# Agrofuel Development in Ethiopia

## Rhetoric
## Reality
## Recommendations

If we take care of the Earth, the Earth will take care of us.

**Forum for Environment**

In Collaboration With

Horn of Africa Regional Environment Centre and Network

Heinrich Böll Stiftung


**EDITORS**

***Tibebwa Heckett* and *Negusu Aklilu***

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# Agrofuel Development in Ethiopia: Rhetoric, Reality and Recommendations


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and

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# PREFACE

Dear Colleagues,

The last two years have seen lots of controversy and debate regarding agrofuels. There have been lots of stories about the potentially positive roles that can be played by agrofuels in promoting rural development and energy security as well as combating climate change and environmental degradation.

A key milestone in agrofuel development in Africa in general and in Ethiopia in particular was the high-level workshop on agrofuels organized in August 2007 by the African Union Commission in collaboration with UNIDO and the Brazilian government. The whole discourse, in my view, was flawed in that there was no enough room to genuinely discuss the potential social and environmental costs of agrofuel development so much so that one participant was calling such concerns and their proponents 'malicious detractors'. The Commission could have taken a more constructive role through allowing the presentation of various opinions so that some degree of caution could have been incorporated in national agrofuel development processes. I think we should seriously and genuinely question why Brazil is interested in supporting this initiative. It could be the case that Brazil is now considering Africa as potential market for agrofuel technologies, which the former is very rich in. I wouldn't call it 'South-South cooperation' unless genuine multi-stakeholder discussions are conducted and Africa is allowed to draw its roadmap of agrofuel development and cooperation based on consultations and research.

Just preceding this workshop, FfE undertook a national workshop on agrofuels in Ethiopia to sensitize national stakeholders and to contribute to the national discourse so that a blindfolded approach would be avoided. The workshop was organized in collaboration with

the Environmental Protection Authority (EPA) and the Horn of Africa Regional Environment Center and Network (HoAREC/N).

Another interesting development in the just ended Ethiopian fiscal year (2007-8) was the encroachment of an elephant sanctuary by a foreign agrofuel company. Ethiopian Wildlife Association (EWA) and Forum for Environment (FfE) campaigned against this move by taking it to the highest level of Government and succeeded in halting any further expansion. However, the company is still cultivating agrofuel crops on an elephant corridor and efforts are still going on to resolve the situation.

Although some degree of bio-ethanol production has been existent in Ethiopia for long, the growth and cultivation of biodiesel has just started and advanced during the last two years. *Jatropha*, oil palm and castor bean constitute the major feedstocks for biodiesel development in Ethiopia at the moment. This report is both a compilation of papers presented during the workshop and a paper that is meant to update stakeholders on Babille Elephant sanctuary. It's hoped that this report will provide some information on existing projects and also guidance on future directions.

Please bear in mind that the terms agrofuel, biofuel and sometimes bioenergy are interchangeably used by the different authors.

We would like to thank the Horn of Africa Regional Environment Center/Network and the Heinrich Boell Foundation for providing financial support to the workshop and this publication respectively. Our thanks also goes to the Federal Environmental Protection Authority for its collaboration in organizing the national workshop.

Happy reading!

Negusu Aklilu

Director, FfE

# KEY ENERGY ISSUES IN ETHIOPIA: CHALLENGES, OPPORTUNITIES AND THE WAY FORWARD

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## 1. INTRODUCTION AND BACKGROUND

### 1.1. OVERVIEW OF THE ENERGY SITUATION IN ETHIOPIA

Currently, Ethiopia's economic and social development efforts are geared towards raising the country to a middle-income level within the coming 20 years. To this effect every sector pursues its own targets since the vision is of national interest. Energy development, if designed in line with the needs of agriculture, industry, transport and other related sectors, would highly accelerate the achievement of this goal.

The country, with a total land area of 1.12 million square kilometers, contains distinct agro-climatic zones: semi-arid highlands; semi-tropical valleys; and hot semi-arid lowlands. Population and agricultural potentials vary accordingly. Overall, 66% of the total land area is potentially suited to agriculture, only 14% of which is currently under cultivation while more than 50% is used as pasture land. The availability of transport facilities determines the ability of poorer communities to access major social service centers, such as schools and health facilities, and to be actively involved in the markets. Rural women transport goods such as water, firewood, and agricultural produce on their backs, often traveling long distances. This severely affects their health and deprives them of time for other social involvements. This burden is being addressed by the policy of expanding the road network to allow motorized access to rural settlements. However, this effort needs to be complemented by a sustainable supply of energy to fuel these vehicles. Moreover, processing perishable agricultural products so that they fetch higher

prices in the market becomes easier when modern forms of energy are available in the vicinity of the farms.

The government is strongly committed to extending the availability of modern energy to those who do not yet have access to it, in order to facilitate an accelerated national socio-economic development. Provision of electricity to rural areas through the Universal Electrification Access Programme (UEAP) is implemented directly by the Ministry of Mines and Energy through the Ethiopian Electric Power Corporation (EEPCo), and makes grid electricity accessible to villages. Using the grid system is proceeding vigorously. The rate of electrification in 2004 was 13% and now has increased to 22%. This is a very commendable achievement, but still does not take Ethiopia out of the lower bracket of energy consumption, even in Africa. The country's short-term target is to increase the electricity coverage to 50% by the end of 2010. To expand access to locations at present beyond the reach of the grid, the government is implementing the Off-Grid Rural Electrification Program (OFF-GRE) with the active involvement of the private sector and rural cooperatives by the provision of loans. In this program, power is generated either from small hydroelectric plants or from solar and wind energy sources and then connected directly to households.

But all these efforts do not address the immense demand for cooking energy of the rural poor, because they cannot afford to pay electricity bills or purchase the relatively expensive electric cooking stoves. To remedy this situation, alternative technologies such as solar cookers, Lakech improved charcoal stoves (with 25% fuel saving), Mirt improved Enjera-baking stoves (with 50% fuel saving), and Gonzie improved multi-purpose (cooking and baking) stoves (with 54% fuel saving) are being promoted (EREDPC, 2002).

To effectively address the energy problem of the country, the baseline scenario must be changed and for this purpose different alternatives must be looked into. Currently, the world is advancing in the

development and utilization of new energy technologies and fuels that will not compromise the needs of future generations nor destroy the environment. Our country, being endowed with various renewable energy resources, must benefit from the recent technological developments which attempt to harness these resources, giving due care to the interests of all relevant stakeholders. This paper will highlight the pros and cons of the existing energy supply and demand, and related technologies, to all those involved in the process of providing improved and modern energy technologies in Ethiopia. The second section describes the relationship between energy, poverty and the Millennium Development Goals (MDGs) in Ethiopia; section three briefly describes the key issues in the electricity and transportation sub-sectors; the fourth section addresses resource potentials and the utilization levels of different energy resources. The section further briefly discusses the opportunities, constraints and challenges of the sector. The way forward to deal with energy issues in Ethiopia is addressed in section five, and the paper concludes with a few conclusive remarks.

## 2. ENERGY, POVERTY AND THE MILLENNIUM DEVELOPMENT GOALS (MDGS) IN ETHIOPIA

### 2.1. ENERGY

Energy has a catalytic role in almost all socio-economic sectors and clearly comes into the picture when provided in its modern form. For instance, time is saved when traditional grain milling is replaced by a modern system; modern transport facilities can carry large volumes or mass of different items and human beings at the same time without being impeded by altitude or other factors; and long distances can be covered within a short period of time. Another example is the difference in the quality of life between rural households who utilize inefficient end-use devices that pollute the indoor environment and those who use modern energy and improved devices with high efficiency and minimal indoor environment pollution. With the help of

modern energy sources, perishable agricultural products can be preserved and processed to fetch better prices than those that are unprocessed. For the positive effects mentioned above to be seen, the wide scale supply and utilization of both modern energy technologies and alternative energy sources is imperative.

Ethiopia is endowed with enough energy resources to meet the demand in those areas where the vast majority, the rural population, resides. The resources that we have in plenty, such as labor and small and scattered farmlands should be combined with energy to optimize their productivity and reduce wastage, thereby addressing the issue of poverty in the MDGs.

In Ethiopia to date, the two most used energy resources are biomass (mainly firewood) and hydro-resources (see Table 3). The development of hydro potential until recently was very low, considering the long years of attempting such development. Major factors causing this low development, especially in connection with the grid, are the high investment cost for power generation and lack of local capacity (other than that of the government institution, EEPCo), for expansion of the grid system (COWI and GOPA, 2006).

Low levels of demand due to poorly developed and backward agricultural and industrial sector technologies and the relatively small amount of power demand by the household sector have also contributed to the slow power expansion. Judging from the current electricity supply level, which is 3,112 GWh/year (Workineh, 2006), the existing economically exploitable potential will be able to meet the electricity demand for several years to come (Table 1).

Table 1: Hydro-potential of the major river basins of Ethiopia

| River Basin | Gross potential (GWh/Yr) | Economically exploitable (GWh/Yr) | % of total wattage | Utilized (GWh) | Utilized (MW) | Utilized (%) |
|---|---|---|---|---|---|---|
| Abay | 280,144 | 70,036 | 43.2 | 1,311 | 218.6 | 1.87 |
| Omo-Gibe | 104,241 | 26,060 | 16.1 | 722 | 185 | 2.77 |
| Baro Akobo | 79,303 | 19,826 | 12.2 | 20 | 5 | 0.1 |
| Genale Dawa | 50,034 | 12,509 | 7.7 | 2 | 0.4 | 0.02 |
| Rift Valley | 48,960 | 12,240 | 7.5 | 0 | 0 | 0 |
| Tekeze | 35,870 | 8,968 | 5.5 | 0 | 0 | 0 |
| Wabe Shebele | 24,770 | 6,193 | 3.8 | 347 | 153 | 5.6 |
| Awash | 22,354 | 5,589 | 3.4 | 315 | 100 | 5.64 |
| Mereb | 3,072 | 768 | 0.5 | 0 | 0 | 0 |
| Total | 648,748 | 162,189 | 100 | 2,717 | 662 | 1.68 |

Source: MWRE, 2006 as quoted by Workineh, 2006

The development of solar and wind energy resources is not encouraging. Even though there are some efforts by the private sector, the approach followed by most of them is not convincing for many customers. Many of the products on the market are unaffordable to the majority of society and are not properly promoted to attract the customers who could afford to buy them. Lack of information on potential demand centers is also one of the major constraints to the development of these resources. At present, the Ethiopian Rural Energy Development and Promotion Center is running a Solar and Wind Energy Resources Assessment Project to address the problem of information barriers. The outputs of this project will identify the potential demand centers for solar and wind energy technologies at regional level in the country and the different purposes for which they could be used, including lighting, refrigeration, water pumping, cooking, etc.

## 2.2. CURRENT PATTERNS OF ENERGY CONSUMPTION

Despite the availability of huge energy resources, the current level of harnessing this energy is very low. This, to a certain extent, depicts the poor socio-economic situation in the country on the one side, and a low level of awareness about the potential and value of energy by most stakeholders on the other side (Figure1). Rural households utilized the greatest proportion of energy (>80%) out of which 99% is of biomass origin and comprises mainly of firewood, charcoal, crop-residues, and dung cakes. This biomass energy is most often utilized without being processed, which has many disadvantages to the users including loss of energy due to poor efficiency of utilization, health problems, etc. The vast majority of Ethiopian households (93%) depend on open fire stoves with a very poor fuel efficiency of 10-12%.

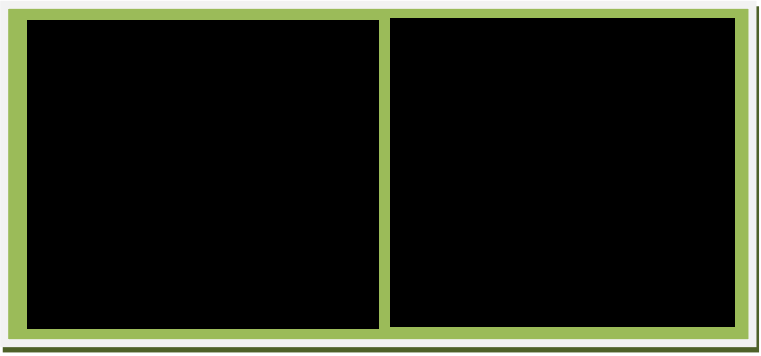

Figure 1: Energy consumption by sector and by source, 1999

The household sector, being the major consumer of energy in the country, is putting pressure on the natural ecosystem by devastating the forest resources and compromising food self-sufficiency by taking most of the residues from farms and fields. Other sectors like transport, agriculture, industry and services account for very little (about 12%) of the overall energy consumption.

The transport sector, in spite of consuming very little energy (about 4%), needs significant amounts (77%) of the country's foreign currency earnings to purchase this energy from abroad. The expenditure on petroleum fuels is growing through time because of the price increases on the world petroleum market and the increment in vehicle imports. This is greatly influencing the trade balance of the country. The revenue to finance social services like health, education, and other infrastructure is significantly reduced by the pressure caused by the national transport energy expenditure. The land-locked nature of the country, dependence on unreliable rainfall and the rapidly growing population make the situation even more challenging (COWI and GOPA, 2006).

Commercialization of agriculture and growth of non-farming private sector are amongst the major aims of the Plan of Accelerated and Sustainable Development to Eradicate Poverty (PASDEP). To facilitate such development, the country has been divided into four major zones. These include:

i) Areas with significant potential for commercialization and diversification of agriculture;
ii) Drought-prone areas;
iii) Regions with adequate rainfall; and
iv) Pastoralist areas

Infrastructure development, especially of the transport sector, is one of the essential prerequisites for the accomplishment of the goals set by the Plan. The enhancement of family welfare through better access to work, the reduction of women's time and energy burdens, access to markets and services and, more generally, the creation of links between urban and rural areas as well as between these identified zones all require improvements in the transport sector. Currently transport facilities are concentrated in urban areas, except for long distance public transport services, which still tend to link different urban centers rather than rural areas. Although supporting figures are not available currently, compared to the huge investment made in

transport energy, the sector's contribution to overall development is relatively small.

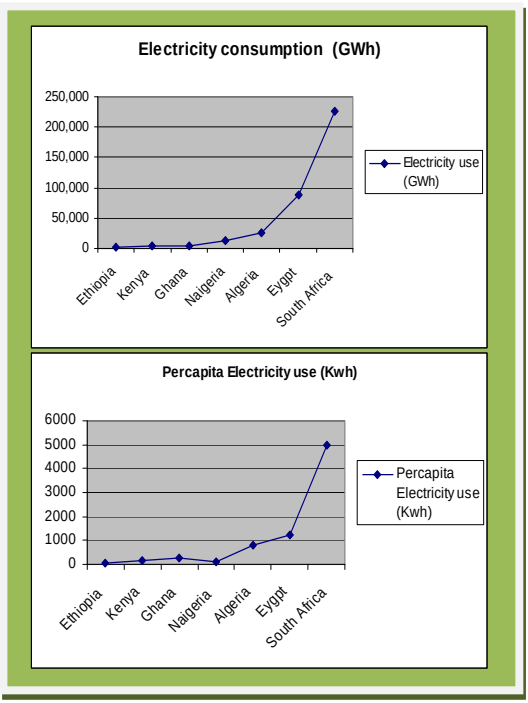


Figure 2: Selected African countries' electricity consumption (GWh) and per-capita electricity use (KWh)

The use of energy in the agricultural and industrial sectors is insignificant; the latter uses either petroleum products or electric power from the main grid. A short summary of the current patterns of energy consumption reveals that:

- Ethiopia has the lowest total power consumption (GWh) in Africa;
- The per capita electricity consumption of the country is also very low;

The Ethiopian Electric Power Corporation (EEPCo), the only power utility of the country, has reached few customers considering the long duration of its existence (about 50 years).

These figures depicting selected African countries' total electricity consumption (upper figure) and per-capita electricity use (lower figure) are also indicators of the countries' overall economic status.

## 2.3. ENERGY AND THE MDGS

Energy is closely tied to the Millennium Development Goals (MDGs) in many aspects. It is reported that providing the world's poor with modern household energy would contribute to preventing the deaths of 4,000 people a day. More than half of the world's population, especially in Africa, uses solid biomass fuels for cooking. The UN Millennium Project, recognizing the significance of the issue, states as one of its goals that the number of people without access to modern cooking fuels is to be reduced by 50% and improved cook-stoves should be made widely available by 2015 (Elizabeth *et al*., 2006).

It is possible to upgrade the productivity of both social and economic sectors in the country by injecting energy in different forms. For instance, farmers need modern manufacturing facilities to produce modern hand tools and simple farm implements. Preserving perishable farm products such as dairy products would add value to them by maintaining their quality and enable farmers to fetch better prices on the market. To realize this, modern forms of energy such as electricity from different sources are required. The power, however, must be made accessible to the rural poor in their vicinity, either through the grid system or through solar home systems. The implementation of both the Universal Electrification Access and the Off-Grid Rural Electrification Project serve achievement of these goals.

The vast majority of MDG components are likely to involve energy supply for direct use or indirect application. For instance, increasing the coverage of primary education in remote rural settlements

necessitates lighting and audio-visual equipment. Medical treatment in rural areas also requires at least sufficient light for the patients. Medicines spoil easily unless refrigerated, especially in lowland areas where the risk of malaria infection is high. Interestingly, the eradication of malaria is also one of the issues addressed in the MDGs.

Supply of water is an essential component of women's work in rural areas. Ensuring people's access to water nearby their residences is a major government agenda. The country has a significant potential for solar and a relatively good potential for wind energy. These energy sources could be used for pumping drinking water in order to reduce the burden on women, and even for irrigating small land holdings to enable farmers to produce crops continuously.

In most Ethiopian households, cooking is done indoors and often during the night, creating a very smoky environment. This significantly affects women and children because they stay up longer than other household members and routinely spend more than 4 hours a day in the kitchen. In most rural settlements, dining, living, and cooking are done in the same room. This seriously affects the people's health, causing acute respiratory diseases and eye infections. Smoke from burning biomass is found in nearly half the kitchens in the world. A World Health Organization (WHO) report states that 1.5 million people worldwide die prematurely because of inhaling smoke from kitchens. Among the pollutants, particulate matters are the greatest contributors to health problems caused by indoor pollutants.

## 2.4. ENERGY AND POVERTY REDUCTION

The PASDEP, as a derivative of the Millennium Development Goals (MDGs), primarily aims at empowering the rural poor, especially women and disabled persons. This could be achieved, among other things, through creating markets for the farmer's products and by making information technology accessible in his vicinity. The expansion of information technology in turn depends on access to modern energy for the majority, the rural poor.

A socio-economic study, conducted amongst women at Kebribeyah refugee camp before they used “Clean Cook” ethanol-burning stoves, indicated that women and children needed to travel on the average 6 hours to collect firewood. They had to do this every three days and one can imagine the burden this constituted on these women and girls. They ran the risk of confiscation of the collected firewood, sexual harassment, injuries and sickness due to traveling for long distances carrying heavy loads (average weight 20 kg). Consequently, the benefit of more leisure time, enjoyed by other members of society, is not available to women and girls in rural areas.

The rural development policies and strategies of the country stress that women should participate in rural development for two most important reasons: First, their absence in the development efforts would mean loss of 50% of the labor power of the country. Second and most importantly, they should equally share the benefits to be obtained from such efforts (MoI, 1994 EC). This participation can be achieved through supply of efficient household stoves and the provision of modern fuels, like biofuels, around their living areas. Biofuels have double advantage of providing sources of direct income and of being directly usable as cooking and lighting fuels. Providing the rural poor with improved modern energy services can also facilitate irrigation schemes, which release farmers from dependence on rain-fed agriculture; and enable communities to engage in diverse income generating ventures.

## 3. KEY ENERGY ISSUES IN ELECTRICITY AND TRANSPORTATION

Energy development must be of utmost concern to a nation like Ethiopia, which envisions the eradication of the poverty that has haunted her for generations. The country has a very large potential for electricity generation, to the extent of being able to meet all its modern energy demands.

## 3.1. ELECTRICITY

Electricity supply is unevenly distributed in Ethiopia. The main demand centers are the major towns and Addis Ababa. Access to electric power is recognized as necessary for attracting investment, especially in rural areas. In order to reduce the gap in electricity coverage between urban and rural areas, the government is implementing the Universal Electrification Program, which aims at equitable distribution of electricity to all regional states. Its purpose is to ensure that these development efforts, which create employment opportunities and a better quality of life, benefit the poor in all regional states.

In Ethiopia, power is generated mostly (about 98%) by large hydroelectric power plants, while the remainder (about 2%) is produced by Self Contained Systems (SCS) which use diesel generators and small hydro power generation plants. So far, only wind energy is in the pipeline to be used as an additional alternative power generation source, despite the existence of several alternative sources. EEPCo plans to establish wind power generation farms with a capacity of 150 MW. The erection of the wind farms should begin in 2008. Wind power in Ethiopia is a very good complement to hydropower, since wind energy production is relatively high during the dry season when hydropower production decreases.

Large amounts of foreign currency could be earned by exporting hydro-generated electricity. Countries like Kenya, Djibouti, Sudan, and Egypt are possible customers. The government is committed to realizing this opportunity. Extensive preparation is needed to guarantee safety, sustainability of supply, identification of dependable generation sources and the establishment of a modern power control and system monitoring mechanism. The current generation capacity is about 783 MW and by the year 2010, the country will have a capacity of more than 3,000 MW (**የማዕድንና ኢነርጂ ሚኒስቴር**፣ 1999) of electric power generation and be in a position to export power to other countries.

Table 2: Electrification status and future plan

| Description | Status (2004) | Plan (2010/11) |
|---|---|---|
| Towns with access to electricity | 635 | 6000 |
| Number of customers | 800,000 | 2,600,000 |
| Electricity access coverage | 13% | 50% |
| Km of line transmitted | 6534 | 136,320 |
| System losses | 20% | 15% |

- Electrification of rural towns and villages is underway until 2010 (UEAP);
- Equity is to be introduced to balance the power distribution in rural areas;
- Regional governments identify sites and request for electrification;
- The generation capacity has grown to nearly 800 MW (about 3%);
- Off-grid rural electrification is underway to complement the UEAP (MHP & SW energy).
- The level of electrification is lagging behind all other Sub-Saharan African countries;
- UEAP should lead to a dramatic improvement;
- Investment promotion in connection with this program has a multiplying effect; and
- Affordability remains an issue for discussion.

The energy supply depends on the extent and type of demand. Electricity in the household sector in large towns, especially in Addis Ababa, is mainly used for lighting and baking, however, only a few households with relatively better earning capacity utilize electricity for cooking and other high power consuming end uses. Consequently, the per-capita electricity consumption in the household sector is very

low (33 KWh). The country has the lowest per-capita electricity consumption in Sub-Saharan Africa.

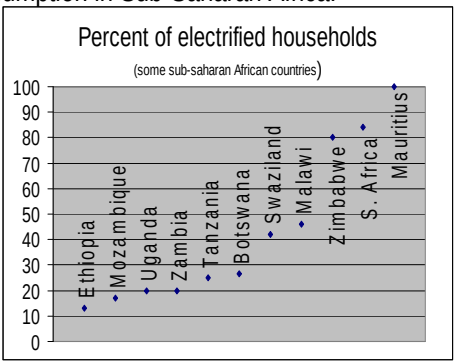


Figure 3: Level of electrification in Ethiopia vs. other sub-Saharan African countries

Both UEAP and OFF-GRE programs facilitate investment, either through provision of power to the existing rural settlements or by being causes for the establishment of new settlements. Provision of power all over the country allows establishment of industries in these localities where the raw materials are easily accessible. This will help to minimize raw material costs, which means a relatively better market to producers and good price to consumers.

## 3.2. TRANSPORT SECTOR

The country utilizes both traditional and modern forms of transportation. Often transportation is used for product exchange between producers, consumers and all other stakeholders, such as in the distribution of agricultural products and raw materials. Tourism also involves the transport sector. For rendering such services, this sector needs a sufficient and sustainable energy supply. Except for the traditional and a few modern means of transport like bicycles, most forms of transport use petroleum fuels such as gasoline, diesel, jet fuel, and fuel oil. Due to the rugged nature of the Ethiopian terrain and the highly scattered nature of its settlements, road transport is

and will remain the most important means of transport in the country (MOI, 2003).

Most vehicles in the country are used cars with a good external appearance but poor engine performance. Moreover, no age standard has been set for discarding old vehicles. Vehicles are unevenly distributed in the country, which is an indication of the differences between regions in terms of transport facilities. However, overall vehicle numbers are growing relatively fast. The annual growth rate is higher for buses and mini buses, with respective increases of 19.5 and 17.3%. Taxis and trucks increase by 10.7 and 9% respectively, while the growth rate for private cars is lowest at 6.1% (Road traffic Studies, 2006).

Even though the industrial and household sectors consume relatively large amounts of petroleum fuel, the greatest portion goes to the transport sector. The dominant fuel is diesel. Most often this fuel is utilized for road transport vehicles, mainly large and medium buses, all sorts of trucks, and a few minibuses. As is well known, the use of diesel in internal combustion engines produces atmospheric pollutants.

Until recently, the greatest proportion of roads was of very poor quality. Even now, only the main roads from the national capital (Addis Ababa) to regional capitals and smaller roads in a few large towns and in Addis Ababa are in a relatively good condition. Although the efforts made by the government to improve the road network coverage and quality are highly commendable, much more effort is needed towards further road improvement, which plays a significant role in reducing the energy consumption of the transport sector.

In other countries, the modes of road transportation are diverse and so are the energy sources. For instance, most developed countries use electric power for railway transport within and between countries and for trolley buses in large cities. Both are very good examples of

mass transport, which reduces energy use and Greenhouse Gas (GHG) emissions. Brazil uniquely utilizes bio-diesel and ethanol for land transport; this was initiated during the oil crisis of the 1970s. Even though the country initially faced resistance both from fuel distributors and from the public, it is currently the world leader in using biofuels for transport, in saving foreign currency on petroleum fuel imports, and in contributing to the reduction of global GHG emissions.

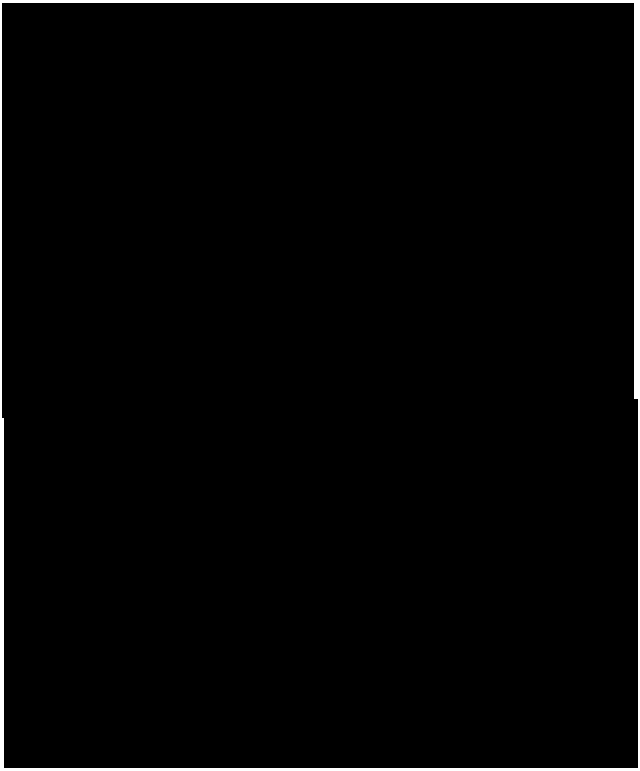

**Figure 4: Petroleum energy consumption by sector and by fuel type**

As we have seen, Ethiopia, like most developing African countries, depends on increasingly expensive petroleum fuels. This has led to

plans for the introduction of electric buses and biodiesel fuel blends within the next few years. Bio-diesel should be extracted mainly from non-edible plants (i.e. *Jatropha* and castor beans) produced on marginal lands, without the disturbance of the vulnerable biodiversity or food security. Another form of biofuel is bio-ethanol, which is to be produced in the existing and additional planned sugar factories. Bio-diesel and bio-ethanol are to be blended with petroleum diesel and benzene respectively. The introduction of these technologies will have significant advantages like: creating employment for the rural poor; reducing dependence on imported petroleum fuels; and diversifying the energy sources for road transport. To tap these advantages, these technologies should be introduced with due care so as not to disturb our sensitive natural environment and to secure a broad participation of stakeholders. The government is strongly committed to these plans and is currently producing strategies to guide the implementation of this program.

## 4. ENERGY RESOURCE POTENTIALS, OPPORTUNITIES, CONSTRAINTS AND CHALLENGES

### 4.1. RESOURCE POTENTIALS

The economically exploitable hydropower resource potential of the country is more than 45,000 MW, or nearly 162,189GWh/yr. It is sufficient to meet the domestic power demand for many years to come. However, within the current economic context, power generation and distribution methods that target the demand of the country's scattered population are not financially viable for the private sector unless the tariff is increased, which would make power unaffordable for the majority of the population. On the other hand, the power sector development is one of the most crucial factors for achieving accelerated development. Therefore, the government should take the lead due to the lack of involvement of the private sector.

Some natural gas, oil shale and petroleum resources are believed to be present in Ethiopia, although the quantities are not certain. The proven potential of oil shale is about 108 million tons, and that of natural gas is 4 trillion cubic feet (TCF). The exploration and development of natural gas at Calub in the Somali Region is underway. The gas is intended exclusively for the export market as Compressed Natural Gas (CNG), using pipelines.

**Table 3: Energy resource reserves, exploitable and exploited potential**

| Energy type | Unit | Total reserve | Exploitable | Exploited | Exploited percentage |
|---|---|---|---|---|---|
| Wood | Million tons | 767 | 37 | 40 | >100 |
| Dung | Million tons | | 37 | 40 | >100 |
| Agric-residue | Million tons | | 40 | 40 | 100 |
| Hydro power | Mega Watt | | >45,000 | 783 | <2 |
| Solar energy* | KWh/$m^2$ | | 7,466,232 | 7,432 | 0.1 |
| Wind energy* | | | 18,049,000 | 901,000TJ/yr | 5 |
| Geothermal energy | MW | 700 | 700 | 3 | 1.2 |
| Coal | Million tons | 78 | 14 | 0 | 0 |
| Natural gas | Trillion Cubic Feet | 4.1 | 4.1 | 0 | 0 |
| Cogeneration energy from bagasse | MW | | 119 | 0 | 0 |

*Data from Workineh Gashie, 2006

The coal reserves are scattered in different parts of the country, with a total exploitable reserve of more than 78 million tons. Some of the known reserve sites include the Mush Valley with about 300,000 tons, Delbi with more than 6.4 million tons, Moye with more than 7.2 million tons, and Yayu with more than 64 million tons (MME, 2007) Most of the deposits are found in thin seams mixed with clay and are scattered rather than continuous, making extraction difficult.

The three sugar factories currently under operation, Wonji-Shoa, Metehara, and Fincha, and a fourth plant, Tendaho (soon to become operational), have good potentials for cogeneration energy. Cogeneration is the process of combined production of heat and electricity from agricultural wastes through modern industrial plants using chemicals or biomass fuels. Most often cogeneration energy is best obtained from sugar factories. The total cogeneration potential of these plants is estimated to be 119 MW. Wonji-Shoa has a potential of 40 MW, Fincha of 14 MW and Tendaho of 65 MW. These potentials, which represent the amounts of power left after the factories' own demands are met, can be supplied to the main grid. Currently only 7 MW are generated by the Fincha Sugar Factory (Workineh, 2006).

## 4.2. OPPORTUNITIES

As we have seen, the country has diverse potential energy resources, and the government is committed to creating enabling policies and legal grounds to facilitate the utilization of these resources.

The current trend in agro-industrial development and the demand for modern energy are opportunities for the effective implementation of UEAP and OFF-GRE Programs. The agro-industries are located where the raw materials are found and most of them need power for their operation. Industries benefit from being situated nearby sources of raw materials by fetching better profit margins and by reducing transport costs, as the space needed to transport raw materials in bulk is much greater than transporting finished or semi-processed goods. Also they need large number of relatively cheap labor, which then settles nearby these industrial establishments gradually changing into small villages and then to urban settlements. The efforts towards the eradication of extreme poverty and the adoption of the principles of accelerated economic development have triggered the need for electrification of the whole country, especially the rural areas.

Biofuel is relatively environmentally friendly since it is extracted from renewable sources. Production of this fuel in large quantities would

both reduce the burden on export earnings and become an important source of export revenue. In addition, it would create significant job opportunities. Proven technologies and approaches are available for the introduction of biofuel technology. In addition, a large amount of data exists on both the successes and failures within this field. This information can serve as a valuable lesson for Ethiopia, allowing us to assess our own situation, adopt the appropriate technologies and gain our own experience in managing these resources. Biofuel plants are locally available, often indigenous, and the conversion technologies are not complicated, have no negative health impacts and require little effort. The technology for the utilization of biofuel, especially for rural household use, could be obtained at an affordable price. It fits all types of settlements and serves more than one purpose, for instance cooking, lighting, and use as transport fuel. Since it targets several customer groups, it is a strategically important fuel and has become a focus of government policy.

## 4.3. CONSTRAINTS AND CHALLENGES

Alternative energy exploitation at the moment is very low in Ethiopia, mainly because the necessary technologies are not easily available or, where available, are either very expensive or cheap but short-lived. This makes the cost of exploiting the resources very high for Ethiopian households, thereby making access to and appropriation of energy technologies dependent on economic capacity. Another hindering factor is poor technical know-how due to the practice of outsourcing most of energy development activities to external consultants. There is also the problem of poor information flow. In general, the promoters of alternative technologies do not want to incur the large costs of promoting the new technologies amongst the rural masses. Furthermore, monitoring and evaluation of performance also cost more than the expected profit for the private sector as the flow of information between households is relatively slow. Consequently, the expansion of such technologies remains restricted to large urban centers and is not developed or marketed properly.

The scattered settlements and the traditions of the people might also be constraining factors for the proper utilization of the energy resources. For instance, the high mobility of nomadic people prevents them from using biogas technology despite having large numbers of cattle.

Energy resource development is also dependent on the existence of road and other communication facilities. The new age of information technology has made the world just like one big village. Technological change is happening so fast that a day's delay in accessing information about development puts a nation behind the global socio-economies. Incomplete information, on the other hand, can lead to misinterpretation and rejection of new technologies, which in turn may cause a loss of trust in new innovations. For instance, most Ethiopian households use traditional energy sources and are not aware of either the implications of unsustainable energy technologies or the existence of alternative energy technologies, thereby excluding themselves from future ownership of such technologies.

Energy development in Ethiopia has been impeded by insufficient institutional set-up. The extent of the problem is not appreciated by all concerned parties and has not been seriously worked on. This has forced the majority of the Ethiopian poor to stick to obsolete technologies even though they do not like them.

## 5. CONCLUSION AND THE WAY FORWARD

### 5.1. CONCLUSION

- The vision to raise Ethiopia's socio-economic status to middle-income level within 20years could be highly accelerated by diversifying energy development especially using more renewable resources.
- Transformation of the current trend of rural society's energy utilization to the modern form requires large-scale promotion and distribution of renewable energy and related technologies.

- Exploitation of the country's resources, upgrading the efficiency of labor, and improving the productivity of land, would highly facilitate the achievement of Ethiopia's responsibility to the MDGS.
- The current reliance on hydro-power should be augmented by wind and geothermal energy. Co-generation using energy from the sugar factories can also provide an additional source of electricity.
- The transport sector and alternative energy development should form synergy to enable the country to save on foreign currency earning and to contribute to the achievement of tangible socio-economic benefits.
- Implementation of strategic issues of MDGs which include access to education, medical services, gender, access to pure water etc. need modern energy inputs.
- As the national policies and strategies of Ethiopia highly encourage women's participation in the development effort, more widespread use of modern and renewable energy technologies in rural settlements would help to ensure this participation. One of the means to realize this would be to involve them in the promotion and dissemination of efficient energy technologies.
- It is imperative to take the opportunity provided by globalization, which provides existing technologies for harnessing Ethiopia's abundant energy resources and reduces the need for development of new energy technology.
- Rural electrification and universal electrification access programs highly support agro-industrial development and modernization of people living in remote rural areas, and needs to be intensified.

- Although biofuel as renewable energy source is an opportunity for combating the current petroleum energy crisis, great care needs to be taken not to compromise the interests of all relevant stakeholders, including the natural environment.

## 5.2. THE WAY FORWARD

The vision to raise Ethiopia to a middle-income level by 2020 entails, amongst other factors, availing modern energy facilities in every compound (Figure 6). This vision has to be shared and appropriated by all relevant stakeholders. Unless it captures their attention and increases their awareness concerning the importance of energy, we will end up impeding our vision for many generations to come.

The government as the maker of enabling policies, other executing organs as implementers of the energy development programs, the broad masses who benefit or suffer from the effects of such programs emanated from the policies, and the natural environment, which is the habitat for both current and future generations, are all major stakeholders in the process of energy development. All those who want to see a civilized Ethiopia should internalize and debate about the constraints and challenges identified in this study, as well as issues that have not yet been discovered, in order to find the solutions together.

It is undeniable that the extraction and utilization of renewable energy resources and technologies need strong promotion and information flow. Considering that renewable energy technologies like biofuels are expected to make at least the transport and household sectors self-sufficient in their energy need, promotion of these technologies should be made to secure positive response from concerned stakeholders. Renewable energy, especially biofuel, sufficiently meets the domestic demand for clean and affordable energy, reduces the pressure on our foreign currency earnings due to petroleum imports, and protects our sensitive environment. Striking the balance between our needs and those of the future generations should be appropriated as the motto for all involved in energy development in this country.

The challenges can only be tackled by a systematic approach, concerned actors include: policy makers; technology

developers/promoters; consumers; and investors. Representatives of these groups should be combined into either a renewable energy forum or a stakeholders steering group. This body should serve the purpose of communicating and brainstorming on interests, uncertainties, potentials, and national & global information related with development of the energy sources and technologies. This would be a good ground for mainstreaming the successful energy sources and technologies. It would further help to develop confidence among stakeholders and empower the society at large to be able to make informed and rational decisions concerning aspects related to energy. Such a system would help to easily filter any adverse effects of new developments in the energy sector as a whole.

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# BIOFUEL DEVELOPMENT IN ETHIOPIA: CURRENT STATUS AND THE WAY FORWARD

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## ABSTRACT

Biofuel in this document comprises two types of fuels, namely bio-ethanol and biodiesel. Ethanol is produced mostly from agricultural crops, and biodiesel is typically produced by a reaction of vegetable oil or animal fat with an alcohol, such as methanol or ethanol, in the presence of a catalyst. Liquid biofuel made from biomass is attracting increasing interest worldwide. Industrial countries see biofuel as a way of reducing greenhouse gas (GHG) emissions from the transport sector and diversifying energy sources. Developing countries such as Ethiopia see biofuel production as a way to stimulate rural development, create jobs and save on foreign exchange.

Ethiopia imports its entire petroleum fuel requirement, and the demand for petroleum fuel is rising rapidly due to a growing economy and expanding infrastructure. Given the current and expected oil price trends and volatility, the gradual substitution of imported petroleum fuels by biofuel and a diversification of energy sources will rapidly gain macroeconomic importance.

Biomass resources like wood, agricultural crops and residues can be converted into biofuels such as ethanol, methanol, biodiesel, and biofuel oil. Bio-ethanol and biodiesel have immediate potential in, and relevance to, Ethiopia, which has a huge potential for using biofuel as well as for growing biodiesel crops and using molasses to produce ethanol in the sugar industries. In order to fulfill this potential, issues of awareness, capacity building, sustainability, research and development and others must be addressed. Also, the following measures need to be considered: stimulating feedstock enhancement; stimulating demand; enhancing environmental sustainability; capacity building; defining roles and responsibilities of different institutions; supporting research and development; awareness creating and

promoting of biofuel; updating the existing national energy policy or enacting a new biofuel policy; and establishing a biofuel development program.

## 1. INTRODUCTION

In this paper, biofuel is defined as 'liquid fuels produced from biomass', excluding solid biomass as a source of energy. It focuses on the two most important biofuels, bio-ethanol and biodiesel, based on currently available and commercially developed technologies.

### 1.1. ETHANOL

Ethanol is manufactured by a microbial conversion of biomass materials through fermentation. Ethanol contains 35% oxygen. The production process consists of conversion of biomass to fermentable sugars, fermentation of sugars to ethanol, and the separation and purification of the ethanol. Fermentation initially produces ethanol containing a substantial amount of water. Distillation removes the majority of water to yield about 95% pure ethanol, the balance being water. This mixture is called hydrous ethanol. If the remaining water is removed in a further process, the ethanol is called anhydrous ethanol and becomes suitable for blending into gasoline.

### 1.2. BIODIESEL

During biodiesel production, oil is extracted from oil seeds by mechanical crushing or solvent extraction. The by-product is a protein-rich residue cake that can be used for animal feed. The oil is filtered, washed, decanted, dried and heated. It reacts with methanol in the presence of a base catalyst (typically caustic soda potash) at 50$^{o}$C in a process called transesterification.

## 1.3. USES

The most prevalent use of biofuel is for transportation. Ethanol is used primarily in spark-ignition engine vehicles. The amount of ethanol in the fuel ranges from 100-5% or lower, blended with gasoline. The ethanol added to gasoline needs to be free of water (anhydrous), or else phase separation can occur between gasoline and water-ethanol. Anhydrous ethanol is transported separately to terminals to minimize contact with water and typically blended into gasoline just before loading into trucks by a process called splash blending, which requires no special equipment or temperature control.

## 1.4. THE NEED FOR A BIOFUEL DEVELOPMENT PROGRAM FOR ETHIOPIA

Ethiopia is the second most populous country in sub-Sahara Africa, and meeting its energy requirements in a sustainable manner continues to be a major challenge. A development strategy for biofuel to become the Ethiopian Millennium Fuel will help the country's economy through:

- Diversification of energy sources and lower exposure to price volatility on the international oil market. Ethiopia, a net importer of gasoline and diesel fuel, will help to enhance its energy security through substitution of gasoline and diesel fuel by locally produced biofuels;

- Contributing to rural development through the expansion of agricultural land and through creating jobs in feedstock production, biofuel manufacturing, and transport and distribution of feedstock and products;

- Reduction in harmful pollutants from vehicle exhausts. Biofuels have the added advantage of being sulfur free; and

- Net reduction in lifecycle GHG (Green House Gas) emissions. Ethiopia does not currently have binding GHG reduction targets under the Kyoto Protocol, and is typically more concerned with potential climate change impacts than with reducing her own GHG emissions. Under the Clean Development Mechanism (CDM), however, Ethiopia could sell carbon credits to countries with reduction commitments.

## 2. DEVELOPMENT STATUS OF BIOFUELS IN ETHIOPIA

A national Biofuel Development Program that encourages and facilitates investment activities in the field of biofuels must be put into action to strengthen the development of the energy sector, achieve economic growth and improve the living conditions of the population. As experience from the flower industry has shown, biofuel investments will create job opportunities and foreign earnings. At the same time the government must play its own role in the ethanol and biodiesel development program.

The Economic Development Policy of the country is to create an environment conducive to the participation and contribution of the private sector in the economic development of the country. The Biofuel Development Program will help to create alternative energy sources as well as favorable conditions for the development of the industrial sector. This effort is linked with the *Agricultural Development Led Industrialization (ADLI),* which aims at achieving an optimum utilization of the country's natural, human and material resources.

The production of biofuels and 'green power' in Ethiopia should also be considered from the point of view of its potential for poverty alleviation through rural employment and income generation, and its environmental impact, such as sustainability, ecosystem rehabilitation and climate change mitigation through carbon sinks and net $C0_2$ abatement.

Commercially available and transferable technologies exist for the production of ethanol (all scales) and biodiesel (small and medium scale). The development status of the two biofuels in Ethiopia is at different stages. Therefore it is important to analyze the situation separately for ethanol and biodiesel.

## 2.1. ETHANOL

Ethiopia recently commissioned a state-of-the-art 8-million liter per year ethanol distillery at the Fincha sugar factory. Studies for a second plant (distillery and bagasse power cogeneration system) at the Metahara Sugar Company are underway. This initiative -- originally intended for gasoline blending -- met with unanticipated resistance from the oil companies, forcing the Government of Ethiopia to look for alternative uses for the ethanol (K-50, Millennium Gel-fuel and straight ethanol for cooking), to build additional ethanol storage tanks and to operate the Fincha distillery at below installed capacity. While this experience has been a major drawback in the development of the ethanol industry in Ethiopia, it has provided the Government of Ethiopia and the private sector with significant technical, policy and institutional lessons and the necessary experience to be able to move forward on a firm footing. Since 2005, Fincha is reportedly exporting the bulk of its production of ethanol to Europe, demonstrating that there is not only a potential local market for biofuels, but that Ethiopia could play a role in the international market and thus increase export earnings in the future.

## 2.2. BIODIESEL

Biodiesel is another important resource to be exploited in Ethiopia. The technology used to extract biodiesel is not well known in Ethiopia. However, there is a growing demand for biodiesel development in Ethiopia. Both local and foreign companies are very interested to develop this resource due to the availability and suitability of land to grow the feedstock. Some of these companies are either in the process of acquiring land, or have already done so, in Oromia,

Southern Nations Nationalities and People's Regional State, Benishangul Gumuz Regional State and other states.

## 3. POTENTIALS, OPPORTUNITIES AND CHALLENGES OF BIOFUEL DEVELOPMENT IN ETHIOPIA

Despite the existence of several excellent research centers with experienced staff in Ethiopia, there is generally a lack of adequate expertise and skills. This is a major constraint on the development of biofuel (specifically of biodiesel) in Ethiopia. Compared to other countries such as Brazil, India, USA, EU and South Africa, the effort made here so far is unsatisfactory, due to lack of: awareness; policy and regulations; trained human resources; and research and development. During the preparation of this document, this lack was experienced first-hand by the taskforce, and is attributed to the fact that priority has been given to research on other crops, and that biofuel is not well understood by researchers.

### 3.1. ISSUES OF BIOFUEL DEVELOPMENT

#### 3.1.1 AWARENESS OF LOCAL PRODUCERS

Globally the demand for, and investment in, biofuel is increasing. The potential for biofuel feedstock to be grown in Ethiopia is receiving more attention from foreign investors, whereas local investors are generally not aware of this market. However, it is advisable to encourage local investment into this sub-sector in the future.

#### 3.1.2 LAND DEMARCATION AND ZONING FOR FEEDSTOCK GROWING SITES

Ethiopia has a total landmass of 1.1 million square kilometers, and most of that area is located in the lowlands where the temperature is high. As a result these areas are sparsely populated. Oil crops such as *Jatropha curcas* grow below 1500 meters above sea level and could thus be cultivated in these lowlands, thereby ensuring a huge

potential of landmass suited to the production of these oil crops. However, some regions have not made inventories of land in terms of real crop growing potential and land development plans are not well integrated. An inventory of land including zoning of biofuel feedstock growing areas should therefore be undertaken. Currently, allocation of land by regional governments to investors without guidelines, may adversely affect Ethiopia's capacity for growing food crops. This also should be considered thoroughly.

### 3.1.3 CAPACITY BUILDING

The dynamics of biofuel development are increasing day to day. Science and technological advancements have made a tremendous impact, yet in Ethiopia, the capacity in this area has not yet been developed. This also affects the Biofuel Development Program.

### 3.1.4 POLICY AND REGULATION

Ethiopia's Energy Policy of 1994 E.C. includes adequate coverage of the development of biomass energy. It addresses the questions of how to enhance supplies and how to use energy more efficiently (demand). However, the issue of biofuel was not addressed properly; hence, the policy measures should be updated to stimulate demand and create favorable conditions for the development of biofuel.

### 3.1.5 RESEARCH AND DEVELOPMENT

Biofuel developing countries such as Brazil, India, USA, Germany, France, Australia, etc. have given much attention to research into high yield feedstock and to developing end use devices that can be run efficiently on biodiesel and ethanol. Therefore, research should be undertaken in Ethiopia as well.

### 3.1.6 SUSTAINABLE BIOFUEL DEVELOPMENT

The growing demand for biofuel may affect the capacity to grow food crops. Ethiopia at present is not producing sufficient food crops for its

own consumption. Realizing this fact, areas used for biofuel feedstock production should be separate from land used for food production, as well as from natural forest areas.

### 3.1.7 INFRASTRUCTURE

Infrastructure is a key to economic growth. The production of biofuels such as bio-ethanol and biodiesel also needs to link with infrastructure development. Infrastructure includes roads, telephone, access to electric power, etc.

### 3.1.8 FINANCING

The Biofuel Development Program needs a special financial arrangement. The Program will not be easily developed without accessing both national and international funding schemes.

## 3.2 POTENTIALS OF BIOFUEL DEVELOPMENT IN ETHIOPIA

### 3.2.1 POTENTIAL FEEDSTOCK FOR OIL PRODUCTION

Biodiesel can be produced from a large variety of vegetable oils and animal fat. The three non-edible oil crops with high oil content most suitable for the Ethiopian agro-ecologies are *Jatropha curcas*, castor bean and palm oil (this is also used for cooking oil). All these plants yield more than 1000kg of oil per ha. Most are reported to be viable in arid climates and poor soils and very productive with relatively low rainfall and fertile soils.

#### *JATROPHA CURCAS*

The highest oil yielding *Jatropha* variety, *Jatropha curcas*, can be grown in arid climates (rainfall as low as 200 mm, mean temperatures of 20-25 degrees Celsius) and marginal soils to produce 1000 kg of oil per ha. A wide range of productivity estimates ranging from 0.5 ton to 12 ton of seed per ha is currently given for the plant. Production of 5

tons of seed per ha can be expected for the plant in good soils and rainfall (900-1200 mm). On soils of marginal productivity and in an arid climate productivity can be expected to drop to as low as 2 tons per ha. It is estimated that 23.3 million hectares of land in Ethiopia are suitable for growing *Jatropha curcas*. In Oromia Region an inventory has been compiled with suitability factors for *Jatropha curcas*, and the available land is estimated at 17.23 million hectares.

## CASTOR BEAN

Castor bean is native to Ethiopia. The castor plant grows in diverse climates but favors a warm, dry climate (600-700 mm of rain, 1600-2600 meters above sea level altitude). It requires moist, deep, and well-drained soils for optimal yields.

Due to its adaptability castor is widely distributed in Ethiopia. It has a high oil yield (260-1250 kg of oil per hectare).

## PALM OIL

The oil palm originates from the wetter parts of West Africa. It is mostly grown within 10 degrees, north or south, of the Equator. It does grow commercially in latitudes of 17 degrees from the Equator, but yields are reduced at such sites. Its temperature requirement is roughly 22-32ºC and its rainfall demand is usually in excess of 2000mm, with a fairly even distribution required throughout the year. Oil palm, per hectare, is the highest yielding vegetable oil crop in the world. Planting 120-150 palms per hectare are common establishment rates. Yield potential is 5 tons per ha in year 1 of harvest, and by year 4 should be approaching 20 tons per ha of fresh fruit bunches (FFB). In a mature plantation of 8 to 20 years of age, good management should produce up to 30 tons per ha of FFB. Average bunch weights will usually increase from 4 kg to over 25 kg, with exceptional bunches weighing up to 75kg.

In 2010/11 (2003 Ethiopian Calendar) the total area planted with biodiesel crops may reach 45,000 ha and oil production 43,000 tons.

### 3.2.2 POTENTIAL FOR ETHANOL PRODUCTION

The raw materials used for ethanol production are sugarcane, sugar beet, corn, corn stover, wheat, barley, molasses and cellulose biomass. In Ethiopia 960,000 hectares of irrigable land are available for multipurpose use. Of this, the area identified as suitable for sugarcane plantation is 700,000 ha and this can yield more than 1 billion liters of ethanol.

## 4. THE WAY FORWARD

A number of issues have been raised and discussed in this document, some of which refer to individual sectors, and others to a number of interlinking components of the biofuel industry. In order to utilize the biofuel potential of Ethiopia, it is important to consider the following measures:

- Stimulating the supply of feedstock, including zoning of ethanol and biodiesel feedstock growing areas in the regions;
- Stimulating the demand for biofuel;
- Ensuring the environmental sustainability of biofuel production;
- In the course of feedstock production, protecting forest ecosystems, encouraging sustainable crops and management practices, improving degraded lands and maximizing GHG benefits;
- Processing, distribution, and end-use of biofuel products;
- Encouraging a range of uses for biofuels;
- Capacity building;
- Defining roles of the different institutions;
- Supporting research and development;

- Awareness creating and promoting of biofuels;
- Developing a Master Plan on biofuels;
- Allocating special financing modalities;
- Linking the Biofuel Development Program with the Agricultural Extension Service;
- Encouraging investment in infrastructure development; and
- Maximizing rural development benefits.

Finally, biofuel has a tremendous potential positive impact and Ethiopia will benefit hugely from it. Leading this sub-sector in a coherent way will enable Ethiopia to achieve great advancement in energy security, rural economic development and environmental gain. Thus, the Government of Ethiopia has so far given due attention to this important issue, and this should be continued.

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# A PRELIMINARY ASSESSMENT OF SOCIOECONOMIC AND ENVIRONMENTAL ISSUES PERTAINING TO LIQUID BIOFUEL DEVELOPMENT IN ETHIOPIA

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ABSTRACT

The sustainable growth of Ethiopia's economy depends on the availability and security of energy, of which liquid fuel is an important part. Current sharp fluctuations in fossil fuel prices have frustrated development efforts and forced the country to review its energy development strategies. As Ethiopia relies entirely on imports for its oil needs, the volume of imported fuels grew by 115% between 2003/04 and 2004/05. Simultaneously, the fuel bill increased tremendously and consumed about 82% of Ethiopia's export earnings in the year 2004/05. The continuously high oil prices are a heavy burden for the country's economy.

Recently, the Government of Ethiopia has started to think about alternatives to oil and about replacing gasoline and diesel fuels with liquid biofuels, such as bio-ethanol and bio-diesel, from molasses and energy oil seeds respectively. Production and use of biofuel, besides providing energy security, will create jobs and improve rural and urban livelihoods, as well as having other environmental and social benefits.

Nevertheless, until recently the absence of a clear strategy and relevant regulations for biofuel development in the country caused some misuse and mismanagement of natural resources. The absence of clear guidelines on land allotment and its sustainable use creates danger to the food security endeavors of the country.

The production and use of biofuel will not be sustainable and environmentally sound unless it is supported by economic, energy and environmental policies in the field of biofuel development with clear prospects for food production, biofuels production and energy security.

## 1. INTRODUCTION

Energy is an essential prerequisite for the development of any country. It is also one of the critical areas where technology, economics, and politics intersect. Its centrality to social and environmental issues is beyond question, as it plays key roles in any system of planning or development. Access to modern forms of energy will transform the living conditions of the population and boost industrial, agricultural, urban and rural development. If made available in rural areas, modern energy could provide lighting to extend the day, supply energy for cooking, power water pumps to eliminate lengthy, exhausting walks to fetch water, and liberate millions from the burden of poverty.

However, the unreliability and high cost of modern energy supplies in many developing countries impede production, growth and development and debilitate their efforts to meet the basic needs of their peoples. Moreover, the increasingly high oil import bills and the financial losses of parastatal energy utilities handicap developing economies.

Ethiopia is facing acute and urgent challenges as the result of increasing oil prices. The lack of energy infrastructure creates formidable impediments to social and economic progress. Over three quarters of the population have no access to modern energy or electricity; millions of women and children trek long hours to collect fuel wood; and urban dwellers spend large proportions of their income on their minimum daily fuel needs. The energy consumption of the

average Ethiopian is among the lowest in the world. In 1994, Ethiopia's per capita kg oil equivalent commercial consumption was 5 times less than that of Kenya, 65 times less than the world average and 17 times less than the average of other low income countries.

Biomass in its various forms - wood, charcoal, dung and agricultural residues - accounts for more than 94% of the total energy consumption. Petroleum products and electricity provide only 1% and 5% respectively of the national energy demands. In relative terms, the consumption of petroleum and electricity is insignificant. However, petroleum fuels and electricity supply almost all the modern energy needs of the transport, communication, trade, industry and social services sectors. Moreover, petroleum imports consume the lion's share of the export earnings of the country. As economic growth and infrastructure development are gaining momentum, the demand for fuel oil is rising rapidly. Over the last decade alone, the country's oil demand has grown at an annual average rate of 5%, and the volume of imported petroleum reached 1.37 million tons in 2004/05.

On the other hand, oil prices have remained high since 2004 and currently float around 90 USD per barrel. Moreover, the major oil reserves of the world are located in geopolitical regions where the political situation is usually unstable. Consequently, the rising oil price and the insecurity in its supply have a great impact on the economic development of the country. In particular, its transport and industrial sectors are extremely vulnerable to oil market disturbances.

Due to the above reasons and the need for the enhancement of rural livelihoods, the Government of Ethiopia is devising a strategy for developing alternative sources of energy, including the development of liquid biofuel. The energy and environmental policies of Ethiopia encourage the development of biofuel as an alternative energy source.

The driving forces behind biofuel development in Ethiopia are:

- Expansion of agribusinesses and agro-industries to improve rural livelihoods;
- Improved social well-being and poverty reduction as a result of greater access to energy services in rural areas;
- Substitution of imported petroleum and increased ethanol and feedstock exports;
- Foreign exchange savings;
- Assurance of energy security;
- Creation of new job opportunities;
- Conservation of soil (resulting from the cultivation of biofuel feedstock crops on degraded lands), water and forests; and
- Reduction of air pollution, including indoor pollution caused by firewood use.

Some assessments indicate that Ethiopia is endowed with a huge potential for feedstock production for biofuels, especially for sugarcane and *Jatropha* for bio-ethanol and bio-diesel production.

So far Ethiopia has taken only limited steps towards developing its biofuel potential so as to ensure its fuel supplies. Since 1998, the Fincha sugar factory produces ethanol through the fermentation of molasses. Its current annual ethanol output amounts to 8 million liters, with a distillation capacity of 4500 liters per day. However, while the ethanol industry is maturing, the bio-diesel industry is still in its infancy.

Both the scale of investment and the number of companies involved in the bio-diesel industry are currently accelerating. Surging investment in the bio-diesel industry is being driven by a variety of factors, including the increasing world biofuel market and the government's policy of promoting agricultural investment in the country. However, the expansion of biofuel industries may increase the competition for

food croplands and drive up the prices of staple foods, thereby potentially endangering food security. The cultivation of energy crops will also affect biodiversity and soil and water resources.

The primary aim of this preliminary study is, therefore, to review the status of biofuel development in the country, and to assess some of the socioeconomic and environmental aspects of biofuel feedstock production. Policy issues will also be studied, and the paper will conclude with some recommendations for decision makers.

## 2. METHODOLOGY

The methodologies used for this assessment were: 1. desk reviews; and 2. interviews with company and government officials as well as other experts. Questionnaires were developed for biofuel companies and government offices, which included questions on: profile of the company/organization; mandate and responsibilities; socioeconomic and environmental issues; knowledge about general and renewable energy issues (with specific attention to biofuels and bio-energy); attitudes towards renewable energy sources and energy efficiency. The questionnaires were dispatched to selected companies and governmental organizations and their responses were collected. Furthermore, face-to-face interviews with government officials and experts from Oromia and SNNP Regional State were conducted. Desk reviews of existing documents and information from internet sites were also used in the assessment.

## 3. DEFINITION OF BIOFUELS

Biofuels are defined as energy carriers derived from the conversion of biomass to provide sustainable inputs for heat, power, and transport applications. Biofuels can be liquid, solid or gaseous. The principle sources of biomass are agriculture and forestry (UNIDO, 2007).

Biological (e.g. agricultural) sources from which biofuels are derived include:

- Cereals, grains, sugar crops and other starches, which can fairly easily be fermented to produce ethanol to then be used pure or as a blending component (as ethanol or after being converted to ethyl tertiary-butyl ether, ETBE);
- Cellulosic materials, including grasses, trees and various waste products from crops, wood processing facilities and municipal solid waste, which can also be converted to alcohols or diesel type fuels, although the process is more complex compared to processing sugars and grains;
- Oil-seed crops (e.g. rapeseed, soybean and sunflower), which can be converted into methyl esters to then be blended with conventional diesel or burnt as pure bio-diesel; and
- Organic waste material, which can be converted into various energy forms to then be used as automotive fuel: waste oil (e.g. cooking oil) into bio-diesel; animal manure and organic household waste into biogas (i.e. methane); and agricultural and forestry waste products into ethanol.(IEA, 2004).

The most important liquid biofuels are:

- Straight vegetable oil: Pure plant oil obtained from oil containing seeds (rapeseed, sunflower, *Jatropha*, etc.) by pressing and filtering without the need for any other process steps;
- Bio-diesel: Vegetable oil that has been chemically modified (esterification) by adding methanol or ethanol to the oil to form diesel and glycerin. The glycerin is then separated from the diesel. The end product has properties similar to fossil diesel;
- Bio-ethanol (Ethanol): Alcohol produced by the fermentation of sugar and starch containing plants such as grains, sugarcane, etc.; and

Bio-methanol: Gasification of biomass and transformation into methanol by methanol synthesis.

Liquid biofuels have attracted much attention and investment because they can be used to replace or supplement traditional petroleum based transportation fuels and can be used in existing vehicles with little or no modification to engine and fueling systems. They can also be used for heating and electricity generation. Large quantities of liquid biofuels are being used in many countries, and the potential exists to greatly expand their use in the future.

In many countries liquid biofuels substitute imported transport fuels. The most commonly used liquid biofuels nowadays are bio-ethanol and bio-diesel. This assessment therefore focuses on these two biofuels.

## 4. STATUS OF LIQUID BIOFUEL DEVELOPMENT IN ETHIOPIA

### 4.1. BIO-ETHANOL DEVELOPMENT

Bio-ethanol is produced by fermenting the sugar or starch portions of agricultural raw materials. The feedstock used for ethanol production varies from country to country, i.e. sugarcane in Brazil, grain and corn in the USA, and sugar beets in France. The top three ethanol producers in the world are Brazil, USA and China.

Many countries produce bio-ethanol on a large scale as a substitute for gasoline. In Brazil, for instance, large fermentation and distillation facilities now produce enough ethanol to power much of the auto and truck fleets in the country, to cut oil imports and to generate over half a billion jobs in the ethanol industry.

In 1998, the Ethiopian Sugar Development Agency (ESDA) started an ethanol production project. The driving forces behind the initiative were the positive experiences of other countries, the rising trend of global oil prices and a strong desire to exploit alternative energy sources.

In Ethiopia, various crops are suitable for production of bio-ethanol by conventional fermentation. However, many of these crops are grown for food. The sugar by-product molasses is currently the most favorable feedstock for large-scale ethanol production.

Sugar production in Ethiopia was started in the mid-1950s by a Dutch company, HVA. The first sugar factory was Wonji Sugar Factory, followed by Shoa and Metahara Sugar Factories. A fourth sugar factory was established in 1998 at Fincha. Among the three government owned sugar factories*, only Fincha has an ethanol production plant. The company produces ethanol from the fermentation of molasses. The annual production capacity of the plant is 8,000 m3. The other two factories, Metehara and Wonji-Shoa*, have a potential of 11,000 m3 and 6,700 m3 ethanol production per annum respectively.

Sugarcane and sugar production in Ethiopia has increased significantly in recent years. However, the country still does not produce enough sugar to meet local demand and has to import sugar. Until Ethiopia becomes self-sufficient in sugar, molasses is likely to be the only sugarcane-derived feedstock used for ethanol production.

The government has now commissioned the expansion of the existing factories to include ethanol production plants, and also plans to

* Wonji and Shoa are considered as one factory, the Wonji-Shoa Sugar Factory.

establish a new sugar factory at Tendaho, with a production capacity of 106,000 tons of sugar per annum.

The reasons for establishing this new factory and the expansion of the existing factories are:

- To meet the steadily growing local sugar demand;
- To export substantial quantities of sugar to EU countries under the EBA (Everything But Arms) agreement and to the international market;
- To substitute 20% of gasoline imports with bio-ethanol; and
- To co-generate 50-70 MW electric power to be sold to the national grid.

When the expansion of the existing factories is completed and the new factory becomes operational by the year 2011, the ethanol production of the country will reach an estimated 80,000 m3. Table 1 lists the present and projected sugar and molasses production from 2006/2007 to 2012/2013 for Wonji-Shoa, Metahara, Fincha and the about to be established Tendaho Sugar Factories.

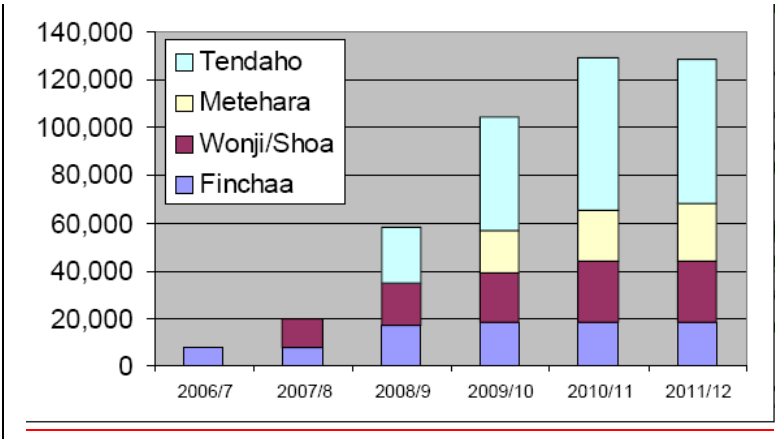
The viability of producing ethanol for vehicle fuel consumption in Ethiopia has already been evaluated. In 1984, the French company SOFRECO conducted a feasibility study for production of ethanol from molasses in Ethiopia. It found that the country has a substantial potential for producing ethanol from sugarcane molasses, and concluded that ethanol-blended fuel is economically viable. Based on the ESDA's estimates of future sugarcane production, the potential for ethanol production from molasses will be 130 million liters by the year 2012/13 (see Figure 1).

**Table 1: Present and projected sugar and molasses production of Ethiopian sugar factories**

| | | Year | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Production | Unit | 2006/07 | 2007/08 | 2008/09 | 2009/10 | 2010/11 | 2011/12 | 2012/13 |
| *Wonji-Shoa Sugar Factory* | | | | | | | | |
| Sugar | tons | 73,000 | 73,000 | 80,922 | 128,956 | 195,680 | 225,967 | 279,793 |
| Molasses | tons | 24,219 | 24,211 | 27,067 | 41,696 | 63,270 | 73,063 | 90,467 |
| *Metahara Sugar Factory* | | | | | | | | |
| Sugar | tons | 126,000 | 130,000 | 143,169 | 150,209 | 223,689 | 287,049 | 361,849 |
| Molasses | tons | 45,819 | 47,421 | 52,061 | 54,621 | 81,341 | 104,381 | 131,581 |
| *Fincha Sugar Factory* | | | | | | | | |
| Sugar | tons | 100,145 | 108,039 | 140,219 | 176,200 | 211,236 | 235,824 | 270,289 |
| Molasses | tons | 33,211 | 35,828 | 46,500 | 58,432 | 70,051 | 78,205 | 89,634 |
| *Tendaho Sugar Factory* | | | | | | | | |
| Sugar | tons | - | - | 105,493 | 268,390 | 419,753 | 556,909 | 608,785 |
| Molasses | tons | - | - | 40,007 | 101,785 | 159,188 | 211,203 | 230,877 |

Source: Ethiopian Sugar Development Agency

**Figure 1: Potential of ethanol production from molasses production**




Source: ESDA 2007

### 4.1.1 EMPLOYMENT OPPORTUNITIES

The three sugar factories currently operating have created job opportunities for more than 25,000 employees. The number of job opportunities created by all four sugar factories in the year 2014/15 is estimated to be over 100,000 (see Table 2).

**Table 2: Employment opportunities**

| Factory | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006/07 | 2007/08 | 2008/09 | 2009/10 | 2010/11 | 2011/12 | 2012/13 |
| Wonji-Shoa | 8,000 | 12,300 | 17,000 | 20,200 | 23,300 | 23,300 | 23,300 |
| Metahara | 10,000 | 12,100 | 14,200 | 16,300 | 18,300 | 20,100 | 20,100 |
| Fincha | 8,400 | 10,200 | 15,200 | 20,200 | 20,200 | 20,200 | 20,200 |
| Tendaho | - | - | 11,000 | 22,119 | 29,655 | 38,333 | 38,333 |
| Total | 26,400 | 34,600 | 57,400 | 78,819 | 91,455 | 101,933 | 101,933 |

Source: Ethiopian Sugar Development Agency

### 4.1.2 FEEDSTOCK PRODUCTION

The feedstock for ethanol production comes primarily from large-scale sugarcane plantations. However, outgrowers produce feedstock on 1,120 ha of land at the Wonji-Shoa factory. The total area under cane cultivation is expected to increase from 23,000 ha in 2006/07 to 118,135 ha in 2014/15, which would result in an additional cane production of 12 mt (metric tons) The totals for existing and planned cultivated areas and sugar cane production of the four factories are shown in Table 3.

Sugarcane provides a higher potential yield of ethanol per hectare of land invested than any other feedstock currently available in the country. Besides sugarcane, corn stover is also considered as a potential feedstock for ethanol production. According to the Ministry of Mines and Energy draft Potential Bio-ethanol Assessment Report, 2.3 billion liters of ethanol could be produced annually using corn stover as a feedstock.

**Table 3: Existing and projected cane areas in hectares and sugarcane production in thousand tons**

| Factory | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006/07 | 2007/08 | 2008/09 | 2009/10 | 2010/11 | 2011/12 | 2012/13 |
| *Wonji-Shoa* | | | | | | | |
| CA | 4,162 | 4,162 | 4,651 | 7,165 | 10,871 | 12,554 | 15,544 |
| CP | 624.2 | 624 | 697.6 | 1074.64 | 1630.65 | 1883.05 | 2233.16 |
| *Metahara* | | | | | | | |
| CA | 10,277 | 12,277 | 16,277 | 21,277 | 27,277 | 30,277 | 30,277 |
| CP | 1145.46 | 1185.54 | 1301.54 | 1365.53 | 2033.54 | 2609.53 | 3289.54 |
| *Fincha* | | | | | | | |
| CA | 9,218 | 11,590 | 14,560 | 16,120 | 19,120 | 20,620 | 20,620 |
| CP | 855.94 | 923.41 | 1198.45 | 1505.98 | 1805.44 | 2015.59 | 2310.16 |
| *Tendaho* | | | | | | | |
| CA | - | - | 7,684 | 20,115 | 32,546 | 44,253 | 48,755 |
| CP | - | - | 1061.45 | 2678.55 | 4189.16 | 5558 | 6075.7 |
| *Total* | | | | | | | |
| CA | 23,657 | 28,029 | 43,172 | 64,677 | 89,814 | 107,704 | 115,196 |
| CP | 2625.6 | 2732.95 | 4259.04 | 6624.7 | 9658.79 | 12066.17 | 13908.56 |

Source: Ethiopian Sugar Development Agency (CA=Cultivated Area; CP=Cane Production)

### 4.1.3 LAND FOR FEEDSTOCK PRODUCTION

In the year 2006/07, the total area under sugarcane cultivation was 23,657 ha. Additional suitable potential sites for sugarcane cultivation in 8 river basins, covering an area of about 700,000 hectares of land, have already been identified (see Table 4).

**Table 4: Potential areas identified for sugarcane production**

| | Name of identified area | River Basin | Region | Net irrigable area |
|---|---|---|---|---|
| 1 | Maro Gella | Awash | Oromia | 6,600 |
| 2 | Kolla | Rift Valley | SNNPRS | 12,800 |
| 3 | Gelana (Amaro) | Rift Valley | SNNPRS | 6,000 |
| 4 | Upper Beles | Blue Nile | Amhara | 55,300 |
| 5 | Arjo Dedessa | Blue Nile | Oromia | 125,100 |
| 6 | Anger | Blue Nile | Oromia | 55,000 |
| 7 | Dinder | Blue Nile | Amhara | 49,550 |
| 8 | Rahad | Blue Nile | Amhara | 49,185 |
| 9 | Humera | Tekeze | Amhara/Tigray | 42,965 |
| 10 | Middle Genale | Genale Dawa | Oromia | 33,200 |
| 11 | Lower Omo | Omo Gibe | SNNPRS | 29,000 |
| 12 | Gode Irrigation | Wabi Shebele | Somali | 25,000 |
| 13 | Itang | Baro Akobo | Gambella | 50,900 |
| 14 | Ubela | Baro Akobo | Gambella | 39,400 |
| 15 | Lower Awash | Awash | Afar | 60,000 |
| 16 | Lower Genale | Genale | Oromia | 20,000 |
| 17 | Omo Gibe | Omo | Oromia | 40,000 |
| | Total | | | 700,000 |

Source: Ministry of Mines and Energy, 2007

### 4.1.4 MARKET ORIENTATION

When the ethanol plant at Fincha sugar factory was constructed, the initial plan was to blend 10% of ethanol with gasoline, to then be used for local vehicle consumption. Due to several reasons, including the lack of preparedness for the blending process, the ethanol that was produced was not used for its intended purpose. As a result, a large stock of ethanol (about 5 million liters) was stored by the company for long a period of time and at a considerable risk. However, recently, the ethanol produced by the factory has been sold both domestically (46.4%) and exported abroad (53.8%).

Fincha Sugar Factory also generates electric power from bagasse, producing more than twice the power the factory receives from the national grid.

According to the ESDA, agreements have been reached with fuel retail companies to blend 5% ethanol with gasoline that could be used by vehicles in Addis Ababa starting in November 2007; however, this plan has not been put into practice yet. The blending could then be increased to 10% ethanol throughout the country in the following 1½ years.

Besides using ethanol for transport fuel, there are attempts to utilize it as a substitute for kerosene in cooking stoves. A previous attempt to blend 50% ethanol with kerosene was not successful. Currently, a pilot project for using pure ethanol in cooking stoves is being implemented. (Mekonnen 2007) If it is successful, there will be more domestic demand for ethanol.

## 4.2 BIO-DIESEL DEVELOPMENT

Unlike bio-ethanol, the development of bio-diesel is a recent phenomenon in Ethiopia. However, within a short period of time a significant number of foreign, local and joint companies have invested in the bio-diesel industry. Information from the Ethiopian Investment Agency indicates that 12 companies have applied for investment permits in this field between 1992 and 2007 (see Table 5).

**Table 5: Companies that have applied for investment permits between 1992 and 2007**

| | Name of Investor | Investment Type | Region | Capital in Thousand birr | Investment Status | Employment Opportunities | |
|---|---|---|---|---|---|---|---|
| | | | | | | Permanent | Temporary |
| 1 | Shegar Agro Industrial Park P.L.C. | Foreign | Oromia | 10,000 | Pre-implementation | 250 | |
| 2 | Flora Eco Power (Ethiopia) P.L.C. | Foreign | Oromia | 671,000 | Pre-implementation | 4,000 | 12,000 |
| 3 | Ertale Bio Diesel P.L.C. | Foreign | Multi-regional | 12,000 | Pre-implementation | 10 | 200 |
| 4 | Adventure Ethiopia Agriculture Development P.L.C. | Foreign | Amhara | 50,000 | Pre-implementation | 1,500 | 2,000 |
| 5 | ABSA Biofuels P.L.C. | Foreign | Multi-regional | 37,553 | Pre-implementation | 1,537 | 1,000 |
| 6 | Africa Sustainable Energy Corporation P.L.C. | Foreign | Multi-regional | 9,500 | Pre-implementation | 200 | 800 |
| 7 | Africa Ethiopia Biomass EnergyP.L.C. | Foreign | SNNPR | 2,000 | Pre-implementation | 40 | 70 |
| 8 | Energy Seed Ethiopia P.L.C. | Foreign | Multi-regional | 1,607.87 | Pre-implementation | 17 | 50 |
| 9 | Ciosco Petroleum P.L.C. | Foreign | Multi-regional | 17,400 | Pre-implementation | 100 | 200 |
| 10 | National Bio-diesel Corporation | Foreign | Multi-regional | 365,000 | Pre-implementation | 47 | - |
| 11 | African Climate Exchange | Foreign | Multi-regional | 195,000 | Pre-implementation | 110 | 270 |
| 12 | IDC Instrument P.L.C. | Domestic | Multi-regional | 8,200 | Pre-implementation | 120 | 380 |

Source: Ethiopian Investment Agency

Information from the Ministry of Mines and Energy, however, indicates that 14 companies are involved in the bio-diesel industry and that some of them have already started feedstock plantation for bio-diesel production, while others are at the pre-implementation stage. The discrepancy in the information obtained from the two institutions shows that there is a gap in the procedure of registering and issuing permits to such companies.

Despite the fact that many investors have shown interest in biofuel development, to date only a few companies are actually active in this field.

## 4.3 BRIEF DESCRIPTION OF BIOFUEL COMPANIES

### A. SUN BIOFUEL ETHIOPIA P.L.C.

Sun Biofuel P.L.C. is a foreign-based company that has already started bio-diesel feedstock plantation. The company has received 5,000 ha of land in Mancha, a site in Wolayta Zone of the Southern Nations, Nationalities and Peoples Regional State (SNNPRS), and has transplanted *Jatropha curcas* seedlings on 200 ha of the given land. Previously the company had signed a lease agreement with the Benishangul-Gumuz Regional State government for 80,000 hectares of land. After clearing about 50 ha of land for a nursery site, the company then decided to discontinue its operation in that area. The company has also requested 50,000 ha of land in the Bilate area (SNNPRS). Sun Biofuel P.L.C., with an initial capital of 41 million USD, has created permanent and temporary job opportunities for about 1,000 people. The company's investment approach is to establish large-scale plantations as well as outgrower schemes. Currently, the company targets the domestic market and plans to substitute the heavy fuel used by Ethiopian cement factories.

B. FLORA ECO POWER

Flora Eco Power is a foreign company that invests on 13,000 ha of land in the Eastern Hararghe Zone of Oromia Regional State. The company has already started growing castor oil plants and plans to semi-process castor oil seeds locally. The company, with an initial investment capital of 75 million USD, has created job opportunities for 246 skilled workers and 3,000 unskilled daily laborers. It operates large-scale plantations and also involves about 4,000 farmers in its outgrowers scheme. The company targets the export market and plans to send semi-processed castor oil seed to European refineries to be converted to bio-diesel (Flora Eco-Power, 2007).

C. FRI-EL-GREEN POWER

Fri El Green Power is an Italian power firm that has secured a 30,000-hectares plot in the Omo valley to grow palm trees for palm oil. The new venture takes over the site of the failed Ethio-Korea Palm Oil Project, established in the 1980s. Fri El Green plans to invest at least 320 million birr (36 million USD). Other foreign companies such as LHB CHATZ, BECCO Company, Villar Energy Co., RINA International Investment, Kenya Bioenergy Limited, Gento Consulting Ltd., and Global Trinty Group have shown their interest to invest in the biofuel industry, but none of them are operational yet.

LOCAL COMPANIES

Besides foreign companies there are also some local companies that are showing interest in bio-diesel development, both at small and medium scale levels. These companies are:

ATRIF ALTERNATIVE ENERGY P.L.C.

The company is currently investing on 100 ha of land obtained from the Investment Office of SNNPRS in Welkite Zone and plans to request an additional 50 ha of land for the expansion of the farm. The

imported species *Jatropha curcas* is being cultivated by supplying it to outgrowers in the community.

The company, with an initial capital of 217,155 USD, has created job opportunities for about 32 permanent workers. The company uses an outgrowers scheme, and it targets the domestic market. Other local companies are Ethan Biofuels, Assosa Association of Biofuels, and Tiret. None of these companies are operational yet.

## 4.4 LAND FOR BIO-DIESEL FEEDSTOCK PRODUCTION

According to the Ministry of Mines and Energy draft report, about 23 million hectares of land are potentially suitable for *Jatropha* and castor oil plantation. Most of this land is found in Oromia Regional State. The identified lands in the Amhara and Benishangul-Gumuz Regions are wood, grass, bush, bamboo or cultivated lands. This land assessment does not clearly specify what type of land use and biodiversity exist in these identified areas.

**Table 6: Gross potential areas for *Jatropha* and castor oil plantation in Ethiopia (in hectares)**

| | Region | Area |
|---|---|---|
| 1 | Benishangul-Gumuz | 3,128,251 |
| 2 | Gambella | 2,829,999 |
| 3 | Somali | 1,485,000 |
| 4 | Oromia | 17,234,523 |
| 5 | Amhara | 966,535 |
| 6 | SNNPRS | 49,025 |
| 7 | Tigray | 6,500 |
| 8 | Afar | n.a. |

**Source: Ministry of Mines and Energy, 2007**

On the other hand, information obtained from the Oromia and SNNPRS Investment Commissions indicates that the amount of

available land is about 123,906 ha and 80,000 ha respectively. This obvious discrepancy between the information from the Ministry of Mines and Energy on the one hand and the regional Investment Commissions on the other may mislead both decision makers and investors.

## 5. POLICY AND LEGAL INSTRUMENTS

### 5.1 ENERGY POLICY

The Ethiopian Government issued the National Policy of Energy in 1994. The policy addresses the energy problem by promoting agro-forestry and the increased utilization of biofuel as well as facilitating the shift to greater use of modern fuels. In general, these include hydroelectric, solar and geothermal power and other renewable energy sources. The policy also encourages the participation of the private sector in the development of the energy sector in Ethiopia.

Recently, the Council of Ministers approved a strategy for biofuel development in the country. Issues pertinent to the sustainable development of biofuel, detailed strategy principles and the major problems of biofuel development are included in the document.

### 5.2 ENVIRONMENTAL POLICY AND LAWS

The Environmental Policy of Ethiopia (EPE) stresses the importance of mainstreaming the socio-economic dimension of development programs and projects. The EPE, in its energy sector policy, mentions a number of policy elements on energy resources, one of which is to promote the development of renewable energy sources and reduce the use of fossil energy sources, both to ensure sustainability and to protect the environment. Strategies for the development of liquid biofuels as well as of other alternative energy sources and their utilization are included in the EPE.

In addition, proclamations and supporting regulations were promulgated with provisions for the protection and management of the environment that reflect the principles of both the Ethiopian Constitution and the EPE. Those proclamations include the Environmental Impact Assessment (EIA) Proclamation and the Pollution Control Proclamation.

The EIA Proclamation (Proclamation No. 299/2002) facilitates the implementation of the environmental rights and objectives enshrined in the Constitution by providing for the prediction and management of likely adverse environmental impacts of projects and activities, and the maximization of their socioeconomic benefits.

In its general provision, the Proclamation states that without authorization from the Environmental Protection Authority (EPA) or from the relevant Regional Environmental Agencies, no person shall commence implementation of any project that requires environmental impact assessment.

## 6. ENVIRONMENTAL AND SOCIOECONOMIC ISSUES OF BIOFUEL DEVELOPMENT IN ETHIOPIA

### 6.1 ENVIRONMENTAL ISSUES

The spontaneous start of biofuel development in the country has overlooked the potential environmental impacts of the industry itself. This is clearly demonstrated by the fact that none of the operational companies conducted an Environmental Impact Assessment (EIA) before the start of their operations.

Despite the site-specific nature, heterogeneity and complexity of biofuel feedstock production activities, there are some general and more specific environmental considerations that can be applied to

biofuel production in Ethiopia. The current large-scale activities in the field of biofuel development in Ethiopia affect biodiversity, hydrology, and soil. Biofuel production has already threatened natural forest and wildlife areas. The clearance of 50 ha of forest by National (Sun) Biofuel and the plowing carried out inside an elephant sanctuary by Flora Eco Power are good examples of this. To date, no methods for managing or mitigating these impacts have been developed by the biofuel industries operating in Ethiopia as part of their social and environmental responsibilities.

### 6.1.1 IMPACT ON BIODIVERSITY

Biofuel production has both direct and indirect impacts on biodiversity. From this preliminary assessment it has been learnt that neither the Environmental Agencies, the Investment Agencies (which provide the land) nor the companies themselves try to identify and conserve the biological diversity of the proposed investment sites. Also, the crops used for biofuel feedstock production are not properly identified. The environmental impacts of large-scale plantations for biomass feedstock production vary considerably, depending on both the feedstock chosen and the system being replaced. Where existing grasslands or forests are planted with energy crops, negative impacts on biodiversity are very likely. However, these problems have to be balanced with the likely benefits arising from a well-managed bio-energy production.

### 6.1.2 IMPACT ON WATER

According to this preliminary assessment, almost all bio-diesel feedstock production is rain fed, except for some micro-irrigation for nurseries and during rainfall shortage, whereas sugarcane production depends on large-scale irrigation schemes. High water consumption and contamination as a result of feedstock production and conversion to biofuel remains a serious concern. For example, during peak growing periods, energy crops can require large amounts of water per day to meet the crop's evapotranspiration requirements. Exploitation of water resources for irrigation therefore needs careful planning.

Equally, agrochemicals applied to feedstock plantations as well as effluents from biofuel processing plants emit significant amounts of liquid pollutants with high biological and chemical oxygen demands (COD and BOD) and other toxic substances. This may cause damage to the surrounding ecosystems by polluting the water bodies, killing aquatic life, and causing eutrophication. A water quality analysis conducted by the EPA on a sample taken from a water body close to one of the sugar factories revealed a high level of pollution.

Another example of possible negative impacts from the introduction of energy crops on the local and regional hydrology is the potential reduction in rainfall infiltration and the subsequent effect on aquifers in the region. None of the companies mentioned above has identified either the potential impacts of their activities or possible measures that could be taken to mitigate these negative impacts.

### 6.1.3 IMPACT ON SOIL

This preliminary assessment shows that most of the lands provided to biofuel developers are fertile lands covered either by grass or forest. Large-scale cultivation of such lands will result in: increased soil disturbance; less soil cover and hence high erosion; poor soil organic matter and carbon levels; and reduced biodiversity, particularly where the change results in the increased application of inputs (i.e. fertilizers and pesticides). Release of nutrient-rich waste (i.e. spillage) from conversion facilities back into the fields will also increase soil contamination.

Information on the amount and rate of application of chemical inputs such as inorganic fertilizers and pesticides by individual companies has not been available for this Assessment. However, it is generally recognized that these companies do utilize such products. The application of chemicals will have negative impacts on the soil. Currently, none of the companies has a chemical management plan to reduce or mitigate those negative effects.

### 6.1.4 IMPACT ON THE ATMOSPHERE

Atmospheric emissions can result from all stages of biofuel production, but it is critical to evaluate these emissions against a reference production system or alternative uses of the biomass feedstock in order to gain a realistic overview of the net benefits of the bio-energy production system. In this assessment, no attempt was made to evaluate the possible impact on the air from current biofuel production activities.

## 6.2 SOCIO-ECONOMIC ISSUES

### 6.2.1 JOB CREATION

The establishment of a local biofuel industry creates substantial job opportunities. For example, Flora Eco Power has created more than 7,000 jobs (with a potential of 20,000 jobs in the future), Sun Biofuel has created about 1,000 jobs, and the sugar factories (all activities) have created employment opportunities for more than 80,000 people. Job generation includes permanent positions at the pilot plantation and processing facilities, temporary work for contract workers for field clearing, maintenance, and harvesting, and additional work and income for farmers currently depending on food crop harvests.

Almost all employment opportunities created by the companies are for unskilled labor; however, some jobs at the head and field offices involve a mixture of both skilled (management, administrative, education and extension work) and unskilled labor. Farmers are attracted by the short-term advantage of earning money by clearing land for biofuel feedstock plantations. However, if the job is not sustainable in the long term, the farmers can end up poorer than before.

### 6.2.2 FOOD SECURITY

Soil degradation is one of the major environmental problems of the country, and food insecurity is equally rampant in Ethiopia. According to the PASDEP report, about 8.29 million people face “chronic” and 6.71 million “transitory” food insecurity problems. One of the solutions suggested in the Food Security Program (FSP) is supporting voluntary resettlement to more productive areas. Therefore, allotment of productive areas for biofuel production (which is the current practice) may have a negative impact on the FSP. Plantations of *Jatropha* or castor beans for local biofuel production may compete with the food growing activities of the farmers, thereby intensifying the food insecurity problem. Additionally, during the introduction of the new biofuel business, food-producing farmers will be motivated to start growing the energy crops on fallow land or on cropland. As biofuel production expands and the demand and price for biofuel feedstock increases, local farmers may become involved more in biofuel production and neglect food crop production.

## 7. CONCLUSION

The current biofuel activities and opportunities in Ethiopia can be roughly divided into large-scale and out-growers approaches. Large-scale biofuel feedstock production undertaken by the sugar companies, as well as by large companies such as Flora Eco Power and Sun Biofuel in the bio-diesel sector, will require supportive strategies and regulations in place for start-up in order to secure the sustainability of biofuel development in the country.

A recent assessment indicates that Ethiopia has 23 million hectares potential area for *Jatropha* production and 700,000 hectares for sugarcane production. While these figures present only a broad picture of land availability in what is a very large and diverse country, they suggest that land availability is not likely to be a barrier to bio-energy production in Ethiopia.

However, at present there are no clear procedures or criteria for land allotment or for the selection of biofuel seeds. This in turn has negative environmental consequences, especially for areas identified as protected areas or biodiversity hot spots.

Employment opportunities are one of the main benefits of bio-energy production. However, the quality of the jobs and the welfare of the workers are also important developmental issues that need proper investigation.

Today, the Government of Ethiopia has approved a strategy for the increased use of biofuels. The development of a biofuel strategy was mainly initiated by the Ministry of Mines and Energy. However, for the implementation of this strategy, the development of an integrated and enabling framework and close co-operation and consultation between several Government departments (e.g. Ministry of Mines and Energy, Ministry of Agriculture and Rural Development, Ministry of Transport and Communication, Ministry of Finance, Environmental Protection Authority, etc.) as well as with the non-governmental and private sectors engaged in the promotion of liquid biofuels in Ethiopia are urgently necessary.

Consultations between Government representatives and biofuel stakeholders might help to address several important issues, such as the comparison of the economic, environmental and social benefits (e.g. employment generation, rural development, foreign exchange savings, etc.) with the costs (e.g. reduced tax revenues) of biofuel programs in Ethiopia and the potential negative effects of diverting crops towards biofuel production and away from other (e.g. food) markets.

In conclusion, the biofuel industry is poised to make important contributions to meet Ethiopia's energy needs by supplying clean and environmentally friendly fuel. The bio-ethanol industry, already

relatively developed, can benefit from improved agricultural practices in feedstock cultivation and more efficient production processes. On the other hand, the bio-diesel industry is in its infancy, and comprehensive procedures and guidelines for large-scale castor bean, *Jatropha* and palm oil cultivation must be established before the industry can be placed on a rapid-growth track.

## 8. RECOMMENDATIONS

This list of recommendations identifies the first steps to be taken as soon as possible in order to exploit the opportunities offered through the development of a biofuel sector for the production of alternative energy sources in Ethiopia. The list is by no means comprehensive or exhaustive:

- In order to take informed decisions on the economic, energy and environmental policies in the field of biofuel development, detailed feasibility studies, taking into consideration food production, the sustainability of biofuel production, and energy security, should be conducted;
- Effective cross-ministerial action on biofuels (and bio-energy) needs to be ensured through careful consideration of how to integrate activities in the field of biofuel and renewable energy development;
- Promotion of applied research and development is required, and local academic institutions and research organizations should be encouraged to collaborate on research and development in this critical emerging sector;
- In order to provide solid grounds for the development of a biofuel sector in Ethiopia, the population has to be informed about the significant benefits and opportunities offered by biofuels as alternative energy sources; and
- Because of the broad range of social and environmental impacts of biofuel feedstock production, these impacts need to be assessed taking into account the heterogeneity

between site-specific environmental impacts, which should be managed through the development of site-specific good management guides.

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# AGROFUELS BEYOND THE HYPE LESSONS AND EXPERIENCES FROM OTHER COUNTRIES

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## ABSTRACT

Growing evidence suggests that the global economy is now destroying its own ecological base and offering little to billions of impoverished people. In response, pioneering policymakers, business leaders and concerned citizens around the globe are creating the architecture of sustainable economies, one innovation at a time. A major problem facing the global community is the continuing loss of biodiversity. This loss is the result of insufficient investments being made in conservation and over-investment in activities that reduce biodiversity further. Solving the problem thus requires a combination of improving existing investment frameworks, developing new mechanisms for the conservation of biological diversity and reviewing the policies and practices that encourage its destruction.

For some time multinational companies, supported by their home governments, have been working hard to come to Ethiopia with the aim of producing and exporting agrofuels in order to meet the given targets for the EU and/or USA. The supposed benefits of agrofuels include: diversification of the energy sources and lower exposure to the price volatility of the international oil market; expansion of rural development through job creation in feedstock production, transport

and distribution; reduction of harmful pollutants from vehicles exhaust, as biofuels are sulfur-free; reduction of green-house-gas (GHG) emissions; contribution to soil and water conservation; creation of potential new markets for agriculture; increased direct foreign investment, technology and resource transfer; and building of a local industrial base.

On the other hand, critics argue that biofuel production demands large quantities of subsidies, water, land (whether previously cultivated lands, natural forest or wetlands), fertilizers, chemicals, and fossil fuel for production and distribution. Since it is mainly aimed at meeting the set targets of developed countries at the expense of African agriculture, and because of the biodiversity loss and adverse affects on the land that poor people depend on, it should not be allowed into Africa. This paper will discuss some of these counter arguments by looking at examples from different countries.

## 1. INTRODUCTION

No one would doubt that there is a strong link between energy and development and that energy is essential to achieve overall economic, social and even political development of any society. Emphasizing this linkage, the International Atomic Energy Agency argues that, “Socio-economic development requires energy for improved living standards, enhanced productivity, the transportation of goods to markets and as inputs to a wide range of other economic activities” (United Nations, undated).

Sources of energy include: “Hydro (mainly micro and mini), biomass (biogas, bio- gasification, fermentation, direct combustion, etc.), solar (photo-voltaic, water heaters, dryers, water desalinators, etc.), wind,” biofuels (biodiesel, bio-ethanol etc.) and others (UNIDO, 2004). Hydroelectric power generation potential in Ethiopia is in the range of

15-30,000 mega watts (MW). So far only 663 MW or only 2-4% of this total has been developed (MoFED, 2006).

While there is such ample and un-tapped potential and a big task awaiting the government and development partners in the energy sector, unplanned and aggressive pushes are being made to introduce large-scale agrofuel production into Africa in general and into Ethiopia in particular. The objective of this paper is to share some experiences from across the world on the potential and actual adverse impacts of large-scale agrofuel production on biodiversity, the environment, the livelihood of rural populations, human rights and other issues, thereby showing the other side of large-scale agrofuel production. Finally, recommendations will be made on how to approach renewable energy in an environmentally friendly, pro-poor and sustainable manner.

## 2. LITERATURE REVIEW AND GEO-POLITICS OF AGROFUELS

The bulk of the world's biological biodiversity is found in developing tropical countries, and within these countries in areas and among people who are frequently politically and economically marginalized (Dove, 1996). Biodiversity and genetic resources are not only biological but political resources as well. (Redford & Richter, 1999) This has become evident in the pressure put on biodiversity rich countries by the economically rich countries and their multinational companies (Sanchez & Juma, 1994).

Explaining the political wind blowing towards agrofuels, a recent study by GRAIN argues that:

> Agrofuels *are not only about business. They are highly political, and the corporations that control the production both shape and follow the shifting political situations in the world. Although there is a general euphoria for* agrofuels *among most governments,*

> *most national policies are influenced by the different dynamics among business lobbies, geopolitical concerns and trade politics. For instance, governments and corporations in China, South Korea and Japan are looking to other countries for the production and supply of raw materials. Brazil wants to supply the world with both ethanol fuel and technologies, and has been negotiating packages with countries on every continent to that end. The US and Europe see* agrofuels *as the answer to everything from climate change to farm crises to problems with oil rich "rogue" states. As a result,* agrofuel *deals are being struck all over the place, determining where the* agrofuels *are being produced, by whom and for whom, and, perhaps most importantly, how they are being traded (GRAIN, 2007).*

This shows how some nations are working hard through their foreign policies to ensure their needs are met at whatever cost. Multinational companies have become major actors in the foreign policy making process, especially in developed nations. What has been seen to date is that power-hungry individuals and countries have used the international scene to push their national interests, ideologies and agendas, sometimes without any regard to the nations and people they may affect directly or indirectly (Olson *et al*., 1983).

The rush to produce agrofuels has been driven mainly by the desire to maximize profits at the expense of livelihoods and biodiversity in poor countries. Yet the said actors are using the threat of global warming and higher oil prices as major arguments for agrofuels. With the world's major energy consumers seriously searching for ways to reduce their dependence on fossil fuels and guarantee constant energy supplies, we are observing the beginning of a revolution in energy production, spearheaded by the most known capitalist countries, like the USA (Saletan, undated & Castro, 2007). On the other hand, some studies show that agrofuel production actually uses more energy (through agriculture, processing, and transport) than is contained in the final product. Similarly, the cutting down and burning of forests and peat lands to make way for biofuel plantations produces

many times more carbon dioxide per gallon of biodiesel than the equivalent amount of fossil fuel (ABN, 2007).

Making decisions on which side's position is right or wrong may not be that easy. In order to draw some lessons and help make wise decisions, case studies on 'the other side of agrofuels', i.e. their adverse effects, will be discussed in the following section.

## 3. LESSONS/CASES FROM SOME COUNTRIES

### 3.1. BRAZIL (LATIN AMERICA)

President Inez Inacio Lula da Silva of Brazil in his message, prepared in press release form for the African Ministers participating in "The First High-Level Conference on Biofuels in Africa", held from 30 July - 01 August 2007 in Addis Ababa, proudly says that his country has over thirty years of success in the production of fuels that combine energy security and broad economic, social and environmental benefits (Lula da Silva, 2007). He further argues that a mixture of ethanol and gasoline in a 1:3 ratio used by regular cars and the use of alcohol in flex-fuel cars made it possible for Brazil to cut the consumption and imports of fossil fuels by 40%. Flex-fuel cars are claimed to be designed and manufactured for low emissions, fuel efficiency and low environmental pollution. (http://www.flexcar.com) President Lula da Silva says that since 2003, Brazil has reduced carbon dioxide emissions by over 120 million tons, thus helping slow global warming. He goes on to say that biofuel in Brazil impacts only 2% of agricultural land and hence does not threaten food security, rather helps to combat hunger by generating new income that can be used to buy food.

On the other hand, the Brazilian Forum of NGOs and Social Movements for Environment and Development (FBOMS) pointed out a

number of impacts of monoculture biofuel production that have multiplied in recent years, including (FBOMS, 2006):

- Illegal deforestation in order to make place for new sugar cane or soya plantations or eucalyptus forests;
- Expulsion of small farmers from their land, sometimes through the use of violence, generating rural conflicts;
- Land concentration in the hands of latifunda (large land holdings) owners, in some cases in areas allocated by the government;
- Intensive use of agro-toxics and other agrochemicals, threatening mainly when area spraying takes place;
- Contamination of the soil, rivers, subterranean and spring waters due to deforestation and the high quantity of chemical products used in monoculture areas, as well as vinhace (sugar cane industry liquid waste) disposal in soil and rivers; and
- Rural and urban poverty because monoculture hardly creates any jobs. With no option, many rural workers move to the peripheries of cities.

Another critic, Zibechi (2007) says that the price for all the claims put forward by the Brazilian government as a great emerging power in biofuel production has been paid by the environment and by the cane cutters who are the invisible characters in this story. Interviews with people who have been directly affected by biofuel production in Brazil, show that there are huge adverse effects on human health, human rights (wages), biodiversity, the social fabric, etc. For instance, one interview with a female cane cutter quoted in the article reads: “When the airplane passed, pouring out that bath of poison, my father was soaked. He fell ill because of the toxins that were sprayed over the cane. This is the end for many young people here.”

Moreover, it has been reported that job creation has been only nominal; that for each 100 hectares, there is 1 job in eucalyptus plantations, 2 in soya and 10 in sugar cane production (FBOMS, 2006). According to Brazilian Forum of NGOs and Social Movements

for the Environment and Development (FBOMS), abuse of workers' rights by the biofuel companies is rampant, and they say that:

> *They [the workers] live on the farms, in cabins with no mattresses, water or stoves, cook in cans over small campfires and buy their food in the farm paying sums that are well over market prices. … Working conditions include poor housing, lack of water and sanitary provisions, lack of sufficient food, no work training, use of agrochemicals without sufficient protection, health impacts of sugar cane burning before harvesting, minimum rest and exhaustion, wage level under living standards, child and even forced labor (*FBOMS, 2006*).*

Regarding payments made to the workers, the critics say that, "The people work and they give them a slip of paper to shop within the super market." (Zibechi, 2007) The implication is that the workers do not see any money, have to spend in the supermarkets and hence cannot save from what they earn. Cheating with scales, exploitation by middle men, obligation to work overtime, together with illiteracy and coming from the distant north-east part of the country made almost all the workers face working conditions resembling slavery. It has been also reported that, "There are many young workers who retire due to disability and dozens of deaths due to exhaustion in the Brazilian California." During the recent international labor conference in Geneva, the Minister of Work, Carlos Lupi, admitted that, "Parts of the production of cane in Brazil is done with degrading work in awful conditions, including working without protection and even losses of fingers" (Zibechi, 2007).

In a nutshell, the agrofuel production is meant not to meet the needs of the poor in Brazil but those of the three big actors, oil companies, agro-businesses and transnational capital, who all have vested interests to maximize their profits and keep their monopoly in the world. The future in the sector is not encouraging. Neither global warming nor the cane cutters' working conditions cross the minds of

the three big actors. This is what is being proposed to be replicated in Africa.

## 3.2. INDIA (ASIA)

*Jatropha* monoculture is being aggressively promoted in India for biodiesel on 50 million hectares of land classified as "waste land". In spite of the claim that *Jatropha* can be grown on arid, semi-arid or dry land, regular and sufficient rainfall is needed to sustain its yield. Fertilizers and irrigation are also required at least for the first three years. According to the World Institute of Sustainable Energy, "Promotion of *Jatropha* for biodiesel is likely to lead to the destruction of primary and secondary forest in India, with serious consequences for biodiversity" (Biofuel Watch, 2007). It has been reported that the communities in the Himalayan foothills are extremely concerned that *Jatropha* will threaten the forests and biodiversity on which they depend for their livelihood. However, the concerns of the community do not seem to be taken into account and *Jatropha* is being promoted without any feasibility study in spite of study results warning that alien invasive plants would be prime causes of biodiversity losses in the area. Civil society organizations and communities are expressing their concerns, that since *Jatropha* is a weedy species and spreads fast it will leave less grasslands for grazing animals. There have even been some cases reported in Chhattisgarh State of animals dying after eating *Jatropha* leaves (The Indian Express, 2006). Another lesson from India is the increase of food prices related to biofuels introduction into the country. According to James (2007), the food price index in India has risen 11% in 2007, and this is mainly attributed to the allocation of land for *Jatropha* plantations.

## 3.3 ITALY AND GERMANY (EU)

Italy is one of the European Union countries with a legal framework in place to encourage biodiesel and bio-ethanol production, and some production is taking place. Following its new budget law, passed by the Parliament in December 2006, Italy has been working hard to conform to the EU Directive 2003/30 on biofuels, establishing that at

least 2.5% of total fuel consumed in Italy (both diesel and gasoline) must be biofuel by the end of 2008 and 5.75% by the end of 2010 (Perini, 2007). Some say that, *"Around 40% of Europe's agricultural land would be needed to grow* biofuel *crops to meet the 10% fossil fuel substitution target. That demand on arable land cannot be met in the EU or the US, say the scientists, so is likely to shift the burden on land in developing countries"* (Farrow, 2007). The new budget law also obliges companies that place gasoline and diesel on the market to blend the fossil fuels with at least 1% of biofuel in 2007 and 2 % in 2008. The same law provides for penalties for missing these targets to be assessed, although the actual penalties will be spelled out in forthcoming decrees. The new law approved adjustments to incentives for utilizing appropriate raw materials from agricultural, livestock, forestry and food processing activities within the specific plans of local "agro-energy" districts.

However, Italian and German consumers are experiencing unusual price hikes on their beloved food staples, pasta and beer respectively, attributed to the booming biofuel industry which converts corn, sugar, wheat and other crops to fuel and energy. According to a Business Week report, putting a plate of mama's spaghetti on the table will cost 20% more for the consumers. And a 40% increase in beer price is leaving a bad taste in the mouths of German beer drinkers, as Germany's farmers grow less barley for beer production and more crops for biofuels. The situation isn't likely to turn around any time soon (Willey, 2007).

## 3.4 AFRICA

In some African countries the introduction of agrofuels or allocation of land for agrofuel production, though at an early stage, is already adversely affecting small holder farmers and agricultural systems. The following brief discussions will help to explain what is going on in some parts of the continent.

### 3.4.1. TANZANIA

In Tanzania, following the allocation of thousands of hectares of land to European companies for planting *Jatropha* for agrofuels, thousands of Tanzanian rice and maize growing farmers are being evicted from their lands, which are both fertile and have good access to water. Villages are being cleared, but families have been given minimal compensation for their loss of land and way of life. Evictions have already taken place in Kisarawe District and the Usangu plains, and tens of thousands of hectares in Bagamoyo and Kilwa districts are being given to foreign investors. In addition, the government has identified millions more hectares in at least 10 other districts as potential sites for agrofuel production (ABN, 2007). It has been argued that in a country like Tanzania, routinely dependent on food aid, the current allocation of land for agrofuel production will further aggravate poverty in the country.

### 3.4.2. UGANDA

In Uganda, plans to cut down thousands of hectares of the country's largest rainforest reserve for a sugar plantation for ethanol production have fortunately been cancelled following civil protest. Such deforestation would threaten local water cycles, as the Mabira Forest is a key water catchment area for Lake Victoria and the River Nile. The popular outrage supported by demonstrations against the plans culminated in a week long civil unrest and claimed the lives of 3 citizens. Unfortunately, however, thousands of hectares of forest on Kalangala and Bugala Islands in Lake Victoria have already been cut down to make way for palm oil plantations (ABN, 2007).

### 3.4.3. ZAMBIA

Private plantations are not the only models for large-scale agrofuel production in Africa. Some investors in Zambia are choosing to grow crops such as *Jatropha* through huge numbers of out-growers, using contracts that last up to 30 years. These contracts serve to transfer

control over the production from the farmer to the company through a system of loans, numerous extra charges and service payments, and prices determined by the company. Under such a dependence system, farmers are likely to become increasingly indebted to the company until they are either obliged to hand over their land (ABN, 2007) or are not paid for what they would produce at all. A living example of this is a recent study report from Brazil, where small farmers in the Amazon region (Southeast of Pará State) have signed contracts with the agrofuel company Brasil Ecodiesel to grow *mamona* (castor beans) as out-growers. However, the company never came back to buy castor beans or to pay the farmers, nor did the company give any technical assistance. It just disappeared. Local organizations believe that the company used the contracts with small farmers to get the "social label", but in fact used soybeans as raw material for agrofuel production. These soybeans certainly did not come from small farmers (Cordiero, 2007).

### 3.4.4 WEST AFRICA

In West Africa, the agrofuel craze is also gaining momentum. *Jatropha* is already being grown in Togo, Ghana, Senegal, Mali, Côte d'Ivoire and Niger. In Senegal there is great enthusiasm about an African "biofuel revolution", and fuel crops have been placed at the heart of an agricultural renewal program. In Ghana one company is planning to plant 1 million hectares of *Jatropha* with support of the government, while in Benin another company has obtained permission to plant a quarter of a million hectares of agrofuel crops. Farmers in Benin and in many other countries in the region have, on the average, no more than 1 hectare to grow their products, and the agrofuels are expected to make a serious dent into their food production (Cordiero, 2007, Ibid., pp. 9-10).

## 4. CONCLUSION

New large-scale agrofuel projects are mushrooming across Africa. The continent is being told that agrofuel exports will be good for

development, good for the economy and good for the environment. There is a high level of enthusiasm for these new developments as African governments hope that agrofuel initiatives will lift their countries out of poverty by providing the fuels that Europe craves while hoping it will improve energy security in Africa at the same time. However, there have been several warnings that agrofuels may bring more problems than they can solve. It has been argued that the push for agrofuels amounts to nothing less than the re-introduction and re-enforcement of the old colonial plantation economy, redesigned to function under the rules of the modern neo-liberal, globalized world. Indigenous farming systems, local communities and the biodiversity they manage have to give way to provide the increased fuel needs of the industrialized world.

## 5. RECOMMENDATIONS

1. As a poor and landlocked country, Ethiopia should focus on promoting diversified and small-scale production of non-staple food feedstocks for local consumption of biofuels. This would have multiple positive effects by stimulating investment, being more pro-poor, not depending so much on large-scale economies, having lower transportation costs and by being a smallholder activity.

2. The industrial agrofuel policy approach is not a solution to the climate crisis or an answer to peak oil. The massive infrastructure of fossil fuel based production and transportation systems cannot be maintained by converting food to fuel, and plants to oil for cars. The heavy infrastructure of automobiles and power generation needs to be adapted to the limits of the land, which should not be further plundered, and the poor should not be further burdened to uphold a non-

sustainable system for a few more years. The rich should be told to consume less.

3. Rural communities need to be protected in order to ensure that they can provide for their basic needs of food, fodder, fuel, medicine etc. Rejuvenation of rural populations through biodiversity that maximizes production for local needs should be immediately taken up under rural employment guarantee schemes and environmental programs. The transfer of these rural populations to industrial *Jatropha* or other plantations must be immediately stopped to avert ecological and economic catastrophe. The colonial thinking of characterizing village commons as "wastelands" must be immediately revised.

4. To protect rural livelihoods and food and energy security for the rural poor, agricultural policy must shift from industrial farming to biodiversity based ecological farming. The rural people play a vital role in providing inputs to the agrarian economy. Land must be used for the food and energy needs of the people, not the fuel demands of industry. The biological produce of commons must first go to meet local needs. Decisions about the use of rural natural resources should be made by the rural community themselves or with their full participation. Rural communities should be given absolute rights over the land use decisions for enhancing their livelihood and ecological security.

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# ALARM BELL FOR BIOFUEL DEVELOPMENT IN ETHIOPIA: THE CASE OF BABILLE ELEPHANT SANCTUARY

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## 1. INTRODUCTION

Until the 1960s, Ethiopia, unlike other countries in Africa, used only its own systems of wildlife conservation, except during the five years of trial and war caused by the Italian invasion. However, over the past four decades, the country has made progress in modern wildlife conservation and management systems, and has seen both considerable successes and failures in law enforcement. In the 1960s and 1970s, great steps were taken by the Government of Ethiopia to modernize its wildlife conservation system. Hearing about wildlife conservation in neighboring countries and around the world, the Ethiopian Emperor Haile Selassie I requested external assistance in establishing and monitoring key wildlife conservation areas in the country. As a result, in 1963, the UNESCO made a series of recommendations, which led to the establishment of a system of national parks and other wildlife conservation areas in 1964-1965.

In spite of the establishment of these protected areas, wild animals of the country have suffered from a considerable reduction in numbers. This decline has been most marked in larger mammals like the African elephant (Yalden *et al*., 1986). Elephants are referred to as a "keystone" species, as they play a pivotal role in structuring plant and animal communities (Owen-Smith, 1988; Shoshani, 1993; Dublin *et al*., 1995).

Elephants used to be relatively abundant throughout Ethiopia except in the northern highlands, the most densely populated part of the country, which has been occupied by agriculturists for thousands of years, and the Danakil Desert in the northeast due to scarcity of fresh water. (Yalden *et al*., 1986) Elephants roamed over all other areas from sea level to about 2,500 m above sea level. Over the past three decades, however, elephants were driven from vast areas of Ethiopia, as can be seen from travelers' notes and other historical documents (Plowden, 1868; Pankhurst, 1965, 1974, 1992; Largen and Yalden, 1987). Species ranges shrank as the herds were hunted intensively

and suffered increasing pressures from habitat destruction and the poor management system of the recent decades (Yalden *et al*., 1986; Largen and Yalden, 1987; Allen-Rowlandson, 1990; Lamprey, 1994; Enawgaw, 1996; Yirmed, 1998, Yirmed and Afework, 2000a). As a result of its global decline, the African elephant was transferred to Appendix I of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in January 1990.

At present, elephants in Ethiopia are among the 37 mammal species that are threatened by extinction (Yirmed *et al*., 2006). Since the 1980s, Ethiopia has lost about 90% of its elephant population, and hence the species is nationally regarded as critically endangered. At present, the total elephant population of the country is estimated at about 1,200 (Yirmed, 2006). In the 1990s, elephants were found in 16 areas comprising 94,291 km$^2$ (EWCO, 1991; Yirmed, 1997; Barnes *et al*., 1998), while by 2006 there were only 9 confirmed sites with fragmented populations covering 28,895 km$^2$ (Yirmed, 2006). The latter national estimate accounts for 0.9% of the elephant ranges on the African continent (3.3 million km$^2$), and for 3.3% of the East African ranges (Blanc *et al*., 2007). Elephant ranges occupy 2.6% of the land surface area of the country, although no confirmed data are available for the Mizan Teferi area. An estimated 93.3% of the ranges lie within the designated protected areas (Yirmed, 2006). Of the nine separate elephant populations found in Ethiopia today, three populations are located in the west, three in the south, two in the north and only one in the east, in the Babille Elephant Sanctuary (see Figure 1). At the time of its establishment, the Babille Elephant Sanctuary (Babille ES) was the largest Principal Wildlife Protected Area (PWPA) in the country, constituting 30% of the total PWPAs, followed by Gambella and Omo National Parks with areas of 5,061 km$^2$ and 4,068 km$^2$ respectively.

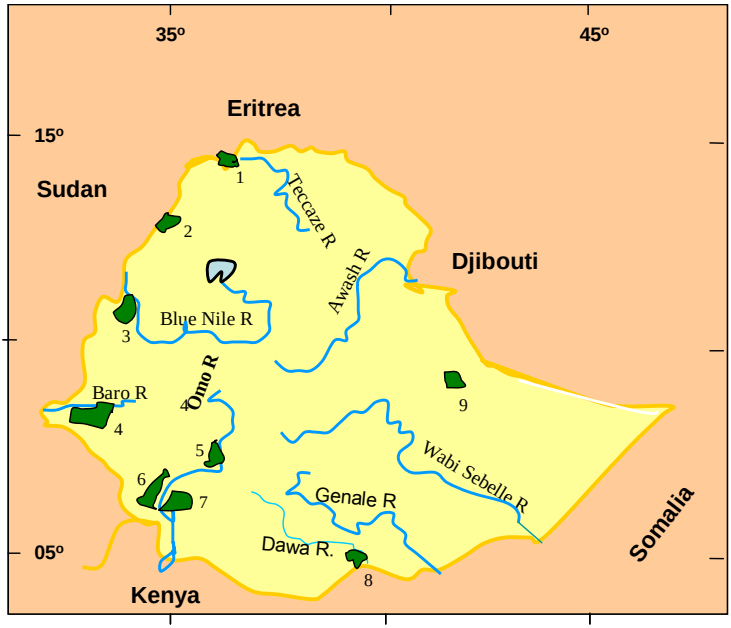


**Figure 1: Babille ES and other confirmed areas currently supporting elephants in Ethiopia**

**Legend:**
1 = Kafta-Shiraro National Park, 2 = Alatish National Park,
3 = Dabus Controlled Hunting Area, 4 = Gambella National Park,
5 = Chebera-Churchura National Park, 6 = Omo National Park,
7 = Mago National Park, 8 = Borena Controlled Hunting Area,
9 = Babille Elephant Sanctuary

The Sanctuary holds one of the most important elephant populations in the Horn of Africa. These elephants have been separated from other populations in Ethiopia for more than eight decades. Despite the establishment of the Sanctuary in 1970, their range of distribution has shrunk considerably. The number of other large mammals has also been declining for several decades, although figures are not currently available (Stephenson, 1976; Yirmed, 2008).

## 1.1 HISTORY OF THE ESTABLISHMENT AND MANAGEMENT RESPONSIBILITY OF BABILLE ES

Before the establishment of the Babille Sanctuary, the vast area surrounding the present Sanctuary was known as a game-hunting site, called Harar-Wabi Shebelle Hunting Area. The area extended as far south as the Wabi Shebelle River. The most notable large game animals hunted in the region were lions and other mammals. Later on, concerns grew over the small elephant population that had long been known to inhabit this semi-arid eastern region of the country. The "stress" situation of the elephants in the area, mainly due to crop raiding conflicts with the local farmers, was reported to the then Emperor Haile Selassie I during his visit to Fafum, eastern Ethiopia (Stephenson, 1976). In 1970, based on the report, the Emperor issued an order for the designation of the present conservation area as a Sanctuary. The vast controlled hunting area was reduced in order to establish the Babille Sanctuary with an area of 6,982 $km^2$. Its boundaries were defined with particular references to valleys and roads. The excised land was redesigned and two new controlled hunting areas, Chercher-Highland and Harar-Wabi Shebelle, were created, both of which do not exist anymore.

The Imperial government's efforts towards the protection of the faunal and floral diversity of the newly created Elephant Sanctuary successfully ended legal large game hunting in the area. An office with a small staff of wildlife guards and a warden was established in the town of Harar. Since then, no additional protection has been provided: the area remains ungazetted by law; it has not yet been upgraded to the status of a national park; no sufficient budget has been allotted; and the anti-poaching team responsible for law enforcement is still performing unsatisfactorily. Security problems in some parts of the Sanctuary have hindered the already inadequate protection of the species (Yirmed, 2008).

Since the creation of wildlife conservation areas in the country, the Ethiopian Wildlife Conservation Organization (EWCO, at present named the Ethiopian Wildlife Conservation Authority), an autonomous government body, has been responsible for the management and conservation of the country's wildlife resources. However, in accordance with Proclamation 4/1995 defining the duties and responsibilities of the Regional and Federal Governments, the Federal EWCO in 1995 handed over the management of national parks and wildlife sanctuaries that fall into only one region to the Regional States, and only those located in the trans-boundary of two or more regions remain under the direct control of the Federal EWCO. As the Babille Sanctuary is situated between the Oromia and Somali Regions, the management of and responsibility for the Sanctuary has remained with the Federal EWCO for the past 37 years.

## 1.2. AREA/TOPOGRAPHIC CHARACTERISTICS

The Sanctuary office is situated in the semi-arid trans-boundary of Oromia and Somali Regions, about 560 km from Addis Ababa in eastern Ethiopia. It is delimited by latitudes 08°22'30"-09°00'30"N and longitudes 42°01'10"-43°05'50"E. The major portion of the Sanctuary (77.7%) is located in the Somali Region, while the remaining 22.3% falls in the Oromia Region. It lies in three districts: Fedis; Midega Tola; and Babille-Somali Districts (see Figure 2). According to the old boundary description of the Sanctuary by Stephenson (1976), the average length of the conservation area is 80 km from north to south, and its width 98 km from east to west. The area is made up of highlands (with altitudes over 1500 m) and lowlands (with elevations between 850 m and 1500 m). About 84% of the topography of the Sanctuary can be categorized as flat to gentle slopes, while the remaining 16% of its land surface range from complex valleys to deep gorges. The gorges and valleys are formed by four rivers, which all dissect the Sanctuary north to south. Gobele and Erer Valleys comprise the highest portion of such rugged lands, characterized by highly entrenched tributaries. The climatic condition of the area is semi-arid.

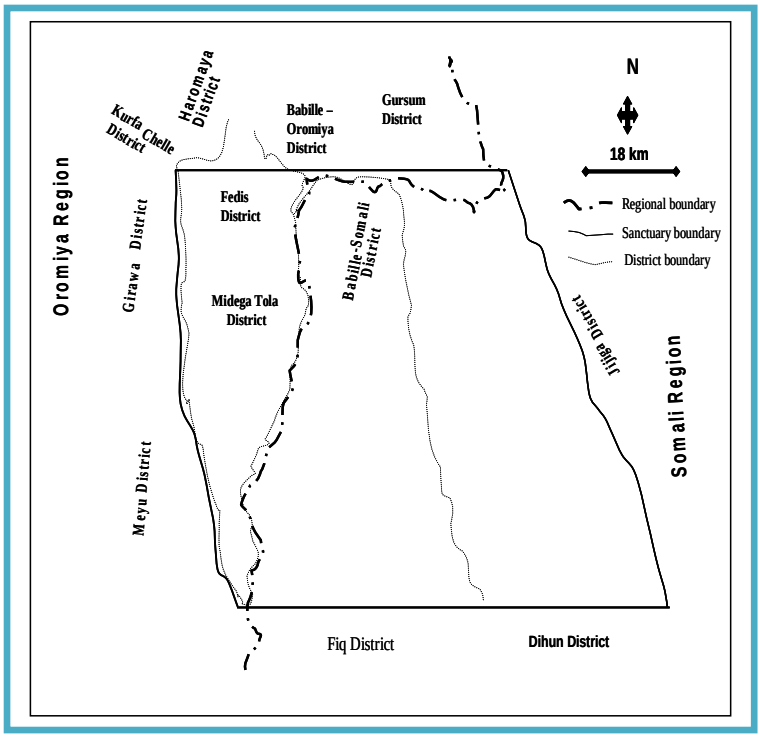


**Figure 2: Regional and district physical and administrative boundaries of Babille ES**

## 1.3. RESOURCE DIVERSITY

*Flora:* Phytogeographically, the biome of Babille ES is a center of endemism in bush-lands and thickets, and also contains semi-arid grasslands and scrublands (Friis, 1992; World Bank, 1993). So far, 1,250 species of plants have been recorded from the Somali-Masaai biome (White, 1983). At lower elevations where rainfall is less consistent, vegetation becomes semi-arid scrubland (EWNHS, 1996). Generally, the Sanctuary is represented by *Acacia commiphora* woodland, semi-desert scrubland and evergreen scrub ecosystems.

The report on the flora of Dakata Valley by Demil (1995) showed that the floristic composition of this valley significantly differs from that of the other areas. He documented 202 species of plants comprising 54 families. The report indicated that a tree found in the area, *Erythrina burana,* and a herb, *Pelargonium erlangerianum,* are endemic to Ethiopia, while 18 other species are near endemic, having been recorded in only two or three other countries. A systematic study undertaken by Anteneh (2006) on the floristic composition and ethno-botany of the Upper Erer Valley of the Sanctuary documented a total of 238 species of plants, grouped in 155 genera and 57 families. Of the recorded species, 102 were herbs, 59 shrubs, and 32 trees, while the remaining 49 species were grasses, climbers, shrub/trees, ferns and epiphytes. The major portion of the plants (47.5%) was woody species.

*Fauna: Eastern Ethiopia* supports a high diversity of animals (mammals, birds and reptiles), which are adapted to the semi-arid environment. Mammal species restricted to the eastern region of Ethiopia include: Dibatag (*Ammodorcas clarkei*); Speke's gazelle (*Gazella spekei*); Beira (*Dorcatragus megalotis*); Desert warthog (*Phacochoerus aethiopicus*); Somali dwarf mongoose (*Helogale hirtula*); Soemmerring's gazelle (*Gazella soemmerringii*); and Yellow baboon (*Papio cynocephalus*). Dibatag is restricted to a single vegetation type, and prefers areas with well-drained sandy soils. Beira is threatened with extinction.

The Sanctuary holds various mammal species including: the African elephant *(Loxodonta africana africana)*; Lion (*Panthera leo)*; Leopard (*Panthera pardus)*; Black and white colobus monkey (*Colobus guereza*); Hamadrayas baboon (*Papio hamadrayas)*; Bat-eared fox (*Otocyon megalotis*); Aardvark (*Orycteropus afer*); Lesser kudu (*Tragelaphus imberbis*); Greater kudu (*Tragelaphus strepsiceros*); Oribi (*Ourebia ourebi*); Salt's dik-dik (*Madoqua saltiana*); Common bushbuck (*Tragelaphus scriptus*); and Spotted hyena (*Crocuta crocuta*). Salt's dik-diks are the most numerous of these. The existing mammals are found mainly in the valleys and escarpments.

Babille ES is among the 73 important bird sites in Ethiopia that are registered as Globally Important Bird Areas (EWNHS, 1996). Currently, 191 species of birds grouped into 17 orders and 51 families are documented for the Sanctuary. (Hillman, 1993; Yirmed, 2006) Of these, 76.9% are resident species, 13.5% northern migrants and 8.3% African migrants, while the remaining two species are known as both African and northern migrants. The Sanctuary supports the endemic Salvadori's serin (*Serinus salvadorii*), which is restricted to the eastern lowlands. The Black-winged lovebird (*Agapornis taranta*) is near-endemic (restricted to only Ethiopia and Eritrea) and is confined to the highland section of the Sanctuary.

The herpetofauna of Babille has not been studied so far; however, a report from adjacent areas of Ogaden suggests the probable presence of a large number of endemic reptiles (EWNHS, 1996). It is believed that the Sanctuary supports many reptile species including the African rock python (*Python sebae),* some unidentified snake species, agamas, geckos and skinks.

## 1.4. ELEPHANTS AND HOME RANGE PATTERNS

In the past, elephants inhabited the thicket plains and dry lowlands of eastern Ethiopia and adjacent northern Somalia. The population was fairly dense and widely distributed between altitudes of 850 m and 1,850 m (at Gara Muleta Mountains in the west). This range has been shrinking since 1900; more recently, the population has collapsed (Largen and Yalden, 1987). In 1928, elephants were exterminated from northern Somalia (Yalden *et al*., 1986). The surviving population in Ethiopia today occupies only a small portion of its former range (see Figure 3).

**Plate 1: One of the sites on top of Gobele Valley to be developed for elephant tourism**

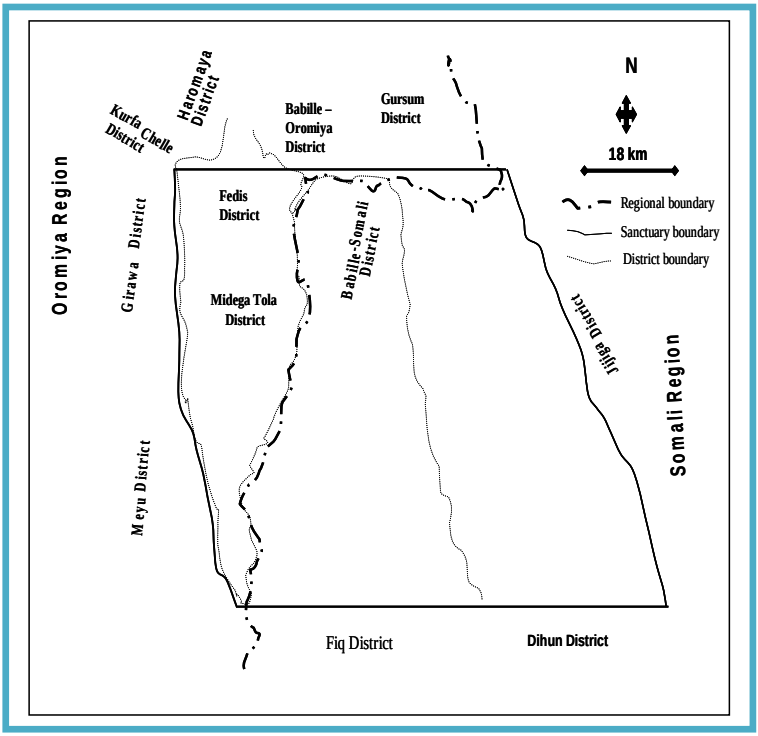


**Figure 3: Shrinkage in elephant ranges from 1941 - 2007**

At present, the elephants of Babille occur in two big groups: the first group, which seasonally moves between the Erer and Gobele valleys, totals 234 animals, and the other group, which remains in the Erer Valley all year round and moves north and south within the valley, numbers about 90. The most recent count of elephants in Babille gave a total number of 324. The calculated mean birth rate from 2004 to 2006 was 7.4%, and the population increased at a mean growth rate of 5.8% per annum over this three year period.

The total size of home ranges covered by elephants during the past three years was 3,014 $km^2$, 2,583 $km^2$ (85.7%) within the boundaries of the Sanctuary and 430 $km^2$ (14.3%) outside. The ranges outside the Sanctuary were located in three different areas (see Figure 3), namely in Upper Erer (1.8%, 8 $km^2$), Upper Gobele (11.2%, 48 $km^2$), and west of Gobele Valley (87%, 374 $km^2$). The sizes of the home ranges varied seasonally. During the wet season, home ranges were restricted to the Erer Valley. In the dry season, the elephants split into two distinctive groups and ranged both the Gobele and the Erer Valleys.

## 2. SOCIOECONOMIC CHARACTERISTICS AND THEIR ANTAGONISTIC IMPLICATIONS ON CONSERVATION

The Sanctuary extends into three administrative zones, East Hararge Zone in Oromia Region to the north and west, and Fiq and Jijiga Zones in Somali Region to the south and east, respectively. These three zones comprise 12 districts: 7 in the northern, 2 each in the western and southern, and 1 in the eastern part of the Sanctuary (see Figure 2).

Since its establishment, the Babille ES has been continually under threat from growing human populations, particularly in the northern and northwestern parts of the Sanctuary and its adjacent areas, where agriculture is the predominant activity of the residents. People living inside and in the vicinity of this conservation area regularly present serious challenges. In Ethiopia, where agriculture consists mainly of

subsistence farming and plays a central role in income generation, the rapidly growing population consistently seeks additional land. This ultimately threatens the conservation areas through progressive extension of settlements, farms and grazing lands. In recent years, the situation in the Babille ES has become severe.

The human population varies considerably from district to district (OBFED, 2003; CSA, 2004) and ranges from 406.5 persons per $km^2$ in Haremaya District in the north to 6.7 persons per $km^2$ in Meyu District in the southwest. Currently, the population is growing at a rate of 2.9% per annum (EHPEDO, 2004). Based on the crude estimates of the Population and Housing Census of 1994, the population density of Babille District had increased from 18 persons per $km^2$ in 1990 to 26 persons per $km^2$ in 1995, an increase of 47.8% (EHPEDO, 2004). The average household size for rural areas of the district given in these estimates was 5.4. This is an indication of the extent of the population increment in the last fifteen or more years, resulting in a high density of human settlement inside the Babille ES. For the continued survival of the conservation area, it is imperative to first have updated data on the human population, its livestock abundance and the associated impacts on the wildlife in the area.

Yirmed (2008) has identified eight districts (Babille-Somali, Babille-Oromiya, Fedis, Midaga Tola, Haremaya, Kurfa Chele, Girawa and Meyu) that have the most serious conflicts with the wildlife of the Sanctuary. Other districts also put profound pressures on the Sanctuary. Those having severe problems with elephants are situated to the north and west of the Sanctuary. Three districts, namely Babille-Somali, Fedis and Midaga Tola, all in the north, share a considerable portion of land with the Sanctuary. The other nine districts border the Sanctuary on different sides.

About 75 villages were identified both within (53.3%) and in the vicinity of (46.7%) the Sanctuary. Of the 40 villages located within the Sanctuary, 70% are in the Babille-Somali District and 30% in Fedis

and Midega Tola. The villagers in the former district are mostly pastoralists, those in the latter (with two exceptions) agriculturalists. A total of 46 villages were identified as having contacts with the Babille ES. About 82.6% of these are located in three districts within the Sanctuary. Twenty-five villages (18 in the west and northwest and 7 in the north) border the Sanctuary, and these were found to be in the forefront of conflicts with wildlife, particularly with elephants. Most of the problematic villages (26.7%) lie in Babille-Oromia District, while 20.0% are in Meyu, and the rest are shared between four other districts. A total of 13 villages are located within the Oromia part of the Sanctuary (see Figure 4), in the Fedis and Midaga Tola Districts, which are situated on the flat high grounds between the Erer and Gobele Valleys. Five villages face towards the Erer and seven others towards the Gobele. All of these have seasonal contacts with elephants and other wildlife.

**Plate 2: Increasing encroachment of farm plots on the eastern plains of the Sanctuary, Somali Region**

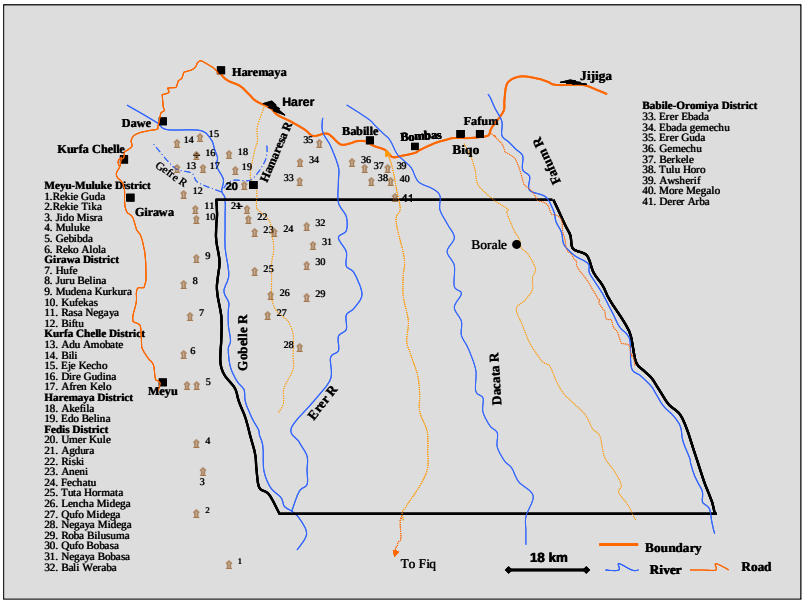


**Figure 4: Villages and farmlands that have direct contact with the elephants and other wildlife of Babille ES, and their respective districts. Numbers represent villages.**

The villages inside the Sanctuary were established between the mid-1970s and 1985 (Helen, 1989). The outbreak of war between Ethiopia and Somalia in mid-1976 forced many farmers to leave their villages and settle as refugees at the edges of the Sanctuary (Henze, 2004). As a result, the original extensive bush and shrub cover around these villages was cleared, primarily for crops and settlements.

## 3. CONSERVATION VERSUS BIOFUEL INVESTMENT

Today we live in a world of global connections, in which actions taken in one part of the planet can have far-reaching ecological impacts in another area. Examples are: the use of resources; the production of

pollutants; habitat degradation; and policy decisions that may have both direct and indirect effects on areas beyond the specific locality. Recognition of the reality of a global ecology has resulted in new ways of looking at things. One of these alternative approaches endeavors to lower fossil fuel carbon emissions and thereby decrease greenhouse gas pollution (Lovett, 2007). A possibility that is now being taken very seriously is the use of biofuels for general transport use. Biofuels are derived from crops and harness the ability of plants to convert atmospheric carbon dioxide into complex organic molecules through photosynthesis. These molecules can then be used for fuel. Advances in biorefinery technology for the production of biodiesel and the implementation of biofuel policies in various countries are opening the way for much a wider use of biofuels (Ragauskas *et al*., 2006). For example, in 2003 the European Union Parliament passed the Biofuels Directive (European Commission, 2003) that set the targets for the use of biofuels in EU road transport at 2% by the end of 2005 and at 5.75% by the end of 2010.

According to Lovett (2007), policy makers regard biofuels as providing a suite of dividends. The EU Biofuels Directive has four main objectives:

1. It helps Europe in meeting her Kyoto obligations for the reduction of greenhouse gas emissions by using fuels from renewable sources instead of mineral oil;
2. Since the main oil reserves are located in geopolitically unstable areas of the planet, politicians consider it prudent to develop alternative sources of fuel. The rapidly industrializing economies of India and China, which are not constrained by Kyoto limits, have become major players in the oil market and can exert control outside the direct European sphere of interest;
3. A subsidized market for biofuels derived from agricultural crops could help stimulate the economies of relatively underdeveloped European countries with abundant

agricultural land resources and so enhance European harmonization; and

4. The European biofuels market will be huge and so has the potential of boosting the agricultures of non-European countries as well. This is where Africa has a major part to play.

Other oil-dependent countries are also making commitments to biofuels. The United States of America, although it has not ratified the Kyoto Protocol in 2005 passed a 551 page Federal Energy Policy Act, which includes support for biofuels, and a number of individual states have renewable fuel standards or other legislation promoting biofuel use.

Although a shift to biofuel sounds attractive, and indeed may be imperative given the increasing evidence that global warming is induced by human activity (IPCC, 2007), there are some concerns about the sources of the required fuel. In some countries, biofuel feedstock production competes with food production, causing an increase in the costs of basic foodstuffs (Lovett, 2007). But then, some biofuel feedstocks, such as *Jatropha* and castor beans are promoted as crops that can grow in semi-arid conditions and therefore can be grown on lands not suitable for high yield agriculture. They could, however, displace food crops in areas such as the Sahel. Additionally, the expansion of biofuel crop production could result in the loss of biodiversity. For example, oil palm and soya farms could replace tropical rainforests; sugar-cane competes with biodiversity-rich wetlands; and *Jatropha* is often grown on land previously used by pastoralists under traditional systems that are compatible with maintaining the local fauna and flora.

A recent investment in east Ethiopia has encroached on a globally registered protected area, the Babille ES. This example clearly shows how biofuel investments, if their ecological and social sustainability

has not been considered thoroughly, can directly collide with key conservation activities in Africa.

At present, environmental organizations worldwide are increasingly expressing concerns over the promotion of biofuels as the silver bullet for climate, social and economical challenges the world is currently facing. The expansion of biofuels particularly in forested and conservation areas has also drawn more attention and serious scrutiny. Lovett (2007), for example, has produced several critical articles on the ecological sustainability of biofuel production. The key to the ecologically sound production of biofuels are environmental impact assessments, which are increasingly being made legal prerequisites for external investors during the planning and development phases of biofuel projects in Africa. Whether biofuel production will be ecologically sustainable or not will be determined by the care taken in the initial planning of projects and by the appropriate use of environmental impact assessments.

Specifically, the recent activities of Flora Eco-power Holding AG, a Germany registered biodiesel producer based in Munich, have been antagonistic to wildlife conservation efforts in Babille ES. About 10,000 ha of land were granted to the company for castor bean plantation without the knowledge of the Office of the Sanctuary or the Ethiopian Wildlife Conservation Authority (EWCA), under whose responsibility and jurisdiction the Babille ES falls. The company started its operations inside the Sanctuary in March 2007 with the consent of the Ethiopian Investment Agency (EIA) and the Oromia Investment Commission. With the help of about 15 tractors, Flora Eco-power cut down the *Acacia commiphora* and bush vegetation in the northern and northwestern sections of the Sanctuary. No Environmental Impact Assessment was prepared by or required from the company before commencing these activities.

## 3.1 ACTIONS TAKEN FOLLOWING THE START OF THE COMPANY'S OPERATION INSIDE BABILLE ES

1. On the third day after the commencement of the clearing of the Sanctuary area, the EWCA and the Babille Elephant Conservation Project jointly went to the area and discussed the issue first with the Council of East Hararge Zone, the Zonal Investment and Agriculture Departments, and the District Council of the Midaga-Tola, where the investment started, and then with the owner of the company. As a result of these discussions, the company agreed to refrain from any further expansions within the Sanctuary. Flora Eco-power consistently claimed to be an environmentally friendly company operating for a green environment. However, three days after this first consensus, the company violated its commitments and resumed its destructive activities in all directions within the Sanctuary.

2. Following these actions, the Ethiopian Wildlife Association (EWA) and the Forum for Environment (FfE) directly addressed the Ministry of Agriculture and Rural Development (MoARD), the Office of the President of the Federal Democratic Republic of Ethiopia, the Environmental Protection Authority, the Council of Oromia Regional State, the Institute of Biodiversity Conservation and a few concerned individuals on this serious issue, urging for a reconsideration of the investment, which has been infringing upon the boundaries of the Sanctuary. The consequences of allowing the investment project to operate in this core elephant conservation area were outlined. Of the total 10,000 hectares of land granted to the company, 87.4% was proved to fall within the boundary of the Babille ES, and of this 79.2% were within the present elephant ranges (see Figure 5). The discussions between the Ministry of Agriculture and Rural Development (MoARD) and the Oromia Regional State went slowly and largely not fruitful. Both the Federal and the

Oromia Regional Governments each sent teams twice, but their reports were contradictory. However, the MoARD has consistently expressed its concern about the potential adverse impact of this investment on the biodiversity of the Sanctuary.

3. The Sanctuary areas granted to the company have been proved to be an important range (including movement corridors and regular feeding grounds) for elephants. Instead of reconsidering its environmentally unfriendly actions, the company continued to promulgate its business-centered propaganda to the local media, denying facts brought to the fore by governmental institutions and conservation groups. The company disseminated misleading information about the natural home of the species that existed there for centuries, and defied reality by saying, "We were not touching one area where there are elephants," and "our work is 30 km away from the elephants". (*The Daily Monitor News Paper,* June 2-3, 2007) In contrast to these statements, Figure 5 clearly shows that some of the farm plots of the Flora Eco-power investment are located 40-55 km inside the boundary in the heartland of the Sanctuary. Additional information can be obtained from the Sub-Saharan Informer (May 25, 2007), Fortune (May 2007), Reuters (June 1, 2007), and ABB (December 26, 2007 – January 1, 2008) newspapers.

   The authors of this document feel that these actions of the Flora Eco-power are unethical and do not conform to national and international rules, regulations and conventions.

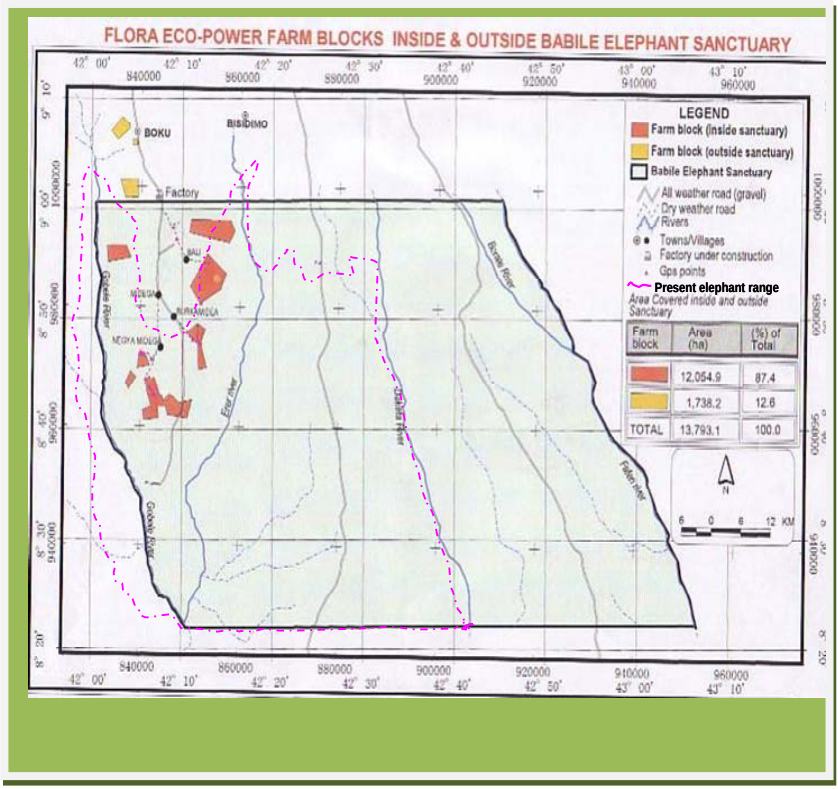


**Figure 5: Flora Eco-Power farm blocks inside and outside Babille ES**

**Plate 3: Investment scheme clearing the main elephant ranges on the top of Gobele Valley**

## 3.2 DECISION BY THE GOVERNMENT

In July 2007, a meeting was called by His Excellency the Minister of Trade and Industry, whereby few relevant government offices, the company and two CSOs (EWA and FfE) were represented. Following a long discussion, the Minister finally ordered any further expansion to be halted and promised to hold further discussions with other government officials for a final political decision. This was followed by a meeting called by His Excellency the Deputy Prime Minister and Minister of Agriculture and Rural Development whereby a larger number of stakeholders participated. Subsequently, a team was set up from the federal and regional government offices to look for a solution. Following the submission of a report by the team, in November 2007, His Excellency the Deputy Prime Minister ordered the re-demarcation of the Sanctuary boundaries to begin as soon as possible in a participatory way. Accordingly, by the end of December a team composed of representatives of the MoARD, the Oromia Agriculture and Rural Development Bureau and the IBC was given the responsibility to delineate the new boundary. This process, which was started in March 2007 and discontinued after the investment encroached the Sanctuary in July is now still underway.

**Plate 4: Discussions among government officials about the impact of the investment scheme on the elephants' range**

## 4. SUGGESTED INTERVENTIONS

1. *Urgent actions are necessary:* Although further expansion of the company into the Sanctuary is halted, some existing plantations are still situated in core areas that used to be covered with dense vegetation and served as feeding ground and shelter for the elephants and other wild animals. The clear and present danger presented by the company on the elephants and their habitats is also confirmed by the Environmental Impact Assessment (EIA) report commissioned by the company. Lisanework Nigatu *et al.* (2008), the group that authored the EIA report, stated that ''according to respondents from Mudhii, Nuham and nearby sites, a portion of the land put under cultivation of castor bean by the company is considered as seasonal pass route for elephants in search of feed and water … the company should maintain its policy that prevents damaging the wildlife habitat while undertaking agricultural development activities.'' The danger actually goes beyond affecting the natural habitats of the elephants because some other plots already cultivated by the company do also present indirect threats. In this regard, the EIA report admitted that ''conversion of grazing land to cropland by the company will create shortage of grazing land in the near future forcing the farmers to look for alternative grazing lands. Some local farmer respondents expressed that they will start using the sanctuary as alternative grazing land and for their livestock if the situation is not reversed. This condition will obviously increase grazing pressure on the wild animals' habitat that can undoubtedly reduce its carrying capacity and fertility and growth rates of animals. Besides, it might be the potential cause of conflicts between wild animal, local farmers and the company.'' Therefore, all the plantations that are directly and indirectly affecting the elephant population as such should be immediately removed.

2. *Finalizing the re-delineation of the boundary of the Sanctuary*: There is no question about the necessity of a revision of the old Sanctuary boundary, as human habitations and related activities as well as the activities of Flora Eco-Power inside the Sanctuary have exerted a tremendous pressure on the Sanctuary and its wildlife. Recent studies indicate that villagers expanding in all directions within the Sanctuary take no less than 260 ha of new lands every year. Considering such uncontrolled encroachments, starting the re-demarcation of the Sanctuary boundaries with the involvement of key stakeholders is a commendable measure. . Demarcation started in April 2008 and to date this activity was finalized in 26 villages in Oromia Region. Only two villages remain un-demarcated as these demand political decision. Once completing boundary demarcation from the Oromia side, the same activity will continue to the Somali Region. The proposed new boundaries are shown in Figure 6. It is hoped that the new boundaries of the Sanctuary will be legally observed and respected by all actors who have got stakes around the Sanctuary.

3. *Compensation of land*: The land that the Sanctuary lost through the aforementioned activities has been compensated for by annexing some plots of land that are unoccupied but useful to the elephants from adjacent areas. To the west of the Gobele Valley, the western boundary of the Sanctuary, which has ample forested and evergreen areas, Hamaresa and Gefre Rivers, which are regularly used by elephants during the dry season (from mid-November to March) have been included as part of the Sanctuary. These areas are easily accessible for visitors, and the surrounding landscape is suitable for eco-tourism development. The boundary of the compensation area begins north of Agdura Village, extends north for 6 km west of Umer Kule Village, and then joins the Hamaresa River Valley. From Hamaresa it turns $90^{o}$ to the west to the Gefre Valley, crossing the Gobele River. This part is characterized by deep gorges and has no value for agriculture. Water is perennial and the

vegetation is in good condition. The boundary then runs west of the Gobele Valley, at a distance of 2 km in the north to 6 km in the south, up to the confluence of the Gobele and Erer Rivers. This area has been included as an elephant range. This reallocation of land for the Sanctuary would alleviate the existing tensions between expanding communities and conservationists.

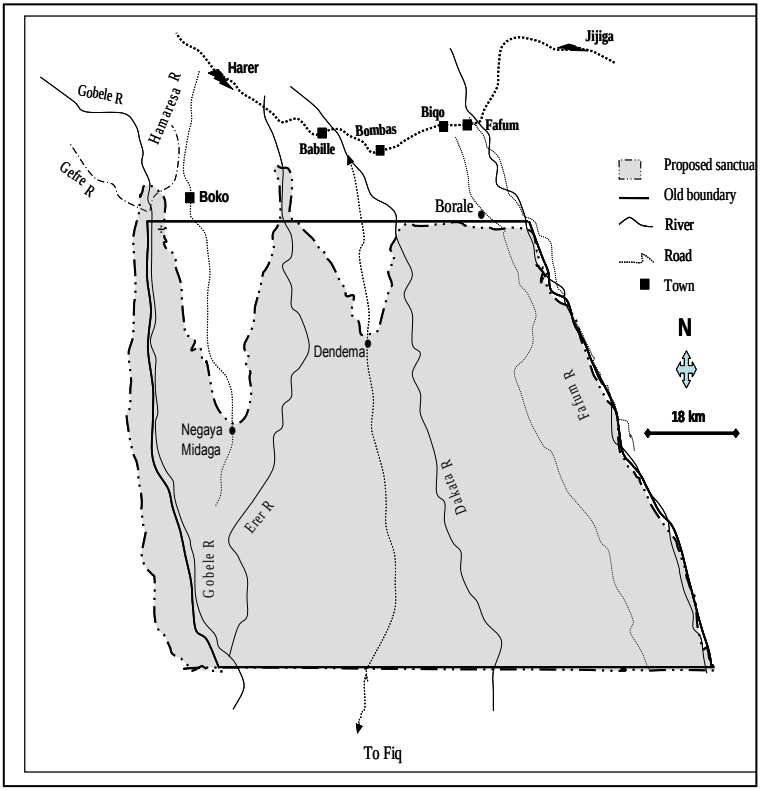


**Figure 6: Proposed new boundaries for Babille ES**

4. *Awareness promotion among the local communities*: Awareness raising is of utmost importance because without i, the value of wildlife will remain unclear to the villagers. The

best solution is to work towards sound conservation in close collaboration with local agriculturists. Discussions and awareness raising programs are crucial for people in and around the Sanctuary. Elephant avoidance methods need to be practiced by the conservationists and the communities. However, there is no doubt that all these activities require a substantial input of funds and expertise. Some funds have been allocated for this activity by the Dutch Embassy in Addis through Forum for Environment for one and a half year project.

5. *Preparation of a management plan for the Sanctuary:* The development of a management plan is fundamental to the conservation of elephants and other wildlife in the Babille Sanctuary. It should clearly demonstrate the ways in which the local people can be involved in protecting the natural resources of the area, and the benefits they would derive from their involvement. Based on the data that have been collected during the last three years, it seems possible to prepare a well-organized management plan for the Sanctuary with short- and long-term plan of activities. The plan will have the following objectives: describe the biophysical and cultural features of the Sanctuary within the national and regional contexts; identify the general background conditions and describe the current management and conservation situation in the Babille ES; design appropriate uses of the Sanctuary through zoning; introduce and justify the idea of integrated conservation and development within the Sanctuary and its surrounding rural areas; and propose material and human resources needed to run an effective management.

6. *Ecotourism development*: Wildlife management in Babille ES needs to be viewed from an economic point of view. Since the turn of the 20th century, the economic importance of elephants as sources of ivory has been superseded by their value in attracting tourists in several African countries. Tourism is now

one of the world's most important industries, and an effective form of it is essential for expanding the economies of developing countries (WTO, 1998). For example, in Botswana, the revenue from photographic tourism has increased from 34% to 59% of the country's total income (Barnes 1996). In 1992, tourism accounted for 71% of the economic value of elephants. Hart and O'Connell (2000) expressed the fear that, with the human population doubling every 30 years in Ethiopia, wildlife areas that do not contribute to human economic welfare inevitably will be converted to uses that directly benefit humans.

Since the commencement of the Babille Elephant Conservation Project in 2003, the elephant population has been actively protected from ivory poachers and from shooting in response to crop raiding. The current project of Wildlife for Sustainable Development in tha area has a long-term vision that includes the development of eco-tourism in the Sanctuary, which might help to reduce the existing intense conflicts with wildlife and improve the economic situation of the local people. It is possible to generate direct benefits from elephant tourism in Babille. The present project has already identified all sites accessible for tourists, but a road network needs to be established soon. Tourism-based trophy hunting is presently not allowed in Ethiopia because of the small number of elephants, but could offer considerable benefits to offset the costs of co-existence. If the number of elephants in the Sanctuary recovered enough to permit culling, one elephant would be worth no less than 90 oxen.

In addition to wildlife-based tourism, there are also considerable historic and scenic sites near the Sanctuary. The "Rock Valley" of Dakata, the attractive mountainous landscape of Gara Muleta, the ancient historic city of Harar, and the house where Emperor Eyasu was imprisoned, are all potential tourist attractions. These resources are indicators of the immense potential of the surrounding areas for tourism development.

7. *Additional interventions* include habitat restoration; minimizing the conflicts between people and elephants; and capacity building of the Sanctuary.

## CONCLUDING REMARKS

The granting of a considerable portion of land to Flora Eco-power Holding AG for plantation of castor seeds for biofuel production, partially inside the Sanctuary, was illegal and unacceptable, as it completely neglected national and international laws.

Flora Eco-power, an internationally registered company, launched this project inside an internationally recognized conservation area without conducting the environmental impact assessment required by federal law. The actions of the company have since been detrimental to the wellbeing of the Sanctuary. Only at the end of December 2007, 10 months after the investment activities were started, a draft environmental impact assessment (EIA) document was finally sent by the company to the concerned officials for comments. While the EIA document is not yet approved, the company is expanding to neigbouring areas in east and west Hararghe through promoting castor bean production with outgrower model.

In our view, the company should take full responsibility for all the damages incurred during and after the biofuel development process in and around the Sanctuary and seriously commit itself to redress the damage .

This case presents an alarm bell to biofuel development in Ethiopia from which lessons should be learnt for the future. Can we really afford to put our precious resources to graver danger for something that is not carefully researched and properly consulted? The authors strongly doubt that.

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# REFLECTIONS ON AND RECOMMENDATIONS FOR THE CURRENT AGROFUEL DEVELOPMENT IN ETHIOPIA

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## I. BACKGROUND

Poverty in Africa in general and in Ethiopia in particular affects the majority of the population. In addition to the food insecurity in the country, another big challenge is the energy poverty. According to the PASDEP document of the Ministry of Finance and Economic Development (MoFED, 2006) of the Ethiopian Government, the national per capita electricity consumption during 1998/99 was 24 kwh, which is extremely lower than the average for developing countries (938 kwh); of the sub-Saharan Arica countries average (456 kwh); and of the low income countries average (317kwh).

Ethiopia is a highly environmentally degraded country and one among the most vulnerable countries to climate change. According to FAO (2005), the annual forest cover change in Ethiopia is about -40,000 ha, which is roughly an 8% decline per annum every year. The forest cover, according to several estimates, has dwindled to about 3%, which has plummeted from a mere 40% at the turn of the last century.

Ethiopia is currently one of the major targets for agrofuel production in Africa. The rush for agrofuels has been 'justified' by many actors in such a way that many African nations, Ethiopia being no exception, have decided to play with this card with the intention that agrofuels would eradicate most of the problems at hand. This has been the case because agrofuels have been touted as a magic bullet, among others, to:

- Promote rural development by way of greater income generation and value addition through agrofuel production

- Promote energy security via promoting local use of biofuels and reducing dependency on imported fossil fuels, which in recent years has become a stumbling block for economic development
- Augment foreign currency revenues through export development and import substitution
- Mitigate climate change through reducing green house gas emissions

Mathews (2006) summarizes the advantages of biofuels against fossil fuels for developing countries in asserting that they:

- are cheaper than oil;
- provide energy security as opposed to dependence on imports from unstable oil regimes;
- burn more cleanly;
- generate fewer greenhouse gases;
- promote rural development;
- can generate new export industries for developing countries;
- can get started even in countries with a low level of science and technology; and
- promote South-South cooperation, led by cooperation and investment between Brazil, India and China.

This apparently makes a big sense to a country like Ethiopia, which, like many other African countries is heavily dependent on imported fuel. This dependence has resulted in a huge loss of export earnings on fuel imports. In Ethiopia, during the just ended fiscal year (2007/08), expenditures for fuel imports have just surpassed export revenues of the country, which is an alarming situation for the cash-strapped local economy.

UNDESA (2007) forecasted some opportunities with small-scale biofuels for economic and social development:

- As biofuel industries grow, significant economic opportunities can emerge for small-scale farmers and entrepreneurs as the production, transport, and processing of crops often takes place in rural areas. Rural communities can also derive income from the processing of biofuel by-products, such as soap, fertilizers, cattle cakes, etc.
- Small-scale farmers and entrepreneurs have a role to play in leading the creation of biofuel markets, particularly in rural areas, and providing access to modern energy for off-grid local communities. Small and medium enterprises can also participate across the supply chain, including feedstock development and production, processing, transportation, and marketing.
- Currently, energy is a priority in sub-Saharan Africa, as 95 percent of all staples must be cooked. Traditional cook-stoves, powered by fuel-wood and dung yield negative health and social impacts. Transition to improved cook-stoves using bio-based feedstocks could free women and children from the collection and transport of wood and dung which can account for up to one-third of their productive time, and reduce the effects of indoor air pollution which is responsible for more deaths of women and children than malaria and tuberculosis combined. These cook-stoves can also be used by local shopkeepers and vendors to generate more income.
- Agricultural crops for biofuels can offer new income streams for farmers. Non-edible crops can be grown and harvested for biofuel applications and several biofuel feedstocks can be planted and grown on arable and marginal lands that are not under cultivation.
- In many instances, biofuel crops can help to improve soil fertility and regenerate land, increase rotation cycles, and bring back nutrients.

## II. SOME NOTABLE ARGUMENTS AGAINST AGROFUELS

Currently, most, if not all, of these claims are seriously contested by several parties. There have been lots of arguments against agrofuels in the past few years, some of the most important of which are focusing on food security, climate change and biodiversity issues.

### FOOD INSECURITY

According to several studies, agrofuels have contributed to about three-quarters of the world food crisis that affected the whole world and the Global South in particular. Although not given much attention then, Ziegler (2007)* prophesied that agrofuels could worsen food insecurity in the world in some ways, which summarised as follows:

A) Food for fuel: Agrofuels are presented in rich countries as a solution to two crises: the climate crisis and the oil crisis. But they may not be a solution to either, and instead are contributing to a third crisis, food insecurity (Oxfam, 2008).

There is currently a severe competition of agrofuels with some major food crops such as bio-ethanol from maize, wheat, sugar beet, potatoes, cassava, (the staple food for many African nations) and biodiesel from peanuts. This would result in a sharp rise in food prices, which would be unaffordable mainly to the poor people in the Global South (Table 1).

* John Ziegler served as the UN Special Rapporteur on the Right to Food.

**Table1: Projected rises in food prices due to agrofuels (adopted from (Ziegler, 2007))**

| Food crop | Projected rise by 2010 (%) | Projected rise by 2020 (%) |
|---|---|---|
| Maize | 20 | 41 |
| Wheat | 11 | 30 |
| Soya and sunflower | 26 | 76 |
| Manioc (Cassava) | 33 | 135 |

The consequences of such a rapid increase in food prices would be grave. Kartha (2006) projected that the number of suffering from undernourishment would increase by 16 million people for every increase in percentage point in the real price of staple food. This could mean that 1.2 billion people would be suffering from hunger by 2025.

There are serious concerns that, as the United States produces more than two thirds of the world's grain imports, the diversion of maize to ethanol distilleries will have a substantial impact on its availability and global prices, including for food aid.


**Fig. 1: Food versus fuel**

B) Dependence on agro-industrial model that hampers a trickle-down economy and fail to benefit poor peasant farmers would generate violations of the right to food. The Brazilian Landless Workers' Movement argues, "the current model of production for bio-energy is sustained by the same elements that have always been the cause of the oppression of our peoples" — the appropriation of land, concentration of ownership and the exploitation of the labour force.

C) Many farming families are net buyers of food. As they do not have enough land to be self-sufficient, and will therefore be affected by rising consumer prices. In addition, prices received by farmers at the farm gate are often exploitatively low, particularly for remote farmers with little choice of whom to sell their crops to, and often do not reflect global prices because of the greed of intermediaries. If increased agricultural production is to benefit poor peasant farmers, it will be essential to build mechanisms, such as cooperatives and non-exploitative out-grower schemes that would ensure a trickle-down to the poorest.

D) Forceful evictions of smallholders: A rapid increase in the prices of food crops will intensify competition over land and other natural resources, including forest reserves. This will pit peasant farmers, pastoralists and indigenous communities of forest dwellers against massive agribusiness corporations and large investors who are already buying up large swathes of land or forcing peasants off their land.

E) Heavy water-dependence of agrofuels: The production of agrofuels requires substantial amounts of water, diverting away from the production of food crops. Rising prices of water would limit access to water for the poorest communities, in ways that would negatively affect the right to food.

## CLIMATE CHANGE

The potential of agrofuels in mitigating climate change has been contested by several authors. Kartha (2006) put forward three scenarios regarding the interface between agrofuels and climate change:

Scenario 1: If a natural forest is cleared to provide fuel for an agro-energy facility, leaving a denuded site that cannot readily regenerate, the carbon emissions from the bio-energy cycle could well be greater than the carbon emissions from a fossil-fuel cycle providing an equivalent amount of energy. There is no justification for this fuel cycle from any environmental perspective.

Scenario 2: If a natural forest is cleared and replanted with an energy plantation harvested sustainably to supply a bio-energy facility with biomass continuously, roughly 300 metric tons of carbon per hectare (tC/ha) will be released in to the atmosphere, which would otherwise have been sequestered in the natural forest. As biomass feedstock is grown and harvested in cycles, carbon will be held on the land, partly compensating for the carbon released when the natural forest was cut down. Averaged over a growth cycle, a typical amount of carbon sequestered on the plantation might be 30 tC/ha. Thus, the natural forest holds 270 tC/ha more than the energy crop. If the bio-energy crop is used to displace fossil fuels, thereby reducing carbon emissions, it will compensate for this 270 tC/ha difference over a period of roughly 45 years. However, when environmental and social considerations, such as preserving habitat and protecting watersheds, are taken into account, these considerations might outweigh any carbon benefits.

Scenario 3: If a bio-energy crop plantation is developed on unproductive land, such as degraded land that could benefit from revegetation, the degraded land most likely could have held considerably less carbon than the plantation, even in the soil and

other below-ground biomass. In this case, the change in land use will offer three-fold benefits, namely, benefits resulting from displacing fossil fuels, carbon benefits and other ecosystem benefits.

## BIODIVERSITY

The Subsidiary Body on Scientific, Technical and Technological Advice (SBSTAA) of CBD (2007) has expressed the following major concerns on agrofuel production in view of its potential impacts on biodiversity:

- Change in the use of natural lands, such as wetlands and natural forests, for biofuel production is reported as an important threat to biodiversity through the loss of habitats, their biodiversity components and essential ecosystem services. The use of natural lands can also contribute to greenhouse gas emissions caused, for example, by deforestation and the degradation of peatlands and soil carbon sinks;

- The need for fertile agricultural land to produce biofuels may result in land conflicts and an increase in food prices, which affect indigenous and local communities and small-holder farmers, forcing them to rely more heavily on food from the wild and/or clear additional lands for agriculture;

- The increased use of water due to agricultural expansion and water pollution caused by biomass conversion processes can also result in biodiversity loss.

## III. RHETORIC VERSUS REALITY: THE STATUS OF AGROFUELS DEVELOPMENT IN ETHIOPIA

Ethiopia has developed a country strategy with the following objective and goals:

Objective: Substituting petroleum imports and exporting biofuel products through promoting the production of plant-based biofuel production

Goals

- Augmenting import substitution and export revenues
- Fostering rural development through promoting the industrial and service sectors as well as creating employment opportunities and additional income generation
- Supporting soil and water conservation
- Implementing environmental protection measures

The Strategy also clearly spells out some key principles to ensure community benefits:

- The development will be implemented while at the same time ensuring food security
- It will never harm economic, environmental and cultural values; never compete with farm land, grazing land
- It will ensure full participation and benefit sharing by farmers and pastoralists
- It will be implemented via ensuring environmental sustainability whereby soil, water and biodiversity conservation will be ascertained.
- While utmost efforts will be exerted to use the byproducts for other economic purposes, all other wastes will be removed in a way that wouldn't harm the environment

- It will ensure the country's economic sustainability and consumer safety
- It will be consistent with international policies that reduce GHG emissions
- Monitoring and evaluation will be undertaken to check if the biofuels development and utilization is undertaken according to the above-mentioned principles

Regarding the actual implementation of projects on the ground, so far, more than 20 companies have applied for land acquisition to develop agrofuels, out of which about 10 might have already taken plots and at least three are operational. The main agrofuel feedstocks of choice are *Jatropha*, castor bean and oil palm for biodiesel production and sugarcane for bio-ethanol production.

There is already a plan going for implementation to blend ethanol with gas oil and discussions are still going on between the Ethiopian Government and domestic gas suppliers. This is a positive step in light of the fact that the sugar plantations and factories have been producing and exporting ethanol to some European countries at a very low value.

An attempt to convince the public to use kerosene blended with ethanol failed some years ago due mainly to the use of inappropriate stoves that has resulted in loss of confidence by the public. Currently, however, special ethanol stoves are being promoted by some NGOs and a number of businesses, which have already started producing the stoves for domestic cooking purposes. This would definitely contribute positively to the national economy through substituting fuel imports and supplying probably a less expensive clean energy for household purposes.

The major model of agrofuel development at the moment is large-scale industrial model, which is sometimes coupled with outgrower

schemes. Some efforts are underway in Amhara and Tigray by local development organizations, on the other hand, promoting small-scale agrofuel development involving farmers. It still needs to be confirmed whether the small-scale model is making use of *Jatropha* trees or hedges and degraded areas or some kind of intercropping with food crops. As to the big companies, there is no proof that they have taken degraded lands for the agrofuel development. A study is currently being conducted by Forum for Environment to check on this. On the land allocation process, neither EIA has been conducted by agrofuel projects nor the local community and other pertinent stakeholders have been consulted. This has recently resulted in the encroachment of part of an elephant sanctuary that has aroused a big uproar by environmentalists and other segments of the public.

## IV. SOME MYTHS AND MISCONCEPTIONS

### 1. THE 'LAND AVAILABILITY AND SUITABILITY' MYTH

The strategy document declares that there are 23 million hectares of land potentially suitable and available for agrofuel production in Ethiopia, which makes up about a fifth of the total area of the country (Table 2).

**Table 2: Availability of suitable land versus total area**

| Region | Total Area (ha) (CSA, 2005) | Area claimed suitable (ha) (MoME, 2007) | Estimated %age |
|---|---|---|---|
| Tigray | 5,007,864 | 6,500 | |
| Oromia | 35,300,681 | 17,234,523 | 50% |
| Benishangul Gumuz | 4,928,946 | 3,128,251 | 60% |
| SNNPR | 11,234,319 | 49,025 | |
| Gambella | 2,580,261 | 2,829,999 | ??? |
| Somali | NA | 1,485,000 | |
| Amhara | 15,917,366 | 966,535 | |
| Total (for Ethiopia) | 115,000,000 (???) | 23,305,890* | 20% |

**Adopted from CSA (2005) and MoME (2007)**

This assumption has at least five flaws that are making the implementation process quite inconsistent with the principles spelt out in the strategy document:

- This vast plot of land includes woodlands, bushlands, grasslands, bamboo forests, and pastures, which, by no standards, could be classified as 'marginal' lands.
- The total available area that suits agrofuels for Gambella actually surpasses the total area of the region.
- If the basis for the assumption was just the altitudinal suitability of the areas, it must have severely underestimated the potential uses of these areas for other economic or conservation purposes as if the whole nation is just a agrofuel nation.
- Since *Jatropha* needs a reasonable moisture to be an economically competitive crop, this figure is apparently quite exaggerated in terms of the rainfall distribution and irrigation potential of the different regions and agro-ecological zones of the country.
- Declaring a fifth of the country as a land available and suitable for agrofuels would be misleading because the assessment is not based on detailed suitability assessments that takes into account a range of other factors.

In summary, this assessment and assumption lacks a thorough suitability and resource assessment and thus could be dangerously misleading. What is more, when other regions that are not yet considered in this assumption are included, the figure could be even higher.

## *Some* myths and realities about *Jatropha* (Ouwens *et al.*, 2007)

1) ***Jatropha* is a high-yielding crop:** Actually, *Jatropha* has a high variability in terms of yields based on age, soil

conditions, moisture, nutrient availability and occurrence of pests and diseases.

2) *Jatropha* can thrive under low precipitation: As a matter of fact, although *Jatropha* can survive precipitation as low as 300mm by shedding its leaves, it does not produce well under such conditions. Accordingly, while the minimum requirement for survival could be just 300mm/ha/yr; the minimum rainfall requirement to produce fruits and the optimum rainfall for optimum yield respectively are 600mm/ha/yr and 1000-1500mm/ha/yr.

3) *Jatropha* is highly resistant to pests and diseases: Unlike this common belief, *Jatropha* is actually vulnerable to most common pests and diseases found in food crops. However, most of these pests and diseases can be treated fairly easily and if required agrologically.

4) *Jatropha* can live for up to 50 years: This assumption seems to be based on individual trees, and not on a production plantation level. There is already some evidence that the duration of a plantation might optimally last less than 20 years, as quoted in many guides.

5) *Jatropha* can have long-term sustainable yields: In reality, long-term sustainable yields could be difficult. In Nicaragua, yields slowly decreased after the fifth year due to increasing pests and disease levels. Severe pruning is necessary to keep production on a good level, but this also increases the plants susceptibility to plant diseases.

According to Jongshaap *et al.* (2007), the claims that have led to the popularity of *Jatropha curcas* as an oil-producing crop are based on the incorrect combination of positive characteristics, which are not necessarily present in all accessions, and have certainly not been proven beyond doubt in combination with its oil production. A major constraint for its extended use is lack of knowledge on its potential yield under sub-optimal and marginal conditions.

Therefore, it is recommended all planning and implementation processes should seriously take into account these pieces of information.

## THE ISSUE OF MARGINAL LANDS

Jongschaap *et al.* (2007) define marginal soils or marginal lands as those areas with unsustainable conditions for crop production due to soil and climate constraints. There is a grave concern and doubt whether it is such marginal lands that are currently being allocated for agrofuel development in Ethiopia.

The definition of 'marginal' land is ambiguous at its best or misinterpreted at its worst. Any argument on this issue requires further investigation. However, from the amount of land declared available and suitable for *Jatropha* production in Ethiopia, one can easily comprehend that the claims are not based on detailed assessments.

## V. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the agrofuel development plan in Ethiopia has the following major flaws:

1) There is a big disconnect between the principles stated in the strategy document and its implementation.
2) Hasty decisions based on false promises and over-expectations rather than researched and established data as well as proper EIA reports and public consultations characterize the decision-making process.
3) There is a clear lack of coordination between the Ministry of Mines and Energy and other implementing government agencies in the process of land allocation and granting. This is a serious issue that should be addressed as soon as

possible to such an extent that ongoing decisions should be reconsidered and future decisions are informed.

*4)* The total amount of available land that is suitable for *Jatropha* as claimed in the strategic document needs further thorough assessment.

If the agrofuel development is to contribute positively to the sustainable development of the country, current directions should be carefully re-examined. Otherwise, instead of stimulating positive changes, current directions would exacerbate already existing social, environmental and economic problems. Therefore the following measures are recommended as the way forward:

1. Utmost efforts should be exerted to bridge the gap between the strategy document and its implementation.
2. Agrofuel projects should undertake environmental impact assessment based on public consultations before land is allocated and the projects are implemented.
3. Further assessment should be undertaken on the availability of suitable land based on proper research and multi-stakeholder consultation.
4. Addressing food and feed insecurity must remain a priority in light of existing food shortages in the country.
5. In the long run, land use plans should be developed for the country and land allocations should be based on the plans.
6. The country should give priority to import substitution of fossil fuel rather than export-oriented markets to eventually ensure energy self-sufficiency that is much needed for the country's development.
7. Ethiopia should immediately halt the large-scale, export-oriented model and take time to look into how to make the best use out of the process.

8. Further research should be conducted on a range of related issues, including the need for appropriate feedstocks for different agro-ecological conditions.
9. The lack of coordination among the relevant government bodies should be rectified as soon as possible.

As a final note of caution, the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC) stated that the impacts of human-induced climate change are likely to be felt more in poor countries and poor communities first. One of the most vulnerable groups is Africa, especially the least developed countries including Ethiopia. While these countries and their people (particularly the poorest communities) will suffer severely over the next decades from the impacts of climate change, they bear minimal responsibility for creating the problem. Low economic development and severe environmental degradation are two major reasons for the high vulnerability to climate change.

While economic development is absolutely necessary to address most of the challenges of the nation, 'development' endeavors should ensure that they are not aggravating the environmental crisis and the vulnerability of the country to the impacts of climate change.

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FfE is an indigenous, non-profit, non-political and secular association of concerned individuals. It serves as a platform for environmental communication and advocacy among people concerned with the Ethiopian environment. In order to carry out its mandate, FfE organizes public meetings and debates on issues of environmental concern; publishes a magazine (Akirma) and information dossiers; prepares speaking engagements on environment at different institutions; conducts researches; facilitates access to advisory services on the environment; create and join networks; establish and strengthen local groups in the different parts of the country; undertakes lobbying and campaigning; and acts as a liaison for funding projects that focus on protecting or improving the environment. Since its establishment FfE has been actively engaged in drawing the attention of citizens to the severity of environmental challenges in the country and promoting solutions to the challenges.

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