Global Assessment of Biomass and Bioproduct Impacts
on Socio-economics and Sustainability

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Global-Bio-Pact Case Study

Socio-Economic Impacts of Jatropha Chains in Tanzania

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Abbreviations

BtL	Biomass-to-Liquid
CSDI	Centre for Sustainable Development Initiatives
EIA	Environmental Impact Assessment
ESP	Energy Service Platform
EU	European Union
GDP	Gross Domestic Product
IPM	Integrated Pest Management
JPTL	Jatropha Products Tanzania Ltd
KAKUTE	Kampuni ya Kusambaza Teknolojia (The Company for Technology Dissemination)
MEM	Ministry of Energy and Minerals
MFP	Multifunctional Platform
NBTF	National Biofuel Task Force
NGO	Non- Governmental Organisation
NSSF	National Social Security Fund
SJO	Straight Jatropha Oil
SVO	Straight Vegetable Oil
SUA	Sokoine University of Agriculture
TaTEDO	Tanzania Traditional Energy Development Organisation
TFWG	Tanzania Natural Resource Forum Forestry Working Group
TIC	Tanzania Investment Centre
TPC	Tanzania Planting Company
UNDP	United Nations Development Programme
USD	United States Dollar
UU	Utrecht University
WWF	World Wildlife Foundation

Preface

This report was elaborated in the framework of the Global-Bio-Pact project (Global Assessment of Biomass and Bio-product Impacts on Socio-economics and Sustainability) which is supported by the European Commission in the Seventh Framework Programme for Research (FP7). Global-Bio-Pact is coordinated by WIP Renewable Energies and runs from February 2010 to January 2013.

The main aim of Global-Bio-Pact is the improvement and harmonisation of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative socio-economic impacts. Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of raw material production and a variety of biomass conversion chains. The impact of biomass production on global and local food security and the links between environmental and socio-economic impacts are analysed. Furthermore, the Global-Bio-Pact project investigates the impact of biomass production on food security and the interrelationship of global sustainability certification systems with international trade of biomass and bio-products as well as with public perception of biomass production for industrial uses. Finally, Global-Bio-Pact focuses on socio-economic sustainability criteria and indicators for inclusion into certification schemes, and the project elaborates recommendations on how to best integrate socio-economic sustainability criteria in European legislation and policies on biomass and bio-products.

An core activity of Global-Bio-Pact is the description of socio-economic impacts in different countries and continents in order to collect practical experience about socio-economic impacts of bio-products and biofuels under different environmental, legal, social, and economical framework conditions. The results of these surveys are described in different case studies.

This report presents the Global-Bio-Pact Case Study for the *Jatropha* value chain in Tanzania. This Case Study was elaborated by TaTEDO – Tanzania Traditional Energy Development Organisation.

1 Introduction

A strong public debate on sustainability aspects for biomass use for energy and products emerged in the last few years. This debate focused mainly on negative social and environmental impacts. In consequence, several initiatives were set-up, which are engaged in developing tools to ensure sustainability of biofuels. One option to ensure the sustainability of biofuels is the application of certification systems.

The main aim of the Global-Bio-Pact project is the improvement of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative and to promote positive socio-economic impacts. Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of feedstock production and a variety of biomass conversion chains.

In order to generate data on the ground, five in-depth case studies for socio-economic impacts were investigated in the framework of Global-Bio-Pact:

- Biodiesel from soy in Argentina
- Palm oil and biodiesel in Indonesia
- Bioethanol from sugarcane in Brazil
- Bioethanol from sugarcane in Costa Rica
- Jatropha oil and biodiesel in Tanzania
- Jatropha oil and biodiesel in Mali
- 2nd generation biofuels and products from lignocellulosic material in Canada

This report presents the Global-Bio-Pact Case Study for the Jatropha Value Chain in Tanzania. This Case Study was elaborated by TaTEDO – Tanzania Traditional Energy Development Organisation.

1.1 The Biofuel Development Situation in Tanzania

Tanzania is blessed with potential land for liquid biofuels production which could considerably be used for export earnings; reduce fossil oil imports, employment, rural economy growth, etc. Nearly half of Tanzania's land area has been identified as suitable for biofuel production. It is argued that Tanzania has the potential of becoming a world leader in biofuel production from its 88 million ha reserve and that less than 6% of this land has been utilized.

Biofuels have recently been a fast growing industry in Tanzania. In recent years, there has been a growing interest in the liquid biofuel sector in Tanzania. Local and multilateral companies have been acquiring big portions of land all over the country for biofuel feedstock production. The booming of biofuels is caused by different reasons, but probably the major one is the ever escalating fossil fuels prices. Biofuels are seen as an environmental friendly source of energy, that is likely to stimulate rural and urban development. But also some smallholder farmers have developed interest in taking advantage of this opportunity through improving rural energy services, soap production and selling seeds and oil to large companies.

The growing interest in liquid biofuels production has also increased the government commitment to the promotion of the biofuel sector. However, while the biofuel sector is growing, the country is facing several socio-economic challenges without clear bioenergy policy. There are only statements within the energy, agriculture, forest, land and environment policies aimed at enhancing production and use mostly of solid biofuels. Liquid biofuel guidelines have recently been approved by the parliament. However, recent development in biofuel production in the country has led to calls towards the government to develop a comprehensive policy and strategies for biofuels development.

1.2 Jatropha as Biofuel Crop

Jatropha is being considered as one of the main crops for producing biofuels (biodiesel or SVO) in Tanzania. Currently, Jatropha is being widely promoted throughout Tanzania for small and large scale biofuel production. Jatropha has for a long time been planted in Tanzania as a protective hedge around homesteads, gardens and fields, since it is poisonous and not browsed by animals. It is a common crop,

but was not used for farming in large plantations until the advent of commercial biofuel production. Jatropha oil yields are lower than other oil crops. However, its advantages are that it is a resilient plant able to grow in difficult conditions including arid and otherwise non-arable areas, leaving prime areas available for food crop production. Each Jatropha seed can yield 30-40% of its mass in oil.

Jatropha grows well on marginal lands of Tanzania with more than 600 mm of rainfall per year, and it withstands long drought periods. It also does well in areas where the rainfall is only 250 mm, but the humidity of the air is very high. Yield is obtained in the second year of establishment, reaching full production in the fifth to sixth year, once the plant start production, it may continue for the next fifty years. Jatropha is scattered and known by majority of Tanzanian since a long time, but its utilization was limited to the use of the plant as protection hedge around homestead gardens and graves.

1.3 Objective of the Study

The study critically examines the socio-economic impacts of Jatropha farming (production, processing and marketing) in Tanzania in particular to the livelihoods of smallholder farmers and indigenous communities at national level (by large company), regional level (out-growers model) and local level (by smallholder farmers or women groups).

The areas selected for this study are Kisarawe District in the Coast Region (for Sun-Biodiesel), Arusha Region for Diligent Company and smallholder Jatropha and ESP scheme at Leguruki Village.

The study reviewed the following areas in order to get socio-economic impacts of Jatropha farming in Tanzania:

- Describing the Jatropha farming in Tanzania, both large and small scale schemes
- Conducting an analysis of Jatropha faming in terms of production, processing and marketing of its products
- Evaluating the socio-economic and environmental impacts of Jatropha farming (for both large and small scale) in the rural communities
- Recommending possible measures for improving the development of Jatropha in Tanzania

2 Case Study Selection

Since the impacts of the production of biofuels and bio-products depends on the investigated scale, different levels were investigated in all Global-Bio-Pact Case Studies, including the national, regional, and local/company/project level (Figure 1). In each Case Study country of the Global-Bio-Pact project the following assessments were made:

- One study at national level
- One study at regional level
- One study at local, company or project level

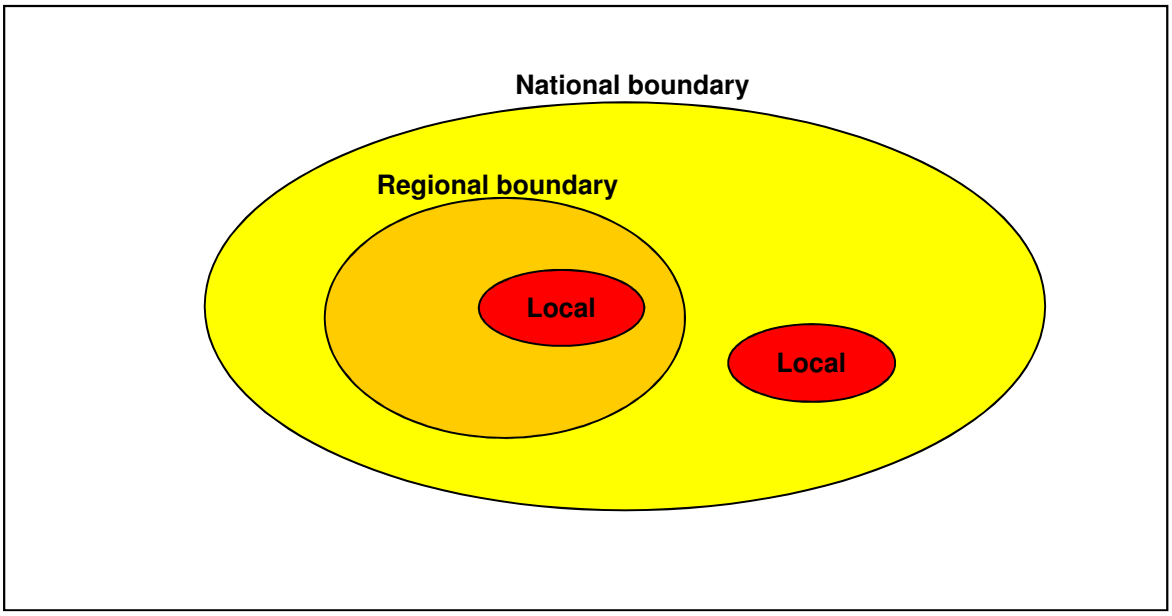


Figure 1: System boundaries of the Global-Bio-Pact project

2.1 Case Study at National Level

The Global-Bio-Pact Case Studies at the national level were selected in order to balance the geographical distribution (Africa, Latin America, Asia, Europe, and North America), feedstock sources (soy, palm oil, Jatropha, sugarcane, and lignocellulose feedstock), conversion technologies (e.g. fermentation, pressing, trans-esterification, hydrolysis and gasification) and products (biodiesel, pure plant oil, ethanol, bio-products, second generation technologies). Thereby, the assessment focuses on existing conversion technologies since these are the current hotspots of socio-economic concern, but also include impacts of future technologies which are not yet commercially available.

Under this Case Study of Tanzania, firstly the general situation aabout different sectors such as land use, economy population, etc. at the national level are described. Furthermore, the **Sun Biofuels** company has been selected to be a national case study representing other companies due to its large socio-economic effects on national level. The company has directly and indirectly affected over 10,000 inhabitants in 12 villages from which the lands were allocated for Jatropha plantation. More than 2,000 ha have currently been planted with Jatropha. The company under this study have one business model of large scale plantations with four associated players namely: employees, former landowners, former land users and population at large.

2.2 Case Studies at Regional Level

In the Global-Bio-Pact project, the regional level was defined as a homogenous region in climate, soil, and socio-economic parameters. The size of the region depends on the country and can be a province or district.

In the present report, the Arusha Region was selected as Case Study region due to the growth of Jatropha plants for many years as hedges in many places, availability of the installed Energy Services Platform (ESP) which favours processing and local utilisation of Jatropha by products for productive and consumptive purpose. Another reason is the presence of companies which deal with promotion, training and purchase of Jatropha seeds and locally produced oil through out-growers schemes. Jatropha is widely dominated in the Arusha Region especially in Monduli, Meru and Karatu Districts as hedges in the village farms. The origin of the plant in most villages of Arusha is unknown although Jatropha has been grown in such villages for more than a century.

The model of **Diligent** company (out-grower model) was selected as a case study at the regional level due to its activities coverage in all Jatropha growing areas in the region of Arusha. Diligent Company has been facilitating seed collection from Jatropha farmers in the Arusha Region. For biodiesel and Straight Vegetable Oil (SVO) production, Diligent promotes Jatropha cultivation to small-scale farmers by means of intercropping and hedges. They use out-grower and collection schemes in which they provide support to small and large-scale farmers from whom they buy seeds. The company is considered to have socio-economic effects to the Jatropha farmers in the Arusha Region.

2.3 Case Study at Local Level

At the local level the system boundary is a local area from an e.g. farmer, company, association or project level. The local area refers to the area where the biomass feedstock (including by-products) is produced and converted into the final or intermediate product. In each Global-Bio-Pact Case Study country one local Case Study (projects) was selected and investigated. Thereby, the local Case Study can be within or outside the regional boundary.

In the present report, the **Smallholder Jatropha Farming at Leguruki Village** was selected as local case study. Leguruki was selected since this village is located in the potential area for Jatropha production and since it is a village which has a Jatropha Smallholder Farmers Group and an installed Energy Services Platform (ESP).

3 Case Study at the National Level: Tanzania

Tanzania is located in Eastern Africa and boarders Indian Ocean to the East; Uganda and Kenya to the North; Burundi, Rwanda, and Congo to the West; and Mozambique, Zambia and Malawi to the South. The country has a total area of 945,087 square kilometres of which 59,050 square kilometres are covered with water and the rest 886,037 square kilometres are dry land.

3.1 Land Use

Tanzania mainland occupies about 94 million ha of landmass of which 88.9 million ha is land and the remainder is covered with water. Except for a few major mountains this landmass lies in the range of between 102 and 1,650 metres above sea level protruding out of the 1,000 km long coastline to the tops of great mountain ranges, about 75% of the land area is either uninhabited or too difficult to manage because of difficult relief, tsetse flies or unreliable rainfall, national parks, game and forest reserves which are scattered throughout the country, including mountains and inland waters, notably lakes and rivers. About 40.8 million ha or 46% of the total land area are forests and woodland, while 40% is permanent pasture. Although Tanzania has about 48.7 million ha of arable land, only about 10.1% of the country's total land area is under cultivation. Of this area, nearly 93.4% (4.6 million ha) is used for small-scale farming mainly under customary tenure. The remaining 6.6% is under large scale farming, under granted rights of occupancy. Furthermore, 61.1 million ha or 69% of the total land area is made up of pasture and about 36% of the total land area of Tanzania is covered by natural forest and woodland. A total of 17,449 square kilometres has been designated as protected areas.

Figure 2: Map of the Land Use of Tanzania

The land use is under the mandate of the National Land Use Planning Commission. The main purpose of the National Land Use Planning Commission is to have sustainable land management systems which address issues of land degradation and conflicts in order to maintain peace and harmony. This can only be achieved through co-ordinated participation of all stakeholders in land resources management at all levels such as national sectors (ministries, non-governmental organisations, and companies), regions, districts and villages. Any business operating in a rural area will be expected to follow the conditions of the regional physical land use plan for the particular region.

3.2 Economy

Tanzania's economy, in terms of real GDP growth after reforms, appears to be stabilizing and hence poised for higher levels of growth in the long term. The GDP amounted to Tshs 28,212,646 million at current prices in 2009 which was equivalent to Tshs 15,721,301 million at 2001 constant prices. Since the population of Tanzania Mainland was estimated at 40.7 million the per capita income was Tshs 693,185 at current prices. The composition of GDP is such that, agricultural sector accounts for around 50%, followed by trade sector which accounts for around 16%. Financial and business services rank third at the tune of 10%, followed by the industrial sector by around 8%. The mining sector has been contributing around 2%.

The growth rates were relatively high over the past decade, reaching 7.8% in 2005 and 7.4% in 2008, boosted by government measures and reforms such as liberalization of the economy and encouragement of private investment. Tanzania has made major progress over recent years towards putting into place a policy environment for investment promotion. Increase investment flows are a sign of an improving integrity environment. Government priorities have included stable macro-economic environment, privatisation, promoting good governance and poverty eradication and development of a strong civil society.

Due to economic growth, the proportion of Tanzania's population living below the **poverty line** dropped to 33.3% in 2010 from 35.7% in 2000/01 (NBS, 2010). However, the number of people in Tanzania who have to survive on USD1.10 a day or less has risen by one million to 12.7 million in the last six years. Researchers have attributed this mainly to an annual population growth of 2.6%. The strength of the national economy fluctuates widely depending heavily on changing weather conditions for agriculture. Despite comparatively low-income disparities, indicated by a **Gini coefficient** of 34.6 (2009), Tanzania's level of development permits freedom of choice only for a tiny minority of the population.

3.3 Population

According to the 2002 census, the population has increased to 34.4 million. The total estimated population in Tanzania was last reported at 43.2 million people in 2010. Tanzania has 0.63% of the world´s total population which means that one person in every 160 people on the planet is a resident of Tanzania.

The different censuses show that rapid population growth has characterized Tanzania for a long time. In 1948, Tanzania (Mainland) had a small population of 7.5 million people. By the time of the 1978 census, another 10 million people had been added to the size of the population. By 2005, the population was near 36 million, nearly five times larger than it had been in 1948.

Population distribution in Tanzania is extremely uneven. Density varies from 1 person per square kilometre (3 per sq. mi.) in arid regions to 51 per square kilometre (133 per sq. mi.) in the mainland's well-watered highlands to 134 per square kilometre (347 per sq. mi.) on Zanzibar. More than 80% of the population is living rural areas. Although the population is still predominantly rural, the proportion of urban residents has been increasing steadily, from 6% in 1967 to about 23% in 2002 during last census.

Most densely populated areas in Tanzania are along the Indian coast, in and nearby the largest cities and on the islands of Zanzibar and Pemba. There are heavy population concentrations in the urban centres (including Dar es Salaam, Mwanza, Tabora, and Mbeya), in the foothills of Mount Kilimanjaro, and along the coast of Lake Nyasa. Culture in Tanzania has resulted through the influences of Arabs, Europeans and African tribes. The people of Tanzania are known for their generous hospitality to foreigners. A total of 128 languages are spoken in Tanzania, most of them from the Bantu family. After independence, the government recognized that this represented a problem for national unity, and as a result introduced the Swahili language into all primary schools to spread its use. Swahili and English are the official languages; however the former is the national language. About 62% of the population of Tanzania is Christian, 35% is Muslim, and 3% are members of other religious groups.

3.4 Agricultural Sector

Agriculture is the major and important sector of the Tanzanian economy. It accounts for about half of the national income, three quarters of merchandise exports and is source of food and provides employment opportunities to about 80% of Tanzanians. It has linkages with the non-farm sector through forward linkages to agro-processing, consumption and export; provides raw materials to industries and a market for manufactured goods.

Agriculture in Tanzania is dominated by smallholder farmers (peasants) cultivating an average farm sizes of between 0.9 ha and 3.0 ha each. About 70% of Tanzania's crop area is cultivated by hand hoe, 20% by ox-plough and 10% by tractor. It is rain-fed agriculture. Food crop production dominates the agriculture economy 5.1 million ha are cultivated annually, of which 85% is under food crops. Women constitute the main part of agricultural labour force. The major constraint facing the agriculture sector is the falling labour and land productivity due to application of poor technology, dependence on unreliable and irregular weather conditions. Both crops and livestock are adversely affected by periodical droughts.

The majority staples that are produced in Tanzania include maize, sorghum, millet, rice, wheat, pulses (mainly beans), cassava, potatoes, bananas and plantains with the bulk of the country's export crops being composed of coffee, cotton, cashew nut, tobacco, sisal, pyrethrum, tea, cloves, horticultural crops, oil seeds, spices and flowers. Zanzibar grows spices, rice, cassava and banana. Household-level urban agriculture is common, with available ground planted with crops for household consumption and sale to urban residences and businesses.

Irrigation holds the key to stabilizing agricultural production in Tanzania to improve food security, increase farmers' productivity and incomes, and also to produce higher valued crops such as vegetables and even flowers. Tanzania's main irrigated crops are rice, maize, vegetables and banana.

3.5 Forestry Sector

Tanzania has about 33.5 million ha of forests and woodlands. Out of this total area, almost two thirds consists of woodlands on public lands which lack proper management. About 13 million ha of this total forest area have been gazetted as forest reserves. Over 80,000 ha of the gazetted area is under plantation forestry and about 1.6 million ha are under water catchment management. The forests offer habitat for wildlife, beekeeping unique natural ecosystems and genetic resources. Also bioenergy is the main sources of fuel for rural population and accounts for 92% of the total energy consumption in the country. However, it is estimated that the sector's contribution to the Gross Domestic Product is between 2.3% and 10% of the country's registered exports. This contribution is underestimated because of unrecorded consumption of wood-fuels, bee products, catchment and environmental values and other forest products.

The value of the Tanzanian forests is high due to the high potential for royalty collection which increases revenues to the country, exports and tourism earnings as well as the recycling and fixing of carbon dioxide and conservation of globally important biodiversity. The sector also provides 730,000 people – years of employment who are engaged in various forest related activities. The real contribution is under estimated due to unrecorded labour in the collection of wood-fuels and other forest related products consumed by households. The wood industry accounts for about half of the sector. The other half is contributed by non-wood products and services.

The forestry sector has a very important role to play in Tanzania's economy. Although in absolute terms, its contribution to total gross domestic product (GDP) is low, it has increased considerably during the past 10 years by about 35%, from 2.6 to 3.4% of GDP.1 Covering 37.8% of the total landmass, which is about 33.5 million ha, the country's forests contain such a high level of biologically diverse resources that Tanzania is one of the richest countries in terms of biodiversity in the world and among the 12 most diverse countries. Tanzania has Africa's largest number of mammals, second largest number of plants (10,000 species), third largest number of birds (1,035 species), fourth largest number of amphibians (123 species) and fourth largest number of reptiles (245 species), all harboured by the country's forests. In addition, the forests provide over 92% of the energy resources, support the development of other important sectors (such as agriculture and tourism) through provision of water resources and catchments, maintain hydrological balance and soil protection, recycle atmospheric gases, provide construction materials, employment sources and others.

3.6 Land Ownership Concentration

All land in Tanzania is held in trust by the President on behalf of all Tanzanians and is therefore public property. According to the Land Ordinance Act, Cap 113, of 1923, which is still in force, all land, whether occupied or unoccupied, belongs to the Republic of Tanzania and is Public Land. This means that land is under the control of the President and is held and administered "for the use and for the common benefit, direct or indirect, of the natives of Tanzania". The maintenance and improvement of the quality of the land, however, depends crucially upon the land user, and often demands considerable investment of labour and resources, e.g., ridging or terracing, or investments of manure, compost, or chemical fertilizers. It is, therefore, essential that all users feel confident that their efforts and investments will benefit them and their families. This principle applies equally to the peasant farmer, the village community, and the private or commercial farmer. The main forms of land tenure in Tanzania today are:

Village land: The Village Land Act recognizes the rights of villages to land held collectively by village residents under customary law. Village land can include communal land and land that has been individualized. Villages have rights to the land that their residents have traditionally used and that are considered within the ambit of village land under customary principles, including grazing land, fallow land and unoccupied land. Villages can demarcate their land, register their rights and obtain certificates evidencing their rights. As of 2009, 10,397 villages were registered, and 753 had obtained certificates (GOT Village Land Act 1999b; World Bank 2010a; Dondeyne, et al. 2003; Lange 2008).

Land under Customary right of **occupancy:** Villagers have a customary right of occupancy for village land that they hold under customary law or have received as an allocation from the village council. Customary rights of occupancy can be held individually or jointly, are perpetual and heritable, and may be transferred within the village or to outsiders with permission of the village council. Village land allocations can include rights to grazing land, which is generally shared. The village council may charge annual rent for village land (GOT Village Land Act 1999b; Sendalo 2009; Baha et al. 2008; Alden Wily 2003).

Granted right of **occupancy:** Granted rights of occupancy are available for general and reserved land, subject to any statutory restrictions and the terms of the grant. Grants are available for periods up to 99 years and can be made in periodic grants of fixed terms. Granted land must be surveyed and registered under the Land Registration Ordinance and is subject to annual rent. Squatters and others without granted rights may have customary rights to occupy general land, which may be formalized with a residential license or remain un-formalized and insecure (GOT Land Act 1999a; Maoulidi 2006).

Leasehold: Leaseholds are derivative rights granted by holders of granted or customary rights of occupancy. Holders of registered granted rights of occupancy may lease that right of occupancy or part of it to any person for a definite or indefinite period, provided that the maximum term must be at least ten days less than the term of the granted right of occupancy. Leases shall be in writing and registered. Short-term leases are defined as leases for one year or less; they may be written or oral and need not be registered. Holders of customary rights of occupancy may lease and rent their land, subject to any restrictions imposed by the village council (GOT Land Act 1999a).

Residential license: A residential license is a derivative right granted by the state (or its agent) on general or reserved land. Residential licenses may be granted for urban and peri-urban non-hazardous land, including land reserved for public utilities and for development. Residents of urban and peri-urban areas who had occupied their land for at least three years at the time the Land Act was enacted had the right to receive a residential license for the relevant municipality, provided they applied within six years of the enactment of the Land Act (i.e., by 2005) (GOT Land Act 1999a).

80% of the working population is engaged in agriculture, which is dominated by smallholder farming. There are about 4.9 million holdings; 90% of holdings average 1–3 ha of rainfed land, although a few larger commercial plantations still exist. Seminomadic pastoralists, primarily from the Masaai and Sukuma tribes, and agro-pastoralists raise cattle, goats, sheep and chickens. Much of the rangeland is in the northern and central regions of the country

According to some estimates, the area of the land suitable for biofuel production in Tanzania is estimated to be between 30 million and 55 million ha. To date, approximately four million ha have been requested from the government for biofuels investment. Much less land, about 640,000 ha in total, have been allocated for biofuel investments. Even less land around 100,000 ha have been fully secured by biofuel investors following the procedures for land acquisition.

3.7 Food Security

Tanzania faces profound challenges ensuring its food security. The government will need sound policies for all people to have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life.

Broadly, the concept of food security is built on three pillars: i) Food availability: sufficient quantities of food are available to people on a consistent basis; ii) Food access: people have sufficient resources to obtain appropriate foods for a nutritious diet; iii) Food utilization: people have sufficient knowledge of nutrition and care practices and access to adequate water and sanitation to derive sustenance food. There is a direct and cyclical relationship between poverty and food insecurity, whereby poverty contributes to food insecurity, which contributes to poor nutrition, health, and cognitive development, which in turn contribute to poverty.

In Tanzania, achieving food security presents a profound challenge to the government to implement social and economic policies to meet households' dietary requirements. Currently, 22% of children are underweight at the age of 5, and 30% of Tanzanians live below the poverty line. The nutritional status of rural children is significantly poorer than urban children. Health data (2009) show that 41% of rural children under five years of age were stunted, compared with 26% of urban children.

Admittedly, many factors will determine Tanzania's ability to feed its people now and in the future. There is plenty of land available. Though not all of it is appropriate for cultivation, only a small fraction of that which is arable is under cultivation. Because of low agricultural productivity for both food and cash crops and population pressure in a few areas, farmers are now moving onto more marginal lands to increase the area under cultivation, and in this process are clearing forests and sometimes threatening wildlife. Thus, there is an urgent need to improve agricultural productivity if sustained productive agriculture and food security is to be developed and sustained. Improved agriculture will also strengthen the economic base and thus improve economic accessibility to food. Until this is achieved, even in the presence of enough arable land to go around, the rapidly growing population will continue to place added pressure on the ability of Tanzanians to stay well fed.

3.8 Energy Sector

Tanzania has considerable hydropower, coal and natural gas resources. Hydropower potential is nearly 5,000 MW, of which currently 560 MW is exploited in large hydropower plants, and 4 MW in small hydroelectric power plants. Coal reserves are estimated at 1,200 million t while limited amounts are mined and used for electricity generation in the southern part of the country. Natural gas reserves are estimated at more than 45 billion m^3, some is exploited for electricity production and industrial use. Only petroleum products are imported.

Electricity generation for the national grid totalled 4,185 GWh in 2007, mostly from hydropower (60%) and natural gas (36%). Small amounts of electricity are generated from coal (3%) and diesel (1%). Small amounts of electricity are imported from Uganda and Zambia. In addition, several agro-industries operate biomass-fuelled co-generation plants to produce electricity and heat for their own processes, with a total installed electrical capacity of about 35 MW.

Grid connection rates are very low, i.e. only 14% of the total population and 2.5% of the rural population have access to electricity. The use of energy sources such as solar, biogas and LPG especially in the household sector is very low. It is estimated that about 1.2 MWp of photovoltaic (PV) power has been installed countrywide for various power applications of which 30-40% of the total installed capacity is from solar home systems (SHSs).

Although the potential for solar PV technology is large (main daily solar radiation = 4.6 kWh/m^2) the potential has hardly been tapped. Solar PV in Tanzania has mainly been implemented by donor and NGO projects for dispensaries, hospitals, offices and in communication technology. Solar PV is used for lighting, radio, TV and in a few cases for water pumping. The main source of primary energy both in urban and rural areas is woody biomass.

The situation is further aggravated by the lack of effective policies and strategies to address the growing challenges of renewable energy production and use in Tanzania. For a long time now, policy makers in Tanzania have paid little attention to the development of renewable energy. The government has failed to recognize renewable energy sources as the potential source of energy for the majority of Tanzanians.

3.9 Policy Framework

There is no bioenergy policy, only statements within the energy, agriculture, forest, and land and environment policies aimed at enhancing production and use mostly of solid biofuels. Recently liquid biofuels guidelines have been approved and now the government is in the process of developing a liquid biofuel policy.

Presently, the drivers of liquid biofuels development in Tanzania are unfortunately still external rather than internal, as such the national priorities are not explicitly addressed. Tanzania has only recently initiated efforts towards a liquid biofuels policy, regulatory framework and guidelines for sustainable liquid biofuels development through a National Biofuels Task Force (NBTF).

The legislation (policies and associated laws) that seek to regulate agriculture, land, environment, natural resources management (water, marine parks, fisheries, forests and wildlife), local government authorities and investment are well reviewed by Mwamila *et al.* (2009). The policies recognize that sustainable management issues cut across various sectors and calls for a coordinated approach to the conservation of environmental resources. Table 1 makes a summary of various policies and registrations pointing out their direct or indirect link with biofuel development.

Table 1: Summary of Policy reviews and their Direct and Indirect Link to Fuel Development

No	Policy	When formulated / Reviewed	Contents with reference to biofuels
1	Energy Policy,	2003	Promote to use of alternative sources of fuel that are not harmful to the environment, biofuels being one of the candidate fuel.
2	The Agriculture and Livestock Policy,	1997	Coordinate approach to the conservation of environmental resources as they ultimately have a bearing on the development of the agriculture and livestock sectors to ensure food security. Biofuels are considered as threat to food security.
3	Industrial Development Policy,	1992	Enforcement of EIAs for all projects and the continuous application of a integrated preventive environmental strategy to industrial processes, products and services. All biofuel companies have future plans of producing industrial liquid biofuels.
4	The National Environmental Policy,	1997	Recognizes that Tanzania is a signatory to a number of international environmental legal instruments. Some of these instruments have a bearing on the production of biofuels e.g. Climate Change Mitigation. It also addresses a cross section of issues related to natural resources management generally and provides the overall guide in EIA and SEA processes
5	The National Land Policy,	1995	The policy takes note of the importance of land and seeks to ensure it is put to use that will benefit, among other stakeholders, local communities in food and cash crop (including biofuels) production.
6	The Forestry Policy,	1998	This policy sets out the general guidelines for managing forestry resources sustainability through reduced deforestation and degradation. Land clearing to expand biofuel plantations can be a threat to forests.
7	Land Act,	1999	Stipulates that land can be owned through three different avenues: viz through the granted rights of occupancy, customary rights of occupancy or as a derivative right under the TIC. Customary collective rights lack necessary institutions to enforce them.
8	Village Land Act,	1999	All village lands have been placed under the management and control of village governments. The transfer of ownership and control over village land is strictly regulated under this law to protect the interest of local communities from unscrupulous dealers as the case with biofuel production.
9	Water Utilization (Control and Regulation) Act,	1974	This legislation contains provisions that have a bearing on the management and conservation of water in lands where production of biofuels has commenced or is likely to commence.
10	Local Government (District Authorities) Act,	1982	Empowers Village and District Authorities to make by laws to control and regulate, among other things, natural resources conservation and management activities.
11	National Land Use Planning Commission Act,	2007	Effective protection and enhancement of land quality and encouraging better land use plans that delineate areas for various uses including biofuel development
12	Tanzania Investment Act,	1997	This legislation governs investment activities related to, among other things, the conservation and management of land and natural (environmental) resources in the course of production eg. Biofuel.
13	Environmental Management Act	2004	This Act provides for a framework regulatory for environmental protection. The Act requires certain developments to be proceeded by EIA , SIA and SEA. This is particularly important in areas that are cleared to develop biofuels.
14	Forest Act,	2002	Provides for demarcation of village forest reserves in Village land and management of such reserve as Common Pool Resources which can be threatened with biofuel production.

The link between biofuel production and various policies and acts suggests that biofuel development need to be seen as part of sustainable development which integrate economic, environmental and social development in a win-win scenario.

3.10 The Jatropha Supply Chain in Tanzania

3.10.1 Concept of Value Chain

A value chain refers to a full range of activities that are required to bring the products from its conception to the end use. These include design, production, marketing, distribution and support to get the product to the final user. The activities that comprise a value chain may be contained in a single firm or may embrace many firms. The activities can be limited to a single country or stretched across national boundaries. In every value chain, there must be a chain leader who will lead other stakeholders in the chain to get the final products.

The value chain is a systematic approach to examining the development of competitive advantage. The chain consists of a series of activities that create and build value. These are interlinked value-adding activities that convert raw materials into processed products.

Value-chain analysis looks at every step a business goes through, from raw materials to the eventual end-user. The goal is to deliver maximum value for the least possible total cost.

3.10.2 Jatropha Value Chain

There are three major functions which are taking place in Jatropha production in Tanzania. These functions include cultivation which pertains to Jatropha growing and seed harvesting, processing which includes activities of pressing the seeds to expel the oil and leaving the seedcake and usage stage where the oil and seedcakes are used and further processed to produce other Jatropha products.

Present Jatropha value chains are not fully driven by market forces. There is still a lot of production support from different firms for developing the Jatropha farming. Different business models have emerged in Tanzania in relation to the production, processing and marketing of Jatropha products. These business models among others are a stand-alone large scale plantation, a contractor model for Jatropha in which smallholder farmers are producing Jatropha seeds on contractual arrangements with dominant company and independent small-scale farmers in cooperatives/groups.

The major producers of Jatropha feedstock are smallholders (or seed collectors) and large plantations. The primary products manufactured from Jatropha are oil and seedcake. The oil is processed by individuals, women groups, Energy Services Platforms (ESP), Central Companies (Diligent and Prokon) and Processing Units in the plantations. Oil is used by local producers to manufacture soaps, insect repellents, etc. The main product of central and large companies is oil and part of this oil is sold to local users such as tour operators. Another part is expected to be barrelled and exported to external markets.

3.10.3 Jatropha Value Chain for the Large Scale Plantation Model

The larger scale Jatropha plantation is a new source of revenue, creates employment and has developed plantation for piloting large scale Jatropha farming. The main product within this chain is Jatropha oil which has high potential to be barrelled for export to the external markets. The remains of the processing of oil are by-products called Jatropha seed-cakes which could be used to produce briquettes or fermented in the biogas digester for producing biogas for cooking and slurry used as fertiliser. The briquettes contribute to the initiatives of reducing deforestation while fertiliser is used to improve soil fertility.

Jatropha large scale activities are mainly carried out in the various areas including coastal areas of mainland Tanzania and on the western parts of the country in Kigoma Region and Mpanda District. There are also Jatropha growing activities on large scale going-on in Coast, Rukwa, Tabora, Lindi, Mtwara, Mbeya in the southern highlands. Some of the large biofuel companies involved in Jatropha farming in Tanzania include: Sun Biofuels Tanzania Ltd – a local affiliate of a UK-based company which has acquired 8,200 ha for Jatropha farming in Kisarawe District. The second company is Bioshape, this is a Dutch Company and operates in Kilwa District where the company has already established a 15 ha demonstration and pilot Jatropha farm. Bioshape has been offered about 100,000 ha of land and has paid compensation to villages amounting to USD 315,211 as compensation in four villages. Only 34,000 ha have been acquired, Bioshape has opened a farm in one of the areas of high conservation value and lead to massive forest clearance. Integrity of first EIA was questioned, and a second EIA was commissioned. The third company is PROKON, a German based company which is located in Mpanda District in Rukwa Region. The company is involved in the production of plant oil and biodiesel from Jatropha and rape seed for export. The Kikuletwa Farm is owned by Peter Burland (British farmer) and located at TPC area in Moshi town. It is dealing with the production of oil from Jatropha and Aloe vera for local consumption and export. Donesta Ltd and Savannah Biofuels Ltd are local companies located in Dodoma Region. These companies are dealing with biodiesel production from sun flowers and Jatropha for export. The company has already acquired 2,000 ha and has established tree nurseries with 100,000 Jatropha seedlings; BioMassive is a Swedish based company it is located in Lindi Region dealing with biodiesel production

from Jatropha and pongamia; Bioenergy Resource Tanzania Limited is located in Morogoro and Coast Region mainly dealing with Jatropha farming for biodiesel production.

3.10.4 Actors of the Supply Chain of Jatropha in Tanzania

Large Scale Farmers

Large-scale farmers are defined as farmers cultivating 50 or more acres of Jatropha. The large scale farmers are the main producer and supplier of Jatropha products (oil, glycerol, briquettes, etc.). The cumulative production of these farmers in the future seems to have a large share of contribution to the export of SJO in the country. Some of these farmers are Sun Biofuels, Bio-shape, Prokon, etc. These stakeholders have ability of managing all processes involved in the value chain such as production, conversion and marketing of Jatropha products.

Larger Plantation Surrounding Villagers

These are employees of the large plantations drawn from surrounding village communities who offer their labour to the large Jatropha plantations. These are groups of people directly involved in the cultivation, seeding, weeding, harvesting and processing activities. The labour force from the surrounding village communities has played a major contribution to the production of Jatropha seeds and conversion to the oil and other bio-products.

Government Ministries

The government through different ministries in collaboration with various stakeholders has put emphasis on promoting, strengthening and sensitising communities and individuals' participation as a strategy for developing biofuel (Jatropha inclusive) to contribute to the economy, invigorate environmental conservation and management. Different ministries also provide policy environment for supporting supply of biofuel products. The ministry involved with biofuels include Vice President Office (VPO), Ministry of Energy and Minerals (MEM), Ministry of Agriculture and Food Security (MAFS), Ministry of Lands (ML), Ministry of Natural Resources and Tourism (MNRT), Ministry of Water Development (MWD) and Ministry of Regional Administration and Local government (MRALG).

District Executive Director's Office

The district executive director's office has different departments dealing agriculture, land, community development, forestry, etc. The DED office is required to ensure appropriate governance and institutional framework for small producers and giving permission to companies collecting seeds from farmers. In other districts, DED's offices have facilitated the purchase of ram presses and distributed them to farmer groups, providing the groups with long-term loans to pay for the press. In one occasion a farmer group was observed that had bought a second press on itself without taking a loan.

Medium Jatropha Companies

These are individuals or companies which purchase seeds or oil and produce Jatropha soap out of Straight Jatropha Oil (SJO) or Glycerol or sell oil to the distant markets. Some of these companies (Kakute, Faida Mali, etc.) provide training, demonstrations, seeds and training materials to farmer groups for free as part of their strategy to interest farmers in Jatropha. They also provide soap packaging to their soap making groups.

Out-growers

These are individuals or farmer groups promoted and supported by a central company (Diligent, Kakute, and Prokon) for seed collection and oil production. Other possible activities include nursery establishment, farming, collection and oil extraction. In other places some of out-growers are soap producers. Most individual and groups are extracting SJO from seeds in order to sell it to SJO buyers. Some of these are engaged only in Jatropha farming or seed collection and have no influence over the management of the chain. In general, such farmers are not well connected to markets, so their production is not well tailored to what the market needs.

Transporters

These are stakeholders who facilitate movement of feedstock materials from collection centres or farms for the case of large plantations to the processing plants. There is also need of transportation of Jatropha oil and other Jatropha products to the market or abroad (in the case of exports). These vary from one place to another depending on the business model applied in the Jatropha value chain.

Consumers (Local and Abroad)

These are end-users of Jatropha products that play a big role of buying and use those products. There is still a limited amount of und-users of Jatropha products in Tanzania. The biofuel industry is still growing

and possibly in the future the number of end users will increase in the local markets. Most of the consumers are in the aboard markets where most of the large Jatropha companies are targeting.

3.11 The Sun Biofuels Company in the Kisarawe District

The case study of the large scale plantation model was carried out in the Sun Biofuels Tanzania Ltd Plantation, located in Kisarawe District, Coastal Region, Tanzania. Kisarawe is one of the 6 districts of the Coastal Region. According to the 2002 Tanzania National Census, the population of the Kisarawe District was 95,614 with average growth rate of 2.1% (URT, 2002). By the year 2008 the population was estimated to be 108,472 and the average household size is 4.2 people. Total District area is 353,500 ha, where arable land is 309,000 ha of which 83,645 ha is under cultivation. The District has temperatures ranging between 28°C and 30°C with mean temperatures of 29°C. There are two, main rain seasons which are the short rain season that starts from October to December and the long rain season, starting from March to early June. Average rainfall ranges from 1,400 mm. to 1,600 mm in the Eastern part of the District.

Kisarawe District is administratively divided into 15 wards and a total of 74 registered villages in the Districts of which 11 villages surround the Sun Biofuels plantations. The company has acquired 8200 ha of land out of 18,000 ha that has been requested. The location of Sun Biofuels plantations with reference to the surrounding wards in Kisarawe District is shown in Figure 1.

Per capita income of the district is about USD 250 which is generally lower than the Tanzania average of USD 320 with farming as their main economic activity employing more than 95% of the population. Cashew nut is the main cash crop, though its significance has declined due to marketing problems. Food crops grown include cassava as staple food, maize, paddy, sorghum, banana & sweet potatoes. Cassava though grown as a food crop, is now becoming a popular cash crop for the Dar es Salaam market (DED (a) 2010).

Sun Biofuels Tanzania Ltd, a subsidiary of British company Sun Biofuels PLC, is a biofuel company that has invested in an 8,200 ha concession in Kisarawe District, Coast Region, Tanzania with a strategy to cover all areas of the biofuel industry, from growing, production to processing and marketing.

Sun Biofuels started to apply for the land in Kisarawe in 2006 through Tanzania Investment centre (TIC) and after a long process that took 4 years; the company was able to acquire a 99 years old lease of 8,200 ha. The process had to involve consultation, cadastral surveying, getting village land transferred to general land and compensation. The land use categories involve 6,000 ha of arable land and about 1,000 ha of swampy area for conservation. Out of the arable area, a total of 2,000 ha has currently being planted with Jatropha. The company under this study have one business model of large scale plantations with four associated players namely: employees, former landowners, former land users and population at large.

Socio-economically, the project has a number of positive impacts including employment creation and infrastructural development; a feeling that is also shared with District authorities and the general public. Currently, the company has 422 full time employees and the company plan is to scale up employment to 1,500 employees (most of them will be from surrounding villages). The Company has plans for an out grower scheme when it has created a market and has a full understanding of input costs and benefits of the scheme.

Before the land transfer, local communities in the surrounding villages had access to the land for charcoal making, collecting clay for pottery and gathering firewood, as well as herbs for food and medicine. The land allocated to Sun Biofuels also includes a swamp where the local people used to get water in the dry season. The impact of land tenure on peoples' accessibility to the mentioned resources is one of points of interest for this study. Figure 3 indicate the Jatropha value chain developed from the national case study (large plantation model).

The plantation is on its initial years of harvesting seeds and trial of processing Jatropha oil. It has been difficult to get the actual data of yearly production. The biofuel industry is still at the infancy stage, it is difficult as well to establish local demand of Jatropha oil. The questions of production, demand, yield, inputs, etc. will be left for the future (when the industry will have all processes in full operation).

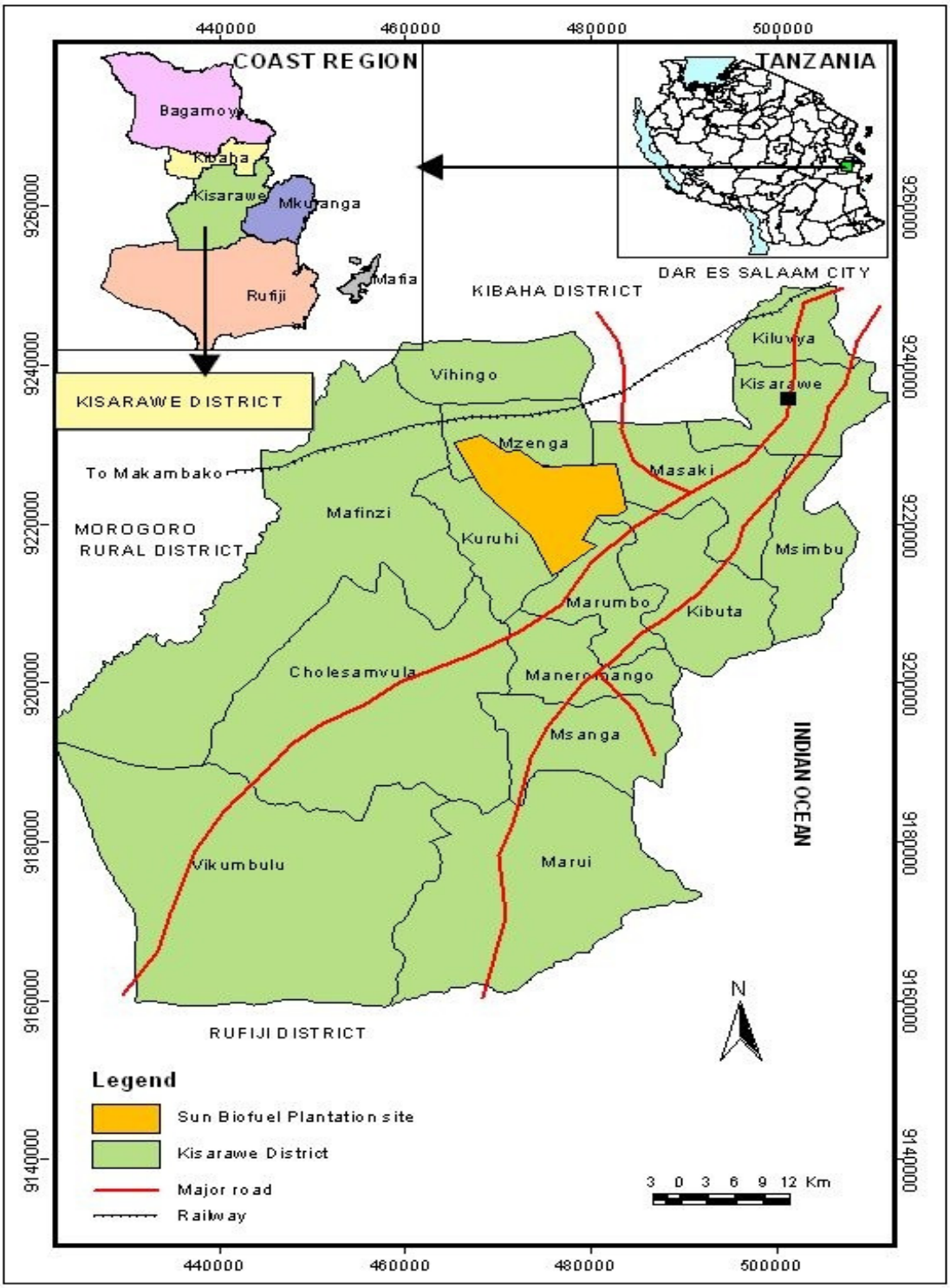


Figure 3: Location of study area showing the Sun Biofuel plantation in Kisarawe District, Tanzania

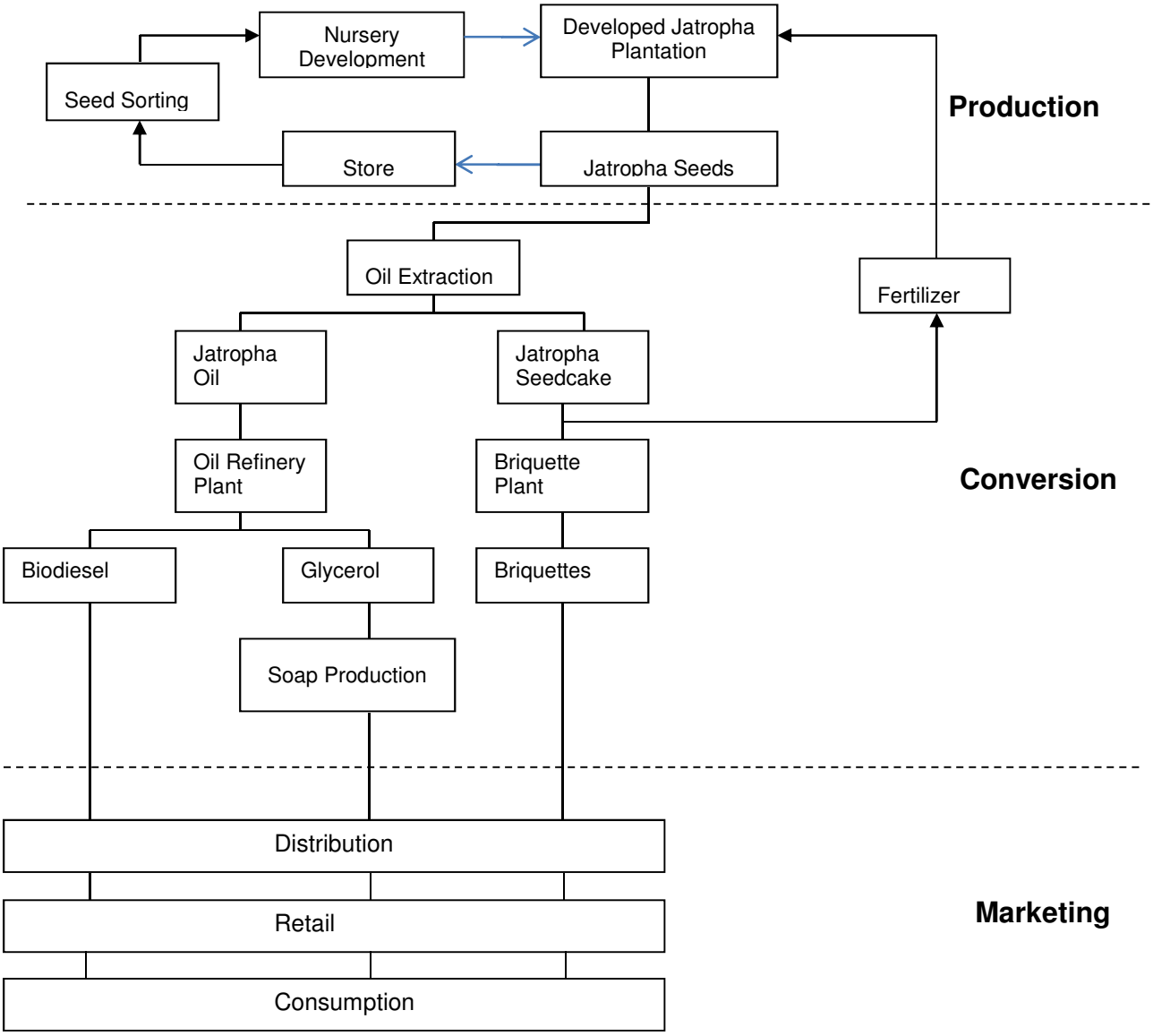


Figure 4: Flowchart of the supply chain of Jatropha in Tanzania (Case of Sun Biofuels)

4 Case Study at the Regional Level: Arusha Region

Formally Arusha Region consisted of ten districts. But, recently has been subdivided into two regions (Manyara and Arusha). Arusha is located below the Equator between latitudes 20 and 60 and longitudinal situated between 350 and 380 east of Greenwich, it is situated in the North-Eastern Tanzania. The region has common border with Kenya in the north. Arusha has a total area of 34,516 km^2 (Table 2), out of this about 3% is covered by water bodies while the remaining is a land area. Arusha Region has five Districts namely: Arumeru, Arusha, Monduli, Karatu and Ngorongoro.

Table 2: Land Area and Administrative Units of Arusha

District	Area Km^2	Administrative			Village /Site Growing Jatropha
		Division	Ward	Villages	
Arumeru[1]	2,896	6	37	133	Leguruki
Arusha	82.5	3	15	10	
Karatu	3,300	4	13	42	
Monduli	14,201	3	14	49	Engaruka, Mto wa Mbu
Ngorongoro	14,036	3	14	31	
TOTAL	34,516	19	93	265	

Source: Arusha Social Economic Profile 1998.

Arusha Region can be divided into three agro-economic zones based on the varied relief feature, soil types and climatic conditions. The agro-economic zones include banana, coffee zone in the slopes of Mt. Meru in Arumeru and Arusha Districts; second zone is a rift valley Highlands which include Ngorongoro and Karatu Districts and Massai Sttepes where Monduli District and Ngorongoro are located.

4.1 Arusha Region

Arusha Region has a total land area of 34,526 km² of which 955.2 km² or 2.7% is covered by water bodies of lakes Eyasi, Manyara and Natron. Arusha Region is one of the smallest regions of Tanzania Mainland. It ranks13th in size and occupies about 3.8% of Tanzania Mainland total area of 942,784 km².

Table 3: Distribution of Surface Area, (Land and Water Areas) by District; Arusha Region

District	Land Area (Sq.kms.)	Percent of Land Area (Sq.kms.)	Water Area (Sq.kms.)	Percent of Water Area (Sq.kms.)	Total Surface Area (Sq.kms.)	Percent of Surface Area (Sq.kms.)
Monduli	6419	18.6	128.4	13.4	6547.4	18.5
Arumeru	2896	8.4	407	42.6	3303	9.3
Arusha	93	0.3	0	0	93	0.3
Karatu	3300	9.6	10.6	1.1	3310.6	9.3
Ngorongoro	14036	40.7	252.6	26.4	14288.6	40.3
Longido	7782	22.4	156.6	16.4	7938.6	22.4
Total	**34526**	**100**	**955.2**	**100**	**35481.2**	**100.1**

Table 3 shows the distribution of the region's area among the districts and that the districts with the largest areas are Ngorongoro and Longido districts, with Ngorongoro district constituting 40.3% of total land area of the region followed by Longido (22.4%), Monduli (18.5%), Karatu (9.3%) and Arumeru (9.3%). Arusha district with 0.3% of the area is the smallest.

4.2 Land Use Pattern

Prior to year 2002, Arusha Region was the largest region in Tanzania and was comprised of 10 districts which were Monduli, Arumeru, Arusha, Kiteto, Babati, Hanang, Mbulu, Karatu, Simanjiro and Ngorongoro. Because of its big size and large number of districts, the government in July 2002, decided to split the region into two regions, namely, Arusha and Manyara.

4.3 Economy

The primary industry of the region is agriculture, with large vegetable and flower producers sending high-quality produce to Europe. Small-scale agriculture was badly hit by the coffee crisis of recent years and is now largely subsistence farming. Currently, only 11% of the municipality is engaged in agriculture. Arusha has several factories including a brewery, tyre and fibreboard plant, and a large pharmaceuticals plant.

The region around Arusha is the sole source of a gem-quality mineral called Tanzanite, currently produced in large quantities by corporate mining concerns.

Tourism is also a major contributor to the economy in Arusha, being the second largest contributor of income in Tanzania. Given the town's location near some of the most popular national parks and game reserves in Africa including Selous National Park (one of the largest national parks in the world), Serengeti National Park, Kilimanjaro National Park, Ngorongoro Conservation Area among others, Arusha has become a popular staging point for tourists visiting Tanzania and East Africa for photo safaris and hiking treks to Mt. Kilimanjaro.

Arusha is home to the offices of the East African Community, and to the International Criminal Tribunal for Rwanda and the African Court on Human and Peoples' Rights, all of which contribute to the local economy.

The population also engages in commercial work. About one tenth of the population works in the administrative sector of white-collar roles, while many others contribute to the bustling tourism sector.

About 20% of residents work in the informal service sector, providing services such as tailoring, carpentry, and shoe making. Here, a man offers to sell lumber and assemble photos, while the woman mends clothing. The informal work-site is situated on the periphery of both the downtown marketplace and a residential sector.

4.4 Population

The population of Arusha Region has experienced significant growth. The region had 1,288,088 people in 2002 compared to 744,497 inhabitants in the 1988 resulting in a significant increase of 543,591 people (73%) during the inter-censual period. In 2002, the region had 3.8% of the total population of Tanzania mainland which was 33,461,849. However, the projections for 2010 put the regional population at 1,162,199 out of which 50.6% are females.

4.5 Agriculture

The main economy activity is agriculture both peasantry and commercial farming, agriculture contributes to more than 40% of regional GDP and accounts for more than 75% of the export earnings. Commercial farming is for seed beans in Monduli, wheat in Karatu, coffee in Arusha, Meru and Arumeru Districts. Maize and food beans are cultivated by smallholder farmers. Livestock keeping, mining and industrial are other economic activities carried out in Arusha Region. Other cash crops include sunflower, flowers, sisal and cotton. Other characteristics of agricultural production in Arusha Region is that unlike other regions quite a sizable amount of production is carried out on estate or large scale farms. Production on large scale farms is characterized by higher yields per ha and greater access to agricultural credit. The whole yields per ha in the region are low because of droughts, use of inferior agricultural implements, poor husbandry and low access to credit.

Arusha offers suitable climate for the growth of cut flowers. The region produces considerable quantities of coffee annually. Still it is no financially sustainable economic coffee processing plant in the region. Coffee is traded in its raw form and it is processed and exported by other countries. An investment in horticultural activity is already in place, still there is a growing demand for flower seeds and cut flowers, which has potentials. The highland zone of the region provides a wide range of exotic fruits and vegetables. There is a big surplus and in the area and very much is thus wasted as it is not possible to take care of it. The region does not have a sustainable fruit/vegetable canning/ processing plant.

4.6 Forestry

Arusha Region has a high rate of depletion of forest resources. The main underlying reason for this situation is high demand of forest products which are estimated at 4,200,000 m^3 of wood per annum,

compared to the existing capacity of 2,000,000 m^3 only. Thus investments in this sector should be directed to reforestation activities such as tree planting. Individuals, companies, non-governmental and governmental institutions could take a leading role.

Arusha Region has about 255,500 ha of forest resources, all over the region. This forest resource area is ideal for beekeeping and current levels of beekeeping activities leave a lot of potential for further beekeeping development in the region. Individuals, particularly youth and women are hereby challenged to venture into the beekeeping industry either individually or as groups with the support ideally of NGOs.

Cash crop production is limited by the small size of the district. The main cash crops are coffee and flowers. Normally Arusha has the best coffee yield per ha. The production and export of flowers is a relatively new development, but this could be a major cash spinner given the district's climate and infrastructure.

4.7 Land Ownership Concentration

All land in Arusha (like other regions) is public property. In practice, most agricultural land is held under either customary or communal systems and most agricultural land is not surveyed. Few users have any documents showing their legal rights and duties or even boundaries. Indeed, few villages have been internally surveyed since villagelization took place in the early 1970s - an exercise which greatly disturbed traditional land holdings and arrangements. There are three types of land ownership.

- Reserved land: Land under wildlife, forests, national parks etc.
- Village land: all land inside the boundaries of villages. Village councils and assemblies have the power, through the Village Land Act, to oversee the distribution and management of village land.
- General land: land under the management of the Commission of Lands.

The large part of village land is owned under the system of pastoral land ownership which faces many challenges including the categories of ownership. Land tenure in pastoral societies of Tanzania comprises of two key concepts namely, territory which denotes land as defined by the jurisdiction of state or community, etc.; and domain which refers to the range of customary control or sphere of influence. The Land Policy turns against the pastoralists, blaming them for encroaching into agricultural lands and causing conflicts with other communities and for land degradation. It states that 'the free movement of pastoralists with their cattle brings about land ownership and land use conflicts with settled communities.

4.8 Food Security

The main food crops are maize, beans, bananas and potatoes. The region is not self-sufficient in food supply and so has to import more than half of its food from outside the district. Livestock keeping is an important economic activity in Arusha district. The district has sizeable herds of cattle, sheep and goats. There are also food products which are produced from livestock like dairy products, beef, lamb, etc. Other types of food are industrial and imported from outside the country supplied through supermarkets and stores in the urban areas.

In the past decade, food production in the region has fluctuated around low levels due to poor productivity of land, limited technological capacity of farmers and a lack of agriculture technical support services. Women, the main producers and reliable labour force, face continual oppression and discrimination in accessing production and economic opportunities.

It is believed by many that Arusha is a cereal food surplus region. In fact it is a member of the club of four giant producers of maize along with Mbeya, Ruvuma and Rukwa. In every one of the last six years under consideration the region managed to produce a surplus. The trend is for more surplus production. In fact by end of 1990s, the region was producing a surplus of 50% over its requirements. In addition to this surplus of energy foods (cereals) the region also produces an average of 55,000 t of wheat each year. On the other hand, Arusha is a deficit region with regards to food beans. But its deficit can be met to a great extent by the use of pigeon peas which is a cash crop. Over the last seven years the average deficit for food beans is 9,187 t. But the region at the same time produces an average of 17,174 t of pigeon peas and 18,258 t of seed beans as cash crops.

4.9 Energy sector

Arusha Region uses various sources of energy for lighting, cooking and running machines. These energy sources include electricity, biogas, LPG, paraffin, charcoal, firewood and others. Arusha Region is served by the national grid from the major hydroelectric power plants. Many areas of Arusha Region enjoy a good water reserve irrigated by different spring and river sources from green vegetation of planes of Mt Meru. The wood-fuel consumption rate in Arusha Region is still high, considering the fact that it is the cheapest source of energy for cooking in the households for the majority of the people in the Region. The charcoal and firewood demand is estimated to be 3,706,900 t of wood. The woodfuel production is coming from unreserved land (57%), 29% from reserved forests and 14% from forest plantations. Arusha is potential area for Jatropha farming. Biogas technology was introduced in early 1980's for domestic use. More than 700 biogas plants have been constructed in Arusha Region.

4.10 Policy Framework

The mandate of the Government is to respond to agreed public policies by building strategies and programmes of implementation through Ministries Departments and Agencies (MDA). Where policies are non-existence, it is Governments' responsibility to design a guide of intended action. All policies are coordinated under the Prime Minister's Office, but work to the village level through existing administrative structure (national-region-district-division-ward-village).

The on-going Local Government Reforms have resulted into new relations between the Regions (Arusha Inclusive) and the Local Government Authorities (LGAs), whereby the former now have been charged with the role of policy interpretation, advise coordination, monitoring, enforcement and creation of an enabling environment for the LGAs to discharge their duties. The Arusha Region is fully committed to devolving power, resources and equipment to the sub-district and sub-municipal entities to ensure that people at the grassroots level are enabled to bring and sustain their own social and economic development. Reforms which seek to devolve authority and resources to the people through their democratically elected institutions, i.e. local governments cannot succeed unless all stakeholders and the general public internalize the objectives, benefits and the responsibilities of reform policies.

The decentralization policy is enacted through the Regional Administration Act (1997) which effectively initiated the decentralization process by scaling down the roles, functions and staffing at the regional level. According to the Act, urban and district authorities are allowed to interact directly with the central government ministries on issues of concern and interest in their areas of jurisdiction. They can work with other organizations located within their respective areas and with NGOs.

4.11 The Diligent Company in the Region of Arusha

The case study at the regional levels focuses on the Diligent Company in the Arusha Region. The Arusha Region is one of the dry regions in Tanzania, with an average annual rainfall of 875 mm. Two rainy seasons are observed, one around April and one around November. Average annual temperatures range between 12.0 and 28.7 °C. The main crops grown in the region are maize and beans.

The company's office is located in Arusha, but their activities stretch to a much larger area of Arusha Region. Diligent Tanzania ltd currently promotes the cultivation of Jatropha and provides farmers with a guaranteed market for their seeds. The seeds are processed into Straight Jatropha Oil and then biodiesel, which can be blended with mineral diesel.

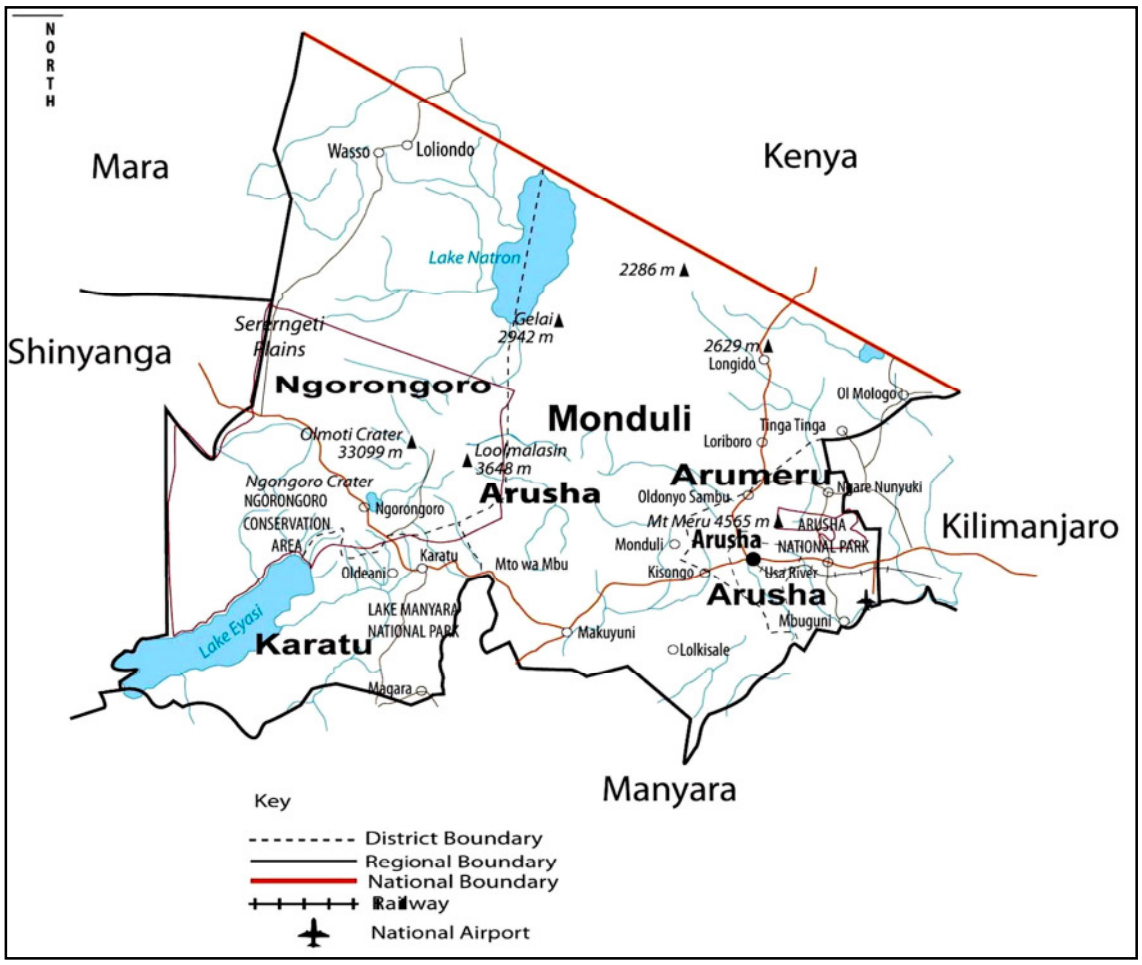


Figure 5: Location of the Arusha Regional Case Study

Most of Jatropha seeds are collected or produced by smallholder farmers in Arumeru, Karatu, Monduli and Arusha Districts. The processing facility of Diligent is located in Arusha Municipality. There are Energy Service Platforms (ESP) installed by TaTEDO at Engaruka Juu in Monduli District and Leguruki Village in Arumeru District. These machines are used by smallholders to press oil. Some smallholder farmer groups have their own ram oil press machines which are manually used to squeeze oil from Jatropha seeds.

Diligent Tanzania Ltd is active in renewable energy services related to the production, promotion and usage of vegetable oil (Jatropha oil). The company produces Jatropha oil and biodiesel for transportation fuel purposes and offer consultancy services for anyone who wants to grow or use Jatropha. Diligent Tanzania ltd is continuously researching all aspects related to vegetable oil.

Diligent was established in 2005 as a commercial company and is based in Arusha. For biodiesel and SJO production, Diligent promotes Jatropha cultivation to small scale farmers by means of intercropping and hedges. They use out-grower and collection schemes in which they provide support to small- and large-scale farmers from whom they buy seeds. 2006 resulted in 70 ha of out-growers and by 2007 this figure had risen to 1,500 ha. They currently have 1,000 out-growers and their target is to work with 30,000.

Although Diligent's core business initially was producing Jatropha Methyl Ester (JME), better known as Jatropha biodiesel, they are currently mainly extracting straight Jatropha oil (SJO) from Jatropha seeds. In 2007 Diligent processed 40 t of seeds and produced 10,000 litres of SJO. Diligent sells SJO to KAMA, KAKUTE, JPTL, two local safari companies and individuals with modified engines in their vehicles. Furthermore, Diligent sells selected seeds for planting purposes to national and international buyers and experiments with different mechanical oil expellers. ELCT provided the Sayari oil expeller to Diligent and in turn Diligent is providing feedback to ELCT on its performance. This is an example of a vertical linkage leading to the exchange of knowledge and subsequent improvement of value chain products and processes, with mutual benefits. Diligent is presently experimenting with the use of the seedcake in their biogas plant.

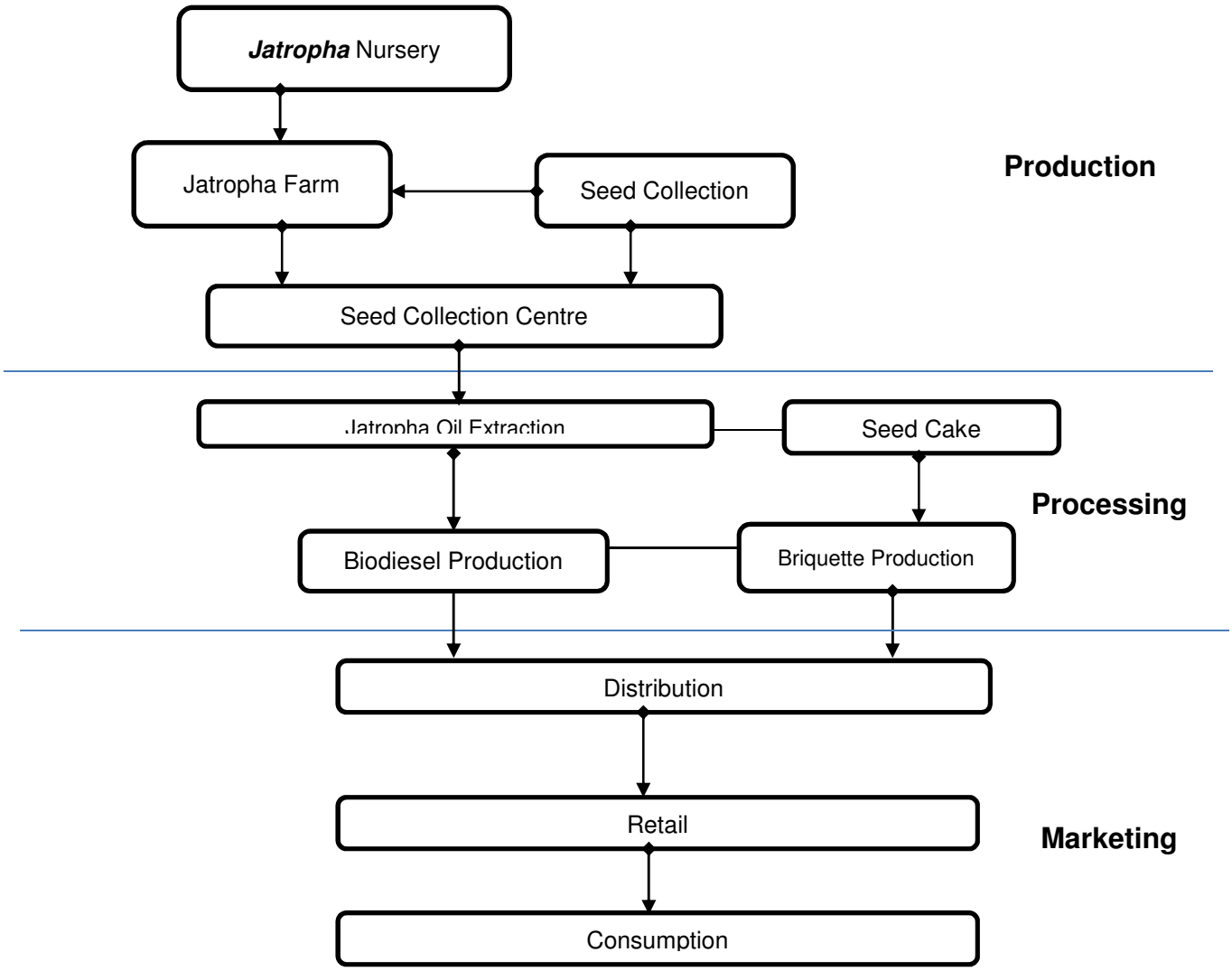


Figure 6: Flowchart of the Supply Chain of Jatropha of the Diligent Company

The Jatropha seeds are collected from smallholders' farm-hedges and public areas. The production of seeds is performed by smallholder groups or individuals supported by companies as out-growers. Some smallholder farmers can locally process and use Jatropha oil and its by-products for meeting their different own needs. The Jatropha production is done through group farming on land areas dedicated by group for Jatropha production. There are farmers who intercrop Jatropha with other food crops. Smallholder farmers play important role of producing, processing and marketing Jatropha. The seeds are collected from farmers to the collection centres. The company hire lorries for transporting seeds to the conversion facility located in Arusha Municipality, where they are processed to get SJO. There are no agrochemical inputs used by smallholder farmers during production of Jatropha seeds. Some chemicals are used during conversion of Jatropha oil into biodiesel. Family labour is used during seed collection and production and processing for groups which are using manual oil press. Hired labour is used to press seeds in ESP sites and at the Diligent Company.

5 Case Study at the Local Level: Leguruki Village

5.1 Location of the Case Study

Leguruki is located in the slopes of Mt. Meru, in Leguruki Ward, King'ori Division of the Arumeru District in Arusha Region. The village is not far from Kilimanjaro International Airport (KIA). The village is divided in five sub-village sections namely Madukani, Mbaaseny, Songambele, Noseiya and Mlimani. Leguruki is bordered by Arusha National Park and by 4 villages: Nkoasenga, Miririni, Shishitoni and Maruango.

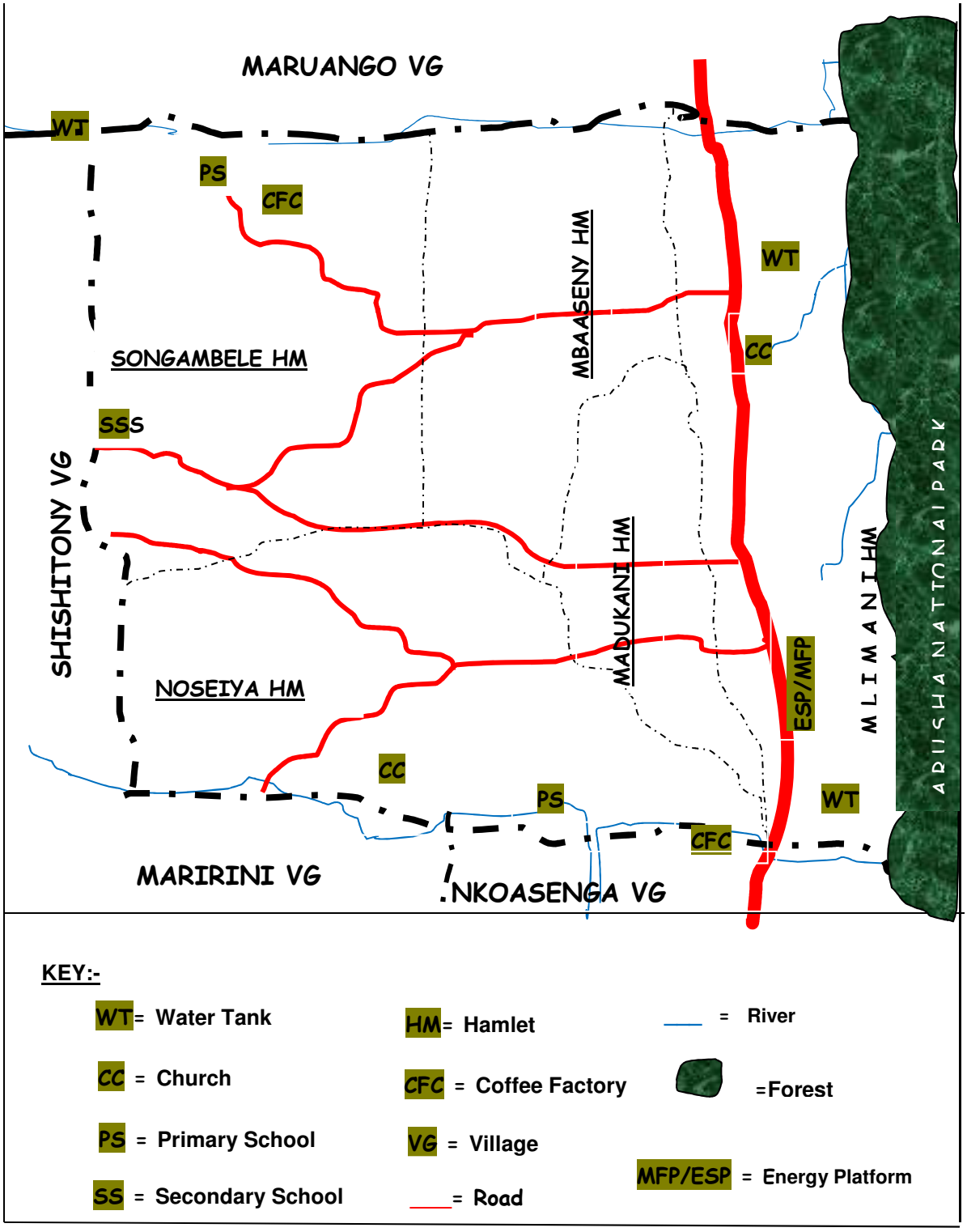


Figure 7: Map of Leguruki Village

5.2 Land Use

Total village area is 2,185 ha, of which 1,740 ha are suitable for agricultural activities. About, 1,537 ha are used for agricultural cultivation and 202 ha are used as pastoral area. The ward is green and lush with fields of coffee, banana trees, beans, and corn, and there are scattered lakes that attract scores of water birds. According to villagers survey about 99-100% of households own land without title in Leguruki.

5.3 Economy

The village economy depends on agriculture. Income, in the form of cash or goods, is most commonly generated through agricultural production. Village leaders in Leguruki listed crop production and sales to be the primary sources of income. Livestock, small businesses, alcohol sales, bee keeping and honey production, brick making, and firewood sales are additional income generators in the village. There exists a large number of income generating activities apart from agriculture, growing Jatropha, castor or any other oil crop, good village leadership, reasonable accessibility and presence of social organizations, such as women cooperatives, youth production groups.

5.4 Population

The village population is estimated to be 4,000 inhabitants. More than 90% of the villages are smallholder farmers intercropping food and cash crops with *Jatropha*. Other sources of income include livestock keeping, trading and employment in schools, churches and business. The average temperature ranges between 15-20℃ and annual rainfall is between 800 mm -1,200 mm.

5.5 Agriculture

Farming, is the main source of income, but is vulnerable to the problem of soil erosion which is harmful to the sustainability and reliability of farming. Though there is little use of inorganic fertilizers, there is extensive intercropping and terracing practiced to control erosion. The village is green with fields of coffee, banana trees, beans, and maize. Other crops are pulses, banana, potatoes, cassava, sunflowers and vegetables. The average land under cultivation per household is three acres.

5.6 Forestry

The village is located near to Mt Meru Forest Reserve. Mount Meru is one of Africa's highest and most beautiful volcanoes, with a route which passes through a wide range of vegetation up into moorland. The forest is protected but is source of medicinal plants, firewood and other forest products in the surrounding villages (Leguruki Inclusive).

5.7 Land Ownership

The Village is under village land ownership held collectively by village residents under customary law. The customary law allow land to be owned by individuals. Villagers have rights to the land that their residents have traditionally used and that are considered within the ambit of village land under customary principles, including grazing land, fallow land and unoccupied land.

5.8 Food Security

The households in Leguruki were the most food secure with a mean index score of 2.49. Kitchen gardens are one means that households can use to protect themselves from periods of food insecurity when there is high crop or livestock loss. Optimal infant and young child (age 6-23 months) feeding practices (IYCF) include: early initiation of breastfeeding, exclusive breastfeeding during the first 6 months, continued breastfeeding for up to two years and beyond, timely introduction of complementary feeding at 6 months, frequency of feeding solid/semisolid foods, and the diversity of food groups fed to children 6-23 months. The most commonly eaten foods by children under-five are vegetables, legumes, maize and milk.

5.9 Energy

Leguruki village is not connected to the national grid electricity. The closest village where there is electricity is King'ori, which is located 6 km south. The majority of the villagers use kerosene for lighting and an average household spends approximately Tshs 9,000 per month on kerosene. Other means of lighting include dry cell batteries, car batteries and generators. A household uses four dry cell batteries per month for torches and radio.

The village has Energy Services Platform (ESP) which is used for electrification, milling, hulling, oil press and battery charging. The ESP can be run by the locally available Straight Jatropha Oil (SJO) and was installed by Tanzania Traditional Energy Development Organization (TaTEDO). A mini grid was constructed comprising more than 50 well treated poles with more than 15,000 metres of overhead cable runs and connecting more than 40 houses (25 household and 17 business points like shops, restaurants, butchers) and more than 200 people at the central business area of the village.

Jatropha grows very well in Leguruki and surrounding villages. It can be grown through the intercropping system where no coffee is grown. Furthermore, Jatropha seeds can be bought from the surrounding villages where there is sufficient land.

5.10 Policy Framework

The policy framework of the local government affects the village levels. The village is under mandate of Arumeru District Council. All sectors are administered and managed from the DED's office and supervised at the village levels by the Village Government.

5.11 The Smallholder Jatropha/ESP Scheme of the Leguruki Village

Leguruki village was selected for ESP installation after feasibility study conducted in Arumeru District in 2006. Participatory Rural Appraisal (PRA) was conducted in Leguruki in May 2007 as initial efforts of preparation for the ESP installation, to facilitate community acceptance and smooth initiation of the project, as well as to enable in-depth understanding of the baseline information on village's socio-economic situation, energy supply, demand and options, human capacity and village development priorities.

Jatropha grows very well in Leguruki and surrounding villages. It can be grown through the intercropping system where no coffee is grown. Furthermore, Jatropha seeds can be bought from the surrounding villages where there is sufficient land. Among the 2,000 kg of Jatropha seeds, which were bought by Mianzini Women Group in 2006, more than half was collected from areas outside the village. The women group believes that they can buy more Jatropha seeds if there would be more promotional activities and if a more attractive price would be offered. The Mianzini Women Group buys seeds from individuals who pick from trees themselves or buy from other people.

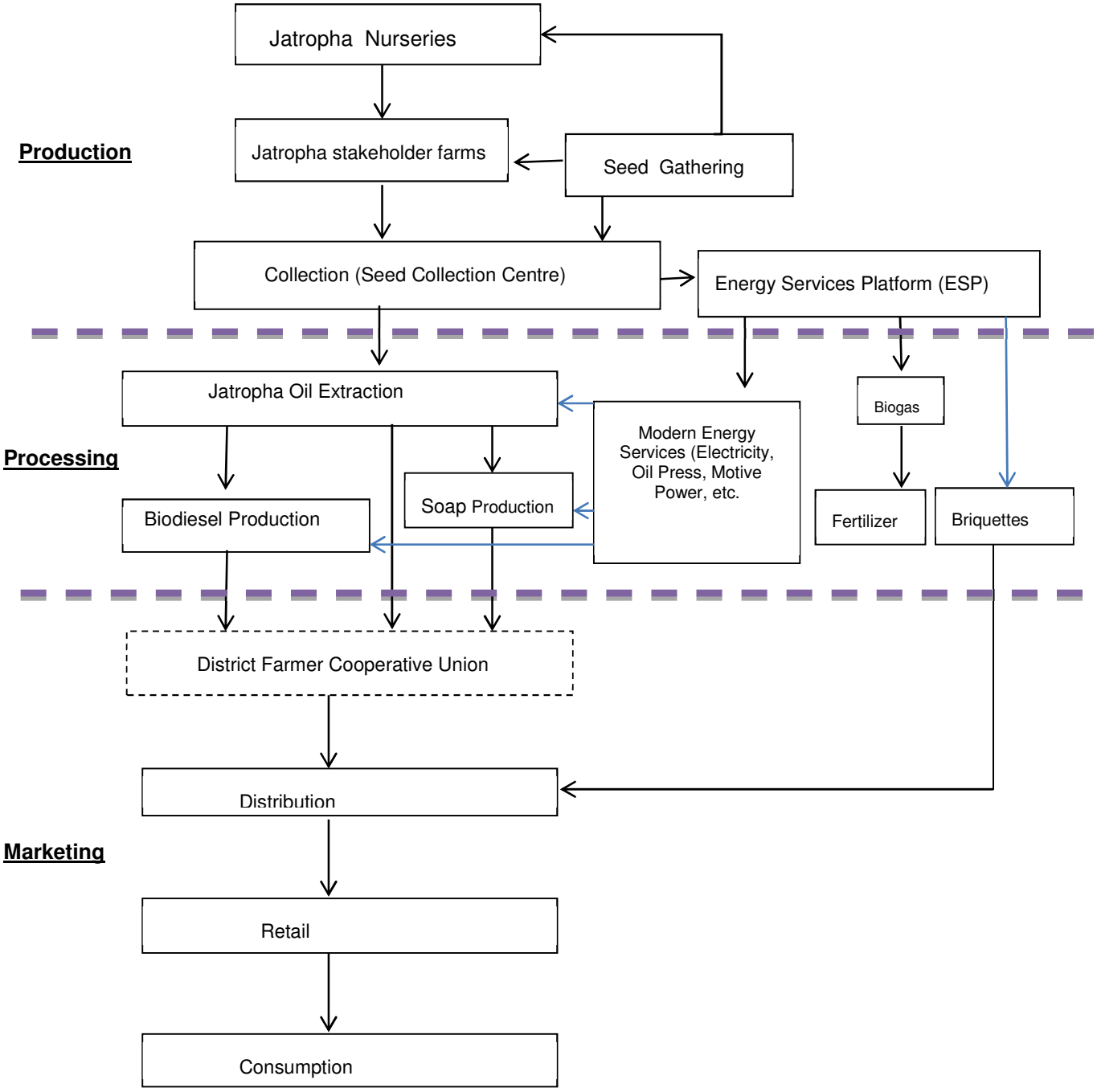


Figure 8: Flowchart of the Supply Chain of Jatropha of the Leguruki Village ESP Project

6 Socio-Economic Impacts of the Jatropha Chain

6.1 Economics

6.1.1 Macro-Economics in the Jatropha Chain in Tanzania

Tanzania is among the countries with no known oil reserves. The entire industrial and transport sector depends heavily on foreign oil imports which value accounted for 1.5 billion USD in 2009 (BOT 2010). The expenditure on oil imports was equal to 40% of the country's total export earnings. This share is likely to increase in 2011 due to continuous hikes of world oil prices. The ever-aggravating situation made the Tanzanian government think about the possibility of displacing fossil fuels with liquid biofuels.

Only recently has Tanzania started production and marketing of straight vegetable Jatropha oil for use in adapted car engines, and for this reason the output is still negligible. Nationally produced biodiesel is so far not available at competitive prices. Jatropha large production would catalyse the macro economy through a new cash crop. The investment has directly or indirectly to employ several local people for a start, more employment opportunities could rise as the project expands. Jatropha oil can be blended by petrol diesel. The oil and by-products from Jatropha plantation can be used for manufacturing various products (varnishes, illuminants, soap, pest control and medicine for skin diseases) and these could contribute to the economy of Tanzania.

The annual yield per ha is up to 8 t of Jatropha seed, which contain over 30% oil. At USD 320 per tonne, this will translate into production of Jatropha crude oil worth USD 768 per ha per year. Of potentially equal or greater value is the yield from Jatropha seeds of glycerine. Up to 7% of Jatropha seeds are made up of glycerine, which sells for up to USD 2,000 per tonne, translating into glycerine sales of up to USD 1,120 per year per ha, or total sales of up to USD 1,888 per year per ha.

It is useful to estimate the potential for bioenergy production from the "potentially available land" (44.4 Mha) in order to gauge the limits of any real production. Using a range of biomass production of 75-300 GJ per ha per annum, the limits of bioenergy production in Tanzania would be in the range 3.3 to 13.3 EJ per annum. This compares with total annual primary energy consumption in Tanzania of 0.602 EJ (IEA, 2002).

The oil yield from Jatropha plantations is reported to be about 1,600 kg oil per ha from the fifth year onwards (Grimm, 1996), although some local experience in Tanzania suggests that actual yields in Tanzania may be significantly less than this (Burland, 2005). On the basis of a yield of 1,600 kg oil per ha, 19,700 ha of Jatropha would have to be harvested each to produce enough biodiesel for a 5% national blend with petroleum diesel in 2010. For a B20 blend, 78,800 ha would be required.

6.1.1.1 Feedstock Production

Generally, straight vegetable oil can be produced from Jatropha. The feedstock required for Jatropha oil production depends on the amount of biodiesel being produced. A wide variety of energy crops can be grown in Tanzania due to its wide climatic variation and agro-ecological conditions.

Tanzania is blessed with a wide range of oilseed crops that can be used as feedstock for producing biodiesel. At the moment, oil palm and Jatropha are viewed as having the greatest potential for biodiesel production in Tanzania. Oil palm has a high oil yield per ha compared with other oilseed crops currently grown in Tanzania. Palm oil, however, is also consumed as a food crop. Jatropha is not a food crop and therefore its use for biodiesel production won't compete with food. *Croton megalocarpus* has been reported to be another potential feedstock for biodiesel production in Tanzania, however there is no field/local experience on this plant. Biodiesel is considered to be an industrial product under WTO rules (FAO 2007).

6.1.1.2 Feedstock Conversion

Jatropha feed-stock conversion has started in some companies (Sun Biofuels, Prokon, etc.). Most of these companies are intending to produce Straight Vegetable Oils (SVOs) for export. Biofuels as a potential source of fuel for transport could be grown and processed locally. Under the revised Petroleum Act (2008), with sufficient supply of biofuels, the government can set blending ratios and targets. Minimum blending ratios that don't require engine modifications is B20 (20% biodiesel by volume) for diesel-fuelled vehicles.

6.1.2 Economics in the Jatropha Chain in the Arusha Region (Diligent Company)

The National Accounts of Tanzania revised/new series show that the Arusha Region's GDP was at Tshs 607,098 million at current prices. The regional economy grew by 27% between 2003 and 2004 but the growth rate however dropped to 19% in 2005 and dropped further to 12% in 2006. The report shows that the economy recovered in 2007 when the rate was 16%. The report further reveals that, in 2007 Arusha Region's share of the National GDP was 4.5% which is equivalent to Tshs 946,309 million.

Arusha Region's economy continues to be dominated by the agriculture sector. Both commercial and peasantry farming are carried out, with the latter being dominant. According to the results of the 2002 population and housing census, the crop and livestock sub-sectors engage about 65% of the economically active population in the region. Agriculture contributes to most of the region's cash income mainly from coffee, floriculture, maize and bananas production. It accounts for about 45% of the region's GDP. Generally, the crop sub-sector's performance has been adequate in ensuring to ensure good food security. Poor performance of this sub-sector in some years has been attributed to the heavy dependence on variable climatic conditions in the form of rainfall. Thus, the relatively high growth rates in some years reflect the availability of favourable rainfall in those years.

According to the National Accounts of Tanzania revised/new series, the per capita income of the residents of Arusha Region was Tshs 621,356 (equivalent to USD 499) in the year 2010. This amount is greater than that of Tanzania Mainland which was estimated at Tshs 547,081 (equivalent to USD 439) in the same year. The average annual per capita income of the residents of Arusha Region improved substantially from Tshs 440,602 in 2004 to Tshs 621,356 in 2010. This is an increase of 41.0%. However, in terms of US Dollars the increase was from USD 405 in 2004 to USD 499 in 2010 an increase of 23.2%.

Jatropha economy in Arusha generates income for smallholders, employees, transporters and the Jatropha companies (Diligent, JPTL, Kakute, FaidaMali, etc.)

The experience of Diligent Tanzania Ltd reflects a commercial project. The company's idea is to generate enough cash flow from selling biofuel and other derived products to be financial viable. However, since this is hard to realize from the beginning, the project started using PSOM3 funding provided by the Dutch government. This funding was established to focus help on projects in new, difficult and emerging markets. The funding paid for the creation of a pilot project, after which follow-up financing would be required to allow further company growth.

The Dutch National Institute for Public Health and the Environment used Diligent as a case study for calculating the greenhouse gas balance, using Diligent oil to generate electricity in the Netherlands. Calculations show a reduction of greenhouse gas emissions of at least 60% compared with more conventional energy sources. Therefore, there is revenue expected from sale of carbon which will also add to the revenue accrued from Jatropha production and conversion

After four years of operation there is a substantial cash flow generated, which covers part of the costs made by the project. However, the break-even point has not yet been reached. More biomass on land is generated; this leads to a positive greenhouse emission balance.

Price for Jatropha Seeds

The price for the seeds is established by negotiation between the farmer and the company. Different regions have different prices, the longer the transport, or the higher the expenses for transport, the lower the price for the seeds. Collectors are always given the option to bring seeds to the factory gate (for a 'factory-gate-price'). Diligent organizes and pays for the transport of the seeds. Diligent has a network of transporters and storage facilities in order to facilitate the transport of seeds.

The Jatropha oil is currently sold for around USD 2.11/litre, while prices paid for seeds to farmers range between 0.09-0.12 USD/kg (in Babati) and USD 0.15-0.19 (in Monduli). However, once availability of seeds (and so oil) is higher, the price for Jatropha oil will be substantially lower, due to economics of scale. The minimum price for farmers as stated in the contract is USD 0.08 per Kg. Different regions may have different purchase prices related to the transport price incidence for Diligent (the higher the expenses for transport, the lower the price for the seeds). Diligent organizes and pays for the transport of the seeds to the factory in Arusha.

Table 4: Aggregated Cost Factors for a Jatropha Farming per ha

S.No	Cost type	Total Average Cost (USD/Ha)
1	Investment Costs	98
2	Annual Costs	Total Average Cost (USD/Ha/Year)
	Year 1	234
	Year 5	202
3	Harvesting and Post Harvesting Processing	Total Average Cost (USD/Kg)
		0.07

Source : Nepomuk Wahl, etl 2009

Van Eijck (2007) estimates the harvesting efficiency to be 2-10 kg per hour which leads to harvesting costs of 0.1075 to 0.0215 USD/kg. Because no figures on drying and shelling were obtained from smallholders study used a rather high value for picking (0.0716 USD/kg equal to 3 kg/h) and assumes that those costs are included. According to table 4, the average cost of Jatropha farming per ha is tumbling down with time. The amount of annual costs is reduced significantly by more than USD 30 per ha per year within five years.

Tax Payments

A big problem for companies like Diligent is that the Tanzanian government has not yet decided whether biofuels will be taxed or not. So far taxes are included in the fuel price of Tshs 2,000. Diligent is the biggest buyer of seeds in the region. A very high percentage of the purchased seeds originate from the innumerable hedges all around Arusha town. To further increase seed production and ensure future supply, Diligent will continue to work together with several hundred small-scale out-growers in Arusha Region.

Feedstock Production and Conversion

The economic assessment of the use of the Jatropha plant performed in Arusha Region. The economic assessment differentiated between seed collection, oil extraction and soap production. The collection of seeds and its sale gives the least added value. Oil extraction is more profitable than seed collection, but not as good as soap making.

All the assessed activities contribute to the rural economy and rural development. It may still take some time, until the Jatropha System will contribute economically to the rural development in a large scale. Seeds are collected from various sources such as from gatherers and farmers, collected seeds at collection stations. Gross margin calculations from seeds collection are presented in Table 5. As it can be observed net benefits and gross margins per ton of seeds were growing consecutively in three years. However, collection is economically feasible. But it seems that the activities of many companies are supporting various Jatropha activities in the chain and especially local processing activities.

Table 5: Gross Margins of Collecting 1,000 Kg of Seeds between 2006 and 2008 at Leguruki

	YEAR 2006	YEAR 2007	YEAR 2008
COST (TZS)			
Seeds (kg)	1,000	1,000	1,000
Price (Farm Gate, Per kg)	120	200	300
Total Seed Cost	120,000	200,000	300,000
Transport	50,000	50,000	50,000
Total Cost	171,120	251,200	351,300
REVENUE (TZS)			
Seeds (kg)	1,000	1,000	1,000
Price (Factory Gate, Per kg)	180	300	500
Total Revenue	180,000	300,000	500,000
Net Benefit	**8,880**	**48,800**	**148,700**
Gross Margin	**5%**	**16%**	**30%**

Source: The Green Myth, 2008

There are various levels of processing of Jatropha seeds. The first processing stage is oil extraction. Under appropriate technology and with well mature and dried seeds one bag (i.e. 70 kg) give on average 10-14 litres of clear oil. KAKUTE processing unit reached on average 13 litres per bag of dried Jatropha seeds. Women groups in rural areas rarely exceed 10 litres of oil per bag of Jatropha seeds. Though all processors use similar ram press, the yield differ depends on the quality of seeds and use of appropriate extraction procedures.

Like Diligent, KAKUTE Ltd has managed to develop and disseminate Jatropha processing technologies to women groups in Arusha and Manyara regions. The various processing technologies include Jatropha oil extraction, soap making, use of Jatropha oil as source of fuel for lamp, biogas for cooking and making charcoal. However, processing which is currently done by women groups include establishment of Jatropha tree nursery, seed collection, oil extraction and soap making.

Due to emergence of various products of commercial value from Jatropha, there has been a growing population of Jatropha seed collectors and traders. Some women groups who extract oil and make soap have been potential buyers of Jatropha seeds. Some women groups have decided to specialise in soap making and marketing and thus buy Jatropha oil from their colleagues who extract the oil from the seeds. Interestingly, there is varying value addition per hour for every function along the chain.

6.1.3 Economics in the Jatropha Chain for Leguruki Village

The value chains in small-scale Jatropha farming systems in Tanzania range from nursery to clearing, planting and harvesting. However, there are many opportunities in which people can improve their life by generating income. The average wage for one man-day is set to be about USD 1.36. The actual wages paid vary between USD 0.68 and USD 1.36 depending on location and season. But the sale of the Jatropha seeds depends on the market situation (supply and demand). The prices at which smallholders can sell the seeds vary, with the maximum being around USD 0.29 per kg.

In 2009, about 2,560 kg of Jatropha seeds were collected by Mianzini Women Group in the village. There are two peak harvesting seasons: one in April-June and the other is during September and October. Most villagers grow Jatropha for fencing and demarcation in almost every household land. There is no one who grows Jatropha as a cash crop. Anyone is able to collect Jatropha seeds from any tree in the village. It is almost impossible to open up large Jatropha plantations in the village due to scarcity of land, which is attributed by an increase in population. The number of people living in Leguruki increased from 3,200 in 2002 to around 4,800 in 2009, equivalent to 540 households and 830 households respectively.

TaTEDO installed the ESP in August 2007. Three weeks were needed to install all equipment of the ESP (16 HP lister engine, 10 kW 3-phases alternator and a battery charger). A mini-grid was constructed comprising more than 50 well treated poles with more than 15,000 m of overhead cable runs and connecting more than 40 houses (25 household and 17 business points like shops, restaurants, butchers) and more than 200 people at the central business area of the village.

Electric lights brought more comfort and increases security. People could see more clearly what is happening around the houses and extend working time to the night time. Furthermore, it is cheaper to pay for electricity lighting than to use candles or kerosene.

Table 6: Length of Jatropha Hedge Needed to Power ESP

S. No	Item	Units	
1	SJO Engine Consumption	Kg/Ha	2
2	Running Time per Day	Hours/Day	6
3	Running Time per Year	Days/Year	350
4	Extraction Rate	%	25*
5	Total Seed Consumption	Kg/Year	16,800
6	Seed per metres of hedge	Kg/Metre	0.5
7	Total hedge to cover ESP Consumption	Km	33.6

Source: Nepomuk Wahl, etl 2009

The villagers are now very excited with the new possibilities brought by the electricity. The most exited are the business people, they say that electricity will allow them to keep their shops open for a longer time and now they can provide services that were no possible before; like cooled soda, welding and battery charging. Also the local carpenters can use electrical tools, doing a faster and easier job and in this way improve their profits. Jatropha has attributed to introduction of ESP which has changed the economy and life of the villagers by creating more income to the people and to the village.

According to Table 6, 33.6 km of hedges were estimated to power the ESP. The land in Leguruki suitable for agriculture is 1,740 ha. It was estimated that if only one farmer fences a one-ha plot he gets at least 400 m of hedge. When 84 ha will be planted with Jatropha on the hedges they could provide 33.6 km of Jatropha hedge in total and this will be enough SJO for the ESP consumption. The seeds are collected from hedges and public areas and along the roads.

6.1.4 Summary of Measurable Units and Indicators

National and Regional Levels

- Volume of seeds and SJO produced by large plantations and smallholders
- Jatropha products price movements in Tanzania
- Share of income for large companies and smallholders
- Amount of revenue collected from Jatropha industry
- Contribution of Jatropha production to Gross Domestic Product (GDP)

Local levels

- Kilograms of seeds and volume of oil supplied by smallholder farmers at local levels
- Number of households benefitted from Jatropha production (electricity, income, etc.)
- Type of new opportunities created by biofuel industry at local levels
- Number of biofuel related technologies available for smallholders
- Number of smallholder Jatropha groups
- Shares of revenue contributed by each Jatropha group at local levels

6.2 Employment Generation

The drivers for the production of Jatropha in Tanzania include the need to create new employment opportunities in rural areas, thus leading to increased incomes for enhanced rural development. Looking at the advancement of technology and the level of agro-mechanization that is taking place in the study area, it is likely that most biofuels activities will be mechanized in the near future and it is unlikely that

more jobs will be created by the companies even if these industries are to expand beyond their current level; moreover, most employment targets by these companies may not be attained. If this happens, it is going to be very disappointing to the communities that will have offered their land in anticipation of gaining employment opportunities.

6.2.1 Employment Generation in the Jatropha Chain in Tanzania

Jatropha investment (especially for smallholders) is considered a strength in the context of pro-poor development since it can be labour intensive. Labour intensive activities generate employment which leads to rising income and development.

The production chain of Jatropha is likely to create sustainable employment at all stages of production, processing and marketing. It will increase income of the rural poor and move them out of poverty.

6.2.1.1 Feedstock Production

According to the Integrated Labour Force Survey of 2006, the unemployment rate stands at 11% of which 1 million are males and 1.3 million are females. Based on the current level of investment in the pipeline, the biofuels industry has the potential to create 58,359 new employment opportunities in different parts of the country, which is about 2.5% of the total unemployment rate. While Jatropha companies were seen to create high expectation for job creation, in reality they create more jobs for casual/seasonal workers who are not covered by social security and medical assistance. The proportion of projected jobs coupled with the nature of employment (seasonal labour) meant for the majority, the loss of land and other common pool resources foregone by the communities may not be justifiable.

In the case of Sun Biofuels, One of the impacts of large scale Jatropha production by Sun Biofuels to the community is possibility of getting employment for some people from affected villages (permanent and casual labourers). Sun Biofuels (T) Ltd has been employing both full time and part time staff. Full time staff includes administrative staff, farm managers, operators, security and drivers, while most of part time staff are farm casual workers. Total number of employees from the surrounding villages stands at 700 staff (both casual labourers and permanent workers). In the case of Sun Biofuels which started farm operations in early 2009, farm workers were employed as temporary workers with three months agreements up to April 2010 when they filled six months contracts commencing in May 2010. During peak seasons the company employs daily casual labourers who were paid Tshs 5,000 per day. The salaries for farm workers were more or less the same at Tshs 112,000 (USD 75) per month out of which Tshs 11,350 is deducted as National Social Security Fund (NSSF) making a net pay of Tshs 100,650 (USD 70). Although farm workers have been complaining that the salary is not sufficient, companies claim that the amounts were well above the minimum wages in Tanzania. Further analysis has shown that the opportunity cost of being employed by the company is less than the forgone opportunity of charcoal production and some other economic activities from village land.

The employees are also using much of their time in the Jatropha farming and less on the food production. Although money obtained from employment could be used to buy food elsewhere, in the case of payments for casual labourers and permanent workers it was not possible to satisfy all household needs and to purchase enough food for their families.

6.2.1.2 Feedstock Conversion

The feedstock conversion requires employees who manage the whole process by processing seeds into SJO and biodiesel. For several companies, about one-third of the energy in the fruit of Jatropha is extracted as oil that has a similar energy value to diesel fuel. Jatropha oil is used directly in diesel engines added to diesel fuel as an extender or transesterificated to a biodiesel fuel. In theory, a diesel substitute can be produced from locally grown Jatropha plants, thus providing an opportunity for Tanzania with the possibility of becoming self-sufficient in fuel for motive power.

The large scale Jatropha plantation of Sun Biofuels for example in Kisarawe, Tanzania needs to employ a big number of workers to maintain the plantation, to process the seeds and other support services. The plantation of Sun Biofuels requires more than 5 million working hours per season to collect the seeds, processing and other activities. There exists no mechanical device to collect the seeds, therefore employment of people has been necessary to ensure seed are collected and processed.

Some of the permanent and casual labourers are employed by the company for processing the seeds. The seeds are de-hulled in a mechanical press and then heated. The seeds are crushed to extract SVO and then convert it into biodiesel. Some local staff are temporarily employed for processing Jatropha seeds into biodiesel under supervision of permanent staff that have been trained processing of Jatropha seeds.

Some universal precaution tools such as protective gears are required during the conversion process for protecting staff from harmful chemicals and physical injury. This study revealed that although the companies' management is aware of health and safety regulations, some companies do not provide full protective gear to workers especially not to those who work with agrochemicals. This is contravening the occupational safety and health regulations, which require employers to safeguard the health and welfare of their employees.

6.2.2 Employment Generation in the Jatropha Chain in the Region

Jatropha cultivation in the Diligent model is very labour intensive since the field work is difficult to mechanise. Theoretically, the site could be prepared with a tractor, but this is an unlikely option for small-scale farmers in Tanzania. Labour is required for clearing the site, ploughing, pitting, planting, weeding, irrigate, spraying of crop protection chemicals, fertilization and pruning. Because labour costs amount for a high%age of total costs, scale effects are unlikely when establishing a Jatropha plantation on a bigger scale. The labour requirement will increase almost linear with the increment of the area. Transportation costs could be lowered when transporting inputs or seeds at a larger scale but this is a rather small portion of the total costs.

The business model used by Diligent Tanzania involves several actors (small farmers, field coordinators, extension staff, local actors, collectors, etc.). Smallholder farmers are self-employed, other farmers, local actors and collectors are employed under contractual basis and extension staff and field coordinators are formally employed by the company.

The model encourages a labour intensive value chain consisting of two main activities. One is to buy all existing Jatropha seeds through collection centres and the other activity is to train contracted farmers to plant Jatropha following the out-grower model. In some villages where it operates, Diligent has established collaboration with local SACCO and NGOs working on the area to implement farmers' recruitment process or for the mediation to reach all farmers interested in starting Jatropha business. Then farmers sign the contract with Diligent and free seeds are provided to them.

The Government provides extension services but it is not enough to solve everyday problems that farmers face. Field officers are selected and contracted among persons suggested by local actors in the community in order to establish trust relationship among farmers and field officers to enforce the contract and assure that farmers are willing to sell seeds to Diligent. Diligent field officers provide training and education to farmers and give precise guidelines on how to cultivate Jatropha. Field officers visit farmers especially after harvesting time and report the production situation to Diligent. Collector centres are managed by community members, usually shop owners with a central location in the village. Collection centres are established in areas with many Jatropha trees. These collection centres consist of a 'main' collector who is often well-known in the region, usually a village chairman or elder.

The only requirement is that there is a room available to store the seeds, and preferably they need to have a bank account to be able to coordinate seed purchasing from one central point. The coordination is done from Arusha where a field coordinator regularly contacts the collector to gain information on the amount of seeds collected and identify any problems experienced.

Diligent tries to include local actors (District level, village level and civic society) in the business model as counterpart in the start-up phase in order to involve community in the process. Every change in the model has to be discussed with the counterpart in the village.

The Government of Tanzania encourages investors to specify the role of out-growers in the production chain and the benefit that they will have and boots out-growers to be more involved in the value adding activities related to biofuel also forming association-cooperatives that may enter into contract agreements.

6.2.2.1 Feedstock production

There is no any change in population or migration of population in the region due to Jatropha production, since Jatropha is cultivated in smallholder farms. Diligent contracts small farmers who usually own small fields (1-2 ha) and their production activities are limited to semi-subsistence and semi-commercial agriculture. Diligent aims to train farmers to become risk taker and be more willing to innovate and enter in the Jatropha business. Due to nature of production, the family labour is used in the smallholder farms and during the peak labour period it is hired from other villagers as casual labourers.

As noted before, the projections for 2010 put the Arusha Regional population at 1,162,199. Diligent has employed about 150 middlemen who set up their collection points at central spots like village market places or village administrative buildings. These middlemen have several smallholder farmers who collect and produce Jatropha seeds and sell to them. It was difficult to get exact number of smallholder farmers. Some studies indicate that since 2005, Diligent Tanzania has developed a network of some 3,000 contracted farmers, who have planted an area of around 3,000 ha of Jatropha.

6.2.2.2 Feedstock Conversion

Diligent Tanzania has its own pilot processing plant, as well as laboratory facilities, based in the town of Arusha, and a staff of about 25 people including production staff and administration staff. There is a core team of factory staff, and more staff are trained and available on stand-by agreements to support production during peak times. The large part of conversion is capital intensive and therefore only a small number of staff is required in the factory for conversion.

6.2.3 Employment Generation in the Jatropha Chain in Leguruki Village

Jatropha plant is used as a natural fence to prevent animals from feeding, crops for medicinal purposes, bark and leaves contain dye and latex with medicals properties for pharmaceutical industry. Seeds are collected from public and private hedges. Other small scale farmers collect seeds from small Jatropha plots. However, groups of women and children who collect Jatropha seeds and sell to the middle men or companies dealing with extraction of Jatropha oil gained income can be used to pay school fees for their children. Average price of Jatropha seed bought by middle men from small scale farmers is about USD 0.14 per kg, while bigger companies buy at a price of USD 0.16 per kg from middle men.

6.2.3.1 Feedstock Production

Jatropha hedges may provide supplementary income without the investment of land, but labour implication need to be considered. Harvesting of Jatropha under smallholders may absorb surplus labour, increasing labour productivity per unit area. Sometimes, labour constraints are represented by labour over leisure and social norms governing the roles of farm work among household members.

The number of members in the Mianzini Women Group which produces Jatropha for selling to the companies (Diligent and Kakute) is 13 each has around 200 seedlings (in total 2,600 Jatropha plants). The labour is provided by family which was estimated to be 78 mandays (each 6 mandays) required each year for weeding and harvesting Jatropha seeds from the farms.

6.2.3.2 Feedstock Conversion

Jatropha conversion is done by village members themselves. The group received one ram press worth Tshs 75,000 from Kakute. Jatropha seed pressing using the ram press is labour intensive and normally the women group hires casual labour to press for them at a rate of Tshs 5,000 per bag of approximately 60 kg. It takes 2 days to press one bag of Jatropha seeds. One bag of Jatropha seeds can provide up to 15 litres of oil, which can be sold to Diligent or Kakute at Tshs 30,000. Deducting pressing and raw materials costs, the women group makes at least Tshs 10,000 profit per bag. Apart from Jatropha oil, women groups also use oil to produce Jatropha soaps which are marketed to different places in and around Arusha.

The installation was also accompanied by the creation of skilled jobs in the village and by job training which aimed on building capacity to local technicians in managing (record keeping), operating and maintaining the ESP. The training was done to two individuals on mechanical and electric parts of the installation. The individuals are the natives of the village. The capabilities of the trainee under mechanical aspect proved enough for him to be selected as an operator of the ESP.

6.2.4 Summary of measurable units and indicators

National and Regional Level

- Number of companies operating in the Jatropha system
- Number and types of new jobs created by the Jatropha industry
- Growth rate of employment in the value chain

Local Level

- Number and%age of smallholder engaged in the Jatropha production
- Potential areas needed for employment creation at local levels
- Number of households connected to the ESP (powered by SJO)
- Mandays used in the biofuel activities by family labour at local level

6.3 Working Conditions

With regard to working conditions associated with the agricultural jobs created by the biofuels industry, the study focused on judicial use of agrochemicals, provision and use of protective gear, availability and accessibility to first aid services, working hours, wages and provisions for establishing a workers union. During the field research it was noted that although the management of the companies were aware of health and safety regulations, compliance varied from one company to another.

6.3.1 Working Conditions in the Jatropha Chain in Tanzania

In terms of working hours, some companies abide to a standard 8-hour working day. However, workers from other companies complained that they were working for longer hours (between 24 hours and 36 hours) and without overtime payment. According to employees of some companies, employees work 9 hours a day (45 hours a week) which is contrary to a standard 8 hours a day (40 hours a week). This again is contrary to Tanzania labour laws; it should be strictly avoided by all means by the responsible organs in order to create appropriate working conditions for workers in the biofuels industry. While this could be handled by a workers union, unfortunately all visited companies have never provided opportunity for their workers to establish workers unions, as required by labour laws in the country. Given this situation, various interventions need to be taken by various stakeholders including civil society organizations responsible for human rights in collaboration with the responsible government ministries to end human exploitation in the biofuels industry.

6.3.1.1 Feedstock Production and Conversion

It was evident that during the production of Jatropha, some biofuel companies provided partial protective gear such as overalls, hand gloves and gumboots as basic protective gear but could not provide respirators, goggles or hats for workers who sprayed agro-chemicals. At the same time, workers in one of the companies indicated that they were recruited to spray agrochemicals without proper training or safety of equipment, something which may have serious implication for the long-term health condition of these workers. In reality this is contravening the Occupational Health and Safety Act of 2003, Section 65, which clearly states that “every person who employs person’s in agricultural activities shall be under the obligation to ensure that no employees is exposed to: hazardous machines and equipment or harmful animals and insects; or infectious agents or allergens; or hazardous chemicals; or hazardous environment while doing work as agricultural worker”. In view of this situation, it is important for the companies to give priority to safety and health of their employees to avoid the associated health risks. They could also be prosecuted for violating the law.

While literature indicates that working conditions on plantations, including those of biofuel feedstock, tend to have differentiated gender impact; for example, company owners tend to prefer women workers as they are able to pay them less than their male counterparts (ILO, 2002). Fortunately, in the study area the situation is different, the majority of employees are males and the payment of wages is therefore not gender-biased. One notable issue, which deserves mentioning, is that a significant number of workers in the study area are employed as casual workers without overhead costs, social security, and medical assistance.

6.3.2 Working Conditions in the Jatropha Chain in the Arusha Region

The education sector in Arusha covers pre-primary, primary, secondary, vocational education and colleges/universities. The Primary Education Act of 1978 requires that every child should be enrolled and complete primary education. The completion cycle of primary education in Arusha Region has improved due to the improvement of school environment which resulted into a large number of reserves of labour in the region. The public secondary schools increased tremendously to 154 due to the government campaign of establishing at least one secondary school in each ward. The region has 3 universities, and 3 colleges for management, accountancy and technical issues.

There is no allocation of quotas for education by age in the region. The government provides general education from primary to secondary schools and specialization is build up during their enrolment with vocational training, colleges and high learning institutions. There is no specific college for the bioenergy sector. Employees in the energy sector receive this knowledge and skills through on-job trainings, seminars and tailor made short courses.

6.3.2.1 Feedstock Production and Conversion

There are several workers employed by biofuel companies (directly and indirectly) of varying levels of education. Most of casual labourers have completed primary school education. A few of permanent employed workers have secondary, college and above education. It has been observed that where

employees are in the permanent terms, they have no legal assistance even to translate employment contracts. This has been the case with Diligent. Furthermore, there were cases where workers could not read and write in English language. Some workers were given employment contracts written in English and required to sign without a clue what the contents entailed. While employment contracts are basic rights of employees, it is important that there should be mutual understanding between the two parties, before signing up the contracts; otherwise there are possibilities for employees to sign unfair deals. In the absence of workers unions, employees may not be able to realize and demand some of their basic rights from their employers because of little understanding of their entitlements associated with their respective carriers.

Looking at the wages and salaries, all companies were seen to effect payments according to the Tanzanian Labour Laws. In Tanzania there is legislation in place that indicates a minimum wage, sector by sector, as enacted in January 2008. According to the Tanzania Minimum Wage Act for the private sector, regarding large labour-intensive and export oriented enterprises like those in biofuels industry; the minimum wage is Tshs 80,000. In the study area the minimum wage offered by companies to permanent employees varied from one company to another, ranging between Tshs 90,000 and Tshs 120,000. In light of the minimum wage paid to permanent workers, the wage paid in biofuels companies is slightly above the rate proposed by the government. Apart from a salary, employees are also entitled to a 28-day annual leave, employer's contribution to national social security funds, and health benefits for those on permanent terms. It was also noted further that companies preferred to engage seasonal labourers instead of permanent workers because the former are paid less compared to permanent workers and they are not entitled to health insurance, payment for annual leave or other overhead costs, which are usually paid by employers to permanent employees.

6.3.3 Working Conditions in the Jatropha Chain in Leguruki

The working conditions for women groups in Jatropha production varies from one place to another depending on the regulations and by-laws set by the group. The site which the group is using for its activities still requires some improvements. The machines which are used for pressing seeds with exception of areas with ESPs like Leguruki, women groups use labour intensive technologies to press oil.

6.3.3.1 Feedstock Production and Conversion

In Leguruki, women have agreed to work in the group farm with specific working hours for each member. The main operations include field preparation, planting, weeding, pruning, harvesting, buying from other farmers and transporting. Filed preparation and planting are performed for new farms, but after establishing the farm smallholders continues with weeding, pruning and harvesting. The conditions created by these groups enable them to work together as groups and devote another time for other productive activities in their households and each of them benefit according to efforts put by individual member in the group work.

In the future, it is expected that economies of scale could be provided by central and local government to improve their production and negotiation of their Jatropha product in the market by establishing district cooperative unions. Each group will not negotiate themselves (as it is now). The groups will transfer the mandate of setting agreements and bargaining with external markets in order to fetch good process for their products to the cooperatives.

6.3.4 Summary of Measurable Units and Indicators

National and Regional Levels

- Number and type of protective gears for employees
- Clear and understandable contracts with smallholders
- Number of farms with workers unions

Local Levels

- Types of protective gears for local levels
- Type of machines which are less manual for different smallholder farmers
- Number of extension workers for supporting Jatropha production at local levels

6.4 Health issues

6.4.1 Health issues in the Jatropha chain in Tanzania

Under small scale farming systems Jatropha seeds are collected from wildly grown *Jatropha* or hedges especially in the Arusha Region. Activities carried out during production processes include land preparation, ploughing, planting, weeding and pruning. Farming systems employed is small scale farming. Under small scale farming neither chemicals, nor inorganic fertilizers are used. Farmers suggest that application of fertilizers, pesticides, fungicides, weeding and irrigation could positively impact farm productivity. Under large scale production chemicals and fertilizers are used which have negative health impacts.

With regard to health conditions, health and safety risks associated with the Jatropha chain, like other agricultural jobs in large scale production where there is a use of agrochemicals, provision and use of protective gear, availability and accessibility to first aid services are crucial. However, farmers are at high risks of getting injured during production or processing of Jatropha. During data collection it was noted that although the management of the companies were aware of health and safety regulations, compliance is questionable since they do not provide protective gear such as overalls, gloves, gumboots, respirators as basic protective gears, goggles or hats for workers who spray agro-chemicals. This is breaking the Occupational Health and Safety Act of 2003, Section 65, which clearly states that “every person who employs person’s in agricultural activities shall be under the obligation to ensure that no employees is exposed to: hazardous machines and equipment or harmful animals and insects; or infectious agents or allergens; or hazardous chemicals; or hazardous environment while doing work as agricultural worker”.

One remarkable issue, which deserves mentioning, is that a significant number of workers in the study area are employed as casual workers without overhead costs, social security, and medical assistance. Even where they are employed on permanent terms, workers have no legal assistance even to translate employment contracts. This was the case with Sun-Biofuels

6.4.2 Health issues in the Jatropha chain at Regional and Local Levels

Jatropha production at regional and local levels is undertaken by smallholder farmers who are working in the informal sector. There is no organisation which takes care of health problems for smallholder Jatropha farmers. As farmers collect Jatropha seeds from hedges of their farms, there is no chemical applied which could cause health problems. Companies which collect seeds from smallholder farmers are not taking care of health issues. Even where they have contracts with farmers, the health issues are left to the farmers. There are no health universal precautions for agricultural workers. Therefore Jatropha farmers are treated in the rural health centres like anybody else in the rural areas.

According to Diligent, in some areas contract farmers are given agro-chemicals to control pest, this reduce possibility of contaminating water and other crops by pesticide which could affect human health. The use of pesticide and other chemical in large scale production of Jatropha affects quality of water especially in down streams. Farmers dealing with Jatropha farming in the project areas do not wear gum boots they get injured skin disease infections.

6.4.3 Summary of Measurable Units and Indicators

National Level

- Type of health problems predominant in Jatropha production area
- Health facilities available in different Jatropha plantations
- Number of staff received medical examination in different farms
- Number of staff with medical insurance inn large Jatropha plantations
- Universal precautions in place for skilled and unskilled workers

Regional and Local Level

- Gears for protecting farmers from injury during Jatropha production in groups
- Groups with first aid kits at local levels

6.5 Food issues

6.5.1 Food Issues in the Jatropha Chain in Tanzania

Tanzania faces profound challenges for ensuring its food security. Currently, 22% of children are underweight at the age of 5, and 30% of Tanzanians live below the poverty line. The government of Tanzania has three categories of domestic policies to improve food availability and access: consumption policies, production policies, and trade policies. It has commonly employed consumer price controls, producer taxation and subsidies and export bans. Changes in the policy environment associated with economic reforms have tended to undermine rural food security among the grassroots poor, according to many reports and analyses. Smallholder producers no longer have access to key support systems such as producer goods subsidies, minimum producer prices, and soft loans. Smallholder farming and livestock-keeping has become a part-time activity for many women and men, who are forced to seek additional cash incomes from off-farm activities. This, in turn, reduces the amount of time available to farm and process food, thus undermining food security at the household level.

Tanzania has the potential to produce biofuels, but it is also food insecure. Raising production of biofuels with the accompanying incentives has been considered by some studies that will result in a worse situation as far as food security is concerned since vital food crops will be diverted to biofuels. As a result, rural communities will not have the financial ability to meet the resulting increased prices of foodstuffs. According to Nyberg and Ramsey (2007) the establishment of energy crop plantations and the impact of the increasing demand for liquid biofuels on food prices might affect at least two key dimensions of food security – availability and accessibility. Availability is likely to be limited due to reduced supply of food crops and competition for production resources such as land, labour and water, between food and energy crops (Doornbusch and Steenblik, 2007).

On the other hand, accessibility entails purchasing power, which is likely to be limited especially for rural and urban communities who rely on net importation of food. The impact is expected to be severe for poor women who are the majority, and who stay home to take care of their households.

6.5.1.1 Feedstock Production

There have been several debates on the impact of Jatropha production on food security. There are those who believe that sustainable production of Jatropha is possible without having any negative impact on food security, and that it all depends on how the whole operation is managed. Farmers can increase their incomes by growing energy crops such as Jatropha on degraded or marginal land not suitable for food crop production.

On the other hand, sceptics argue that production of biofuels will threaten food supplies for the poor and it is likely to draw the world into a ‘food versus fuel crisis’. The argument is based on the fact that any diversion of land from food or feed production to production of energy biomass will influence food prices from the start, as both compete for the same inputs such as fertilizers, water, labour and land.

While supporters of biofuels claim that non-food feed-stocks such as Jatropha are only grown on marginal land, in reality this has not been the case. During the study, it was noted with great concern that Jatropha have been allocated to prime lands.

The extent to which food security may be affected is also partly dependent on land availability. In order to accommodate a new crop where households do not have access to additional land for cultivation, existing crops may be displaced or land use intensified. If farmers decide to displace crops intended primarily for domestic consumption, the food security of the household may be compromised. Although individual households may benefit from an increased cash income, they may still be affected by poor market access or seasonal fluctuations in prices and food availability

In the case of Sun Biofuels Company, the farm workers mentioned that employment has increased their social security as they have steady monthly income. However the quality of life and food security has not changed as salaries paid were not sufficient. Their farm activities have been affected as they have no time for their own farms. The employee leaves home at 5.00 a.m. and returns at 7.00 p.m. Moreover, salaries paid were not enough to hire casual labourers. Many unskilled employed people also leave every morning with lorries that carry the employees and spend their day at the farm site, speculating that they will get daily work but in vain. Some of the negative impacts include inability to get annual crops from their former lands cultivated on their previous farms, lack other food stuffs such as honey, wild fruits etc., food security for families which were tilling the land tumbled down, etc. Therefore, there are no proper procedures for increasing food security for workers in large plantations.

6.5.1.2 Feedstock Conversion

There is no direct relationship between feedstock conversion and its effect to the food security. During the conversion of Jatropha oil and seed cakes are produced. The oil and seed cake have some chemicals which are toxic. Curcin found mainly in the seeds and also in the fruit and sap. Curcin is said to be highly irritant and remains in the seed after the oil has been expressed. Curcin is unable to penetrate cell walls, this has been indicated by the fact that these proteins do not affect protein synthesis by Ehrlich ascites cells. These genera also may contain hydrocyanic acid. There may be a dermatitis producing resin. There may be an alkaloid, and a glycoside which produce cardiovascular and respiratory depression.

The machine which is used for conversion of Jatropha oil is not recommended to convert other types of oil crop seeds. In the areas with few oil press machines, something which is common in rural areas, conversion of large quantity of seeds may hinder pressing other oil crop seeds which could be used as foodstuff.

6.5.2 Food Issues in the Jatropha chain in the Arusha Region (Diligent)

The model of collecting Jatropha seeds from smallholder farmers and contract farmers does not have much of effect to the food security for the smallholders. The smallholder farmers could still intercrop Jatropha with other food crops.

6.5.2.1 Feedstock Production

Jatropha is a pioneer that can grow with a minimum of water, nutrition and protection. Because of these limited requirements and the fact that it is a perennial plant, the energy balance is very positive. Mature Jatropha plants can serve as hedge row, or provide shade and protection within which more fragile food crops can survive. In this way, farm land can be used double. As Jatropha is inedible, the ethical dilemma of food versus fuel is avoided. Developing countries, with their fast growing demand for energy, can this way present themselves on world markets as energy supplier, instead of having to invest in expensive fossil fuel.

In the project areas, Jatropha is planted as a perennial crop to avoid soil erosion and protect food crop from wind and animals. Jatropha is most commonly planted in hedges and in some case intercropped with other local crops (maize, sweet potatoes, onions and sunflower). Diligent suggests a 4 meters spacing between rows and 3 meters between the trees for a successful intercropping. Jatropha is rarely planted as a plot in marginal land with 3 by 3 meters of lines.

6.5.2.2 Feedstock Conversion

Unless there is contamination with other oils squeezed from food crops, there is not much food insecurity, if Jatropha will be planted through Diligent Model.

6.5.3 Food Issues in the Jatropha Chain in Leguruki

The food crops cultivated by villagers in Leguruki are maize, beans, banana, sweet potatoes, cassava, sunflower, finger millets, vegetables and pulses. Other crops include different varieties of fruits such as citrus fruits, avocados, mangoes, guavas and papaws. Jatropha has been used in the Leguruki Village by smallholder farmers for years as a hedge plant to protect these food crops from animals and livestock.

6.5.3.1 Feedstock Production

The biofuel companies which are buying oil and seeds from smallholder farmers are offering different prices (Tshs 100-250) to individuals or groups of farmers in different localities. This is an evidence that the price was very unstable and location-specific. Although the Mianzini Women Group in Leguruki Village still has insightful levels of production of biofuels, and too low to impact on food security, the price offered by the promoting companies, Diligent and Kakute in particular, is too low to enable the farmers cope with the ever increasing food prices. Given the existing situation, the crop no longer poses serious threat to food security because many farmers have retracted from growing the crop because the price is not attractive enough to make any meaningful investment. If prices increase substantially, more land is likely to be allocated to bioenergy crops which may encourage farmers to reduce part of their land for food crops.

6.5.3.2 Feedstock Conversion

Unless there is a high price, smallholder farmers are receiving from the food and cash crops, there is no larger impact to food supply in the village. The village is equipped with the ESP; the amount of seeds converted into SJO for running ESP is small and will not jeopardize food security. The ESP is sometimes used to press sunflower oil but technicians have been trained on how to clean machine parts to ensure

there is no contamination with Jatropha oil. However, a large amount of sunflower is sold in the raw form to sunflower oil producers, who buy sunflower seeds from smallholder farmers.

6.5.4 Summary of Measurable Units and Indicators

National and Regional Level

- Hectares of arable land changed its use from food to biofuel production
- Number of people becoming food insecure due to Jatropha production

Local Level

i. Quantity and types of foodstuffs missing in the communities at local levels

6.6 Land Use Competition and Conflicts

All land in Tanzania is held in trust by the President on behalf of all Tanzanians and is therefore public property. In order to ensure higher security of land tenure, Tanzania has three laws, namely, the Land Act No. 4 of 1999, Village Land Act No. 5 of 1999 and the Land Disputes Act No. 2 0f 2002. The procedure for obtaining land for investment in Tanzania is well explained by Sulle and Nelson (2009). Projects can acquire land directly from the Tanzania Investment Centre (TIC) or from negotiations with villagers to transfer their land from village land to general land. The latter option has been used by both companies as the TIC is yet to establish enough land bank to allocate to investors. Compensation is then paid to the affected villages after which the investor obtains “derivative right”. The land can be owned in three different ways 1) Government granted right of occupancy 2) TIC derivative rights 3) Sub-leases created out of granted right of occupancy by the private sector. Rights of occupancy and derivative rights are granted for a short term and long-term period

- Long term rights of occupancy periods range from 5 - 99 years and are renewable, but for not more than 99 years.
- Long term derivate rights and leases range between 5 - 98 years.

6.6.1 Land Use Competition and Conflicts in the Jatropha Chain in Tanzania

According to procedures in the National Biofuel Guidelines, land is reviewed and endorsed by the Tanzania Investment Centre (TIC), as the draft guidelines give this role to the Biofuels Steering Committee to ensure all sustainability criteria are met. The investment land will continue to be allocated by TIC through a procedure of land bank, and investors will apply and be given a derivative right for a specified period. The guidelines further give two more options through which investment land can be acquired. The first option is through conveyance where an investor can acquire land through buying it from another company or individual but an investor will still have to follow normal application procedures for biofuels investment. The second option is for an investor to acquire land through the Village Land Act of 1999.

However, due to the challenges and controversies surrounding biofuels investment, the guidelines clearly state that village authorities will be guided by the biofuels one-stop centre once the Biofuel Steering Committee approves the biofuel project in their area. While guiding village authorities to grant land to investors is a good idea, it should be clear that this process is complex in itself and it involves land valuation, legal issues and compensation to the affected community members as stipulated in the Land Policy of 1999. In this respect, the one-stop-centre also should be composed of expatriates matching the requirements of the service to be offered. The draft guidelines however are silent on the composition of expatriates who should form the centre; the guidelines only state that the Ministry of Energy and Minerals is serving as the biofuels one-stop-centre. What should be clear is that the role of the Ministry is to formulate policies and regulations, and to monitor the sector performance for review to enhance effectiveness of the policy. In this case, there should be an independent regulatory authority like EWURA for licensing the production of biofuels, based on laws that will be enacted and policy to be promulgated by the government.

The guidelines further recognize the importance of small out-growers and direct clearly the land acquisition procedure for this category, which is through the National Land Act of 1999 and Village Land Act of 1999. Figure 9 presents the legal framework for land allocation and recognition of property rights in Tanzania. In view of this framework, there are three categories of land, i.e. general land, village land and reserved land. General land is mainly urban areas which are under the administration of the commissioner of lands, while village land involves rural areas under the administration of the village councils. Reserved land includes areas reserved for special purposes under the administration of designated authorities.

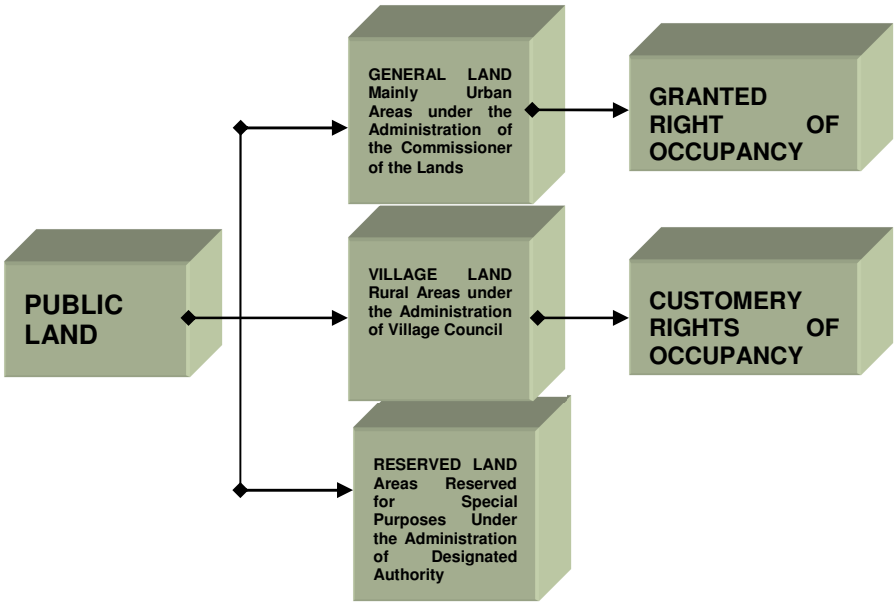


Figure 9: Legal Framework for the Allocation and Recognition of Land right

6.6.1.1 Feedstock Production

For the case of biofuels investment, most land targeted for this purpose is village land but due to legal restrictions imposed by the Village Land Act of 1999, village authorities are not allowed to offer more than 50 ha. In case an investor requires more than 50 ha, the Village Council has to seek approval from the Local Government Authority, which is mandated to offer up to 500 ha. In case the requirement goes beyond 500 ha, the Local Government Authority seeks approval of the Commissioner for Lands, but the land must be transferred from 'village land' to 'general land' before it is granted to an investor. This process requires the Presidents' approval and according to the draft guidelines for biofuels investment, the right of occupancy is granted to TIC and TIC grants derivative right to an investor for a specified period.

However, under the law in Tanzania, occupation of land by non-citizens is restricted to lands for investment purposes under the Tanzania Investment Act 1997 and the revised new National Land Act 1999. Land in Tanzania is government property and citizens or non-citizens only lease the land from the government for 33, 66, or 99 years depending on the nature of the investment. The law does not allow individual Tanzanians to sell land to foreigners; foreigners can only lease land in Tanzania through the Tanzania Investment Centre (TIC).

Figure 10 presents procedures to acquire derivative right through TIC.

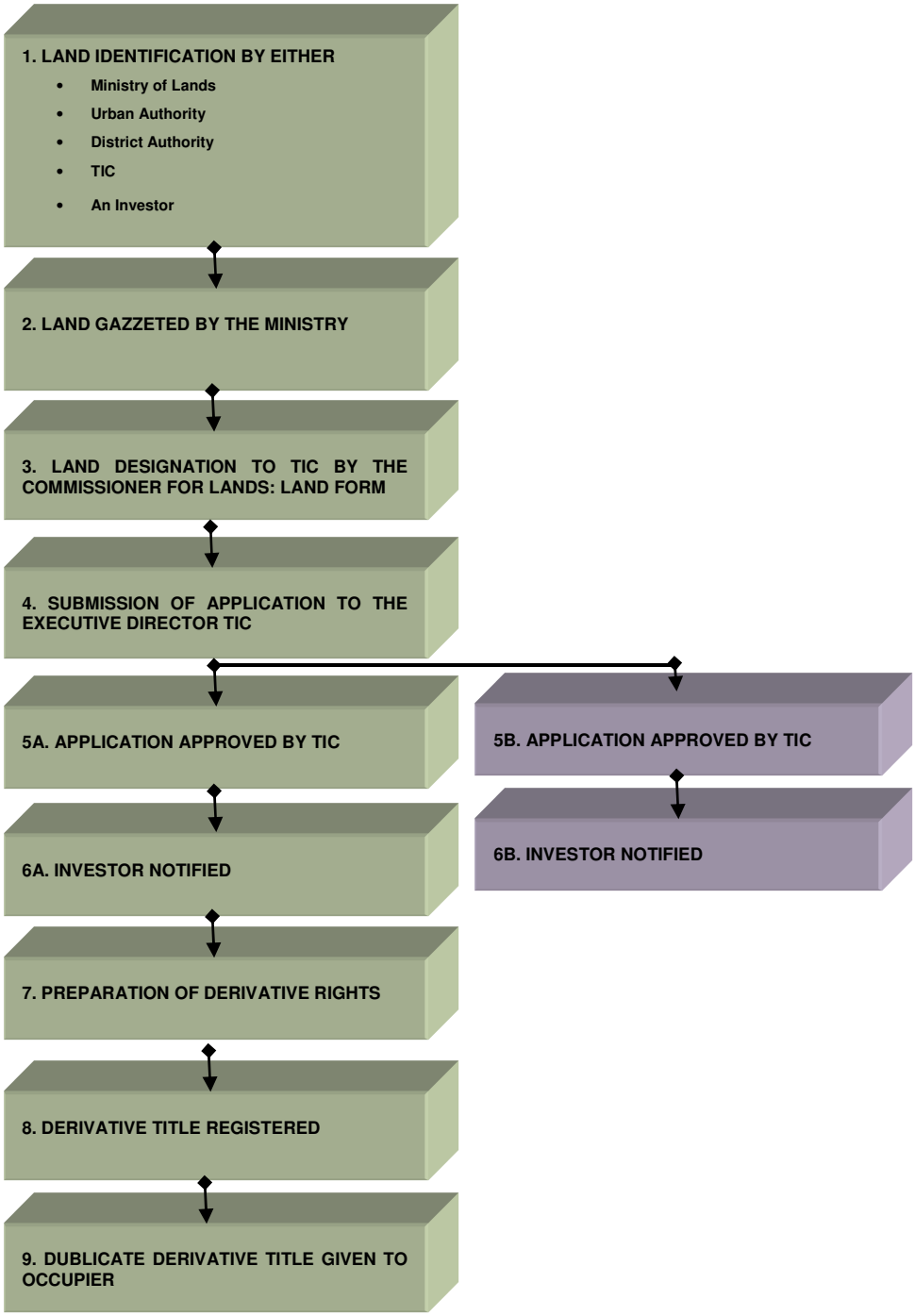


Figure 10: Procedure to Acquire Derivative Right through TIC (Note: Variable Fee Payable Under 7; Source: TIC)

Examining the procedure for granting land through TIC seems to be good but the problem is still on who is responsible to identify the land for investment. If one examines

Figure 10 there are several institutions currently involved in land identification, i.e. Ministry of Land, Urban Authority, District Authority, TIC and Investors. While there is no problem to involve the first four institutions, involving foreign investors directly to identify and negotiate land with the rural communities has had several problems. Foreign investors should acquire land through the land bank from TIC, to avoid inconveniencing both investors and local communities.

There are cases where investors have used tips to solicit consent of communities to support the idea of granting land to them, but the National Land Act and Village Land Act of 1999 requires maximum participation of citizens in decision making on matters connected with their occupation or use of land. The legal requirement is that at least 75% of the total community in a given village should pass the resolution

to release land for investment, otherwise no land should be granted. Here, money was used as an inducement to push people to sign the proceedings of the meeting, which is one of the requirements for application of land acquisition. In view of this, another system should be put in place to engage investors in the process of land acquisition rather than exposing them directly to negotiate with the communities.

The investors should negotiate with the government entrusted to safeguard the interest of its people because it is a democratically elected government. Communities have no capacity to negotiate land issues with investors who are advantaged with all sophisticated technologies and information compared to the villagers.

Sun Biofuels which is based in Kisarawe had neither paid the district nor the affected villages. Almost all the land that is under Sun Biofuels was village land taken from 12 villages that surround the now company land. The valuation of land was done by a valuator from Ardhi University. However, this valuation has not been fair as village governments were not compensated of their land as only few individuals who had long term crops of cashew nuts, mangoes and coconut in the acquired land were paid. Sun Biofuels promised to contribute to the development activities in the following ways:

- Construction of village roads
- Provision of employment to the people in the village
- Construction of dispensary
- Construction of water reservoirs
- Procurement and installation of generator for electrifying primary and secondary schools in these villages

In Kisarawe promises that were given by the company were not fulfilled and it is not clear as to when they will be fulfilled as there is no contract between local communities and the company. The contract which was drawn between the Company and Kisarawe District Council does not specify the amount and time of compensation.

All land regulation documents are in English language and most of land transactions were done in English, a language which is very little understood by the local communities. Besides, very little awareness creation was made to local communities on their rights over land. According to the District land officers, compensation of properties to the people in all villages was not negotiable based on unit payment of Tshs 18,000 (USD 12) per tree regardless of the acreage on their land. In the case of Sun Biofuels the payments ranged between Tshs 120,000 and Tshs 900,000 (USD 80 to USD 600).

The compensation plan did not cover those for those collective uses under customary rights except for Chakenge village (one of the 12 villages that leased land to Sun Biofuels) where the village had been compensated of its land after the village strongly demanded under their Councillor. The implication of this result is that the company used multiple standards in handling the compensation issues.

There are some of immediate impacts observed as a result of land transfer to Sun Biofuels which have direct effect to the people's livelihood strategies. Most of these impacts were more on the negative and not positive sides. These impacts were in the form of lack of yield from their former lands. The land acquisition practices ended into the highest dissatisfaction on low compensation over the land that was taken by the company. It seems that people were not well educated prior to application for compensation. As a result, there were more than 500 people who are claiming for new or additional compensation.

However, transforming the land into monoculture agriculture is sometimes attractive and this transformation is also an increase of the value although the gain of land is shifted to the investor and leaves the majority of people, who were using the land before, on the disadvantage and environmental losses. This also happened in Kisarawe because many people in the village are complaining since the exercise of converting the land from village to general land and compensation was mishandled.

6.6.2 Land Use Competition and Conflicts in the Jatropha Chain in the Arusha Region (Diligent)

In recent times in Arusha Region, there has been a big demand for surveyed land plots. Land use planning is a key aspect in the development of both urban and rural areas of any region in the country. In rural areas agricultural and other production activities are the major needs for land. In the planning of farms, grazing areas and human settlements in rural areas, the village is the first step. Out of 312 villages in Arusha Region, about 83% have been surveyed and demarcated. Arusha, Meru, Monduli and Longido districts are leading with 100% of their respective villages having been surveyed and demarcated. There are followed by Karatu and Ngorongoro with 86% and 5% respectively.

6.6.2.1 Feedstock Production

Some biofuel producers in Arusha Region do not own any land directly but instead buy Jatropha seeds produced by local farmers according to contracts or 'out-grower' arrangements. Several biofuel companies have developed out-grower schemes for producing Jatropha working with thousands of local farmers.

The different production models that these companies are developing have very different impacts on the land rights and livelihoods of local communities. Diligent is one of the few biofuels companies in Arusha Region already producing and selling fuel, and also one of the few companies which is not directly producing or intending to directly produce its own fuel crops, instead relying entirely on contracted smallholder production.

The company developing Jatropha oil production through contracts with local farmers, are not taking control over any land for energy crop production. As a result, the company is able to start producing biofuels earlier, avoiding delays and costs incurred in acquiring land. However, the company may have different challenges - such as ensuring that enough biofuel feedstock at the right quality is supplied by local farmers in order to meet production targets

The smallholder farmers under this kind of arrangements are not compensated for their lands because they don't lose rights of their lands. The productivity of the land is on the decision of the smallholder farmers. They can decide which part of land will be used for energy crops and which can be used for other crops production.

6.6.3 Land Use Competition and Conflicts in the Jatropha Chain in Leguruki

Leguruki is located in the slopes of Mt. Meru. Total village area is 2,185 ha, of which 1,740 ha are suitable for agricultural activities. In 2002, 1,537 ha are used for agricultural cultivation and 202 ha are used as pastoral area.

6.6.3.1 Feedstock Production

The smallholder farmers and women groups are using the land for other crops to produce Jatropha. Sometimes Jatropha in the village is planted as ornamental plant in open public areas. Jatropha is either grown as hedge plant or intercropped with other cash and food crops. Under this kind of arrangements, smallholder farmers will not lose their rights of their lands. The productivity of the land is on the decision of the smallholder farmers. The smallholder farmers are rationing their time for biofuel crops and food crops and other activities.

6.6.4 Summary of Measurable Units and Indicators

National and Regional Level

- Hectares of land suitable for biofuel production
- Hectares under public land (local and foreign investors)
- Hectares under cultivation of Jatropha production
- Previous use of the land in large Jatropha plantations

Local Levels

- Hectares under smallholder Jatropha faming
- Previous use of the land in Jatropha farming

6.7 Gender Issues

6.7.1 Gender Issues in the Jatropha Chain in Tanzania

Jatropha production and processing like other biofuel crops is resource intensive and even in small scale requires sufficient feedstock, equipment, capital and skills. However, women inherently have limited access to resources such as land, water, fertilizers and pesticides. Moreover, due to impossibility of using land as collateral, women lack access to formal credit facilities that would enable them to acquire such productive inputs (FAO, 2004; World Bank, 2003). In Tanzania land is owned by men, women have the right to collect the seeds from the family hedges, and to process or sell them. The money is for them. The village government gives them plots where they can plant Jatropha for their own. Therefore there are unequal opportunities and benefits in Jatropha chain incurring to men and women headed households

which contribute to further entrenchment of equities and the social economic marginalization of women and men headed households. Concerns are voiced on unfair conditions of employment linked to Jatropha chain such as poor working conditions, low wages and health risks due to the use of agrochemicals since women are regarded as cheap and dispensable labour.

6.7.1.1 Feedstock Production

In Tanzania Jatropha is known as “Graveyard Plant” used to mark the graves and at the same time to protect graves from cows and other animals as hedges. Jatropha plants are also used as hedges for keeping the animals out, which has advantage of conserving soil from erosion as well. Jatropha cannot propagate itself it needs to be planted, in the study regions Jatropha grow in semi-arid areas since it can survive in drought localities. Another popular cropping method is intercropping with other crops which are suitable for Jatropha because of the long period until the first harvest. Women are users of land but not owners of the land. Women under the large scale production in large plantations are employees like other men. Most of the women are employed as casual labourers in the farm and have rights to maternity leave. During feedstock production, there is an equal treatment in terms of payments although farm activities which require a lot of energy are performed by men.

6.7.1.2 Feedstock Conversion

There are different scenarios of gender disproportions in Tanzania. Women are users and not owners of the land, most women in large plantations are employed as casual labourers, supervised by men. They get all benefits of women like maternity leave (in some areas unpaid). During Jatropha feedstock production, women are treated equally and paid equally although farm activities which could require more energy are performed by men.

6.7.2 Gender issues in the Jatropha chain in the Arusha Region

Literature indicates that working conditions on big farms including those of biofuels feedstock tend to have differentiated gender impact; for example, company owners tend to prefer women workers as they are able to pay them less than their male counterparts (ILO, 2002). Fortunately in the study areas the condition is different, the majority of employees are males and the payment of wages is therefore not gender-biased.

6.7.2.1 Feedstock production

Jatropha seeds are collected from hedges or farms owned by their husbands in man headed household and selling of collected seeds to locally based companies such as KAKUTE or Diligent. Sometimes women extract oil which they use to make soap or sell oil to the companies for various uses. However, the sale of seeds, the extraction of the oil and soap making are income generating sources in the study region. Some of the people in the study region including women use Jatropha oil as fuel for lighting.

6.7.2.2 Feedstock conversion

Small scale systems have been assisting small scale farmers especially women to engage in biofuel production and to process the outputs into various products in order to add value and improve their income and livelihoods. A typical case is KAKUTE in Arusha that trained small-scale farmers, especially rural women, to process Jatropha seeds. For example, there are several women groups engaged in processing Jatropha seeds into various products like Jatropha oil and medicated soap. The processed Jatropha oil is sold at Tshs 2,500 per litre to customers for various uses such as running motor vehicles (Diligent), and household heating and lighting. Jatropha soap and raw seeds are sold at Tshs 1,000 per piece and Tshs 100 per kg, respectively.

A variety of equipment is used to extract Jatropha seeds for oil production from collected seeds; using either mechanical press or organic solvents (chemicals) and water. Technology used to extract Jatropha oil depends on the production scale of feedstock. Small scale farmers and women use manually operated ram or screw presses. Part of the extracted oil is used to make medicinal soap and the remaining amount is sold to other buyers either for export or other applications. Extracted Jatropha oil can further be processed to make biodiesel production for running engines.

6.7.3 Gender issues in the Jatropha chain in Leguruki

6.7.3.1 Feedstock Production

Under small scale farming Jatropha has become an alternative source of income for women in the study areas through getting money as labour charge for farming activities, growing and selling seedlings, selling collected seeds from hedges and farms. Jatropha plants have been growing for many years in the study

area as hedges. KAKUTE has been working with women groups to demonstrate its potential on reforestation, erosion control, and reclamation of degraded land. About 50 women were trained on growing and managing Jatropha for seed and oil production. In 2007 an ESP was installed at Leguruki village by TaTEDO and the installed MFP stimulated production of feedstock by collecting from hedges and small farms. Collection of seeds is always done by women.

6.7.3.2 Feedstock Conversion

The conversation process of Jatropha at local level includes pressing by using hand press or installed ESP. Hand operated press it is labour intensive, however, it is not user friendly to the majority of women and inefficient as compared to ESP. Oil extraction by ESP is not labour intensive but needs substantial amount of feedstock which is being collected from collectors and farmers. Extracted Jatropha oil is locally used by women groups to make medicinal soaps. On the other hand women benefited from the installed ESP for grinding maize, reducing travelling long distances to other places looking for the same services. If there is any effect from biofuel industry related to climate change, poor women and men are likely to be hardest hit by climate change because they are poor: their lack of assets, security, access to services and voice make them more vulnerable to climate hazards, and less able to adapt to them.

6.7.4 Summary of Measurable Units and Indicators

National and Regional Levels

- Men and women employed in the large Jatropha plantations
- Working conditions of both women and men in the plantations
- Type of work for both men and women in the plantation

Local Level

- Ratio of men and women in the Jatropha production activities
- Benefits distribution between men and women in the family
- Number of men and women providing family labour to the Jatropha production

6.8 Other Issues

Other issues which need immediate attention are Jatropha crop research, participatory aspects, legal aspects for workers and smallholder farmers in the Jatropha production and future development of district cooperative unions for smallholder farmers.

6.8.1 Research on Jatropha as Energy Crop

There is need of research on Jatropha to answer most of the questions asked by different stakeholders in Tanzania. Some of the areas which requires research activities are different varieties (high yielding), performance of different varieties by agro-ecological zones, comparative advantage of producing Jatropha in Tanzania, etc.

6.8.2 Participatory Aspects

The village land for most of the smallholder farmers in villages near to the large Jatropha plantations are converted into general lands without any agreement or consensus with residents. There is a need to find participatory ways for ensuring that there is agreement between two parts which will be guided by legal advisors from both sides (smallholder farmers and a company intending to establish plantation). The implementation of a participatory approach at the rural community level is important to minimize land conflicts and to create sustainability of Jatropha production in the area.

6.8.3 Legal Aspects

There are several legal issues needed to be followed before any biofuel investment is put in a certain village. TIC and District councils are fully involved in the process of ensuring the people in the community will be compensated and all legal procedures are followed for the benefit of smallholder farmers. The existing laws are lagging behind of what is happening in the country regarding biofuel investment. There is also need to improve policies, acts, laws and regulations in order to ensure that local people are benefiting from the biofuel potential and resources existing in their areas.

6.8.4 Comparative Advantage

A comparative advantage is a situation in which a country, individual, company or region can produce an energy crop (Jatropha) at a lower opportunity cost depending on resource endowment in the country. Tanzania faces great disparities in the cost of producing biofuels (Jatropha inclusive), creating the potential for gains from trade. Assessments of gains from trade should, but tend not to, include the opportunity cost (or scarcity value) of resources such as water, land, labour and other local resources. Tanzania as country with potential in biofuel production located in the tropics, with their long growing season, relatively cheap labour and low opportunity cost of land and water, etc. is supposed to understand exactly comparative advantage in growing Jatropha and benefit from increasing trade of Jatropha products. The same trade could relieve the current carbon market for adding value to the biofuel industry. Therefore there is a need to come up with this assessment and use it to guide production and trade of Jatropha products within and outside the country.

7 Environmental Impacts

A number of environmental impacts are usually associated with the production and use of biomass for biofuel / bioenergy or biomaterial purposes. These include impacts on **human health** (release of toxic substances, emission of photo-oxidants and ozone-depleting gases), on the **quality of ecosystems** (release of toxic substances, emission of acidifying and atrophying gases, land-use impacts on biodiversity, water and soil) on **climate change** (global warming) and on **resources** (non-renewable energy carriers and minerals).

Out of this list, Article 23(1) of the European Renewable Energy Directive (RED, 2009/28/EC) specifically mentions the impacts on global warming (greenhouse gas emissions) biodiversity, water resources / quality and soil quality (EP & CEC 2009).

Within the Global-Bio-Pact project, these four environmental impacts were addressed. The same environmental impacts have also been selected for the analytical framework within the FAO-funded Bioenergy Environmental Impact Analysis (BIAS) project (FAO 2010).

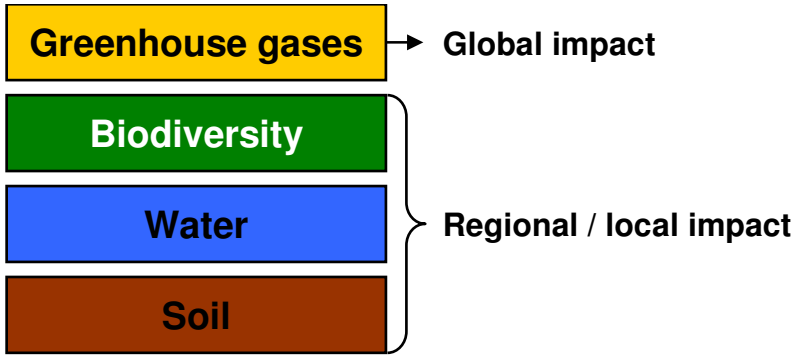


Figure 11: Environmental impacts assessed within the Global-Bio-Pact project (IFEU 2010).

Environmental impacts are occurring at different geographical scales, e.g. at global level (impacts on climate change and on the depletion of the ozone layer) or at regional and local level (impacts on biodiversity, water and soil).

Since the 1970ies, environmental assessment has been developed as a systematic process to identify, analyze and evaluate the environmental effects of products or activities to ensure that the environmental implications of decisions are taken into account *before* the decisions are made. Environmental assessment allows effective integration of environmental considerations and public concerns into decision-making. There are several environmental management techniques (e.g. risk assessment, life cycle assessment, environmental performance evaluation, environmental auditing, and environmental impact assessment). Each of these techniques is appropriate for specific situations.

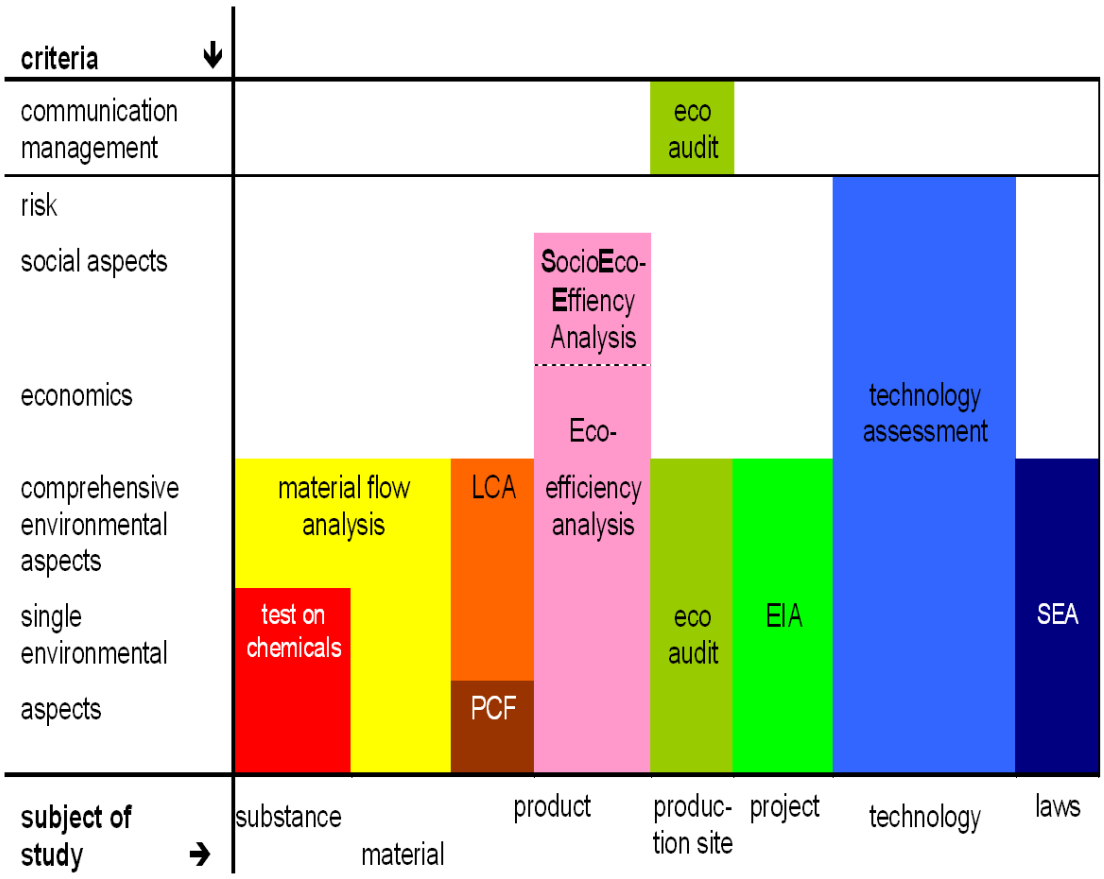


Figure 12: Environmental Assessment Techniques

The main areas of concern within the Global-Bio-Pact project are the use of land and related ecosystem impacts (biodiversity), the quality of soils, the availability and quality of water, and greenhouse gas emissions. While the latter can be quantified, others can only be described on a qualitative basis (e.g. biodiversity).

Consequently, the environmental assessment within the Global-Bio-Pact project combines elements of Life Cycle Assessment (LCA) with elements of Strategic Environmental Assessment (SEA) and / or Environmental Impact Assessment (EIA). LCA will be used for the quantification of greenhouse gas emissions (having a global impact), whereas SEA and / or EIA will be applied to the other three key environmental impacts (having a regional / local impact).

Elements of Environmental Impact Assessment (EIA) will be used to describe the local environmental impacts of biomass cultivation and conversion. Figure 13 depicts the conventional procedure of an EIA.

As stated in the EIA Directive (85/337/EEC), an EIA shall identify, describe and assess in an appropriate manner, in the light of each individual case […], the direct and indirect effects of a project on the following factors:

- human beings, fauna and flora;
- soil, water, air, climate and the landscape;
- material assets and the cultural heritage;

The interaction between the factors mentioned in the first, second and third indents.

Elements of the EIA were used to determine the impacts on biodiversity, water resources / quality and soil quality.

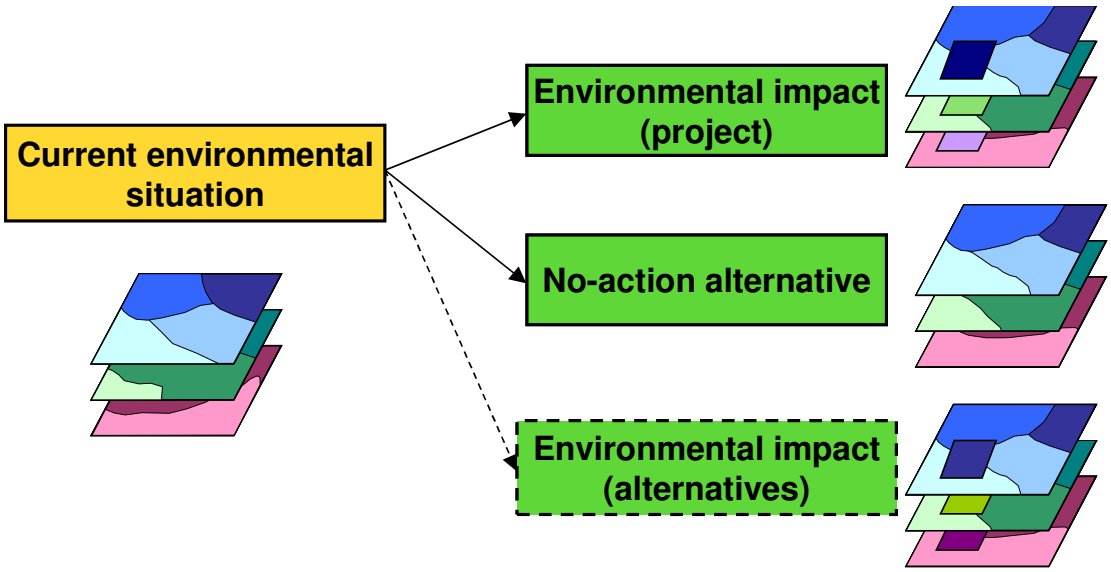


Figure 13: Conventional Procedure of an EIA

For the quantification of greenhouse gas emissions, which are having a global impact, the life cycle assessment (LCA) methodology was used. The calculation rules laid down in Annex V of the Renewable Energy Directive (RED, 2009/28/EC) were taken into account.

7.1 Greenhouse Gas Emissions

Tanzania has been facing serious interrelated environmental problems, including deforestation, soil erosion, water shortage, degraded water quality, and greenhouse gas emissions. Water resources risk pollution from agricultural chemicals as well as from urban and industrial wastes. Also hydropower installations put pressuer on water bodies. A shortage of water is expected to pose a problem in the coming years. Output from forestry also has declined because of resource degradation. Overexploitation over the past three decades has reduced the country‘s timber resources. This loss of forest aggravates erosion and loss of biodiversity. Jatropha has been reported to control land degradation and reverse deforestation. As a perennial it can sequester carbon, too.

Life-cycle analysis or assessment (LCA) is a scientific method which can be used in the Jatropha value chain to record environmental impacts from production to final disposal. Also known as "well to wheel" for transport fuels or "field to wheel" for biofuels. Two of the most used types of life cycle assessment for bioenergy are those used to determine net-energy and net greenhouse gas emissions. In order to investigate the environmental impacts of bioenergy and biofuels it is absolutely necessary to account for several other problems as acidification, nitrification, land occupation, water use or toxicological effects of fertilizers and pesticides.

7.1.1 Greenhouse Gas Emissions in the Jatropha Chain in Tanzania

Climate change is an important issue for all the investors, as alongside oil prices, it has been cited as one of the main reasons why there is increased demand for biofuels. Most of the investors have not yet carried out a greenhouse gas assessment in order to calculate how much they may be saving in emissions.

This does leave a large question mark over the industry as a whole. If the industry is not meeting the demand of one of its main drivers reducing the amount of greenhouse gases - then there is a large uncertainty linked to its future. If biofuel crops are planted in areas where there is a large amount of natural vegetation, the result will be net carbon emissions, but if planted on degraded or disused agricultural land there will be fairly immediate net carbon savings.

Each company needs to carry out in-depth analysis of its carbon balance in order to resolve this issue. Gibbs (2008) calculated the Ecosystem Carbon Payback Time (ECPT) for different biofuels. The ECPT is defined as how many years it takes for the biofuel carbon savings from avoided fossil fuel combustion to offset the losses in ecosystem carbon from clearing land to grow new feedstock. The calculations do not take into account crop yield increases, emissions from future non-conventional petroleum sources or advances in biofuel feedstock and processing technology. This is calculated as follows:

$$ECPT = \frac{\text{Carbon} - \text{land Source} - \text{Carbon biofuel crops}}{\text{Biofuel carbon savings/ha/year}}$$

Figure 14 shows the range of ECPT across the humid, seasonal and dry tropics for different combinations of land sources and biofuel feedstock crops (Jatropha inclusive) across the tropics.

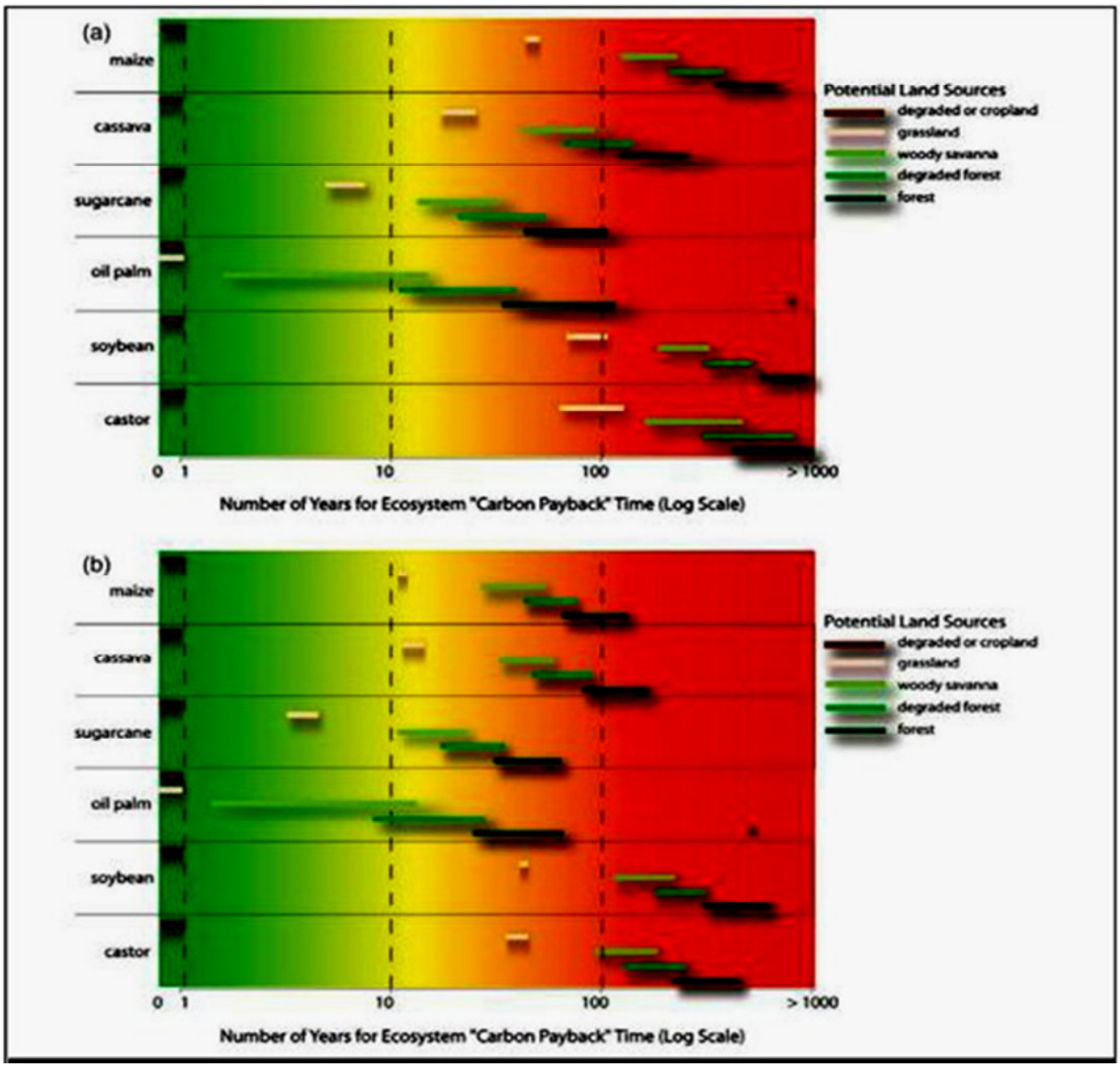


Figure 14: The ecosystem payback time for potential biofuel crop expansion pathway across the tropics

The bars in Figure 14 represent the range of Ecosystem Carbon Payback Time. The green to red background represents a stop light indicating green for go' in replacing degraded lands, yellow for caution' in replacing grasslands, woody savannas and red for stop' replacing forests for biofuel crop expansion. In (a) the payback period for potential biofuel production based on crop yields is about 2,000 as reported in WWF (2009). In (b) the potential payback period is shown if all crops achieved the top 10% global yield through gradual or abrupt improvements in agricultural management or technology. Some additional data is needed on new crops such as Jatropha in order to calculate their ECPT.

The WWF study (2009) reported that the Diligent made an estimation of GHG balance as a function of agricultural inputs (environmental effects) and the harvest (socio-economic effects). The harvested seeds are thought to generate three flows of biofuels (oil, shells and seedcake) and three systems to produce electricity and heat are considered; the Co-firing of Jatropha oil with fossil oil, co-firing of Jatropha seed cake and shells with coal or wood and the co-production of electricity and heat by combustion of Jatropha oil in a CHP (combined heat and power installation), optionally combined with the generation of electricity

from seed co-firing seed cake and shells. The calculation of the GHG balances using the following formula:

$$GHG\ Reduction = \frac{\text{GHG Emission Reference Chain (i)} - \text{GHG Biofuel Chain (i)}}{\text{GHG Emission Reference Chain}}$$

Here it is assumed that the Jatropha hedges will not be replacing existing biomass. If production is restricted to small hedges around smallholders farms this seems to be a fair assumption. Some of the key parameters for greenhouse gas reduction are the efficiency uptake of the uptake of nitrogen, the N_2O emission factor and the N content of the fruits. From this it was calculated that Diligent would make a reduction in GHGs of 60% when considering seeds, cake and shells produced from Jatropha.

Greenhouse Gas Emissions from Carbon Stock Changes

According to different literatures (Yanda, 2005, Sulle 2009, Napomuk 2009), the overall performance of Jatropha in reducing fossil biodiesel use and greenhouse gas emissions varies widely when considering the entire life cycle from production to use. The net balance depends on the production process and the amount of biodiesel needed. Increased Jatropha seeds and oil production will be achieved through improved land productivity and through expansion of cultivated area, using existing cropland as well as less-productive land. However, it is more likely that biofuels will intensify the pressure on fertile lands where higher returns can be achieved.

Tanzania is in the tropics with mixture of tropical and mountainous, wet, moist and dry climatic zones. When forests or grasslands are converted to a Jatropha plantation, carbon stored in the soil is released into the atmosphere. In some areas, effects can be so great that they negate the benefits of SJO or biodiesel and lead to a net increase in greenhouse gas emissions when replacing fossil fuels.

A significant factor contributing to greenhouse gas emissions is the amount of fossil energy used for feedstock production and transport, for cultivation and harvesting of the crops or in the biofuel production plant itself.

By-products from Jatropha production such as fertilizer from seedcakes and remains of plants make a positive contribution to climate change mitigation because they save energy and greenhouse gas emissions that would otherwise have been needed to produce the feed by other means.

A Jatropha tree absorbs around 8 kg of CO_2 every year. 2,500 trees can be planted in a ha, thus, resulting in 20 t of CO_2 sequestration per year for the lifetime of 40-50 years. Moreover, each ha produces an average of 1,000 gallons of biodiesel per year and 3500 kg of biomass. The usage of biodiesel results in the reduction of 3.2 kg CO_2/l produced by diesel. At the 78% efficiency, biodiesel will reduce in 2.5 kg of CO_2/l or 9.2 t of CO_2 for every ha of plantation. The biomass produced after the oil extraction will further result in carbon reduction based on the amount of electricity generated from it.

Many studies have questioned their carbon neutrality when all the emissions resulting from planting, fertilization, transport and refining are taken into account. More recently, is has been suggested that the extra emissions of nitrous oxide (a greenhouse gas with a potential impact nearly 300 times greater than carbon dioxide) as a result of microbial action on nitrate fertilizers used in the growth of biofuels may be 3 to 5 times higher than estimated by the Intergovernmental Panel on Climate Change.

However, changes in land use due to Jatropha production can have dramatic effects on greenhouse gas emissions. When forest or grassland is converted to Jatropha plantation to produce feed-stocks, carbon stored in the soil is released into the atmosphere. The effects can be so great that they negate the benefits of biofuels. Repaying this 'carbon debt' could take decades or even hundreds of years. In some cases it would be more cost-effective to strive for greater fuel efficiency and carbon sequestration through reforestation and forest conservation.

7.2 Biodiversity

As mentioned in Article 17(3) of the Renewable Energy Directive (RED, 2009/28/EC), biomass shall not be obtained from land with high biodiversity value such as primary forests, protected areas (PA) and other biodiversity-relevant areas as well as highly bio-diverse grassland

Tanzania is a country of high biodiversity with many endangered ecosystems. One of these are the coastal forest and woodland, which have many endemic species. The coast of Tanzania where the plantation of Sun Biofuels is located, is seen as one of the key areas earmarked by investors for the establishment of biofuel feedstock plantations and the lack of current data on endangered and rare species could lead to a great loss of biodiversity if areas of high conservation value are not set aside as

no-go zones. Although it is possible to make a concerted effort to help preserve HCV areas and minimise environmental impact, there is no a clear plan and detailed study about this issue. Based on the precautionary principle, until more documentation is made about the biodiversity in each area and until management plans are written that mitigate their environmental impact, the establishment of biofuel plantations remain a threat to biodiversity. How indirect land use will affect biodiversity is a much larger question that Sun Biofuels also needs to address.

Sun Biofuels:

The establishment of the biofuel plant in the Kisarawe District has resulted into change of land cover and biodiversity of the area allocated for biofuel feedstock production. Land cover in this case is the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures. There were some human activities such as agriculture, forestry and construction which were taking place on the land developed for biofuels that have altered land surface processes including hydrology and biodiversity.

Many forests and woodlands around the plantation have already been degraded by the dense human population close to Dar es Salaam, although areas of natural coastal bushland grassland and thicket are still present. The severe charcoal crisis is the major source of forest clearance both in and outside forest reserves. Land in the area is of poor quality for farming. Clearance of forest patches for farm land to gain access to the more fertile forest soils is a major source of forest clearance. The population and final pressures on these forests areas close to the city of Dar es Salaam is great and growing, so that local communities have great difficulties to manage their local natural resources.

Biodiversity is often reduced dramatically by land clearing. When land is transformed from a primary forest or woodlands to a farm, the loss of plant species within cleared areas is immediate and complete. An area occupied by sun-biofuels to the large extent is woodlands. The habitat suitability of woodlands and other ecosystems surrounding those under intensive use were also impacted by changing the environment of different animals and plant species, which expose woodlands edges to external influences and decrease core habitat areas. The medicinal herbs and wild fruits species which were used by people in the surrounding villages are no longer naturally found and harvested from this area.

The Sun Biofuels concession is located next to the large patch of scrub forest/thicket of the Ruvu South Forest Reserve and close to the patches of coastal forest in the Pugu and Kazimzumbwi forest reserves. The Pugu forest reserve has been heavily studied due to its proximity and easy access from Dar es Salaam, and some seven plants species named *Rhynchosia hotzii*, *Humbertochloa greenwayi*, *Lasiodiscus holtzii*, *Grumilea rufecens, Annonaceae indet., Aspilia sp. and Euphorbiaceae* are still only known from this reserve, and may even have become extinct following the heavy degradation of the forest over the last 30 years.

Further eight plant species are only known from the Pugu/Kazimzumbwi forest which is near to the Sun Biofuels Plantation. These species include *Uvaria pandensis*, *Xylopia* sp. B of FTEA, *Combretum harrisii*, *Tragia acalyphoide*s, *Baphia puguensis, Multidentia castanae* and *Millettia puguensis*. In addition, the rare tree *Foetidia africana* is endemic. This is an endemic genus and may well be in the thickets/scrub forest on the Sun Biofuels concession. There are only a few botanical collections in Kazimzumbwi, Pugu and elsewhere in the vicinity.

The presence of so many endemic plant species in this area demonstrates the highly sensitive nature of the Sun Biofuels Plantation Area. This gives implication of losing several endemic species by clearing the land during farm development in Kisarawe District. Table 7 gives some of the endemic species found in Kisarawe Forests and Woodlands.

Table 7: Endemic Species Found in Kisarawe Forests and Woodlands

Mammals*	Forest Dependent Birds**	Plants***
Wahlberg's fruit bat *Epomophorus wahlbergi*	Southern Banded Snake Eagle *Circaetus fasciolatus*	*Rhynchosia holtzii*
Black and white colobus *Colobus angolensis*	Livingstone's Turaco *Tauraco livingstonii*	*Humbertochloa greenwayi*
Garnett's galago Otolemur garnettii	Yellowbill *Ceuthmochares aereus*	*Lasiodiscus holtzii*
Zanzibar galago *Galagoides zanzibaricus*	Green Barbet *Stactolaema olivacea*	*Grumilea rufescens*
Rondo galago *Galagoides*	Eastern Green Tinkerbird	*Eragrostis* sp. - probable new

rondoensis	*Pogoniulus simple*	species
Pangolin *Manis temminckii*	Sokoke Pipit *Anthus sokokensis*	*Pycreus* sp. - probable new species
Red bellied coast squirrel *Paraxerus palliatus*	Little Greenbul *Andropadus virens*	*Aristogeitona magnistipulata*
Lesser pouched rat *Beamys hindei*	Fischer's Greenbul *Phyllastrephus fischeri*	*Aspilia* sp. - probable new species
Black and rufus elephant shrew *Rhynchocyon petersi*	Pale-breasted Illadopsis *Illadopsis rufipennis*	Annonaceae genus indetermined sp. - probable new species
	White-chested Alethe *Alethe fuelleborni*	*Diospyros engleri* (possibly exinct)
	East Coast Akalat *Sheppardia gunningi*	*Tragia acalyphoides*
	Spotted Ground Thrush *Zoothera guttata***	*Millettia puguensis*
	Kretschmer's Longbill *Macrosphenus kretschmeri*	*Uvaria pandensis Verdc.+*
	Little Yellow Flycatcher *Erythrocercus holochlorus*	*Galactia argentifolia S. Moore*
	Little Yellow Flycatcher *Erythrocercus holochlorus*	*Garcinia acutifolia*
	Uluguru Violet-backed Sunbird *Anthreptes neglectus*	*Coccinia sp. B of FTEA*
		Diospyros capricornuta F.White
		Sapium trilochulare Pax & K. Hoffm.
		Tapinanthus longipes (Bak. & Sprague) Polhill & Wiens
		Acridocarpus pauciglandulosus Launert
		Brachiaria lindiensis (Pilg.) W.D Clayton
		Rytigynia binata (Schum.) Robyns
		Tricalysia allocalyx Robbrecht
		Afroseralisia kassneri Hemsl.

Source: WWF, 2009

*Foot notes: *Mammal species endemic and near endemic to coastal forests recorded from Pugu/Kazimzumbwi,*

***Birds endemic and near-endemic to coastal forests found in forests of Pugu Hills. Over 61 forest dependent bird species have been recorded for Pugu/Kazimzumbwe. Many more non forest dependant species (up to 300) have been recorded for the area as a whole.*

Any evergreen forest in this area (including the Sun Biofuels plantation) is highly likely to contain coastal forest endemic plant and animals' species. Some of these plants are only endemic to the existing forest and woodland. The Rondo galago is a critically endangered primate and the rarest of all bush baby species. The rare tree *Foetidia africana* is likely to be found in the Sun Biofuels concession.

Diligent operates in Arusha Region. Jatropha is principally cultivated through an out grower networks of small local farmers. The potential impact on biodiversity values will arise if natural habitats such as forests, woodlands and indigenous grasslands are cleared. There are important bird areas in all regions, which are significant for their resident populations of restricted range and/or endemic bird species as well as migrant populations. There are national parks and numerous forest reserves in each region. Significant areas of natural habitat also occur outside protected areas, which is important for biodiversity. In Arusha Region the dry acacia woodlands, wetlands and small patches of forest occur outside the main protected areas e.g. Mt Meru Forest and national parks of Arusha, Makuyuni and Ngorongoro.

7.3 Water Resources and Water Quality

In Kisarawe area, little information about rivers and their status is available. Based on the discussion held with officials in the Ministry of Water and Irrigation, there is a seasonal river named Mbezi at Bigwa but its water flow has not been assessed. On the presence of aquifers in the area, it was mentioned that a small lake called Lake Manze–Mkongo existed, but its water content and suitability have not been tested. There is little hydrological information on this area.

The cleared lands on the Sun Biofuels Planation have small water streams (other than the large stream left for water conservations). The sources of water from small streams have been cultivated and are no longer used for domestic water uses.

Jatropha is a drought resistant plant and it can grow in both marginal lands (semi-arid and arid areas) and high rainfall areas. Even in areas with water scarcity, still some yield of Jatropha seeds can be obtained even though not to its full potential and capacity. This implies that there is no need of irrigation for this crop at the moment and regeneration will continue during the rainy season.

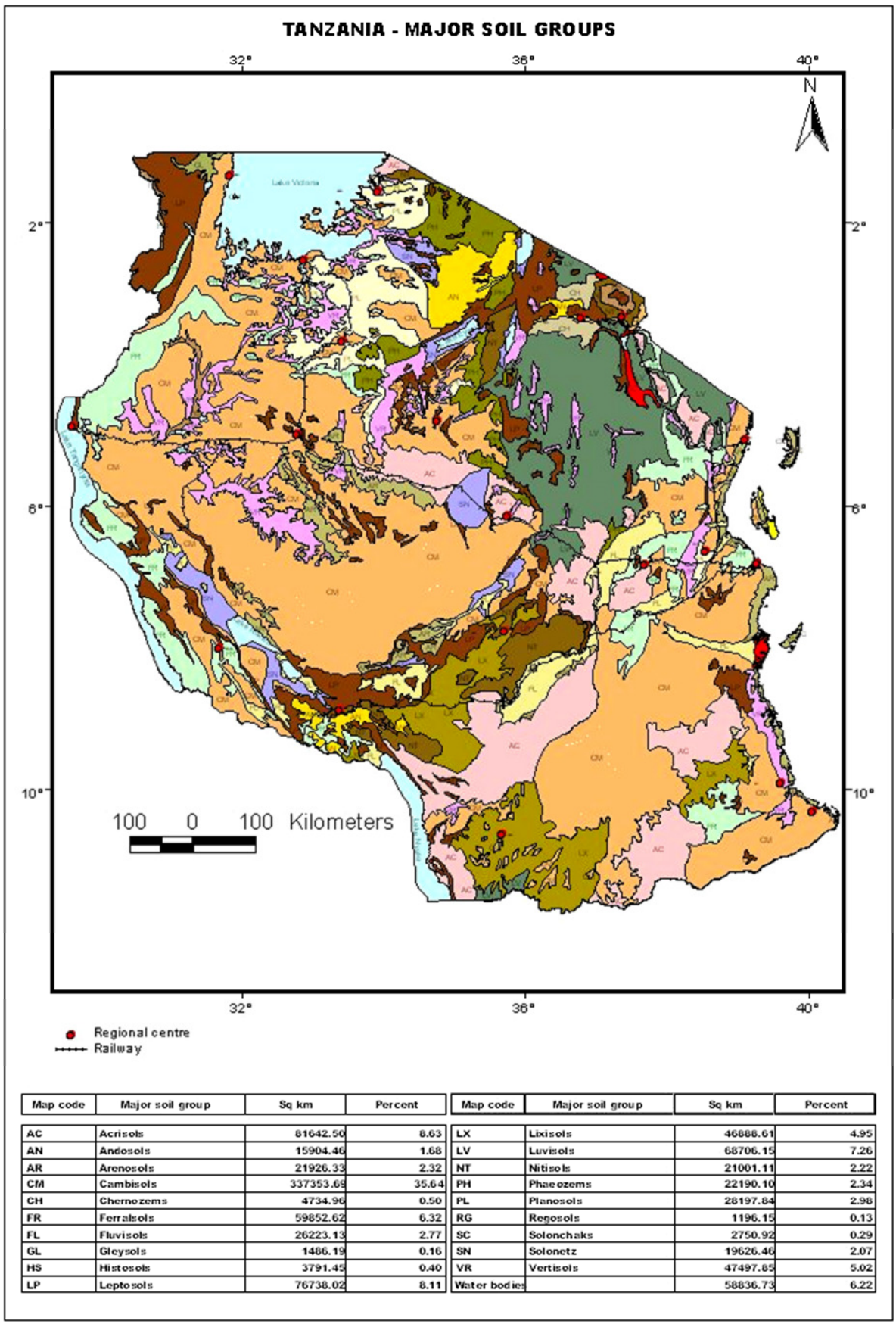
Jatropha production under large plantations and smallholder farmers in Tanzania is practiced under rain-fed conditions. There is no irrigation for any large Jatropha plantation in Tanzania. The contamination in the existing water bodies has not been determined although under this condition, experience shows that there is negligible runoff from the plantation and other production areas to the water bodies.

Since most of the plantations and companies export SJO and not biodiesel, effect of chemicals during Jatropha conversion to water resources is still low and does not have significant effect to the community.

The only problem is for large plantations to limit people in the community surrounding these plantations to have the access to the former water bodies because they are enclosed in areas demarcated for plantations.

7.4 Soil

The area of study (Kisarawe) is in the coastal highland plateau areas. Such area rises from 100 to 480 metres above sea level. The area is dominated by sandy loam and sandy clay and is suitable for vegetables and pulses cultivation. According to the global data in the Harmonized World Soil Database, the dominant soils groups in the area are planosols, fluvisols, cambisols and vetsols. Vetsols are found in the depressions and level to undulating areas, mainly in semi-arid climates with an alternation of distinct wet and dry seasons. The climax vegetation is natural grassland or woodland areas. Cambisols have been identified in the level to mountainous terrain in all climates and under a wide range of vegetation types. The Cambisols are among the most productive soils in the area. The Cambisols, though less fertile, are good soils for mixed farming and grazing. Planosols are found in seasonally or periodically wet, level (plateau) areas, mainly in sub-tropical and temperate, semi-arid and sub-humid regions with light forest or grass vegetation. Natural Planosols areas support sparse grass vegetation, often with scattered shrubs and trees that have shallow root systems and can cope with temporary water logging. Arusha Region is dominated by Chernozems and Leptosols.



Map code	Major soil group	Sq km	Percent
AC	Acrisols	81642.50	8.63
AN	Andosols	15904.46	1.68
AR	Arenosols	21926.33	2.32
CM	Cambisols	337353.69	35.64
CH	Chernozems	4734.96	0.50
FR	Ferralsols	59852.62	6.32
FL	Fluvisols	26223.13	2.77
GL	Gleysols	1486.19	0.16
HS	Histosols	3791.45	0.40
LP	Leptosols	76738.02	8.11

Map code	Major soil group	Sq km	Percent
LX	Lixisols	46888.61	4.95
LV	Luvisols	68706.15	7.26
NT	Nitisols	21001.11	2.22
PH	Phaeozems	22190.10	2.34
PL	Planosols	28197.84	2.98
RG	Regosols	1196.15	0.13
SC	Solonchaks	2750.92	0.29
SN	Solonetz	19626.46	2.07
VR	Vertisols	47497.65	5.02
Water bodies		58836.73	6.22

Figure 15: Major soil groups of Tanzania

Changes in land-use and intensification of agricultural production may harm soils. The impacts depend on the way the land is farmed. Various techniques and the use of certain plant species can reduce adverse impacts or even improve soil quality.

After clearing the lands, most large plantations in Tanzania undertake soil surveys to make analysis of suitability of soils (risk for soil erosion, salinity, fertility, etc.) in their farms for the energy crops (Jatropha). Most of these plantations have soil maps but most of them were prepared after clearing the vegetation on the land. It is possible that the land had high carbon stock but due to prior clearing the stock cannot exactly be determined because the stock of carbon which was on the land before had already been removed.

Soil maps indicate areas with different types of soils in the Jatropha plantation, areas with water ways and places with high possibility of soil erosion. Currently it is possible to measure the organic matter on the land but loss of organic matters will be determined in the future after using the plantations for a while. According to different studies, Jatropha also contribute to the soil fertility.

However, the in-depth study on soils was beyond the scope of this study given its limited time. However the weeding and harvesting method that companies plan to employ have implications for soil conservation, with larger heavy machinery compressing soil. This effect is more pronounced when the soil is wet. Most companies were planning on manual harvesting rather or harvesting feedstock mechanically.

8 Evaluation of the Measurable Units and Indicators

Some of the measurable units and indicators will measure the performance of Jatropha farming (production and conversion) at national, regional and local levels. These indicators measure economic performance, employment, working conditions, health, food security, land use, gender, etc. There is need to come up with more indicators to determine growth of Jatropha farming in Tanzania

8.1 Relevance of Impacts

The socio-economic indicators were relevant to the needs of different stakeholders in the Jatropha farming at national, regional and local levels. The study indicates the positive and negative impacts in several aspects including economics, employment, working conditions, health, food security, land use, gender, etc. Whether impacts are from large plantations or smallholder farmers, the effect will have spill-over to the community in which the farming is drawing labour. The example of Sun Biofuels which is getting labourers from the surrounding villages, most of the negative social impacts will affect these village communities.

8.2 Interlink between socioeconomic and environmental impacts

8.3 Positive correlations between socioeconomic and environmental impacts

i Jatropha Plantation and Improvement of Soil Fertility: The Jatropha plant provides significant benefits to the soil by increasing its fertility. This is due to the fact that:

- Jatropha seeds can be used to increase green cover through the reclamation of wastelands and infertile lands
- Jatropha seeds are highly suited for preventing soil erosion
- It does not inhibit the growth of other crops
- Improves soil fertility by fallen leaves throughout their life cycle
- The plant's roots grow close to the ground surface, anchoring the soil like miniature dikes or earthen bunds, which effectively slow surface runoff during intensive downpours, which are common, thus causing more water to penetrate into the soil and boosting harvests.
- The press cake which remains after oil extraction by the expellers is a very good organic fertilizer, with mineral composition comparable to that of chicken manure.

ii Jatropha Biodiesel use Versus Fossil fuel use which Reduce Carbon Emissions

- Jatropha can help sequester atmospheric carbon when grown on complete wastelands and in severely degraded conditions. Jatropha will induce significant emissions that offset any GHG savings from the rest of the biofuel production chain when introduced on tropical woodlands with substantial biomass and medium/high organic soil carbon content.

- In relation to carbon credits, it has been estimated that 1 ha of Jatropha could result in CO_2 emissions reductions of 10 t per year (Francis and Becker 2001). There is a large potential for CDM Jatropha biodiesel projects in Tanzania. Including revenue from carbon credits from petro-diesel substitution and possibly carbon sequestration and nitrogen based fertilizer substitution; biodiesel projects become considerably financially attractive.

iii Employment brought in rural areas by large plantations and smallholder Jatropha farming reduces number of people from community encroaching the natural forests and woodlands for income generation activities such as charcoal production, timer, poles and other detrimental harvesting of forest products. This will lead into reduced rate of cutting trees from forest and woodlands

iv Lights for rural households and business enterprises at local levels from Energy service Platforms (ESP) reduce use of kerosene in the households and effect of in-door air pollution and GHG emissions.

v Production of briquettes from Jatropha seedcakes does not only create revenue to entrepreneurs but also has contribution to the reduced rate of deforestation caused by using green charcoal instead of normal charcoal produced by cutting trees.

8.2.2 Negative correlations between socioeconomic and environmental impacts

i Jatropha growing has led to significant loss of biodiversity. The main proximate cause of biodiversity loss is the habitat loss associated with the processes of deforestation. The process is associated with areas where a high proportion of output and/or employment derive from Jatropha farming. The level of biodiversity in an agro-ecosystem determines its capacity to respond to external shocks, whether market or environmental. From an ecological perspective, biodiversity protects ecosystem resilience by underwriting the provision of ecosystem services over a range of environmental conditions (Holling et al 1995).

ii Soil erosion is a major problem in Agriculture. There is increased soil erosion in cleared lands areas with high soil erosivity (The vulnerability of a soil to erosion) and rainfall runoff due to removal of vegetation cover in the Jatropha plantations. Volumes of soil are lost from fields every year. This not only reduces organic matters and productivity of energy crop production, but also the soil acts as a pollutant to water bodies. Unless the proper techniques are applied to control soil erosion, it may be destructive to the environment.

iii Inadequate health universal precautions (such as wearing protective gears when handling agro-chemicals, processing of Jatropha oil, etc.) for workers in the plantations or seeds processing companies such as diligent may expose workers to negative environmental effects (damage caused by chemicals, contamination of soils, etc.).

iv There are effects for environmental damage - notably during the critical period of conversion from forest/woodlands to Jatropha plantation and when Jatropha crop stands have to be replaced at the end of their productive lives. Within their production cycle, it is in the early years that the Jatropha plantation stands are most vulnerable to land degradation - that is before a complete ground cover is formed.

8.4 Determination of Thresholds

The following thresholds were determined under this study:

- Tanzania to allocate land for biofuel production to 78,800 ha,
- Increase Jatropha biodiesel blending with mineral diesel to B20
- Price of a litre of Straight Jatropha Oil (SJO) to be USD 1.5
- Retail Price of Jatropha Seeds to USD 0.2
- More than 300 villages with using Jatropha Oil for rural energy generation
- Creation of 58,000 new employment (2.5%) from Jatropha farming
- Working hours in the Jatropha plantations and companies to be 8 hours
- Medical examination and health universal precautions for workers in large Jatropha plantations
- Percentage of 50% opportunities for both gender (women and men) in Jatropha farming

- Compensation of real value of land (both annual and perennial crops and other uses) and land itself

8.5 Impact mitigation options

In order to ensure an environmentally sustainable Jatropha production, it is important that good agricultural practices are practiced and measures to ensure sustainability should be applied consistently to all Jatropha farming business models. Moreover national policy makers have to come up with policies and strategies which will need to recognize the local needs and international consequences of biofuel development to the environment.

All environmental effects such as greenhouse gas emission effects, biodiversity loss, water resources/water quality and degradation of soils need to be mitigated in order to ensure sustainable Jatropha farming with little effect to the environment.

8.6 Impact and Biomass Certification

Certification is the process whereby an independent third party assesses the quality of management in relation to a set of predetermined requirements (standards). These are mostly formulated as criteria that have to be fulfilled for the certification of a product or a production process. To use criteria for the formulation of a certification standard they have to be operational and measurable. For this purpose, indicators and verifiers are used to assess standards set for biomass production.

Many certification initiatives are being employed on various levels. Due to the increasing number of certification schemes, there is a danger of fragmentation and incompatible certification systems.

However, certification of Jatropha and other biofuel products is important in order to keep up with standards and avoid negative effects in the biofuel industry. Although the process of certification is more useful for exported bio-products, its application should also be locally emphasized to ensure and maintain quality of bio-products within the country. However, it is doubtful whether smallholder farmer's involvement in Jatropha farming in Tanzania will not be neglected. The major potential bottlenecks include: impacts on biodiversity, GHG emissions, food security; lack operational indicators and verifiers; particularly for indirect effects. There is need of gradual development of certification systems and at the same time of improving training and education opportunities for stakeholders in order to ensure future expansion and quality of the Jatropha value chain.

9 Conclusion

Jatropha farming is characterized by a wide range of stakeholders with diverse interests. This is combined with the rapid evolution of the sector and needs proper coordination to ensure sustainable Jatropha farming. This study has demonstrated that Jatropha farming in Tanzania is far from being sustainable and therefore policy making has to take into account a number of dissatisfactions with various players and stakeholders and the uncertainties that surround their current and future roles in the production, processing and marketing of Jatropha products. The policy makers must look into the whole process of developing Jatropha and minimize negative socio-economic drawbacks and improve factors which will create growth of production, processing and utilization of Jatropha products.

10 References

Action Aid (2009): *Implication of Biofuels Production on Food Security in Tanzania*, Action Aid Tanzania,

E. Luoga, E. Mzunda, J. Shuma, P. Kiwele E. Liwenga and E. Zainab (2010): *Biofuels Development, Local Resource Rights and Governance in Africa and Asia,* CIFOR, Indonesia

E.Sulle and F. Nelson. Iied (2009) *Biofuels, Land Access and Rural Livelihoods in Tanzania*; Dar es Salaam, Tanzania

Giovanni Venturini Del Greco and Laurens Rademakers (2010): *The Jatropha Energy System: An Integrated Approach to Decentralized and Sustainable Energy Production at the Village Level*, Equator Energy, Florence, Italy

Janske van Eijck (2009): *The Smallholder Model of Biofuel Production in Tanzania*, GTZ and ProBEC for the SADC Energy Secretariat,

Kari Hartwig, and Susan James (2011): *Village Reports for Leguruki, Kingori, Malula Samaria, and Njoro in Arumeru District*, The Whole Village Project and Savannah Forever, University of Minnesota

MAFS (2006): *Food security and co-operatives, Tanga, Tanzania, Rain fed Agriculture Crop suitability for Tanzania*, Milingano Agricultural Research Institute Department of Research and Training Ministry of Agriculture,

MEM (2008): *Guidelines for Sustainable Development of Liquid Biofuels and Co-generation*, the United Republic of Tanzania Ministry of Energy and Minerals, Dar es Salaam, Tanzania

MEM (2003): *The National Energy Policy*, the Government Printers, Dar es Salaam, Tanzania

MAFS (2003): *the Agriculture and Food Security Policy*, the Government Printers, Dar es Salaam, Tanzania

MIT (1992): *The Industrial Development Policy*, the Government Printers, Dar es Salaam, Tanzania

VPO (1997): *The National Environmental Policy*, the Government Printers, Dar es Salaam, Tanzania

MARI (2006), Soils of Tanzania and their Potential for Agriculture Development, Ministry of Agriculture and Food Security, Tanzania

ML (1995*): The National Land Policy*, the Government Printers, Dar es Salaam, Tanzania

MNRT (1998): *The National Forestry Policy*, the Government Printers, Dar es Salaam, Tanzania

Mwalyosi, R.B.B., Yanda, P (1989). *Water Potentials in the Lake Manyara Catchment Basin, Institute of Resource Assessment*, Research Paper No.20. Dar es Salaam, Tanzania.

Nepomuk Wahl, Ramni Jamnadass, Henning Baur, Cristel Munster and Miyuki Liyama (2009): *Economic Viability Of Jatropha Curcas L. Plantations In Northern Tanzania* (Assessing farmers' prospects via cost-Benefit Analysis), World Agroforestry Centre, Nairobi, Kenya

P.Z. Yanda, N.F. Madulu, (2005*): Water resource management and biodiversity conservation in the Eastern Rift Valley Lakes, Northern Tanzania,* Physics and Chemistry of the Earth 30 (2005) 717-725

Richard Brittaine and NeBambi Lutaladio **(**2010): *Jatropha: A Smallholder Bioenergy Crop (The Potential for Pro-Poor Development)*, Integrated Crop Management Vol. 8–2010, IFAD

Sawe EN. 2008. *Decentralized (Off Grid) Rural Electrification through Biofuels*. The Case of

Jatropha oil powered Multifunctional platforms (MFPs). Presentation held at the "Workshop on Biofuels Production from Jatropha" on February, 20 2008 in Dar es Salaam, Tanzania

Shechambo, F, (1998). *Socio-economic trends of the People Living around Protected areas*: The case of Lake Manyara National Park. Paper for the 4th Biosphere Reserves for Biodiversity Conservation and Sustainable Use in Anglophone Africa (BRAAF) Workshop, Arusha, Tanzania.

URT (1996). *The National Investment Promotion Policy*. Government Printer

URT (1997). *The Tanzania Investment Act, 1997*, Government Printer, Dar es Salaam.

URT (2003): The *Occupational Health and Safety Act of 2003, Section 65*, Government Printer, Dar es Salaam

WWF 2009: Biofuel Industry Study, Tanzania (An Assessment of the Current Situation), World Wide Fund for Nature