethiopia due to the current skyrocketing prices of oil in the world. Ethiopia having a favorable climatic condition has the potential to develop biofuel crops. The main objective of the development strategy of biofuels is to reduce Ethiopia's future reliance on external energy sources (mainly petroleum fuels), and to reduce poverty in the rural areas by creating employment opportunities to out growers and contract farmers for biodiesel and ethanol production. Besides, this new assessment of Ethiopia's potential for biofuels development encourages potential investors. This strategy is designed by different stakeholders/institutions (Ministry of Mines and Energy, Ethiopian Petroleum Enterprise, Ethiopian Rural Energy Development and Promotion Center, Fincha Sugar Factory, Ethiopian Forestry Research Institute and Crop Production and Protection of the MoARD) working together.

The major constraint in developing biofuel (specifically biodiesel) in Ethiopia is generally lack of adequate expertise and skills. The effort that was made here so far is unsatisfactory due to lack of awareness, policy and regulations, trained human resource and research and development. The major issues that are incorporated in the strategy were creating awareness to local producers, land demarcation for feedstock growing sites, capacity building, policy and regulation, research and development, sustainable biofuel development, infrastructure, and financing.

The strategy developed is based on the basic understandings that biofuel programs meet the national imperatives including job creation, rural development, human resource development and economic growth, build programs that will bind existing national scientific and technological competencies, and also address energy security and environmental issues. In addition, *Jatropha* along with castor seed, palm oil and animal fat was recognized as the potential principal feedstock for biodiesel production while sugar cane for ethanol production in Ethiopia.

It has also been included that feedstock production for biofuels must ensure the environmental sustainability in such a way the natural resources are conserved, the forest ecosystem is protected, sustainable crops and management practices are encouraged, degraded lands are improved and the benefits of GHG reductions are maximized. Additionally, while processing, distribution and end use of biofuels issues such as developing licensing procedures, promotion of use of renewable energy, encouraging rapid transition to high-blend fuels and range use of biofuels should be taken into consideration. The roles and responsibilities of different government organizations are set in order that they will work together and develop capacity at different levels. Research and development are encouraged since they are needed to understand the possible impacts and develop a sustainable biofuel program.

Recommendations that were included in the strategy were awareness creation and promotion of biofuels, direct government support for bioenergy programs, update the existing national energy policy or enact new biofuel policy, develop master plan for biofuel, allocate special financing modalities, encourage demonstration, link biofuel development program with extension service, encourage investment in infrastructure development and maximizing rural development benefits (MoME, 2007).

Moreover, it has been reported in Fortune newspaper (March 30, 2008) that the Ministry of Mines and Energy has established a forum on March 28, 2008 that enables it to implement the biofuel development and utilization strategy. On the forum the major discussion was on issuing a directive that guides the execution of the strategy with diverse stakeholders. The forum's members include representatives from Quality Standards Authority, Ministry of Trade and Industry, Ministry of Transport and Communications, Agricultural Research Institute, Sugar Development Agency, Ministry of Revenues and Environmental Protection Authority (Wudneh, 2008).

2.9 Conceptual Framework

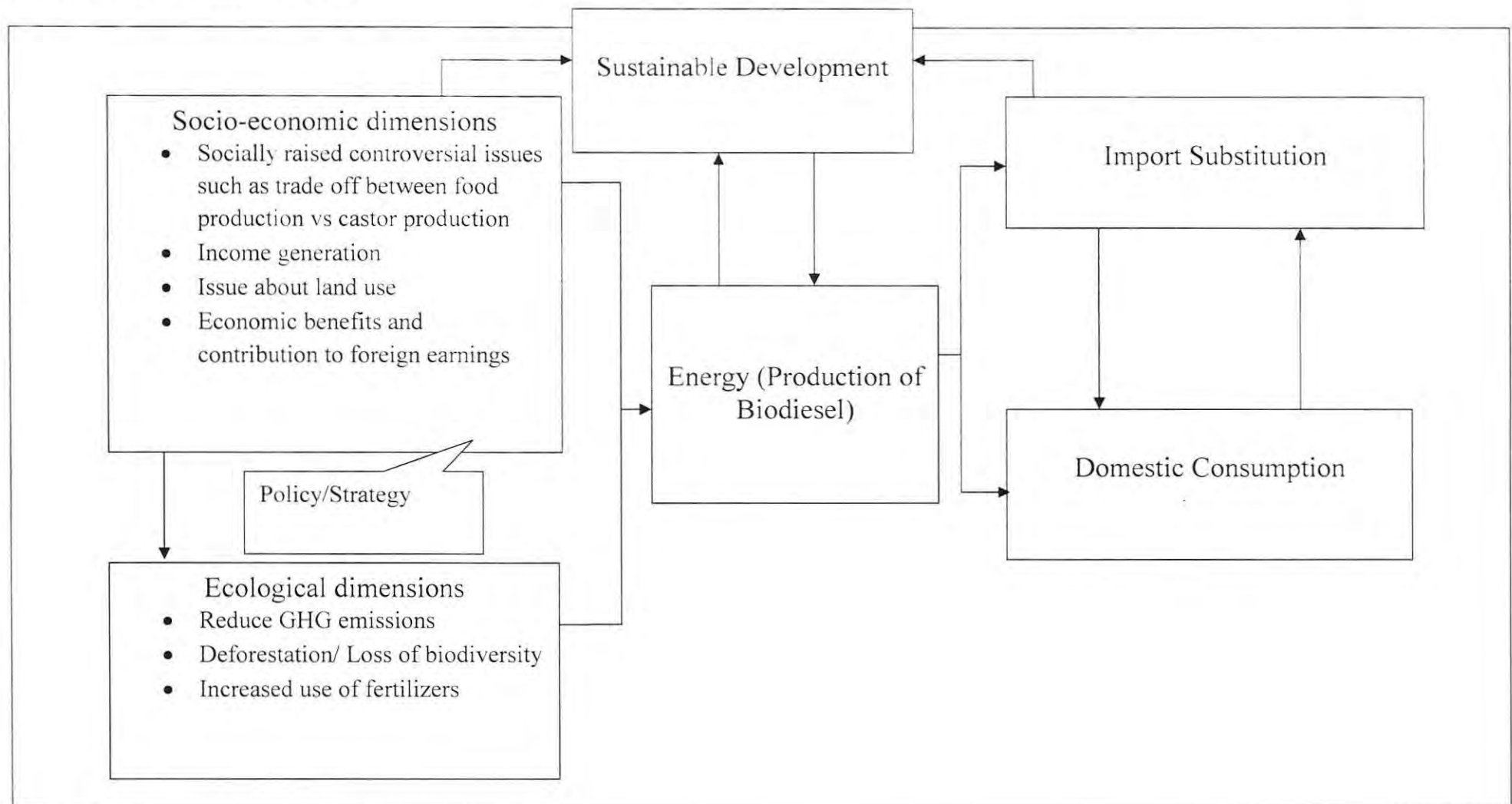


Figure 2-1: Conceptual Framework
Source: Own formulation

The conceptual framework or the above figure (Figure 2-1) clearly shows both the socio-economic and ecological dimensions in developing biofuels. These socio-economic benefits and challenges include socially raised controversial issues such as the trade off between castor production vs food production, income generation, issues about land use, economic benefits and contribution to foreign earnings. The ecological dimensions are reduction of green house gas emissions, deforestation, loss of biodiversity and increased use of fertilizers and etc. By taking all these dimensions and new policies and strategies designed to promote biofuels into consideration energy (biofuel) can be produced in a sustainable manner bringing sustainable development. The locally produced energy could contribute to substitute the imported energy supply by saving large amount of money and also be used locally/ domestically by the farmers and also the community.

3 Description of the Study Area and the Project

3.1 Description of the Study Area

3.1.1 Location and Population

The study area is located in Eastern Hararge around 560 kms from Addis Ababa, in the Oromia region, which is the largest and most populous of Ethiopia's nine regional states. Eastern Hararge zone is geographically located between 7° 32' - 9° 44' North latitude and 41 ° 10' - 43° 16' East longitudes. The Oromia region covers over 32 percent of the country's total land area and is home to at least 23 million people (This estimate is based on a projection made by the 1994 National Census). Eastern Hararge has an area of 24,247.66 square kilometers with an estimated population of 2,555,600 in which 87.4% reside in rural areas and the remaining 12.6% are urban residents. The crude population densities of the district have shown from 95 person/km² of an area in the year 2001/2002 to 112 persons/km² of an area in the year 2005/2006 (RSOEHZFEDO, 2007).

Babille, Fedis and Midaga are 3 of the 180 *woredas* (districts) in Oromia in which FloraEco Power Company (FEP) has started operating and the 3 *woredas* joined represent about 7,270 square kilometers with 280,264 inhabitants (FEP, 2007). The study area is located in the Babille district which lies between 8° 9' and 9° 23' North latitude and 42° 55' East longitude. The elevation of the study area ranges from 850m up to 1750m above sea level (EHPEDO, 2001). Babille *woreda* has a total area of 3,169.06 km² and a population of 80,215 in 2001/2002 and 88,158 in 2005/2006 (RSOEHZFEDO, 2007).

3.1.2 Topography and Soil Type

In general, the geological formation of the zone can be categorized into Precambrian rock, Mesozoic rock and Cenozoic rock. The adigrat sandstone is found in Babille district and the major soil types are calcic and vertic cambisols, rendzinal soil, vertic luvisols, calcareous and eutric fluvisols, eutric regosols, mollic andosols, chromic vertisols, luvic phaeozems, lithosols, orthic solonchak and other rankers (Ibid).

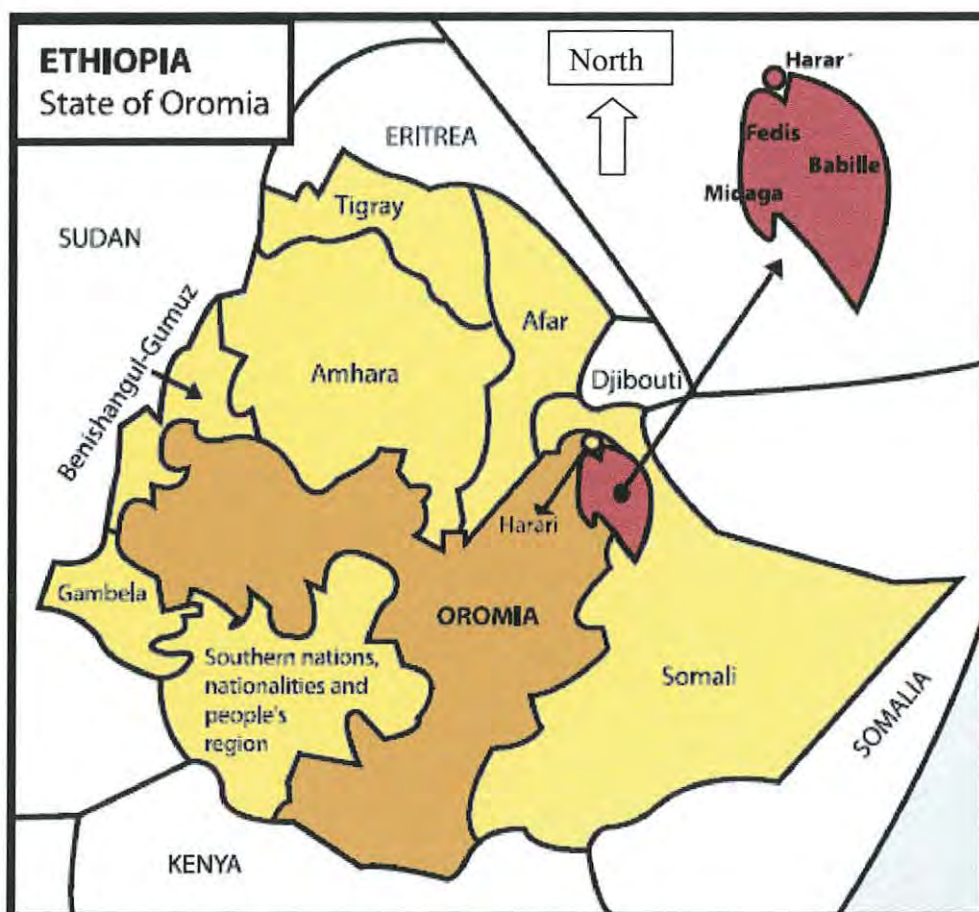


Figure 3-1: Map of the Study area

Source: FEP, 2007

3.1.3 Climate

According to the Ethiopian agro-ecological division the Babille district is classified as *woinadega* and *kola* agro-climatic zones, covering 15% and 85% of the total area of the district respectively. The *kola* agro-climatic zone consists of arid and semi arid climatic conditions. The mean annual temperature is about 19.6 °C, ranging from a mean minimum of 11.9°C to a mean maximum of 27.2°C. There is only a slight difference in temperature throughout the year, with the hottest months from April to June (maximum 29°C) and the coldest months during October to December (minimum 7.8°C). The mean annual rainfall is 702.9mm per year, with high variation from year to year, ranging from 451.7mm to 1115.9 mm year. Rainfall is bimodal occurring from March to April (short rain season) and June to September (long rain season) (EHPEDO, 2001).

3.1.4 Infrastructure

3.1.4.1 Transport

Transport and communication are the most important elements for the economic development of any region of a country facilitating economic and social interactions between regions and people. Assessing the transport situation of the Eastern Hararge zone, in the year 2005/2006 there were 132 kms of asphalt road from Harar to West Hararge zone boundary, 160 kms of all weather gravel road and 514 kms of rural road. In total there is 803 kms of road in the zone, with a total road density of the zone being 0.0355km/km^2 . The road network in the zone is underdeveloped. The vast areas of southeastern parts (especially in the low lands) of the zone remained inaccessible by means of modern road transport facilities. The main road transport density of the zone is mainly confined to the northern highlands of the zone, which has a relatively high population density, better level of urbanization and economic activities (RSOEHZFEDO, 2007).

3.1.4.2 Communication

Regarding telecommunication services in the zone, mobile and wireless telecommunication service were provided for the majority of peasant associations in the zone. The mobile phone and wireless telephone service is under expansion to cover large areas. The capacity of the Babilie *woreda's* telecommunication service was 592 of which 562 lines were already subscribed (Ibid).

3.1.4.3 Potable Water Supply

East Hararge is characterized by shortage of potable water. There are few springs in the low lands of the zone where the primary concern of the community becomes the availability of water regardless of its quality. In the mid and high lands the existing springs were drying up from time to time. The increasing deforestation have degraded the natural environment and aggravated the loss of water and soil in these areas and has thus in turn reduced the quantity of water conserved from precipitation (rainfall) reducing the level of water and the discharge of springs in the area. That ultimately aggravated the water shortage in the zone (RSOEHZFEDO, 2007).

In the year 2001/2002 there were 355 hand pumps, 53 bore holes, 200 springs and other 49 schemes in the zone. While in the year 2005/2006 there were 510 hand pumps, 92 motorized bore holes, 337 springs and other 167 water schemes. Plus in the same year the urban, rural and

total (rural and urban) water coverage of the zone are 76%, 41.32% and 43.4% respectively. In Babille *woreda*, the urban population supplied with potable water is 7,940 (54%) and 68,000 (78.6%) in rural areas with a total number of 75,940 (75%) (Ibid).

3.1.4.4 Energy Supply

The rural population of the zone largely depends upon crop residues, firewood and animal dung. Likewise, the urban population also depends upon firewood and charcoal for their domestic energy supply. In urban areas firewood and charcoal are the major source of energy followed by fuel and electric energy. Electric energy is used mainly for light while in rural areas firewood and crop residue are the major source of energy (Ibid).

3.2 Description of FloraEco Power's Project

FEP's project has started operating in February 2007 with an investment of 671 million birr. Today FEP's project in Oromia counts over 40 foreign workers, 15 skilled Ethiopian employees in the office and administration, 101 graduated agronomists and 25 assistants, 65 machines operators and drivers, more than 3000 unskilled local workers for daily labors, and 4000 farmers involved in community farming project. Farmers in the *woredas* prepare the land, plant castor, can intercrop groundnuts and sell the harvested product to the company. The company provides the farmers with seeds, fertilizers and pesticides. The project covers Babille (around 1100ha and 1350 farmers), Fedis (around 1200ha and 1300 farmers) and Midaga mainly governmental lands (around 2100ha and 1100 farmers) (FEP, 2007).

Even though the farmers are situated in the three districts the oil mill factory, the R&D department and the store of the logistic department are located in the town of Fetchatu, which is a strategic place, 1hour far from Harar, and in a junction connecting Fedis and Midaga. The factory in Fetchatu is dedicated to extraction of oil out of castor seeds that have been harvested in the 3 districts by the farmers. The factory includes 3 main buildings: the first one to crush the seeds and extract about 80% of the oil, the second building by different technical processes enable to extract the 20% oil left, the third building is to create a steam that produce energy for the factory. This oil will be sent to European refineries through Djibouti to be turned into biodiesel (Ibid).

4 Methodology of the Study

As the proposed major objectives of this study is to examine the challenges and opportunities of developing biodiesel from castor seed, the study follows both qualitative and quantitative methods. The details of the methodology are explained below.

4.1 Research Strategy

The socio-economic and ecological dimensions of developing biodiesel were investigated by employing a research strategy. Strategies associated with both qualitative and quantitative approach were employed for inquiry. These strategies are proposed because both are important to identify the challenges and opportunities of developing biodiesel from castor seed and to apply relevant instruments that elicit answer for the proposed research questions.

4.2 Sampling Procedure

Due to time and resource limitation sampling was used to select the representative sample. The study employed two-stage sampling procedure where at the first stage selection of *kebeles* and at the second stage selection of sample farmers was employed. Detailed description of the selection follows below.

4.2.1 Study area Selection

Among the three *woredas* (Babille, Fedis and Midaga) at the project site one *woreda* (Babille) was thus selected according to its accessibility and area development (road availability). From the selected *woreda*, Babille, two *kebeles* were selected randomly. To facilitate the selection process discussion was made with the *woreda's* district department and FloraEco Power.

4.2.2 The Study Population, Sampling Method and Sample Size

The total population of the study in the selected *kebeles* was the list of farmers who are working with FEP to produce castor seed, which was received from the company. As to the sample size determination, among the different methods, one, which has been developed by Carvalho (1984), as cited by Zelalem (2005) was used. The method is presented in the table 4.1 below.

Table 4-1: Sample Size Determination

Population size	Sample Size		
	Low	Medium	High
51-90	5	13	20
91-150	8	20	32
151-280	13	32	50
281-500	20	50	80
501-1200	32	80	125
1201-3200	50	125	200
3021-10000	80	200	315
10001-35000	125	315	500
35001-150000	200	500	800

Source: Zelalem 2005

Taking into account the homogeneity of the sample farmers and resource limitation, a low sample size was applied in accordance with the given population size. A sample size of 90 was selected from the population on the basis of systematic sampling. However, due to some problems encountered in filling the questionnaires only responses from the 80 respondents were found to be valid and are the ones that are considered and analyzed.

4.3 Data Source

Data was generated from both primary and secondary sources of data. Primary sources of data include the use of questionnaire for the selected farmers and checklists for key informants interview (KII) and focus group discussion (FGD). Secondary data sources were assessed to support the data collected from primary sources with the use of different articles, journals, documents, the project document, *woreda* agricultural and rural development office, EIAR, EPA, MoME and etc...

4.4 Data Collection Techniques and Procedures

4.4.1 Data Collection Techniques

Survey - A structured questionnaire (interview schedule) was prepared to collect information from the farmers who have participated in FEP's project and grow castor in the selected *woreda*. The questionnaire was made to incorporate the most important socio-economic and ecological dimensions related to developing biodiesel from castor seed.

Key Informants Interview (KII) – Check list (in-depth interview) was prepared to guide the questions for gathering information from the project manager, environmentalists, experts, *woreda* representatives, and economists. Ten key informants were interviewed as indicated in annex-1.

Focus Group Discussion (FGD) – A focus group discussion was conducted with local elders, non-producers and women (a group of seven in each category) in the selected *woreda* giving due attention to their homogeneity and specific experience for the topic under investigation.

4.4.2 Data Collection Procedure

First, official contact was made with the FloraEco Power Company to get permission and support for the research work. Furthermore a visit was made to the selected *woreda* to become familiar with the local leaders and elders and a preliminary survey was affected to gather general and empirical figures of the selected study area. In addition, the visit helped to get information that was used as an input for subsequent preliminary planning and sample selection tasks.

The enumerators who conducted and collected the data were trained on the interviewing techniques and the subject matter of the study. Next, prior to the actual data gathering, the questionnaire was pre-tested taking respondents from the farmers to check the clarity and simplicity of the questionnaire. After completion of the pre-test, the responses were checked whether the respondents understand the questionnaire properly and the intended information could be gathered. The pre-test also served the candidate to estimate the average time required to fill out the questionnaire. On the basis of the feedbacks from the pre-test, some amendments were made to the previously designed questionnaire.

4.5 Data Analysis

Following the successful completion of data collection the data was edited coded and entered into SPSS software and analyzed. The study was carried out at two levels of analysis that is at the qualitative and quantitative. As to the quantitative, the detail accounts of descriptive statistics were used.

The qualitative information (responses of the FGD and KII) was analyzed, verified and applied to draw inferences and conclusions. Each qualitative analysis was integrated with the quantitative analysis under the discussion of each sub-heading.

5 Results and Discussion

The data collection was conducted in Eastern Hararge, Babilie *woreda*, in the randomly selected two *kebeles* Iffa and Tulla, which is found 600 kms from Addis Ababa. The sample size was 80 farmers who all are engaged in castor production and are working with FloraEco Power (FEP) company.

In this section, the data that was collected has been coded edited analyzed and interpreted. This chapter is divided into five different sections. The first section comprises of background characteristics of the study population including the demographic characteristics. The second section outlines the socio-economic characteristics and farm activities including castor production. The third section shows the institutional characteristics, which indicates the farmers' relationship and work arrangement with the company. The fourth section largely indicates the socio-economic dimensions of developing bio-diesel with different sub-parts that includes the socially controversial issues such as the trade off between food security and castor production, job opportunity, income generation, economic benefit/growth and contribution to the foreign earnings/import substitution/export potential. The fifth section includes the ecological dimensions of developing bio-diesel namely green house gas emissions, issues about land use / deforestation/ increased land use for planting castor seed/ loss of biodiversity, and increased use of fertilizers. An attempt has been made to include the relevant issues regarding the above mentioned dimensions.

5.1 Background Characteristics of the Sample Households

5.1.1 Demographic Characteristics

Gender and Marital Status of sample farmers

In most families worldwide, women have a specific role as primary caretakers of the house. As it has been learnt from the focus group discussion with key respondents, there are many women who are engaged in the program in different tasks and positions. Women are very powerful in the community. They understand the economic benefits quicker, and they are very good at marketing, convincing and influencing the other community.

Women engage in a variety of farming activities that include land preparation (ploughing) together with men, farming in rows, harvesting, and watering the plants. Moreover women in the study area know how to save money and they are the ones who have benefited most in the program.

Table 5-1: Sex and marital status of the sample farmers

Sex of sample farmers	N	Percent
Male	70	87.5
Female	10	12.5
Total	80	100
Marital Status of sample farmers	N	Percent
Married	70	87.5
Widowed	8	10
Divorced	2	2.5
Total	80	100

Source: Survey data: 2008

However, as it can be seen from the table above (table 5.1) out of a total number of 80 sampled farmers, 70 were men and only 10 were women even if there are many women who are engaged in the program. The table also shows that the largest percent (87.5) of the farmers were married, 10% widowed and the remaining that is 2.5% were divorced.

Educational Status

Table 5-2: Educational Status of the sample farmers

Educational Status	N	Percent
Not Literate	30	37.5
Primary	46	57.5
Secondary	4	5.0
Total	80	100.0

Source: Survey data: 2008

Education is an instrument for facilitating the progress of development by creating an educated, trained and skilled manpower resulting in a more productive society that contributes for the development of a country. When the educational level of the farmers was assessed more than half (57.5%) of the respondents were found to have completed their primary education. The second largest percentage of the respondents (37.5%) was found to be illiterate, and the remaining 5% have completed their secondary education (Table 5.2).

Household size and Division of labour**Table 5-3: Division of labour between male and female**

Activities	Male N (%)	Female N (%)	Both N (%)	Total N (%)
Ploughing	76 (95%)	1 (1.25%)	3 (3.75%)	80 (100%)
Planting	72 (91.25%)	1 (1.25%)	6 (7.5%)	80 (100%)
Weeding	42 (52.5%)	8 (10%)	30 (37.5%)	80 (100%)
Harvesting	67 (83.75%)	1 (1.25%)	12 (15%)	80 (100%)
Marketing	18 (22.5%)	44 (55%)	18 (22.5%)	80 (100%)

Source: Survey data: 2008

The average household size in the sample households is 6, which is above the national average family size of 4.9 persons per household (CSA, 2001). Family size determines the labour division between family members and in most cases the more labour in a household the more productive the household will be. The farm division of labour between male and female (table 5.3) shows that 91.25% and 83.75% of the respondents have indicated that planting and harvesting is done by men respectively. Ninety five percent (95%) of farmers mentioned that ploughing is done mostly by men while 55% of the respondents indicated that marketing activities are done by women. Half of the farmers (52.5%) have stated that weeding is done by men and 10% have mentioned that it is done by women while 37.5% have stated that it is done by both men and women.

5.1.2 Socio-Economic Characteristics and Farm Activities**Major Source of Income**

The major source of income in the specific study area is farming and the major crops are maize, sorghum, peanuts and *chat*.³ The farmers' livelihood is based on diversity meaning they do not depend only on one type of crop rather produce different crops as it is shown in the figures below.

³ Chat- a mild stimulant plant whose leaves are chewed by some people in East Africa and Arabian Peninsula

Figure 5-1: Farmers Income from Peanut Production (2005-2007)

Source: Survey data: 2008

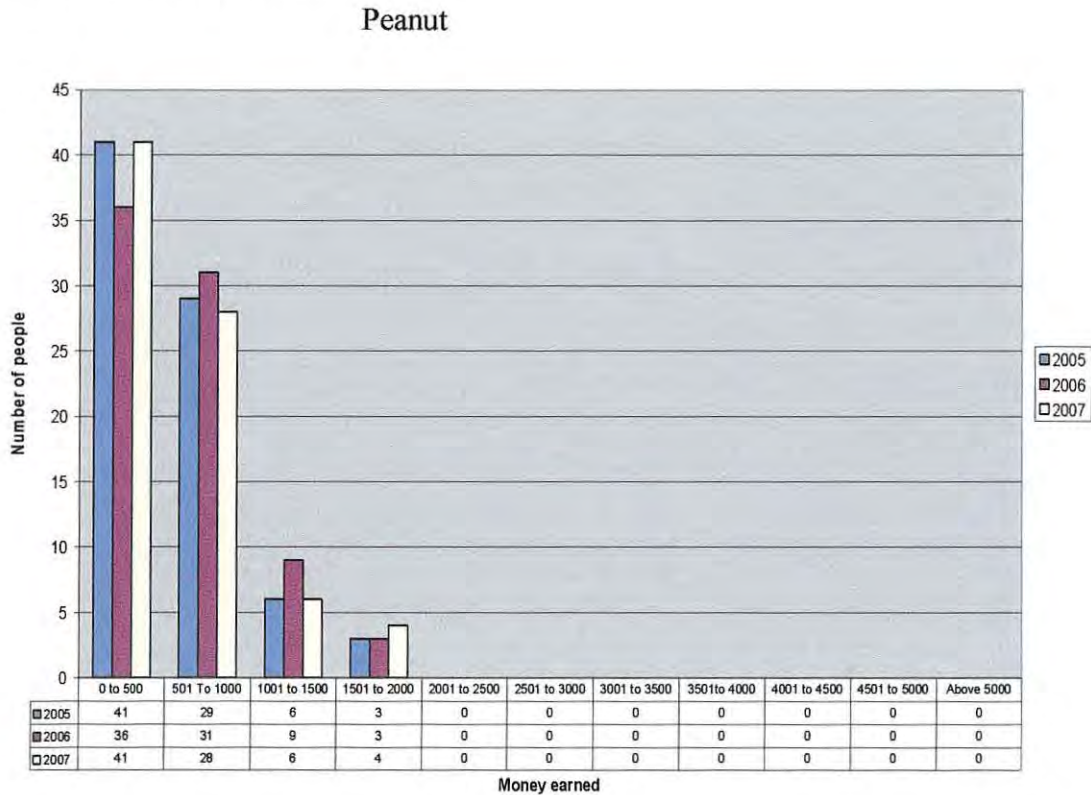
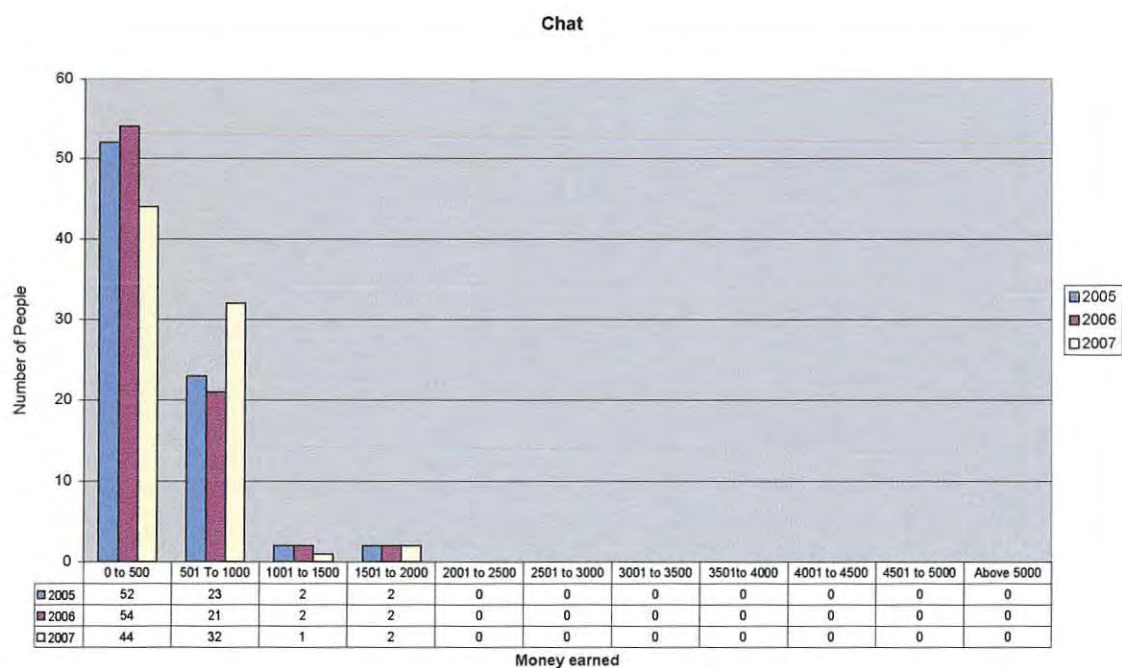
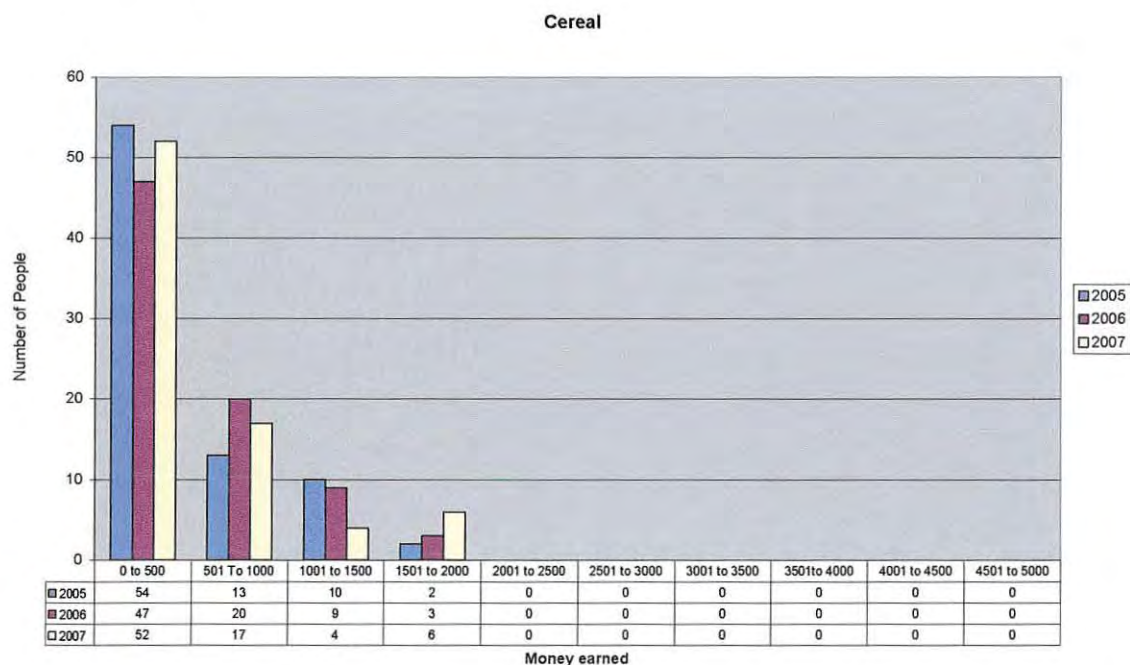


Figure 5-1 shows the farmers' income in the last three years with one of the major crops produced in the area (peanuts). The graph shows the number of farmers who produce peanut and the amount of money earned from the production of the specific crop. Figure 5.2 and 5.3 below also show the income earned from the production of cereals and *chat* respectively. These graphs indicate that farmers are engaged in the production of the major crops, which shows that their subsistence is based on diversity that will not make them dependant on one type of crop.

Figure 5-2: Farmers income from cereal production (2005-2007)

Source: Survey data: 2008

**Figure 5-3: Farmers income from chat production (2005-2007)**

Source: Survey data: 2008

Farm experience

Table 5-4: Farm Experience of the sample farmers and the time they started living in the area

Farm experience	N	Percent
Less than 5 years	6	7.5
Between 5 to 10	6	7.5
More than 10 years	68	85
Total	80	100.0
Farmers started living in the area	N	Percent
Was born here	72	90
Ten years ago	6	7.5
One year ago	2	2.5
Total	80	100.0

Source: Survey data: 2008

The majority (85%) of the farmers has more than 10 years of farming experience and 7.5% have an experience of 5-10 years. The rest 7.5% have less than 5 years of experience. Most of the farmers (72 out of the 80) i.e. 90% were born in the same area they are farming now. Six farmers (7.5%) have moved into this region ten years ago and only two (2.5%) came to this area a year ago. This indicates that these farmers have been engaged in farming for a long time and the new experience of producing castor has not yet motivated others to migrate and start working in the specific *woreda* (table 5.4).

Land ownership and Land size

Table 5-5: Land ownership of the sample farmers

Land ownership	N	Percent
Own land	79	98.75
Rent in	1	1.25
Total	80	100.00

Source: Survey data: 2008

Land is a key resource especially in rural areas of which the majority's life depends on farming and other farming activities. Regarding land ownership, almost all (98.75%) have responded that they own land and only one farmer (1.25%) indicated that he has rented the land (table 5.5). The average size of the land owned by the farmers in the study area is 1.57 hectares where the minimum is one hectare and the largest five hectares.

Livestock Ownership

Table 5-6: Livestock owned by the sample farmers

Livestock Type	Number
Goat	369
Ox	222
Sheep	207
Cattle	180
Chicken	164
Camel	48
Donkey	33
Beehives	7

Source: Survey data: 2008

Livestock is another source of income in the study area, which supplements the farmers' major source of income, which is crop production. Even though the farmers are hesitant to clearly indicate the number of livestock they own they have tried to show how much they have (table 5.6). Goats are the largest number of livestock, the next being ox and followed by sheep, cattle and chicken respectively. Some farmers have fed castor to their livestock thinking it will fatten them without knowing that it will choke them and as a result some have died. Farmers were suspicious about livestock compatibility with castor until they received some training regarding castor and the livestock they breed. The extract of castor after processing is a potentially valuable animal feed.

Crop production

In the study area farmers engage in different crop production. However, the major crops that are produced by the sample farmers are maize, sorghum, peanuts and chat.

5.1.3 Castor Production

"Castor is a suitable crop for production in moisture stress and short season areas. It is also suitable as a rotation crop for sorghum, maize, peanut, sesame and haricot bean as it is not infested with diseases that infest these crops. Although castor is tolerant to moisture stress it is also suitable for irrigation" (Getinet et al., 2008:12). Castor is a suitable crop for, Babille, the study area, which is evergreen with an average rainfall. In this area castor is intercropped with

other crops such as maize and sorghum. Conditions of soil being very fertile and thick and with an average rainfall much product can be harvested from $\frac{1}{4}$ hectares. Castor is harvested in 3-4 months time if planted on an irrigated land but depends on the amount of water, soil materials, and seed variety.

Table 5-7: Type of castor seed used by the sample farmers

Type of seed	N	Percent
Local	4	5
Improved seed	76	95
Total	80	100

Source: Survey data: 2008

All farmers received their seed from FEP, while the majority 95% has used improved seed and only 5.1% used the local seed and all of the production was rain fed (table 5.7). These improved seeds are imported from abroad and this was identified by EIAR as one of the challenges of using castor seed for biodiesel in Ethiopia as the improved seed has less oil content than the local seed resulting in lower yield.

Table 5-8: Amount of castor harvested in quintals

Amount of Castor Harvested in Quintals	N
1 to 4	44
4 to 8	8
8 to 12	12
12 to 15	9
> 15	7
Total	80

Source: Survey data: 2008

All farmers interviewed who produce castor indicated that they joined the program in the beginning of 2007. The mean hectare of land allocated for castor production was found to be 0.55 hectares with a standard deviation (SD) of 0.64. Due to the difference in the land size the farmers have allocated for castor production, the quantity of castor harvested also differs (table 5.8).

Table 5-9: Constraints in producing castor in the area

Constraints faced in producing castor	N	Percent
Shortage of labour	17	21.25
Shortage of input	28	35.00
Shortage of information	6	7.5
Market problem	11	13.75
Compatibility with the area	18	22.5
Total	80	100.0

Source: Survey data: 2008

The main constraint of producing castor in the area was found to be shortage of inputs (35%). These farmers could not invest in farm inputs for different reasons, lack of capital being the major one. The second largest percentage (22.5%) indicated compatibility with the area, and 21.25% indicated that shortage of labour to be constraints of castor production. The 13.75% of the farmers have confirmed that the constraint was a market problem because they sell the harvested castor to only one buyer (the company) at a fixed price. If there were other buyers, farmers would have negotiated price when other food prices have gone up. The remaining 7.5% have indicated that it was shortage of information about castor production since it is a new crop practice in the area (table 5.9).

In addition to the above constraints limited land size, shortage of money and lack of knowledge and information were some of the problems to sustain and expand the castor farm. If these problems were solved farmers could produce more castor and obtain more income.

Table 5-10: Perception of Farmers about the Major Purpose of Castor Production

Major Purpose of Castor Production	N	Percent
Biodiesel production	5	6.25
Use of light	25	31.25
Use the oil as fuel	50	62.5
Total	80	100.0

Source: Survey data: 2008

Farmers were also asked the major purpose of castor production in order to investigate their knowledge about castor for biodiesel production. As 62.5% of the respondents believed the major purpose was to use the oil as fuel followed by using the oil for light (31.25%) and the

remaining (6.25%) for biodiesel production (table 5.10). This shows that farmers have been informed and are aware of the use of castor.

5.1.4 Institutional Characteristics

Contractual Agreement

The *woreda* agricultural office, which is a government institution and FEP are the major institutions working with farmers in the area. However major emphasis will be given to the company (FEP) that is working on biodiesel production from castor seed. Some of the farmers stated that they had contact with FEP through government, while the others mentioned through extension workers. The farmers confirmed that they have joined the program in the beginning of 2007.

Farmers use their own land to grow castor and the grower is responsible for land preparation and can intercrop castor with groundnuts. The company provides the farmers with fertilizers and purchases the harvested seeds. FEP provides the seed, pesticides along with the fertilizers for free for the first season. However in subsequent seasons farmers have to buy with the market price and/or can buy with credits. The average sale price is 2,000 *Birr*⁴ per hectare for 800-900 kgs of castor seeds produced in one season. There will be 20% increase (bonus) on the price per ton beyond 5 tons per year. There is a guarantee of 70% of the 2000 *Birr* per hectare for the first year only (FEP, 2007). Farmers will join the program once they have agreed to produce castor and sign a contract with the company. Farmers are paid when they have delivered the harvested castor and have their own right of deciding the size of land they allocate for planting castor. However, payment has been delayed for the farmers who have already delivered the harvested seed.

The Research and Development department of FEP is trying to provide the best seed variety for the farmers to get the best product. Given that castor production is a new practice in the area, FEP takes every castor that is harvested by the farmers regardless of its quality.

With a focus group discussion held with non- producers, (who are farmers in that same area but not producing castor) different issues have been raised regarding the contract, and have declared

⁴ *Birr*- the basic unit of currency of Ethiopia

that the company is deceiving the farmers breaking the contract with them. The farmers are supposed to get 2000 birr upon delivering the whole harvested amount and 1,400 birr i.e. 70% as a guarantee for those who did not collect the expected amount due to natural reasons but not personal. Non- producers have stressed that the company has paid the farmers less than that amount and has not yet solved the issue about the contract with the farmers. In addition, they have mentioned that it is not an easy task for the farmers to produce the expected amount.

In another focus group discussion conducted with women and the local community in the area it was found out that due to lack of sufficient rainfall, the amount of food crops produced including castor during the 2007 season has been very low. Most farmers have not produced the expected amount and have received only the 70% compensation due to the fact that the produced castor is not much.

Agronomists who are employed by the company and are working with the farmers stated that some farmers have negotiated with FEP that they will cultivate $\frac{1}{2}$ a hectare of castor. In reality they cultivated only $\frac{1}{4}$ of a hectare and for this reason, the payment was lower than agreed in the contract. These farmers are the ones who are not satisfied and complain. The non- producers listen to these farmers and conclude that the program is not functioning according to the contract. On the other hand, others who have produced the expected amount are happy with the payment they have received. Agronomists have also commented that non-producers complain about the program because they regret that they have not joined the program last year.

Compensation Mechanism

Table 5-11: Availability of compensation mechanism for the farmers

Is there a Compensation Mechanism	N	Percent
Yes	62	77.5
No	18	22.5
Total	80	100.0

Source: Survey data: 2008

Crop failure may occur for different reasons including crop pests and shortage of rainfall leading to drought. It is shown that 77.5% of respondents mentioned that there exists a compensation mechanism in case of crop failure. Twenty three percent (22.5%) stated that there is no compensation (5.11). As mentioned in the previous section it is confirmed from the company, it only pays compensation if the reason for failure is natural and not personal. Those farmers who

have indicated that there is no compensation for crop failure are the ones who have not clearly understand the contract or those without sufficient information. As a matter of fact, there are farmers who are paid with the compensation money since they did not harvest the expected amount due to shortage of rainfall in the past year.

Training for the Farmers and Market Arrangement

Table 5-12: Trainings received from FEP

Have you received a training from FEP	N	Percent
Yes	48	60
No	32	40
Total	80	100.0

Source: Survey data: 2008

Regarding trainings provided by the company, it was found that more than half of the respondents 48 (60%) have received training from the company when they started producing castor. However, 32 (40%) have pointed out that they have not received any training (table 5.12). This indicates that not all the farmers were given trainings or the system was unable to engage all the farmers. The company needs to ensure that all the farmers who are willing to produce castor are trained. The 48 respondents who have received the training stated that the kinds of training were agronomic such as row planting, cultivation, and on inter-cropping castor with other crops.

The demand and supply side is not balanced in the study area because castor is produced by large number of farmers and only one company, FEP, buys the harvested product. Most farmers mentioned that they do not know any other buyers than FEP when asked about the market arrangement. This could be considered as one of the major constraints as the farmers can only sell castor to the company and cannot negotiate prices. Since the farmers do not have enough information regarding the current market prices in other places, it was discovered that farmers are selling the castor below the market price. Farmers can obtain an average of 800-900 kg/ha of castor and the average selling price of castor per kilo was 3 *birr* last December (2007), which equals to an average of 2400-2700 *birr* while they have agreed to sell it only for 2000 *birr*. Payments for the farmers need to be revised and need to get paid more and on time.

Table 5-13: Sustainability of castor production if the company leaves the area and forming an association of farmers

What will happen if the company leaves the area	N	Percent
Continue the work	8	10
Plant other crops	65	81.25
Engage in other business	7	8.75
Total	80	100.0
Will you form an association	N	Percent
Yes	46	57.5
No	34	42.5
Total	80	100.0

Source: Survey data: 2008

Concerning sustainability of castor production in the study area, in case the company leaves the area the farmers will have to engage in other work or shift to other crop production since there is no other market for castor other than the company. Regarding the type of work they will engage in the majority (81.25%) of the farmers has mentioned that they would start planting other types of crops. Ten percent (10%) of farmers have reported that they will continue with the same work that is producing castor and the remaining 7 (8.75%) have said that they will engage in other business (5.13).

More than half (57.5%) of the respondents stated that they are thinking of forming an association of farmers without the company's involvement while the others 34 (42.5%) have not thought about it. Forming an association will help farmers to exchange information, share experiences among themselves and could help them if they want to continue the work.

5.2 Socio-Economic Dimensions of Biodiesel Production

5.2.1 Socially raised controversial issues: Trade off between Food Production vs. Castor Production

"Food security is on top of biofuel controversy, and the increase in food prices resulting from expanded biofuel production is also accompanied by a net decrease in the availability of and access to food" (CGIAR, 2008: 6). The practice of using food crops or the land for producing biofuels has raised some controversial issues, which includes competition with food production and is contributing to food insecurity. There is a strong debate regarding the issue of biofuel production compromising food security and it has been taken as one of the major cause for the current global food crisis. Most developed and developing countries which are producing biofuels from food

crops like maize, corn, and sugar cane will definitely compromise food production. Some scholars have commented that biofuel production could be taken as “taking food from someone’s plate” because it is competing with other food production. Using food crops to produce biofuel is not the only cause for compromising food security but also using the land for bio crops instead of food crops.

Table 5-14: Perception of the status of food crops price as associated with hectare allocated for castor production

Status of Food Crop Price has	Area covered by castor production in hectare (ha)						X ² statistics	Significance level
	0-0.5 ha		0.5-1 ha		> 1 ha			
	N	%	N	%	N	%	8.859	.065*
Increased	34	57.9	17	89.5	1	33.3		
Decreased	5	8.8	1	5.3	0	.0		
No Change	19	33.3	1	5.3	2	66.7		

Note: * Significant at 10%

Source: Survey data: 2008

Table 5-15: Perception of the status of food crops supply as associated with hectare allocated for castor production

Status of Food Supply has	Area covered by castor production in hectare (ha)						X ² statistics	Significance level
	0-0.5 ha		0.5-1 ha		> 1 ha			
	N	%	N	%	N	%	5.450	.244 (NS)
Increased	6	10.5	4	15.8	0	0		
Decreased	34	59.6	14	73.7	1	33.3		
No Change	17	29.8	2	10.5	2	66.7		

Note: (NS) Not Significant

Source: Survey data: 2008

In this study it was assessed whether planting castor seed has contributed to the rise in food prices in the *woreda* and also if it has compromised food supply, as it is associated with hectare allocated for castor production. Thus, the chi-square test showed that there is systematic association between food price increase and with an increased area allocated for castor production, at 10% probability level (table 5.14). This is probably due to the fact that the new practice of castor production in addition to shortage of rainfall has contributed to an increase in food crop prices. However, this needs a detailed analysis to conclude whether castor production has directly affected the price of food crops.

Other related issue with this was the status of the supply of food crops as shown in table 5.15. Even though farmers have allocated portion of their land, the statistical analysis shows no significant association between food supply and land allocated for castor production. Regarding the reasons for the decrease of food supply most have indicated shortage of rainfall has contributed for the production of less food crops, which has a direct effect on food supply. Since castor can be intercropped with other food crops castor production might not have a direct effect on food supply in this case.

It was revealed from the key informants interview that the production of peanuts (the major crop that is produced in the specific area) has increased in some places and at the same time has decreased in the other areas, which is attributed to different reasons other than castor plantation. Shortage of rainfall was found to be the major reason that needs special attention, which highly attributes to limited production and hinders the going development process. It has also been indicated that there is excess land in this *woreda*, which can be used for castor production along with other crops. The farmers in this area are using the method of inter-cropping, which will not compete with other food crop production.

In addition to the above findings in the key informants interview with experts there are some who argue that biofuel production will not compromise food production. Biofuels could have an incentive effect on food production and the land allocated to that purpose could have indirect positive impacts. Biofuel is an opportunity for others, is a means and can develop more agricultural products than compromising the production of food crops. Some crops might have an impact in the long term so this has to be critically thought about at first and if projects are not properly designed could have negative effects.

It has been mentioned in the key informants interview that these negative effects could be when more lands are used for biofuel production rather than food production but in Ethiopia's case it is most unlikely to happen for different reasons. "The size of Ethiopian land is 111.5 million hectare, out of this 74 million hectare or 66 percent of the total area is suitable for agriculture. However, the actual size of land cultivated is estimated to be only 16.5 million hectare or 14.8 percent of the total" (EENSLIM, 2004:6). If these lands are used Ethiopia will not only become self-sufficient but can also export large amounts of food to other countries. In a developing country of which the largest percentage of the total population is engaged in agriculture, biofuels could play a major role in increasing the country's income.

It was also mentioned that the 2003 drought period could be taken as one example where there was high food production prior to the drought but the farmers could not sell their products because there was no market or it was very cheap which forced them not to produce more food crops in the subsequent season. By taking all these factors into consideration it can be assumed that the farmers' production will not be affected in any significant sense. Still some precautions need to be taken not to compete with food crops enduring regulatory provisions to ensure that production of biofuels does not become disincentive to food production although no threats could be seen immediately or at the beginning.

In contrast to the above it has been learnt from other key informants interview that biofuel production could compromise food production. In order to produce sufficient crops for fuel production larger areas should be used to plant bio-plants and this in turn could compete with food crops that used to be planted in that same production unit (farm). Furthermore, if these bio-plants are planted in fertile lands there will be direct competition with food crops resulting in food shortage. While taking this specific project as an example, if farmers are producing castor in large areas instead of the sorghum or maize, which, they use for subsistence, they could compromise food production, causing food shortage leading to food insecurity.

Shifting to monocrop production is another factor that should be mentioned in the case of biofuel production. When farmers who are producing bio crops are getting more income, other farmers will be attracted and start producing the same crops which in turn causes a decrease in supply of food crops. Farmers in the study area are intercropping castor, which is a biocrop, with other food crops so shifting to monocrop culture has not happened thus far but could be a threat in the subsequent seasons.

Even though producing bio crops instead of other crops has a negative effect on food price and supply, the result shows that the increase in food price and supply of less food products in Babille *woreda* was mainly attributed to rain constraint in the past year, leading to lower food production and not necessarily due to the introduction of a new crop such as castor.

5.2.2 Income Generation

Traditional bioenergy provision is labour intensive and thus a significant source of formal and informal employment in developing countries (UN-Energy, 2007). Biofuel production is believed

to create job opportunity and increase the income of local producers. The major source of income as mentioned by all participants is farming and the other activities they have engaged in as mentioned by them are livestock production and sale of *chat* and animal products.

Table 5-16: Status on the Income of Households and Reasons

Income of the household	N	Percent
Increasing	34	42.5
Decreasing	29	36.25
No change	17	21.25
Total	80	100.0
Reasons for increasing household income	N	Percent
Cash crops' price hike	20	58.8
Hard work/more productivity	14	41.2
Total	34	100.0
Reasons for decreasing household income	N	Percent
Lack of water for irrigation	24	82.8
Low market prices for farm products	3	10.3
High cost of living	2	6.9
Total	29	100.0

Source: Survey data: 2008

Over the last year, 42.5% of the respondents believe that their household income is increasing but 36.25% believe that it has decreased and the remaining 21.25% have indicated that there is no change. Research has shown that cash crops' price hike benefit the producers but could be a threat to small farmers who purchase food crops. Out of 34 respondents who have stated that their household income is increasing 58.8% attribute the increase owing to cash crops' price hike which has helped them to sell their products in higher prices. The remaining 41.2% stated hard work and more productivity as a reason for their increased income in the past year. Inputs such as fertilizers and water are very important in order to receive higher yield. In the study area, of those who have indicated that their income has decreased the reasons they have given were lack of water for irrigation 24 (82.8%) accounting for a large percentage, low market prices for some farm products 3 (10.3%) and high cost of living 2 (6.9%) (table 5.16). Concerning the income of the farmers, less than half have indicated that it has increased while the majority has mentioned that it has decreased or no change has been seen due to the above mentioned reasons.

Table 5-17: Additional Income and Benefits for the Farmers

Has castor production created an additional income for you	N	Percent
Yes	52	65
No	28	35
Total	80	100.0
Have you received benefits from FEP	N	Percent
Yes	59	73.75
No	21	26.25
Total	80	100.0

Source: Survey data: 2008

For the larger percentage (65%) of respondents the castor farm has created an alternative income and 28 (35%) did not think that it has created an additional income for them. Those farmers who have said that it has created an additional source of income indicated that was possible because they were able to intercrop castor with other food crops such as peanuts.

Seventy four percent (73.75 %) of the farmers pointed out that they have benefited from FEP but the remaining 26.25% said that they have not benefited from the company. When they were asked about the type of benefit from FEP, they stated the additional source of income and the compensation they received even if they have not harvested the expected amount as a benefit (table 5.17).

Table 5-18: Farm's Linkage with Non-Producers

Does the farm has direct linkage with non-producers	N	Percent
Yes	62	77.5
No	18	22.5
Total	80	100.0
Type of linkage with non-producers	N	Percent
Labour	44	71.0
Service	12	19.4
Transportation	6	9.6
Total	62	100.0

Source: Survey data: 2008

Crop plantation for biofuel production benefits both skilled and unskilled workers in the area it is being planted. Farmers who produce the bio-crop will benefit directly and others who are employed for other related jobs will be indirect beneficiaries of the programme. As indicated in table 5.18,

77.5 % of the farmers confirmed that the farm has direct linkage with non- castor producers at the local community level in the area and 22.5% has mentioned that it does not have a direct linkage. The direct linkage with non-producers mentioned above was attributed to labour (71%), service (19.4%), and transportation 9.6%. This indicates that the castor production in the area has benefited not only the farmers who produce castor but also non-producers by engaging them in different activities or creating an employment.

Table 5-19: Change in the Farmers' Lives and the Castor Farm's Role

Change in the farmers' lives	N	Percent
Family established	9	11.25
New house constructed	33	41.25
No change	38	47.5
Total	80	100.0
Does the castor farm has any role in the changes in the farmers' lives	N	Percent
Yes	29	69
No	13	31
Total	42	100.0

Source: Survey data: 2008

Regarding the change the castor farm has brought to the farmers' lives and their living standards, there is no change in 47.5% of farmers' life style after they have started farming castor, while 41.25% stated that they have constructed new houses and 11.25% have pointed out that they have established a family. These are also considered as some of the benefits achieved by the farmers in addition to the previously mentioned ones. Of those who have agreed that their life has improved, 69% said that the castor farm has a role in the improvement of their lives while 31% do not think that the castor farm has any role (table 5.19). This shows that some of the farmers' lives have changed somehow as attributed to the castor farm's role in bringing additional income.

In order to support the above findings, a focus group discussion was conducted with the local community concerning the cultural and social changes. Farmers who have been planting castor seed in the specific area have gained additional income and it has shown some positive changes in their life style. Job opportunities have increased for farmers and agronomists in the area and have created or transferred new technology for the neighbors. In addition to these other related benefits such as self-farm management, motivation for work has increased, and farmers have learnt that they can get more income when they work harder.

New economic activities other than normal agricultural production activities of farmers and the local community have been seen. The community has developed the culture of working hard, the agronomists have helped the farmers to learn more about the production system and also the advantages of planting castor. Associations for “*equb*” were formed, have engaged in commerce or small businesses, micro enterprise, raising livestock, woodwork and metal work.

Even though there is an increase in the farmers’ income it has not brought a significant change due to different reasons, constraint of rain being the major one. Some farmers have also suggested that they would have benefited more if they had planted sorghum last year because the price has increased more than the previous year. In addition, payments were delayed from the company, which has frustrated the farmers who have already delivered the harvested amount. Given the fact that price of most food crops has increased, some prefer to be paid in food crops rather than in cash. However, it is too early to observe significant changes in the socio-economic levels of farmers, given that the project is still in its early stage of development. Still it will be important to monitor the lessons and impacts to ensure that farmers can benefit from this production system in the future.

Confirming the above findings based on the key informants interview, it was indicated that biofuel production plays a great role in creating job opportunities in developing countries like Ethiopia with plenty of unemployed human resources. With human resources being hired, small-scale industries and small enterprises (rural energy) will be developed in rural areas and lots of changes can be witnessed in short period of time. Farmers will have easier access to biofuels’ or energy sources instead of the traditionally used fuel woods and have access to electricity. Hence this will help to transform the society and enhance energy use locally.

Regarding the social benefits it has been indicated that the revenue generated from the biofuel industry will transform the society in a positive way. In the condition that there is an intensive and structured production of biofuels and assured market producing them will bring greater benefits and the society engaged in it will become self-sufficient. Production of biofuels in any area must benefit the local community and involve them in the overall process. While the income of the community increases, it is highly beneficial to the whole society and country. However, it should not be taken as a solution to solve Ethiopia’s problems, rather it should be more for development and supplement the farmers’ income.

5.2.3 Economic Benefits

Biofuels production would induce economic growth and would certainly create jobs in a new producer country (Walter, 2006). In any development project it is mandatory to bring some positive changes and economic benefit or growth for the community and reduce poverty. Developing the infrastructural systems of the area should be part of any investment program, which in turn brings economic growth.

Table 5-20: Perception on the Status of the Infrastructural System in the Area and the Castor Farm's Role

Do you remember the infrastructural system	N	Percent
Yes	70	87.5
No	10	12.5
Total	80	100.0
Has the infrastructure	N	Percent
Improved	35	50
Deteriorated	7	10
No change	28	40
Total	70	100.0
Is the improvement attributed to the castor farm establishment	N	Percent
Yes	32	91.4
No	3	8.6
Total	35	100.0

Source: Survey data: 2008

The majority 70 (87.5%) remembers the infrastructural system before the castor farm was established. Of those 70 farmers who remember the infrastructure, 35 or 50% stated that it has improved while only 7 or 10% said it has deteriorated and the remaining 28 (40%) said that there has been no change. Out of the 35 farmers who have mentioned that the infrastructure has improved 32 (91.4%) attribute the improvement to the establishment of the farm and only 3 did not agree to that (table 5.20).

Table 5-21: Status of the Social Service in the Area and the Castor Farm's Role

Has the social service	N	Percent
Improved	32	40
No change	48	60
Total	80	100.0
Does the farm has any role in the improvement of the social services	N	Percent
Yes	30	93.8
No	2	6.2
Total	32	100.0

Source: Survey data: 2008

Regarding social services, 60 % believed that there is no change since the farm was established, while 40% believed that there is some improvement. Of those 32 farmers who have mentioned that the social service has improved 30 or 93.8 % believe that the castor farm played the biggest role and only 2 (6.2%) do not believe that the farm has any role (table 5.21). In addition, farmers have mentioned that after the establishment of the farm there is new technological flow. This implies that the farm has brought some changes in the infrastructure and social services.

In accordance to the above, it was confirmed in the key informants interviews that the income of the *woreda* has increased in some way after the establishment of the castor farm. The area is showing some changes in infrastructures and other social services. The project is also having more effect to the community while energizing the local community, more people being employed and getting more income, increasing number of development comrades and activities in the *woreda*, developing the working standards, facilities and infrastructures like education, roads, and health centers.

The federal government supports the project by improving the basic infrastructures (roads, electricity, telephone services). FEP has done some works in the Babilie *woreda*, specifically a 5 km road from the major road to the villages has been constructed for vehicles to go into the villages. The company is also providing clean water to its employees and to the local population, and is now running a project in the other *woredas*, improving education and health facilities in partnership with the local authorities, the University of Haramaya and the local population. The

company is taking these measures due to the fact that if the area's infrastructure is developed the community will collaborate with the company and it will be a win-win situation for both parties. Producing biodiesel from castor is a new practice in this *woreda* and the project has the potential to develop the infrastructural systems and bring more positive changes to the area but the existing plans need to be translated into action.

As it has been found out from the key informants interview, it is unwise to tell the economic benefit of producing biodiesel without cost-benefit-analysis. The cost per unit for producing biofuels (biodiesel/ethanol) should be known and if it is not less than or different from petroleum price then it can be concluded that it is not economically viable or has no use.

In countries like Ethiopia where majority of the population live in rural areas and biomass-based energy is limited (fuel wood), biofuels could be beneficial than detrimental to the economy. However, it is too early to talk about biofuels in Ethiopia since it is relatively a new investment area. In view of the fact that petroleum price is increasing rapidly and the current energy crisis developing biofuels should taken as an alternative but is not always a solution. Rather it has to be planned very properly, not affecting the ecology and the community.

5.2.4 Contribution to the foreign earnings/ Import substitution/Export potential

Substituting fossil fuels with biofuels can bring some positive effects on the economy such as saving on fuel imports and high foreign currency outlay and increase potentials of exports (Konemund, 2002). Development of biofuels contributes to foreign earnings and increase the export potential of a country. If non- oil producing countries develop biofuels and substitute the petroleum they import with the local product, large amounts of money will be saved that would have been allocated for importing petroleum. The investment project that is taken as a case study in Eastern Hararge extracts oil from the harvested castor seed in Fechatu and exports the extracted oil to other countries without converting it to biodiesel.

As it has been found out from the key informants interviews, exporting the plant oil that is extracted from the castor seed will still have benefits. Since the demand is very high, if it is produced in sufficient amount and is exported it can bring more foreign currency and that will help the country to import more petroleum. In order to extract biodiesel and use it locally first the

technology that is available should be taken into consideration. For example vehicle engines should be converted to use the biodiesel that is produced locally.

On the other hand, if the castor oil is converted to biodiesel and used locally it can substitute for imported petroleum. In the future, if Ethiopia can produce and substitute at least 5% of the imported petroleum with locally produced biofuels, then it could bring greater return. Developing biofuels locally can adjust the balance of payment in which export earning will increase and balance with the cost of import if the biofuel projects are properly managed.

Promoting biofuels which are converted into fuel in Ethiopia will bring economic benefits by using them for rural transport, motorized bikes which will make the farmers more efficient allowing them to go to the markets and get information about the current market price and fuel being available at the local cost level. When indicating the benefits, it does not mean that all the other related factors should be forgotten but rather given due attention and should work more closely with all the concerned parties to make the development sustainable.

5.3 Ecological Dimensions of Developing Biodiesel

5.3.1 Clearing of Land/ Increased land use for Planting Castor Seed/ Loss of Biodiversity

There are different issues that need to be considered when discussing the development of biofuels. Producing biofuels on a large scale could require huge tracts of land (Arungu-Olende, 2007). This leads to an increased use of land for producing bio-crops, and land being cleared which results in deforestation and loss of biodiversity.

Table 5-22: Land Use Pattern of East Hararge Zone (2001/02-2005/06)

No.	Land Use	2005/2006	
		Area(ha)	%
1	Cultivated land	460,706	19.0
2	Cultivable land	58,194	2.4
3	Pastor (grazing) land	99,415	4.1
4	Forest and wood land	53,345	2.2
5	Shrub and bush land	470,405	19.4
6	Degraded land	1,132,366	46.7
7	Land used for social purposes	150,335	6.2
Total		2,424,766	100.0

Source: East Hararge Zone Rural Development Office (RSOEHZFEDO, 2007)

Based on the data from East Hararge zone rural development office, in the year 2005/2006 the cultivated land area was 460,706 ha from a total land area of 2,424,766 ha. The land area under forest cover was 53,345 ha while that under bushes and shrubs was 470,405 ha. The land used for social purposes was 150,335 ha, 99,415 ha for pastor (grazing) land while 1,132,366 ha of the land is classified as degraded land. From the total area of the zone degraded land possess the highest share (46.7%) followed by shrubs and bush land (19.4%) and cultivated land (19.0%) (table 5.22).

Table 5-23: Land's Use Before Castor Plantation

Land's use before castor production	N	Percent
Grazing land	8	10
Other crop production	70	87.5
Forest land	2	2.5
Total	80	100.0
A year ago farmers were planting on the same land	N	Percent
Sorghum	50	71.4
Maize	17	24.3
Wheat	2	2.9
Vegetables	1	1.4
Total	70	100.0

Source: Survey data: 2008

It has been mentioned by 87.5 % of the farmers that they were using the land for other crop production before they planted castor, while 10% were using the land as a grazing land and the

remaining 2.5% stated that it was forestland. Out of those farmers who were using the land for other crop production (70) a year ago the land they are currently using to plant castor was used to plant sorghum by the largest percentage of farmers (71.4%). The others (24.3%) were producing maize on the same land and only 2.9% and 1.4 % produce wheat and vegetables respectively (table 5.23).

The majority of the farmers who were producing these other crops in 2006 have allocated some hectares of their land for castor production and others have cleared the grazing and forestland making the land ready for castor production. Though, the number of farmers who have cleared the land for castor production is not many which could cause land degradation or deforestation. However, if the number of farmers who will be engaged in this project is increasing in the next few years more grazing and forest lands will be cleared resulting in deforestation. Clearing the shrubs and bush lands could benefit farmers and also the community making the land cultivable but could cause a negative effect when forests are cleared for castor production or other purposes. Additionally, clearing the grazing land compromises the livestock's grazing system.

Table 5-24: Farmers would have used the land for...if they had not planted castor

If not for castor may have used the land for	N	Percent
Grazing land	11	13.75
Other crop production	69	86.25
Total	80	100.0
What would you have planted if not castor	N	Percent
Sorghum	42	60.8
Maize	6	8.7
<i>Teff</i>	2	2.9
Barley	2	2.9
<i>Chat</i>	1	1.5
Peanuts	16	23.2
Total	69	100.0

Source: Survey data: 2008

The majority (86.25%) of the farmers stated that if they had they not been using their land for castor production they would have used it for other crop production and the remaining 13.75% said they would have used the land for grazing their livestock.

Farmers who are now using the land for castor production would have used it for other crops (sorghum, maize, peanuts...) production. The majority of the farmers stated that they would have planted sorghum (60.8%), while 23.2% stated peanuts being followed by maize (8.7%), teff and barley (2.9%) each, and only 1.5% chat if they had not planted castor (table 5.24). This shows that farmers have compromised other food and cash crop production to produce castor but not in a considerable level since castor can be inter cropped with other crops. Although other crop production has been compromised, if farmers earn more income with the specific castor production, it can be said that it has become an alternative income for them. However, as it has been indicated in the above section some farmers have regretted that they have used the land for castor because the price of other crops such as sorghum has increased and if they had planted those crops they would have benefited more than producing castor.

Table 5-25: T-test for the Mean Differences of Land Used for Major Crops Production Over Three Years (2005, 2006, and 2007)

Crop Type	Pair	Mean	SD	t-value	significance
Sorghum	2005	1.1048	.62495	1.755	.083***
	2006	1.0094	.63004		
	2006	1.0094	.63004	-1.531	.130 (NS)
	2007	1.1111	.71370		
Maize	2005	.7051	.55056	.397	.692 (NS)
	2006	.6908	.59428		
	2006	.6908	.59428	2.474	.016 **
	2007	.5494	.72398		
Peanut	2005	.6171	.55446	.756	.452 (NS)
	2006	.5991	.53563		
	2006	.5991	.53563	1.546	.126 (NS)
	2007	.5411	.54660		
Chat	2005	.4044	.51180	-.331	.741 (NS)
	2006	.4076	.51160		
	2006	.4076	.51160	2.477	.015**
	2007	.3728	.49999		

Note: *** Shows significance at 10%, ** significance at 5%

Source: Survey data: 2008

The above table (table 5.25) presents a paired sample mean test of land allocated for major crops produced in the study area over the last three years. It shows the difference in the size of land allocated for sorghum, maize, peanuts and chat production between 2005 and 2006 and 2006 and 2007.

In almost all cases except land allocated for production of peanuts the t-test shows significant difference in lands allocated for sorghum, maize, and *chat* production while the land used for production of peanuts shows a slight difference but not statistically significant. It also shows that the t-value of land for sorghum production for the year 2005 and 2006 being significant at 10%, and land for maize and *chat* production in the year 2006 and 2007 at 5% which shows a decrease in the land allocated for the specific crop production.

This land size difference has shown a similar trend in the area, which is largely attributed to castor production. Therefore, it can be concluded that farmers in the study area have used the land for castor production, which they have used for other crop production in the previous years in addition to other grazing or forestlands. Farmers allocate more land to other crops such as maize, sorghum, peanuts and *chat* rather than castor and the fact that castor can be intercropped with these crops does not compromise other crop production at a large scale.

Table 5-26: Changes in Production System

Have you changed your for production system	N	Percent
Yes	41	51.25
No	39	48.75
Total	80	100.0

Source: Survey data: 2008

It is also noted that 51.25% of the farmers stated that they have changed their production system while almost equal 48.75% of the farmers have not changed their production system (table 5.26). The farmers who have indicated that they have changed their production system stated that intercropping castor with other crops was one of the ways that they have changed their production system.

In accordance to the above finding, on the focus group discussion conducted with the local community it was found out that peanut, sorghum and maize are the major crops in the area and the farmers used to produce them on the land before castor was planted and use traditional farming system. Even though most of the land the farmers are now using for castor production were agricultural lands, certain farmers have used some of the grazing land. The choice of land use was left to the community and the farmers are the one who decided which type of land to use for castor production.

Based on a key informants interview with a representative from Land Use Management in the *woreda* it was mentioned that in Babille *woreda*, there are some farmlands that were supposed to be forestlands and farmland was covered by bush land. Lands that are used for grazing, cultivation, and forestland needs to be identified and categorized correctly. In addition it was stated that FEP has allocated more than 160,000 *birr* to subsidize the clearing of land to expand the area for castor production by taking the mitigation measures proposed in the EIA report. This land clearing expansion will be in the high lands, which will be planted when the low lands are found to be infertile or exhausted. There are possible environmental risks to this strategy and it begs the question of whether this system of castor production is sustainable in the longer run. FEP also plans to open a new natural resource management department within the company, which will hopefully address some of these sustainability issues.

According to the key informants interview with experts, it was found that if projects like this are not properly managed the biodiversity would be affected. When looking at other examples internationally the main negative effect from producing biofuels could be destruction of the existing biodiversity. For example in Thailand large areas of the natural ecosystem have been converted into palm tree plantations for the production of palm oil, which in turn has been converted into biofuels. If for example in Ethiopia, the acacia woodland area is cleared for biofuel crops farming, it will have an effect on the ecology and the species diversity of the natural ecosystem. Biodiesel production from crops could have effects on the natural eco- system and be highly destructive for the ecology and the environment. Some of the trees or dry savanna forests that are cleared in areas to plant the bio-crops could not be found or substituted because it has taken at least two generations to get where it is now and clearing it will definitely cause deforestation.

In agreement to the above facts, environmentalists in the key informants interview have indicated that when looking at the issues of developing biofuels it should be seen in accordance to the Kyoto Protocol which mentions that factors that contribute to climate change should be given due attention. Biofuel plantation helps for soil and water conservation since it can be planted in arid or dry lands. Planting biodiesel plants such as *jatropha* should be in degraded areas, not fertile ones. The question that should be asked is "are we using fertile lands or degraded lands for planting biofuel plants?" The degraded lands should be identified, and then plantation and exporting the produced biodiesel to foreign countries could be made.

In addition, the environmental cost-benefit-analysis should be done and the social benefits to the local community should also be considered. Benefits could be a lot more if bio-crops are planted in degraded lands by taking into account sustainable development by conserving, preserving and using this investment as an income generating mechanism. On the other hand if projects are being implemented in communal crop production lands, it will have some negative effects. The other related issue is if there is an intensive production of bio-crops there is a probability of shifting to monoculture that is producing one type of crop, which will be very difficult to sustain from the environmental point of view.

Even though an EIA has been conducted for this project, however, it was learnt from the EPA that the company submitted the EIA report after a year of starting operation. This shows that the company has not taken the appropriate and mitigation measures before starting the work. Therefore, this needs to be taken into consideration and make conducting an EIA mandatory before any work is done.

5.3.2 Increased use of fertilizers and pesticides

Excessive use of inorganic fertilizers and pesticides degrades the land and also affects the environment (Braun et al., 2006). An increased use of fertilizers and pesticides to get the maximum yield from crops could bring some negative effects if it exceeds the limited amount.

Table 5-27: Investing in Farm Inputs and Reasons

Do you invest in farm inputs	N	Percent
Yes	59	73.75
No	21	26.25
Total	80	100.0
What motivates you to invest in farm inputs	N	Percent
Better market prices for cash crops	6	10.2
Lesson from extension workers	42	71.2
To meet high cost of living	11	18.6
Total	59	100.0
Why don't you invest in farm inputs	N	Percent
Lack of capital	4	19.0
Lack of awareness	17	81.0
Total	21	100.0

Source: Survey data: 2008

Majority of farmers (73.75%) are investing in farm inputs while the remaining 21 (26.25%) are not. Of those (59) who are investing in farm inputs 71.2% mentioned that lesson from extension workers has motivated them. Others (18.6%) have indicated that they invest in farm inputs to meet the high cost of living by selling quality products to earn more income and the remaining 10.2% were motivated by the better market prices for cash crops. On the other hand, of the 21 farmers who are not investing in farm inputs, 19% have mentioned lack of capital as the main reason while the rest (81%) stated lack of awareness as the major reason (table 5.27). The current increase in the price of fertilizers is a major constraint for most farmers to buy and use it.

Table 5-28: Use and Types of fertilizers by the sample farmers

Do you use fertilizers	N	Percent
Yes	75	93.75
No	5	6.25
Total	80	100.0
Type of fertilizers	N	Percent
DAP	8	10.7
Urea	21	28
Both DAP and Urea	46	61.3
Total	75	100.0
Farmers get the fertilizers from	N	Percent
FEP	65	86.7
The market	10	13.3
Total	75	100.0

Source: Survey data: 2008

The majority (93.75%) of the farmers who are producing castor were found to be using fertilizers while only 5 (6.25%) are not using them. Out of those 75 farmers who are using fertilizers the majority (61.3%) are using both DAP and Urea whereas 21 (28%) use only Urea and the remaining 8 (10.7%) use DAP. The majority of the farmers (86.7%) who use fertilizers have mentioned that they are getting fertilizers from FEP and the remaining 13.3% stated that they get them from the market (table 5.28).

Table 5-29: Use of Pesticides

Do you use pesticides	N	Percent
Yes	61	76.25
No	19	23.75
Total	80	100.0

Source: Survey data: 2008

In addition, majority of the farmers are using pesticides on their farm. Seventy six percent (76.25%) were found to be using pesticides while 19 (23.75 %) are not using them (table 5.29).

To supplement the above findings, in the key informants interview with officials from FEP, it was indicated that the particular biodiesel plantation would not have negative impact on the environment or socio-economic conditions of farmers. In the environmental impact assessment (EIA) conducted it was stated that the project could not bring negative effects to the environment. It has also been mentioned in the EIA, that above certain percentage of chemical use can cause negative effects and there will be land degradation but not in this specific project. The fertilizers that are used are organic/inorganic including the residue of the extracted oil and the commonly used fertilizer, DAP.

Additionally, it was mentioned that biodiesel plantation could have some negative effects on the livestock they breed which is caused by the pesticides they are using. Farm inputs including fertilizers like Urea and DAP, anti- pests (landex) are used and a practical test was done regarding that. Anti-pests are used just for 2/3 days in areas where livestock cannot inter.

The types of fertilizers and pesticides used in the area are provided by the company and are the commonly used ones and the agronomists who are working with the farmers determine amounts. Hence problems of using excessive amounts of fertilizers and pesticides will not occur in this area and as a result will not bring negative effects to the environment. However the data above shows that not all farmers are provided with fertilizers or pesticides.

6 Conclusion and Recommendations

6.1 Conclusion

The increasing price of energy from non-renewable sources and concern for the environment have made different countries and scholars give due attention to alternative sources of energy, biofuels being the major one. However since it is a new practice in Ethiopia, there is a need to study the challenges and opportunities of developing biofuels. In order to investigate the socio-economic and ecological dimensions of developing biodiesel in Ethiopia a case study of castor seed production for biodiesel in Eastern Hararge was taken.

Based on the findings from the study, after the establishment of the castor farm, a rise in the price of food crops had occurred which is accounted for the new practice of castor production to a certain degree in addition to other factors such as shortage of rainfall. Farmers who have engaged in the program can only sell their products to one company of which they have signed a contract with and this would not help them to negotiate price or have information about the market price in other places. Due to this fact, farmers get paid less than the market value. In addition, the seed that is provided to the farmers is an improved seed, which is imported from abroad, which makes them dependant on the company's supply bypassing local seed sources.

Concerning the farmers' income castor farm has created an alternative income for them while they were able to intercrop castor with other food crops, which has not directly affected food supply in the area. This project has benefited not only the farmers who produce castor but also non-producers by engaging them in different activities and job opportunities were created for agronomists. In addition to this, other related benefits were gained such as self-farm management, trainings were received and motivation for work has increased in the area. However, payments that were made to the farmers were delayed which has frustrated the farmers.

The project being in its early stage has already started developing the infrastructure in the area that will bring about economic benefits to the local community and the *woreda* in the near future. In spite of this, there is a risk of subsistence farmers who depend upon diversity being engaged in contract farming and produce only castor (a biocrop). There is a high sustainability risk for small farmers to depend on one type of crop due to rain constraint and crop failure.

On the other hand, this project by exporting the extracted oil without converting it into biodiesel to overseas is not directly contributing to the country's energy supply or substituting the fossil fuel that is imported from abroad. If the oil was converted to biodiesel there would have been more employment opportunity for farmers and small industries could be developed in the rural areas. Additionally, if farmers by forming cooperatives were able to process the oil into fuel locally, there is a potential use of the fuel for light and electric generators for nearby schools and hospitals.

Most farmers have used land for castor production they have used to plant other crops in the previous years, while a few have cleared some of the grazing and forest land to make it ready for farming. Even though, the number of farmers who have cleared the land are quite few in this particular survey there is a potential of deforestation and loss of biodiversity when more farmers are attracted and engage in this project. On top of that when prices of other crops are increasing, there is an opportunity cost while farmers have taken land from other crop production. Although the Ministry of Mines and Energy of Ethiopia declares that land allocated for biofuels is the marginal ones this project is using the fertile land which farmers used to produce other food crops on.

In this specific project, the use of fertilizers and pesticides is monitored by agronomists who work with the farmers therefore problems of using excessive amount will not occur to bring negative effects to the environment. The company provides fertilizers only for the first year, and there is a likely increase of input (fertilizer) prices in the subsequent seasons for the reason that fossil prices are increasing so the profit margin of producing castor will be lower. As a result, producing castor will not generate additional income to the farmers as prices of inputs have gone up.

At the national level there is a lack of policy coordination among government institutions who are the stakeholders. Roles and responsibilities of different government organizations are set in order so that they will work together and develop capacity at different level. However, they are not working together as they should be as it has been shown in this project that EIA has not been conducted before the company has started operating.

Finally, the question should be is Ethiopia ready for small scale or large-scale biofuel production? Even if this question cannot be answered based on this study's findings, as more research is required something can be said. Large-scale development of biofuels could be beneficial however, other factors such as import substitution and contribution to the economy should be taken into consideration. Biofuel production by small-scale farmers on a contractual arrangement with a

company may not be an answer to small- scale farmers in poor developing countries where food security is a priority. However, if the projects in small-scale farmers level are properly monitored they can be additional source of income, which could supplement their major source of income.

6.2 Recommendations

In order to minimize the challenges and maximize opportunities of developing biodiesel while ensuring sustainable development the following measures needs to be taken into consideration.

- Since biofuels projects such as this one have potential positive and negative socio-economic and environmental effects they all need proper monitoring to be produced in a sustainable way.
- More research and development is required to investigate the potential socio-economic and environmental impacts of small and large-scale biofuel production to minimize the possible impacts.
- Government should set up a legal and regulatory framework to guide and regulate any biofuel industry such as this one to avoid negative socio- economic and environmental impacts on the society and the environment.
- Government needs to design new policies or implement the policies that are already designed to promote biofuels that are profitable and their production's benefits extend to rural areas and also to promote use of domestically produced biofuel. The availability and accessibility of modern technologies for bioenergy conversion and use should be taken into consideration.
- Regional government agricultural offices/ *woreda* authorities need to monitor and improve contractual relations among farmers and private companies so that small farmers are beneficiaries from projects of this kind.

- Government should monitor biofuel projects that convert food crops to biofuels to reduce risks of food insecurity and giving the current worldwide food crisis due attention.
- Issues about land use need proper monitoring beginning with agro-ecological zoning to indicate the marginal areas that are available for biofuel crops in order not to use land that has been used for other crop production as it is the case in the specific project.
- There should be more research on the use of fertilizers and pesticides to determine the exact amount to be used in order not to affect the environment.
- Different stakeholders need to work together to develop capacity at different levels, which includes agricultural offices, forestry, environment, industry, trade and energy as lack of coordination has been seen in the specific project.
- Alternative sources of energy other than biofuels such as second and third generation biofuels, wind and solar energy should also be considered while they do not compete with food production

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Annex I

List of Key Informants

- Alemayehu Maru, Land Use and Management, Babilie *woreda*
- Alemu Gezahegn (PhD), Director of Forestry Research Institute
- Assaf H., Project Manager of FEP, Harar
- Costantinos Berhe (PhD), Senior Vice President, Africa Humanitarian Action
- Tesfaye Bekelle(PhD), Director of Essential Oils (EIAR)
- Getnet Alemu (PhD), Senior Researcher of Essential Oils (EIAR)
- Melis Teka, Head of the Energy Regulation Department and Coordinator of Biofuel Development at the Ministry of Mines and Energy
- Mohammed Aammee, Head of the Capacity Building office of Babilie *woreda*
- Mohammed Ali, Environmental Pollution Control Department Head, EPA
- Solomon Kebede, Head, Impact Assessment Service, EPA

Annex II

Addis Ababa University
Institute of Development Research
Department of Environment and Development

Questionnaire

The General Objective of this questionnaire is to investigate the challenges and opportunities of developing biodiesel in Eastern Hararge. The study is conveyed for academic purpose. Hence, the responses from respondents are confidential and cannot be traced to the person who provided them. Thank you for your cooperation.

I. Identification

Name of the Enumerator _____
Date of interview _____
Name of the Woreda _____
Name of the Kebele _____
Village name _____

II. Household characteristics

1. Name of the HH _____ Age _____ Sex _____
2. Marital Status: 1. Married 2. Single 3. Divorced 4. Separated
3. Religion: 1. Islam 2. Christian 3. Other (specify) _____
4. Household Size _____ 1. Male _____ 2. Female _____
5. Education level 1. Non-literate 2. Elementary 3. Secondary 4. Completed secondary
6. Farm experience 1. Less than 2 years 2. Less than 5 years 3. Between 5-10 years
4. More than 10 years 5. Other, (specify) _____
7. Since when did you start living in this woreda? 1. Was born here 2. Ten years ago
3. Five years ago 4. 2 years ago 5. A year ago 6. Other specify _____
8. Land ownership 1. Own land 2. Rent in 3. Share cropping 4. Other (specify) _____
9. Size of the land owned in timad/hectare _____

III. Labor and House Hold Income

1. What is the major source of your income?
2. What other off farm activity do you or member of your family has engaged in?

Type of activity	Family Members	Income

3. What is the source of the household income?

Income Source	2005(in Birr)	2006(in Birr)	2007(in Birr)
1. Cereal sales			
2. Chat Sales			
3. Vegetable Sales			
4. Livestock Sales			
5. Milk Sales			
6. Off farm employment (in Birr/year)			
7. Remittance (in birr/year)			
8. Others (specify)			

4. How do you evaluate your household income over the last year?

1. Increasing 2. Decreasing 3. No change

5. If your response to the above question is increasing, what are the reasons?

6. If your response to the above question is decreasing, what are the reasons?

1. Lack of water for irrigation
2. Low market prices for farm products
3. High cost of living
4. Others (specify)

IV. Crop Production

1. What is the major crop produced in the area in the last years?

Crop Type	Area covered by the crop (in timad)			Amount harvested in local unit			Amount consumed by the household in local unit		
	2005	2006	2007	2005	2006	2007	2005	2006	2007
1.Sorghum									
2.Maize									
3.Teff									
4.Wheat									
5.Barley									
6.Chat									
7.Vegetables									
8.Castor seed									
9.Others									

2. What are the major constraints faced in production of crops?

V. Livestock

1. What is the number and types of livestock owned?

Types of livestock	Number

VI. Castor Production

- Do you produce castor? 1. Yes 2. No b) How much?
- Since when did you start producing castor? 1. Three months ago
2. Six months ago 3. A year ago 4. Two years ago 5. Other _____
- From where did you find the seed? 1. On the market 2. FEP 3. Other _____
- What are the problems faced in producing castor in this area? 1.Shortage of labour 2. Shortage of input 3. Shortage of information 4. Market
5. Compatibility with the area

5. How would you have used the land if you haven't produced castor? 1. Grazing land 2. Other crop plantation 3. Forest land 4. Other
6. Last year what was the type of crop planted on the same land? 1. Sorghum 2. Maize 3. Teff 4. Wheat 5. Barley 6. Chat 7. Vegetables 8. Other
7. What would you have planted if you haven't produced castor? 1. Sorghum 2. Maize 3. Teff 4. Wheat 5. Barley 6. Chat 7. Vegetables 8. Other
8. What will be the probable problems to sustain and expand the castor farm?
9. Farm Activities

Farm Activities	Responsibility of (Family Members- Male/Female)
Ploughing	
Planting	
Weeding	
Harvesting	
Marketing	

10. What do you think is the major purpose of castor seed? 1. Biodiesel production 2. Use for light 3. Use the oil as a fuel 4. Other specify
11. For what other purpose do you use castor seed? 1. Biodiesel production 2. Use for light 3. Use the oil as a fuel 4. Selling 5. Other specify
12. What do you know about Plant oil?
13. What do you know about Biodiesel?

VII. Relationship with FEP

1. How did you know about FEP?
2. When did you join the program?
3. In which option are you engaged in? 1. Option 1 2. Option 2 3. Option 3
4. Why did you choose the specific option?
5. How is the option's market arrangement?
6. How often do you get income? 1. Monthly 2. Semi-annually 3. Yearly 4. Other
7. Have you received any payment till now? 1. Yes 2. No
8. If yes, how much did you get?
9. What was your income before you joined the program?
10. Is there any kind of compensation if for example crop failed? 1. Yes 2. No

11. If yes, what kind?

12. Do you have any additional income other than salary from the farm?

VIII. Biodiesel vs Food security

1. a) What happened to the price of food crops after the establishment of the farm? 1. Increased
2. Decreased 3. No change 4. Other 5) What are the reasons?
2. a) What happened to the availability of food crops after the establishment of the farm?
1. Increased 2. Decreased 3. No change 4. Other 5) What are the reasons?

IX. Use of Fertilizers

1. Do you invest in farm inputs?
 1. Yes 2. No
2. If yes, what motivates you to do so?
 1. Better market prices for cash crops
 2. Lesson from extension workers
 3. To meet high cost of living
 4. Experience from neighboring farmers
 5. Others (specify)
3. If your response to the above question is no, what are your constraints from doing so?
 1. Lack of capital
 2. Lack of awareness
 3. Lack of access to inputs
 4. Others (specify)
4. Do you use fertilizers? 1. Yes 2. No
5. If yes, what kind?
6. Where do you get the fertilizers? 1. From the market 2. From FEP 3. Other
7. Do you use pesticides? 1. Yes 2. No
8. If yes, what kind?
9. What kind of seeds do you use? 1. Local 2. Improved seed 3. Other
10. What kind of water system do you use? 1. Irrigation 2. Rainfed 3. Other specify

X. Land Use

1. How did you get this land? 1. Own 2. FEP
2. Have you cleared the land before using it? 1. Yes 2. No
3. What was the land's use before you planted castor on it? 1. Grazing land 2. Other crop plantation 3. Forest land
4. Have you increased the size of your land from your previous use? 1. Yes 2. No
5. Have you changed your farming system on the land after the establishment of the farm?
1. Yes 2. No
6. If yes, in what way?

XI. Socio-economic Effects

1. Have you benefited because of the establishment of the castor seed plantation? 1. Yes
2. No 3. No change 4. Other
2. If yes, in what way?
3. Have you received any kind of training? 1. Yes 2. No
4. If yes, what kind?
5. Have you earned any benefits from FEP? 1. Yes 2. No
6. If yes, what type of benefits did you earn?
7. Has the farm created alternative income for the farmers other than its normal production activity? 1. Yes 2. No
8. If yes, please specify
9. Does the farm have any direct linkage with non-productive farmers at rural local community in the area? 1. Yes 2. No
10. If yes, for what is the linkage required? 1. Labour 2. Market 3. Service 4. Security
5. Transportation 6. Other
11. After you joined the farm what types of changes you see in your life? 1. Family established
2. New house constructed 3. No change 4. Other
12. If it has improved, does the farm has any role in the improvement? 1. Yes 2. No
13. Have you thought of forming an association of farmers without the company's involvement?
14. What will happen if the company leaves the area? 1. Continue the work on my own
2. Plant another seed 3. Engage in another business 4. Other specify

CHECKLISTS-Local elders/ Non- producers/ Women -FGD

- ✓ What was the situation of this woreda before the establishment of the farm?
- ✓ What was the land's use before the establishment of the farm?
- ✓ What was planted on the land before the establishment of the farm?
- ✓ What was the condition of the biodiversity in the area before the establishment of the farm?
- ✓ Has loss of biodiversity occurred after the establishment of the farm? If yes, what are the reasons?
- ✓ Who were the users of the current land before you? 1. Other Farmers 2. Local community 3.No one 4. Government land 5.Other
- ✓ Was there any kind of compensation if there were earlier users? 1. Yes 2. No
- ✓ If yes, what kind?
- ✓ Is there any benefit gained after the establishment of the farm?
- ✓ What are the social benefits?
- ✓ What are the economic benefits?
- ✓ What are the environmental benefits?
- ✓ Has issues of food security been raised?
- ✓ Do you think that the biodiesel plantation has positive effects? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Do you think that the biodiesel plantation have negative effects?
- ✓ If yes, please specify
- ✓ What do you suggest about the negative social and environmental effects of the sector?
- ✓ Has the income of the town increased after the establishment of the farm?
- ✓ Can you remember the infrastructural systems like roads, electric power supplies, water, and so on before the farm's establishment? 1. Yes 2. No
- ✓ After the establishment of the farm what happened to the infrastructure (electricity, communication) conditions of the town? 1. Improved 2.Deteriorated 3. No change 4. Other
- ✓ If it has improved does the farm has any role in its improvement? 1. Yes 2. No
- ✓ After the establishment of the farm what happened to the social services like education and health services of the local community? 1. Improved 2. Deteriorated 3. No change 4. Other
- ✓ If it has improved does the farm has any role in its improvement? 1. Yes 2. No

- ✓ After the establishment of the farm what new economic activities do you see other than normal farm day-to-day production activities for farmers and the local community?
1. Market inducement 2. New technological flows 3. Other
- ✓ Does the farm have any life changing effects on the local farmers and local community living standards in the area? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Does the farm give on job training for the farmers on how to use tools and farming activities at production level? 1. Yes 2. No
- ✓ If yes please specify....
- ✓ Has the woreda become densely populated after the establishment of the farm?
1. Yes 2. No
- ✓ If yes, what are the indicators?
- ✓ After the establishment of the farm, is there any water/environmental pollution in the area? 1. Yes 2. No
- ✓ If yes, what are the indicators?
- ✓ Is there any soil related pollution indication seen by the farm till now? 1. Yes 2. No
- ✓ If yes, how was the problem solved?
- ✓ Attitude towards the overall performance of the company?

CHECKLISTS- FEP

- ✓ What was the situation of this woreda before the establishment of the farm?
- ✓ What was the land's use before the establishment of the farm?
- ✓ What was planted on the land before the establishment of the farm?
- ✓ Has loss of biodiversity occurred after the establishment of the farm? If yes, what are the reasons?
- ✓ Who were the users of the current land before you? 1. Other Farmers 2. Local community 3. No one 4. Government land 5. Other
- ✓ Was there any kind of compensation if there were earlier users? 1. Yes 2. No
- ✓ If yes, what kind?
- ✓ Are there women who are engaged in the program?
- ✓ If yes, are there many?
- ✓ Is there any benefit gained after the establishment of the farm?
- ✓ What are the social benefits?

- ✓ What are the economic benefits?
- ✓ What are the environmental benefits?
- ✓ Has issues of food security been raised?
- ✓ Do you think that the biodiesel plantation has positive effects? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Do you think that the biodiesel plantation have negative effects?
- ✓ If yes, please specify
- ✓ What do you suggest about the negative social and environmental effects of the sector?
- ✓ Has the income of the town increased after the establishment of the farm?
- ✓ Can you remember the infrastructural systems like roads, electric power supplies, water, and so on before the farm's establishment? 1. Yes 2. No
- ✓ After the establishment of the farm what happened to the infrastructure conditions of the town? 1. Improved 2. Deteriorated 3. No change 4. Other
- ✓ If it has improved does the farm has any role in its improvement? 1. Yes 2. No
- ✓ After the establishment of the farm what happened to the social services like education and health services of the local community? 1. Improved 2. Deteriorated 3. No change 4. Other
- ✓ If it has improved does the farm has any role in its improvement? 1. Yes 2. No
- ✓ After the establishment of the farm what new economic activities do you see other than normal farm day-to-day production activities for farmers? 1. Market inducement
- ✓ 2. New technological flows 3. Other
- ✓ Does the farm have any life changing effects on the local farmers and local community living standards in the area? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Does the farm give on job training for the farmers on how to use tools and farming activities at production level? 1. Yes 2. No
- ✓ If yes please specify....
- ✓ Does the farm provide extension services to the farmers? If yes, what kind?
- ✓ Has the woreda become densely populated after the establishment of the farm? 1. Yes
- ✓ 2. No
- ✓ If yes, what are the indicators?
- ✓ After the establishment of the farm, is there any water/environmental pollution in the area? 1. Yes 2. No
- ✓ If yes, what are the indicators?

- ✓ Is there any soil related pollution indication seen by the farm till now? 1. Yes 2. No
- ✓ If yes, how was the problem solved?
- ✓ How do you evaluate the overall performance of the company?
- ✓ Has an EIA been conducted if not why not?

CHECKLISTS- Experts

- ✓ What is Biodiesel?
- ✓ Do you think that the biodiesel plantation has positive effects? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Do you think that the biodiesel plantation have negative effects?
- ✓ If yes, please specify
- ✓ What do you suggest about the negative social and environmental effects of the sector?
- ✓ What are the social benefits?
- ✓ What are the economic benefits?
- ✓ What are the environmental benefits?
- ✓ What do you think is the effect of developing biodiesel?

CHECKLISTS- Economists

- ✓ What is Biodiesel?
- ✓ What are the social benefits?
- ✓ What are the environmental benefits?
- ✓ Do you think that it has economic benefits? If yes, what are they?
- ✓ What is the role of developing biodiesel to import substitution?
- ✓ What is the export potential of developing biodiesel?
- ✓ Do you think that the biodiesel plantation has positive effects? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Do you think that the biodiesel plantation have negative effects?
- ✓ If yes, please specify
- ✓ What do you suggest about the negative social and environmental effects of the sector?

CHECKLISTS-Environmentalists

- ✓ What is Biodiesel?

- ✓ What are the social benefits?
- ✓ What are the economic benefits?
- ✓ What are the environmental benefits?
- ✓ Do you think that the biodiesel plantation has positive effects? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Do you think that the biodiesel plantation have negative effects?
- ✓ If yes, please specify
- ✓ Will there be any water/environmental pollution in developing biodiesel from castor seed? 1. Yes 2. No
- ✓ If yes, what are the indicators?
- ✓ Is there any soil related pollution in developing biodiesel from castor seed? 1. Yes 2. No
- ✓ What do you suggest about the negative social and environmental effects of the sector?
- ✓ Has an EIA been conducted? Have you given environmental clearance?
- ✓ What were the mitigation measures taken for the likely effects?

CHECKLISTS- MoME, EIAR, Forestry Research Institute

- ✓ Do you think that the biodiesel plantation has positive effects? 1. Yes 2. No
- ✓ If yes, please specify
- ✓ Do you think that the biodiesel plantation have negative effects?
- ✓ If yes, please specify
- ✓ What do you suggest about the negative social and environmental effects of the sector?
- ✓ What are the social benefits?
- ✓ What are the economic benefits?
- ✓ What are the environmental benefits?
- ✓ Do you think that Biodiesel has potential in Ethiopia?

ANNEX - III



Picture 1: FloraEco Power's Factory in Fechatu



Picture 2: Oil Storage tank at the FloraEco Power's Factory in Fechatu



Picture 3: FGD with the local community in Babilie *woreda*



Picture 4: FGD with the local community in Babilie *woreda*



Picture 5: Castor seed farm in Babilie *woreda*



Picture 6: Castor plant in the Babilie *woreda*



Picture 7: Harvested castor seed farm in Babilie *woreda*



Picture 8: Harvested castor seeds at the Factory

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any other university and that all sources of materials used for the thesis have be duly acknowledged.

Declared by:

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