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FEASIBILITY OF LARGE-SCALE BIO-FUEL PRODUCTION IN TANZANIA

STUDY REPORT

Sponsored by the Swedish Embassy in Tanzania

(The views and interpretations expressed in this report are of the authors and do not necessarily reflect those of the Swedish Embassy in Tanzania or Sida)

The Study Team

Burton Mwamila[1], Kassim Kulindwa[1], Oscar Kibazohi[1], Hamudi Majamba[1], Hussein Mlinga[1], Domician Charlz[1], Marcelina Chijoriga[1], Abraham Temu[1], Geoffrey John[1], RPC Temu[2], Salim Maliondo[2], Susan Nchimbi-Msola[2], Zebedayo Mvena[2], Matovelo[2] and John Lupala[3]

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Study Team
Dar es Salaam
April 2009

LIST OF ACRONYMS

BAFF	Bio Alcohol Fuel Foundation
CFC	Community Finance Company
CDM	Clean Development Mechanism funding
COSTECH	The Tanzania Commission for Science and Technology
EIA	Environmental Impact Assessment
ESD	Energy for Sustainable Development
EU	Euoropean Union
FELISA	Farming for Energy for better Livelihood in Southern Africa
GDP	Gross Domestic Product
GHG	Green House Gases
GMP	Genetically Modified Plants
GMO	Genetically Modified Organisms
GN	Government Notice
GoT	Government of Tanzania
Ha	Hectare
KAKUTE	Kampuni ya Kusambaza Tekinologia
Km	Kilometre
KOJ	Kurasini Oil Jet
MAFC	Ministry of Agriculture, Food Security and Cooperatives
MEM	Ministry of Energy and Minerals
MP	Member of Parliament
NBTF	National Biofuels Task Force
NEMC	National Environmental Management Council
NICOL	National Investment Company Limited
NLUPF	National Land Use Planning Framework
NPAH	Nitrated Polycyclic Aromatic Hydrocarbons
NTFP	Non-Timber Forest Products
PAH	Polycyclic Aromatic Hydrocarbons
PD	Positive Displacement
PPP	Private Public Partnership
RAZABA	Ranchi ya Zanzibar Bagamoyo
SASRI	South Africa Sugarcane Research Institute
SEKAB	Swedish Ethanol Chemistry AB
TANROADS	Tanzania Roads Agency
TaTEDO	Tanzania Traditional Energy Development and Environment Organisation
TIC	Tanzania Investment Centre
TPA	Tanzania Ports Authority
URT	United Republic of Tanzania
USA	United States of America
WHO	World Health Organisation
WWF	World Wildlife Fund
VEO	Village Executive Officer

EXECUTIVE SUMMARY

ES-1 Overview

(1) The continuously rising price of petroleum in the past decade and the progressive diminishing of fossil fuel reserves have triggered a number of global innovations in search of sustainable alternative energy sources such as biofuels. This has further been accelerated by the ever-increasing demand for fossil fuel in the world, and in the fast growing economies of China and India. Some countries, namely Brazil, USA and Western Europe, are in the forefront of the development of these alternative energy sources while others, Tanzania are just new comers in this regard. They therefore need to learn carefully from the experiences of global leaders of the bio fuel industry to avoid mistakes and optimize benefts.

(2) This project on the feasibility of large-scale biofuel production in Tanzania was conceived on June 28, 2007 through the efforts of the study team and the then Ambassador of Sweden to Tanzania, HE Torvald Åkesson. The same was endorsed by the Ministry of Energy and Minerals, and Sida through the Swedish Embassy agreed to finance the study which commenced in March 2008.

(3) The study was undertaken by a multi-disciplinary team of 16 Tanzanian experts from the University of Dar es Salaam, Sokoine University of Agriculture and Ardhi University covering various fields, namely; engineering, agriculture, law, economics, commerce, land-use planning, environment, ecology, forestry, livestock.

(4) Despite the ongoing disagreements, bio-fuel production and use are on the increase. About one out of every 40 cars and trucks in the United States can now run on a commercial mix of gasoline and ethanol, which is mostly made from corn. Ethanol enthusiasts, such as corn growers and the politicians who represent them, would like to see that number to rise. The growth in world grain consumption during the six years since 2000 averaged roughly 31 million tons per year. Of this growth, close to 24 million tons were consumed as food or feed. The annual growth in grain used to produce fuel ethanol for cars in the United States alone averaged nearly 7 million tons per year, rising from 2 million tons in 2001 to 14 million tons in 2006.

(5) Brazil is an ethanol pioneer where actual production started as early as in the 1930s. Over the past three decades Brazil has worked to create ethanol as a viable

alternative to gasoline. With its sugarcane-based fuel, Brazil started a serious ethanol program, in the 1970s, in response to the uncertainties of the oil market. Brazil now enjoys intermittent success; it is the second in the world after United States in terms of production volume of ethanol. Introduction of flex technology which allows petrol engines to run on any ratio of ethanol-petrol blend has increased ethanol consumption in Brazil; ethanol from sugarcane accounts for over 20% of Brazil's transport fuel market, and it is cheaper to drive on ethanol than on gasoline. Production of ethanol in Brazil is expected to increase to 18 billion liters a year by 2010. In Africa, initiatives are being made to plant *Jatropha curcas* and oil palm, among other feedstocks, for bio diesel production. Ethanol is also produced in Africa with South Africa in the lead.

(6) Tanzania is endowed with energy resources mix estimated at: 1,200 tons of coal of which 304 million tons are proven; 29.02 billion m^3 of proven natural gas; 4.7 GW of macro- hydro (561 MW developed); 314 MW of mini hydro potential of which only 1.5% is developed; 150 MW of Geothermal (completely unexploited); 12 million TOE of biomass potential excluding biofuel; and a solar insolation of approximately 4.5 $kW/km^2/day$. Due to under deployment of these energy sources, the commercial energy consumption is skewed in favour of imported petroleum.

(7) Petroleum importation consumes more than 30% of Tanzania's foreign exchange earnings. The transport sector is the largest end user of imported petroleum fuels, consuming 40.5% of the total. Biofuel can have a direct use in the transport sector either in blended or in new generation flex technology. However, the advent of the biofuel has brought with it the debate on land issues, people's welfare, food security and the environment. Thus, Tanzania needs to look into the biofuel business plantations prudently.

ES-2 Land Use, Food Security, and Environmental Issues

ES-2.1 Land Use

(1) The study of the feasibility of large scale biofuel production in Tanzania has revealed that the land requested or allocated to biofuel investors include prime natural vegetations such as; miombo woodlands, coastal forests, wetlands and riverine forests. Tanzania's miombo vegetation, however, belongs to the Global 200 WWF list of important biodiversity eco-regions. Further, the coastal forests are recognized as a globally important conservation priority hotspot rich in endemic taxa.

(2) The plantation sites are in breeding and migration routes for wildlife e.g. from Selous Game Reserve and the Saadani National Park. Habitat fragmentation by biofuel feed-stock cultivation will prevent or minimize genetic exchange between various organisms, and will affect pollinators' movements. Some plantation sites are close or within catchment and watershed areas. Intensification of agricultural production, interfering with the hydrological cycle of the areas and the increased use of agro-chemicals and water resources will lead to, biodiversity loss, water shortages, increased water pollution and eutrophication, soil degradation and erosion. These will consequently have impacts on plant and animal life. The mangrove vegetation at the far end of river estuaries passing through plantations may also be influenced by siltation and chemicals transported from the project areas by the water. In addition, large changes in water flow by the projects may influence the mangroves as salinity will push inland. This will have consequences on the mangrove ecosystem.

(3 Improperly known or genetically modified feed-stocks may competitively displace native species or lead to gene flow with native species. For example, *Jatropha curcas* is a potentially invasive alien plant species. In addition, it is known to transmit diseases and pathogens, such as cassava superlongation disease and the African cassava mosaic virus.

ES-2.2 Food Security

(1) Tanzania is an agricultural country, however, to-date food security has not been achieved mainly because most of the farmers in Tanzania are small holders who use hoes to till the soil which make it difficult to cover more than 2 acres per household – subsistent farming. The small holder farmers depend on rain and subsidized fertilizers which are not always forthcoming. These facts, and the scarcity of extension officers, lead to low productivity, both in terms of quantity and quality of produce which in most cases cannot meet market requirements.

(2) Under these prevailing circumstances agricultural production cannot meet national demand for food. The situation is likely to worsen if some of what these smallholder farmers produce is diverted towards biofuel production.

(3) Converting suitable land for food crops to produce biofuel crops may thus compromise food security as land and time for producing food crops will be reduced. Large-scale biofuel crops production would require proper planning and land allocation so as not to affect food crops production.

(4) The study has revealed that contracts between investors for large–scale crop production and outgrowers have to be properly formulated to ensure that the

latter get the anticipated benefits in terms of increased income and improved food security. From the study, most of the biofuel investors are planning to grow biofuel crops in monocultural form, which will inhibit plant biodiversity and provoke pest epidemics. Hence, where possible, intercropping of biofuel crops with other crops and rotation cropping should be encouraged so as to maintain soil fertility and minimize pest epidemics.

ES-2.3 Environmental Issues

(1) Large-scale biofuel farming entails heavy use of agrochemicals (fertilisers, herbicides, and pesticides) which pollutes the soil. Heavy use of N-fertilisers increases soil acidification and high nitrate loadings that lower the quality of discharged water for human and animal and use. High doses of P fertilisers when washed into water bodies increase eutrophication and algal bloom. Large doses of herbicides are normally used in large-scale plantations to control weed growth. For example, extensive use of paraquat and glyophate in large sugarcane farms is associated with serious human health problems. Moreover, polluting effluents are generated from the processing biofuel feedstocks into liquid biofuels, e.g. a lot of attached sediments, soot and chemicals are removed by cane washing before crushing. During bioethanol processing from cane juice, if 'vinasse', a byproduct of the process, which is a very strong pollutant is discharged into rivers it will affect various organisms downstream leading to massive death of fish and wildlife using the polluted water. Other chemicals used in liquid biofuel reprocessing including strong acids or alkaline solutions also affect living organisms in fresh and marine waters. Thus, the mangrove ecosystems along the Coast Region could be severely affected if the anticipated 422,000 ha of sugarcane plantations and ethanol manufacture are not carefully managed.

(2) Large-scale farming of biofuels if not well-managed could have serious negative environmental impacts. By altering existing natural ecosystems in quasi-equilibrium with the surrounding environment, with large expanses of low diversity monoculture crops, coupled with intensive management practices can for a very long time negatively impact local hydrology, accelerate soil changes including severe soil degradation, and in severe cases cause desertification. Human, animal and plant life can be negatively affected unless preventive measures are initiated from the beginning.

(3) Projected impacts of large-scale biofuel production on soils include high rates of soil erosion due to removal of the natural vegetation cover and mechanised land preparation and harvesting operations. Loss of soil organic matter and nutrients during clearing of natural vegetation, cultivation and harvesting of feedstocks

poses particularly severe challenges. Soil acidification, reduced soil biodiversity are some of the anticipated long-term negative effects. For example the establishment of large-scale plantations (>1,000ha) of sugarcane and Jatropha in the Coast and Lindi regions (82, 000 and 422,000 ha) on will significantly contribute to soil degradation through increased rates of erosion during land preparation and harvesting. The long-term deterioration of soil and water quality will greatly affect the sustainability of these production systems.

(4) Biofuel crops especially sugarcane requires a lot water to grow (2000 – 3000mm ha^{-1} $year^{-1}$) and requires irrigation water especially during the dry season. High demand of water by large-scale biofuel plantations may reduce water availed to other users. Furthermore, biofuel processing requires a lot of water for extraction and liquid biofuel production. For example, sugarcane cleaning uses a lot of water to remove attached particles and chemicals. Large quantities of water are further required to make ethanol or biodiesel. A lot of water is heated by bagasse to produce steam for power generation. Therefore a lot of water must be abstracted from rivers or underground sources to meet the high demand to grow biofuel crops and process liquid biofuels.

(5) With respect to greenhouse gas emissions and air pollution, contrary to claims that large-scale biofuel production will reduce greenhouse emissions, and hence global warming, it clear that large-scale clearing of land and especially use of fire to facilitate site preparation will increase greenhouse gases (GHG) emission and air pollution. Burning causes air pollution (elevated levels of CO_2, CO, NOx, and O_3) around sugarcane fields. Both pre-harvest and post-harvest burning in sugarcane plantations contribute to GHG emissions and air pollution, with serious consequences on the health of local inhabitants.

ES-3 Techno-Processing and Handling

(1) Biofuels of commercial interest are biodiesel and ethanol. Biodiesel is produced from vegetable oil. Ethanol is produced from fermentation of sugars. The biodiesel feedstock most preferred by companies in Tanzania is *Jatropha curcas.* Few companies have selected Palm, *Croton megalocarpus* and rapeseed. Other biodiesel feedstocks used around the world include Soya beans, and Canola/rapeseed. ***Algae*** is considered to be a future feedstock for biodiesel due to its high oil yield. On the other hand, sugarcane has been selected as the feedstock for the production of ethanol in Tanzania. Other possible ethanol feedstocks include cassava, sorghum, millet and potatoes. Future ethanol feedstocks include ***seaweeds*** and ***cellulosics*** materials. In Tanzania, sisal waste might be a future source for ethanol production.

(2) Biofuel is produced by a chemical reaction known as transesterification whereby the oil is converted to biodiesel in the presence of a catalyst (strong acid or base) and alcohols (methanol or ethanol). After the conversion biodiesel is separated from glycerol and refined. Ethanol, on the other hand, is produced by fermentation of sugar followed by ethanol recovery, usually by distillation and refining of the ethanol using molecular sieves.

(3) In addition to fuel, the biofuel industry will create job and reduce foreign currency expenditure. Ethanol has additional potential of producing electric power of approximately 20 MW from a 20,000 Ha of sugarcane. On the other hand, biodiesel production produces waste including oil-mill cake glycerol and wastewater while ethanol production produces bagasse, ash wastewater and vinesse, all of which must be treated before disposal.

ES-4 Legal Aspects

(1) Available policies and legislation in reference seek to regulate agriculture, land, environment, natural resources management (water, marine parks, fisheries, forests and wildlife), local government authorities and investment. These are relevant in an analysis of the legislative and policy framework for the production of biofuel.

(2) An in-depth analysis of the legal and policy framework of the selected sectors reveals that existing legislative provisions and policy strategies could be used to regulate the on-going development of the biofuel industry in Tanzania. The laws and policies are, however, fragmented and located in a number of legislative enactments and across many inter-related sectors. In this regard, it is therefore erroneous to argue that there is no legal or policy regime to regulate the production of biofuel which has already commenced and whose implications are already causing a lot of concern.

(3) The findings from the field illustrate that there is a lack of awareness of the basic knowledge of the laws that have a bearing on biofuel production among most local community members. This has left room for rampant abuse, among other things, in the process of acquiring village land for use as potential biofuel sites. Also, villagers are not given adequate compensation for their lands, where it is offered. Furthermore, huge tracts of land are being dished out without land use plans. There is hardly any consultation between the TIC and village governments prior to issuing land to foreigners. EIAs are not conducted as required by the law, where an effort has been made to conduct them. The biodiversity that supports other natural resources such as forests, wildlife and marine resources is

increasingly becoming in danger due to competing land use brought by large scale production of biofuels.

ES-5 Economics

ES-5.1 Economics: Marketing and Trade

(1) A general commitment to market access and entry is one of the foundations of the World Trade Organisation's (WTO's) Doha Development Agenda; and it includes supporting the accelerated liberalization of trade in green (environmentally-friendly) goods of special interest to developing countries. Of these products, biofuels offer a unique opportunity to simultaneously enhance export earnings for developing countries like Tanzania, promote rural development, diversify sources of energy supply, meet Kyoto Protocol reduction targets and promote real investment through the Clean Development Mechanism.

(2) Despite its promising prospects, the biofuel sector is exceedingly expensive for small economies like Tanzania mainly due to high trade distortions in the developed world. This is especially the case in the EU and USA – in terms of protection (tariffs and non-tariff barriers), huge subsidies and other financial and non financial incentives and hence limiting the potential biofuel export avenues for developing countries.

(3) Another challenge that may face Tanzania is in the transformation costs including biofuel-related research and development (R&D), installation of biofuel production, storage and distribution/marketing facilities or infrastructure; and acquisition of machines and/or vehicles running on biofuels.

(4) As a top priority, Tanzania needs to measure itself up against the possible costs and benefits; the existing regional and global dynamics in biofuel production, marketing and trade – including the indicated potential barriers and distortions – before indulging fully in the biofuel business. This implies a critical need for carrying out a comprehensive cost–benefit analysis of undertaking the project; and this should at best involve all stakeholders (potential beneficiaries) in the energy, agricultural, environmental, trade and other related sectors.

ES-5.2 Economics: Costs and Benefits Analysis

(1) The framework analysis provide a basis for the Tanzania to embark into the production of bio fuel in Tanzania in a socially, environmentally and economically sustainable manner. The objective is to be able to provide a solid

basis for policy and decision making for the government which is responsible for the overall welfare of Tanzanians.

(2) The analysis considers both those costs and benefits which occur at the national level such as tax revenues for the central government, foreign exchange earnings, investment flows into the economy, etc. as well as local aspects of employment, markets for local produce to workers, etc. The analysis also extends beyond the marketed monetary benefits and costs to non market benefits and cost in the environmental and social economic aspects. This is important in order to capture the type of benefits and costs which are not usually captured in market exchange and yet are important to everyday lives of communities such as; time use, non timber forest products and own production contribution to livelihoods.

(3) The household survey revealed, among others, that the main NTFP enjoyed from the adjacent forests include firewood and charcoal, game meat, building poles, thatching grass, weaving grass, grazing grass, medicinal plants, wild vegetables foods (mushrooms and fruits), pottery soil. The analysis revealed that the value of NTFP was quite a considerable in terms of amount of benefits which should be considered when decisions concerning the alternative use of land containing these resources. Similarly, values from land use for agricultural production by households revealed quite a significant benefits accruing to the village communities from the use of their land for agricultural purposes although not sufficient to lift them from poverty. This means that any investment being made has to generate greater benefits not only to the government through taxes but also to the communities as well.

(4) Contrary to the "without project" scenario, the "with project" scenario which obtains currently requires that villages give away land to investors who in turn will clear it of all vegetation cover to give way to plantations of bio fuel feedstock. The effect of this is to deny villagers the current and future stream of benefits flowing from the cleared land and hence affecting their livelihoods. Although in most of the cases household farmland is not affected, future expansion of production due to family growth and the improvement in availability and affordability of better farming technology with higher factor productivity will be curtailed. Above all, the activities tend to concentrate benefits into fewer hands while denying livelihoods to others as a result of the de-facto re-distribution of income and resource benefits from poor village communities to fewer people including investors, plantation employees and the government through tax revenues.

ES-6 Risk Analysis

ES-6.1 General

(1) The search for bio-fuels in Africa is clearly motivated by three main factors, namely; *depletion of oil reserves, climate change, and the huge bio-mass potential*. Tanzania is seen to be favourable for large-scale bio-fuel production because of availability of land, climate and the ease with which land can be acquired. But large-scale bio-fuel production entails the exploitation of four principal resources, namely; land, natural vegetation, water and labour. Further, the potential of bio-fuels as a source of renewable energy and as a direct source of support for some agricultural producers notwithstanding, there is evidence that they carry social and environmental risks. The said risks relate to relate to such aspects like non existence of consolidated legislative and policy framework, as well as the absence of standards to guide the biofuel development and production. In the circumstances, the following risks may be experienced:

- Too much land may be committed to bio-fuel development and production leaving too little land for other uses;
- Too much land may be leased to foreigners leaving too little for Tanzanian nationals;
- The natural bio-diversity may be completely disrupted to give way to large monocultural plantations of energy crops;
- Land grabbing may occur resulting in displacements of human settlements, disharmony and land conflicts and desputes;
- Mis-use and mis-management of water resource may occur resulting in depletion of sources;
- Misappropriation of natural resources wealth may occur with no or too little benefits accruing to Tanzanians;
- Exploitation of human labour may occur without adequate compensation;
- Perpetuation of scientific and technological dependence on developed countries.
- Food crops are turned into energy crops and farms for food crops changed to produce energy crops.

(2) The absence of streamlined legislative and policy framework, including detailed land-use plans, needs to be properly addressed, urgently and expeditiously, before bio-fuel development reaches too far. Current engagement with investors should allow revisions upon appropriate instruments being put in place.

ES-6.2 Availability of Land

Tanzania has a land area of 886,000 km^2 (88.6 million ha), 44 million ha of which are said to be arable. The population of Tanzania is estimated to be 40 million and it is growing at 2.3%. Agricultural activities generally include food and cash crop farming, as well as livestock keeping. Farming of energy crops belongs to the cash crop farming category. With the introduction of energy crops it is very important that there is distinction between arable land for food crops production, livestock keeping and other agricultural uses, and that adequate land is reserved for food crop production and livestock keeping. This needs to be clearly spelt out in land-use plans, which are currently under preparation. The absence of such detailed land-use plans presents a risk in that too much land may be allowed for cultivation of energy crops thereby leading to food shortage and crisis.

ES-6.3 Viability of Large-scale Biofuel Business

Large-scale farming of energy crops is already, to some extent, being practiced in a number of developing and emerging economies, including Brazil, Malaysia, Indonesia, India, Thailand, Nigeria, South Africa and Mali. It has, however, been observed that despite remarkable reductions in production costs, the bio-fuels industry has been struggling financially until recently – it has not been financially viable without government support and protection (WBI's Development Outreach, 2008). In this study it has been observed that investors from US and EU factor into feasibility studies and business plans the various subsidies and mandates offered in their home countries. Such subsidies cannot be sustained forever, and considering the amount of investment in R&D on alternative and renewable energy sources, there will come a time when they will be removed. The outcome of such a development will be catastrophic for developing countries, like Tanzania, where large scale feedstock production is introduced at the expense of huge environmental and social sacrifices.

ES-6.4 Risks with Jatropha and Others

Jatropha is understood to have carcinogenic properties which would demand very careful handling. Further, although it is claimed to grow in marginal lands with little rainfall, economies of scale required in commercial production of bio-fuels are compelling investors to seek to make it financially viable by growing it in fertile land and applying irrigation to achieve high yields. Other observed risks relate to the following in the case of Tanzania:

- Inadequacy of relevant research and development base;
- Inadequate mobilization of bio-fuel stakeholders;
- Absence of benefit sharing schemes;
- Lack of coordination and strategic handling of bio fuels;

- Inadequate safe guard on matters of national interest; and
- Acquisition of too large pieces of land on long lease tenure.

ES-7 Conclusions

(1) The situation analysis pertaining to introduction of large scale biofuel production in Tanzania, addresses the Government's need to reduce the energy budgets for transport, enhanced rural development, export expectations and contribute to mitigation of climate change.

(2) The impact of the spread of biofuels for poorer groups is likely to create an artificial demand which may persist beyond the commodity boom cycle of about 15 to 20 years. The policy and market inducements to turn land over to biofuels production will tend to raise land values. This could give new opportunities to poor farmers, as well as providing grounds for displacement of poorer people from land.

(3) Growing evidence raises doubts about the concept of "idle" land as an excuse to give land to investors. In many cases, land perceived to be "idle", "under-utilised", "marginal" or "abandoned" by government and investors is vital for the livelihoods of indigenous people. Investment in large biofuel may have repressive displacement inclination on locals who do not have access to pertinent information. These issues are associated, among other things, to the weak protection of local land rights.

(4) Although biofuel industry in Tanzania may be viable, technology is developing fast, the state of the art today may be an obsolete technology in a near future. There is no guarantee that land allocated for biofuel production today will be used for the same after twenty years. Therefore, land tenures of 99, 66 or even 33 years seem to be too long. A periodic renewal should be considered as a sustainable option.

(5) The biofuel initiatives in Tanzania calls for a harmonious relationship between local community, Government and investors coupled with awareness creation at all levels on land and investment laws related to biofuel production for an everlasting sustainability. The Government is strongly advised to observe proper land use, land use plans and safeguard the countries resources and people to avoid unnecessary conflicts and concerns.

ES-8 Recommendations

ES-8.1 General Recommendations

(1) Land allocation

It is strongly recommended that allocation of more land for bio fuel should be stopped until conducive conditions have been put in place for sustainable bio fuel production. Villagers should be empowered and facilitated to effectively participate.

(2) Land allocation to households for agricultural purposes

At least 50% of the village land should be set aside for household agricultural needs before considering allocating any land to investors, and the Government through its various institutions should play a pro-active role in deciding which feedstock should be produced and where.

(3) EIA process and credibility

A more inclusive and transparent process needs to be put in place to ensure credible conduct of EIA due to capacity problems by NEMC. Furthermore, the Government should strengthen the capacity of NEMC to perform its duties more effectively and efficiently.

(4) Community involvement, and benefit through land ownership and partnership

More capacity building and awareness creation needs to be done countrywide so that communities are informed at all levels and participate in decisions.

(5) Land Value

Valuation and inclusion of non market environmental values in the total value (costs and benefits) needs to be made during feasibility assessment of any bio fuel project.

(6) Environmental conservation

Reserved and protected areas need to be left out from any other activities including biofuel production.

(7) Production and processing of biofuels

Value addition should be done locally. Regulations should be clear on this so as to benefit the country through job creation and capital accumulation through investment as well as facilitation of technological transfer.

(8) Clarity and enforcement of regulations on natural resource utilisation
Government should move to prevent abuse of investment intended uses e.g change of land use from previously intended investment or activity. Land allocated for food crops production should not be used for other purposes.

(9) Suitable biofuel crop varieties
Agricultural research institutes should be tasked to conduct research to identify suitable bio fuel crop varieties that will maximize yield, and develop appropriate agronomic packages that will minimize soil erosion and soil-water pollution.

(10) Food security
Village by-laws should be adjusted to require that biofuel out-growers allocate part of their land for food production so as to ensure food security. Where appropriate intercropping of biofuel crops with others, and crop rotation should be practiced to improve soil fertility and to reduce pests and thereby increase crop yields.

ES-8.2 Recommendations for Bio-fuel Guidelines/Policy

ES-8.2.1 Land Issues

(1) Land allocation for large-scale bio-fuel production should be suspended until the legal instruments, and other conducive conditions are in place.
(2) No land should be allocated from villages without land use plans.
(3) Land allocation should take into account village land requirements for the lease period, factoring in technological advancement (in agriculture).
(4) Because technology is changing very fast, land tenures of 33, 66 and 99 years are not justifiable. Flexible short renewable periods of not more than 20 years (lease period) depending on type of feedstock should be adopted.
(5) Use of land by villages/villagers as equity for bio-fuel investment should be encouraged.
(6) There should be deliberate efforts to create awareness of villagers on land issues.
(7) There should be a resettlement policy for affected communities, to take care of livelihood.
(8) In assessing the economic value of land all tangibles and intangibles which are lost when the land use is changed should be considered. Valuation should include non market environmental values (costs and benefits) during feasibility assessment of any bio fuel project.
(9) Existing legislations on land issues should be properly enforced to avoid deviation from intended land use. For example, land allocated for food crops production should not be used for other purposes.

ES-8.2.2 Participation by Locals/Tanzanians

(1) There should be a deliberate policy to accommodate participation of Tanzanians in the bio-fuel industry by setting a minimum percentage of investment by nationals.
(2) Communities within close proximity of a bio-fuel project should be entitled to benefit through contract farming.
(3) All investors should be encouraged to adopt an out grower system.
(4) Villagers should be empowered and facilitated to effectively participate in bio-fuel related activities.

ES-8.2.3 Benefit Sharing

(1) Tanzania should have a share of the carbon credit (of at least 50%) accruing from the bio-fuel business.
(2) A framework for benefit sharing schemes should be developed for adoption by all investors.

ES-8.2.4 Environmental Issues

(1) Bio-fuel activities should not be allowed to destroy important natural vegetation sites, biodiversity rich areas, wildlife corridors and migration routes, breeding areas, and other reserved and protected areas.
(2) A more inclusive and transparent process needs to be put in place to ensure credibility of the EIA process, and NEMC should be strengthened to enable it perform its duties more effectively and efficiently.
(3) Registration of EIA experts should be introduced by NEMC, and EIA should be done only by such registered and accredited experts in the relevant field.
(4) Public hearing should be mandatory for all EIA reports.
(5) Regulations on utilization of natural resources should be made known and properly enforced.

ES-8.2.5 Value-addition and Capacity Building

(1) Legislation should require all raw materials to be value-added before export, so as to benefit the country through employment creation and capital accumulation, arising from investments, and facilitate technological transfer.
(2) Investors should be required to participate in related capacity building efforts for the country.
(3) Investors should be required to utilize local R&D institutions fully for solving technological problems before seeking such services from similar institutions abroad.
(4) More capacity building and awareness creation needs to be done countrywide so that communities are properly equipped to make informed decisions.

(5) R&D institutions should carry out research to identify suitable bio-fuel crop varieties that will maximize yield, and develop appropriate agronomic packages that will minimize soil erosion and soil-water pollution.

ES-8.2.6 Institutional Framework, Coordination and Strategic Handling of Biofuels

(1) Instruments in form of land use plans, guidelines, policy, laws and regulations, and standards for bio-fuels should be developed and operationalized as a matter of urgency.

(2) There should be established a coordinating body with ToR to coordinate all bio-fuel related aspects, monitor and regulate the development and implementation bio-fuel projects, and safe-guard national interests. Alternatively, an appropriate existing institution may be assigned the coordination, monitoring and regulation functions related to bio-fuels.

(3) Certificates of commencement in respect of bio-fuel projects should only be issued to investors after it has been certified that all compensations, resettlements and EIAs have been properly and credibly executed. The bio-fuel coordinating body, referred to in ii) above (not TIC) should be assigned to so certify and issue the certificate of commencement.

ES-8.2.7 Human Rights and Corporate Social Responsibility

(1) Bio-fuel investment should be prohibited from dehumanizing or exploiting labour, and deploying child labour.

(2) Bio-fuel producers should be encouraged to produce food crops on their land as part of corporate social responsibility, to avoid food shortage.

ES-8.2.8 Food Security vis-à-vis Energy Security

(1) At least 50% of the village land should be set aside for household agricultural needs before considering allocating any land to investors.

(2) Government through its various institutions should play a pro-active role in deciding which feedstock should be produced and where.

(3) Village by-laws should be put in place that will require bio fuel out-growers to allocate part of their land for food production so as to ensure food security.

(4) Where appropriate inter-cropping of biofuel with other crops, and crop rotation should be practiced to improve soil fertility and to reduce pests and thereby increase crop yields.

ES-8.2.9 Market and International Protocols Consideration

(1) Bio-fuel production should first saturate local markets before export is considered, *to minimize consumption of what is not produced locally*.

(2) International conventions/protocols of which Tanzania is a party should be respected by all parties.

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1.0 INTRODUCTION AND OVERVIEW

1.1 Introduction

1.1.1 Background

The consistently rising price of petroleum in the past decade and progressively declining fossil fuel resources has triggered a number of global innovations in search of sustainable alternative energy sources. This has been influenced by the ever-increasing demand for fossil fuel in the world and in the fast growing economies of China and India in particular, particularly for construction, industrial as well as motor vehicle consumption. Some countries, namely Brazil, USA and Western Europe, are in the forefront of these alternative energy developments while others, particularly in the developing world like South Africa and Senegal are picking up. Tanzania is quite a new comer in this regard. It should therefore learn carefully from the global bio fuel industry leaders before it embarks on the project.

This project was conceived on June 28, 2007 during a meeting between three members of the Study Team and the then Ambassador of Sweden to Tanzania, HE Torvald Åkesson. It was endorsed by the Ministry of Energy and Minerals vide letter of September 2007, based on which Sida through the Swedish Embassy agreed to financially support the Study. Implementation of the Study started in March 2008. It was undertaken by a multi-disciplinary team of 16 Tanzanian experts from the University of Dar es Salaam, Sokoine University of Agriculture and Ardhi University covering various fields, namely; engineering, agriculture, law, economics, commerce, land-use planning, environment, ecology, forestry, livestock, etc.

1.1.2 Study rationale

While bio-fuel production and use is picking up in the world, not much is known about the status of bio-fuel production, use and trade in the country in general. To be able to benefit from this apparently promising economic activity without jeopardising social, environmental and political stability, more knowledge is needed on the same. Furthermore, to develop bio-fuel production capacity within the country in a sustainable manner, its production and use feasibility need to be determined technically, economically, environmentally and commercially. The institutional and regulatory frameworks for its development need to be established. Risks have to be identified and analysed so as to enable thorough cost-benefit analysis, inform policies and facilitate optimization of benefits while minimizing negative impacts.

1.1.3 Objectives of the study

Generally, this study seeks to examine the current bio-fuel production and trade dynamics in relation to economic, social, technical and environmental implications as well as the potential that Tanzania holds in this arena.
In order to achieve the above general objective, the various issues that need to be addressed include:

a) Ongoing bio-fuel production activities; important areas of enquiry being:

i. Major bio-fuel crops grown in Tanzania;
ii. Current production systems - their characteristics and implications (incl. agronomic, environmental, social, economic, technological, legal aspects);
iii. Who, where and how much is produced;
iv. Costs and benefits of bio-fuel production;
v. Institution framework affecting bio-fuel production; and
vi. Conflicts between bio-fuel production and other land-use systems.

b) Planned bio-fuel production activities

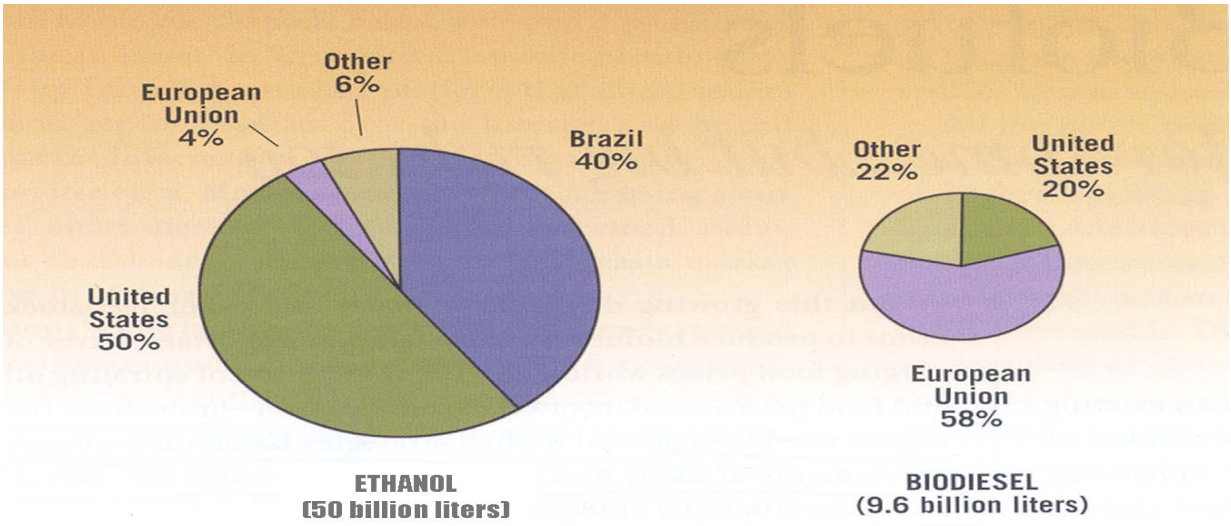
i. Resource availability for large scale bio-fuel production (land, water, human capital, technology).
ii. Research and development capacity status for bio-fuels.
iii. Trade participation, marketing and market access situation.
iv. Potential risks of production and processing bio-fuels.
v. Potential conflicts and possible resolutions.

1.2 Overview

1.2.1 Global Biofuel Trends and Experiences

As mentioned earlier, a few countries dominate global bio fuel production and trade. According to World Bank (2008), about 50 billion litres of ethanol was produced globally in 2007. Of this, 50 percent came from the USA and 40 percent from Brazil. The EU contributed 4 percent only (Fig. 1.1). During the same year, 9.6 billion litres of bio diesel was produced worldwide; and the European Union contributed 58 percent of this while USA produced 20 percent of the total. The USA has recently seen a significant shift of grain from food usage to bio fuel production. The key crops involved include corn/maize, sugarcane, rapeseed and soybean, mustard, flax, sunflower, canola, palm, hemp, *jatropha*, and coffee beans. The rising price of oil and the search for oil substitutes has led to more investments in bio-fuel business, from crop production to setting up fuel ethanol factories. As a result, the market rather than the government drives the grain production which is a key raw material in bio-fuel production in the USA. This is mainly due to the fact that the current price of ethanol is twice its production cost; and

thus the conversion of agricultural commodities into fuel for industrial and motor vehicle use has become extremely profitable.



Source: Development Outreach, World Bank Publications, Oct. 2008

Figure 1.1: Percentage of global production of fuel ethanol and biodiesel

According to World Ethanol and Bio fuel reports, the USA would begin producing annually up to 4 billion gallons of ethanol by end of 2007. This production would consume 39 million tons of grain per year, nearly all of it corn. Consequently, up to 2.5 percent of motor vehicles in the United States can now run on a commercial mix of gasoline and ethanol, which is mostly made from corn. Ethanol enthusiasts, such as corn growers and the politicians who represent them, would be happy to see that figure rise. The growth in world grain consumption during the six years since 2000 averaged roughly 31 million tons per year. Of this growth, close to 24 million tons were consumed as food or feed. The annual growth in grain used to produce fuel ethanol for cars in the United States alone averaged nearly 7 million tons per year, rising from 2 million tons in 2001 to 14 million tons in 2006.

Europe is another place where bio fuel production and trade are pronounced. Nevertheless, the associated challenge as reported in the *New Scientist* magazine states that Europe would have to turn 72% of its agricultural land over to growing bio-fuel crops in order to produce just 10% of its transport fuel from bio-fuels. That alone demonstrates that every option has its advantages and disadvantages. However, substantial progress has been made on production and utilisation of bio-fuels particularly biodiesel from rapeseeds. Germany leads other European countries in biodiesel production. Biodiesel sales in Germany rose to 2.8 million tons in 2006, accounting for almost 5 percent of the country's total transport fuel sales. Other

European major biodiesel producers include France, Italy, Austria, Denmark, United Kingdom, and Sweden.

Between 2006 and 2007 numerous efforts, bilateral and otherwise, have been seen to promote bio-fuel production in both developed and developing countries with Brazil leading the way. Brazil has since the 1970s made successful strides in the sugar cane based bio-fuel project. The programme was in response to the uncertainties of the global oil market, particularly the oil crisis of 1973. The country now enjoys intermittent success; it is the second in the world after the USA in terms of production volume of ethanol which meets about 20% of Brazil's transport fuel market needs.

The developing world is also making strides in this regard. New biodiesel production facilities have been constructed in China, India, and Malaysia. In Africa, initiatives are being made to plant *Jatropha curcas* for biodiesel production. Ethanol is also produced in Africa with South Africa in the lead. Senegal, South Africa, Brazil, Haiti, India, are among countries currently engaged in developing their bio-fuel production potential into marketable products mainly for the developed markets of the USA, EU and Canada.

Two biofuels of major importance are ethanol and biodiesel. Ethanol is a substitute or can be blended with gasoline, while bio diesel is a substitute or can be blended with mineral diesel. The two are very important due to the fact that, they are used for transportation. Ethanol for transportation is produced from sugarcane through fermentation of cane sugar into alcohol followed by distillation and "drying" into high purity ethanol. Other sources of ethanol include starch materials such as corn. In future, ethanol for transportation might be made from cellulose materials. Bio diesel is produced from vegetable oil through a process known as trans-esterification. The process transforms vegetable/seed oil or animal fat into esters of molecular weight and properties similar to petroleum diesel. Since both ethanol and bio diesel are produced from plant and animal raw materials, production of liquid bio fuels stands to boost agricultural activities.

Despite the ongoing disagreements, bio-fuel production and use are on the increase. About one out of every 40 cars and trucks in the United States can now run on a commercial mix of gasoline and ethanol, which is mostly made from corn. Ethanol enthusiasts, such as corn growers and the politicians who represent them, would like that number to rise.

The 2006 USA corn harvest has registered a shortfall of nearly 4 per cent. The growth in world grain consumption during the six years since 2000 averaged roughly 31 million tons per year. Of this growth, close to 24 million tons were consumed as food or feed. The annual growth in grain used to produce fuel ethanol for cars in the United States

alone averaged nearly 7 million tons per year, rising from 2 million tons in 2001 to 14 million tons in 2006. Consequently, up to 2.5 percent of motor vehicles in the United States can now run on a commercial mix of gasoline and ethanol, which is mostly made from corn.

Brazil is an ethanol pioneer where actual production started as early as the 1930s. Over the past three decades Brazil has worked to create ethanol as a viable alternative to gasoline. With its sugarcane-based fuel, Brazil started a serious ethanol program, in the 1970s in response to the uncertainties of the oil market. Brazil now enjoys intermittent success; it is the second in the world after United States in terms of production volume of ethanol. Introduction of flex technology which allows petrol engines to run on any ratio of ethanol-petrol blend bas increased ethanol consumption in Brazil; ethanol from sugarcane accounts for over 20% of Brazil's transport fuel market, and it is cheaper to drive on ethanol than on gasoline. Production of ethanol in Brazil is expected to increase to 18 billion liters a year by 2010. In China, India, and Malaysia, new bio diesel production facilities have been constructed. In Africa, initiatives are being made to plant *Jatropha curcas* and oil palm, among other feedstocks, for bio diesel production. Ethanol is also produced in Africa with South Africa in the lead.

1.2.2 Bio-fuel Production, Marketing and Utilisation Status in Tanzania

Energy resource for Tanzania includes coal, natural gas, hydro, solar, tidal, geothermal, and biomass, which includes biofuel. It is estimated that there are 1,200 million tones of coal deposit out of which 304 million tones are considered proven along the Kiwira coal mine deposits in southern Tanzania. The Songo Songo and Mnazi bay natural gas deposits along the Indian Ocean in Mtwara region has a proven reserve of 29.02 billion cubic metres. The macro hydro potential in Tanzania is 4.7 GW out of which only 561 MW have been developed. From the diverse biomass energy resources in terms of agricultural waste, forestry waste, including potential biomass forests, it is estimated that the total energy potential amounts to 12 million tones of oil equivalent (TOE). On the other hand, due to the high tropical solar insolation for Tanzania (4.5 kW/km^2/day) and with the bordering Indian Ocean, solar and tidal wave is another considerable energy potential, these facts are depicted in Table 1.1. There are also reported high geothermal activities in Mbeya, Rufiji basin and Arusha areas.

Due to under deployment of these energy resources, the commercial energy consumption for Tanzania is skewed to imported petroleum supply, which supplies 90% of the commercial energy needs. Hydro electricity and coal contributes to less than 10% of the commercial energy where as the remaining energy sources are contributing marginally. Further analysis of the installed electricity generation in Tanzania as detailed in Fig. 1.2 shows that 54.35% of the installed capacity is on hydro sources where as thermal (petroleum) sources installed capacity is 23.08% and natural gas

installed capacity is 17.42%. Installed capacity for biomass cogeneration and coal is 4.58% and 0.57% respectively.

Table 1.1: Tanzania Energy Resources Mix

S/N	Resource type	Available potential	Remarks
1	Coal	1,200 million tones	304 million tones are considered proven
2	Natural gas	29.02 billion cubic metres	Proven
3	Macro hydro	4.7 GW	561 MW developed
4	Micro hydro	314 MW	1.5% developed
5	Biomass	12 million tones of oil equivalent (TOE)	Total biomass excluding biofuel potential
6	Solar insolation	4.5 kW/km^2/day	Viable for thermal/PV application
7	Geothermal	150 MW	Not exploited

Source: Data extracted from IGEC (2007), ESI Africa (2006)

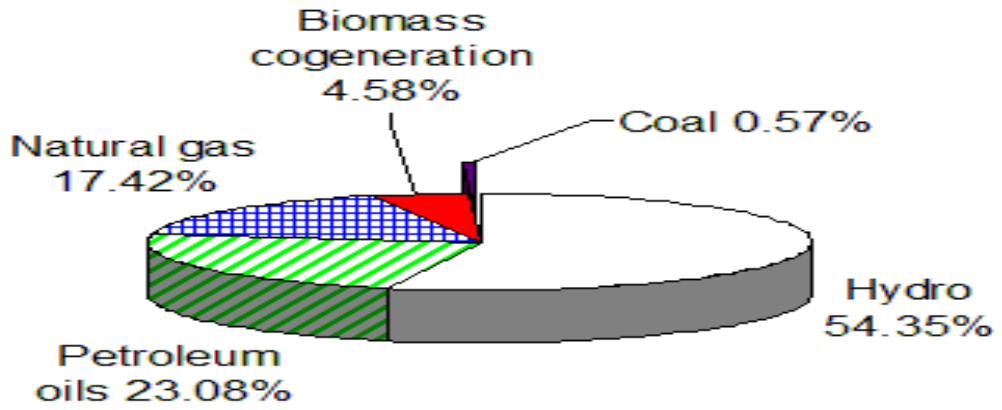


Fig. 1.2: Electricity installed capacity generation capacity

Petroleum importation per annum amounts to over 900,000 metric tonnes and the average cost of importation is more than 30% of the foreign exchange earned by the country. The transport sector is the largest end user of imported petroleum fuels, consuming 40.5% of total importation. The transport consumes almost 100% and 98% of the imported petrol of the diesel respectively. Petrol and diesel fuel consumption in the transport sector has been increasing over years (Fig. 1.3). This is due to increased vehicle fleet importation and the associated economic activity.

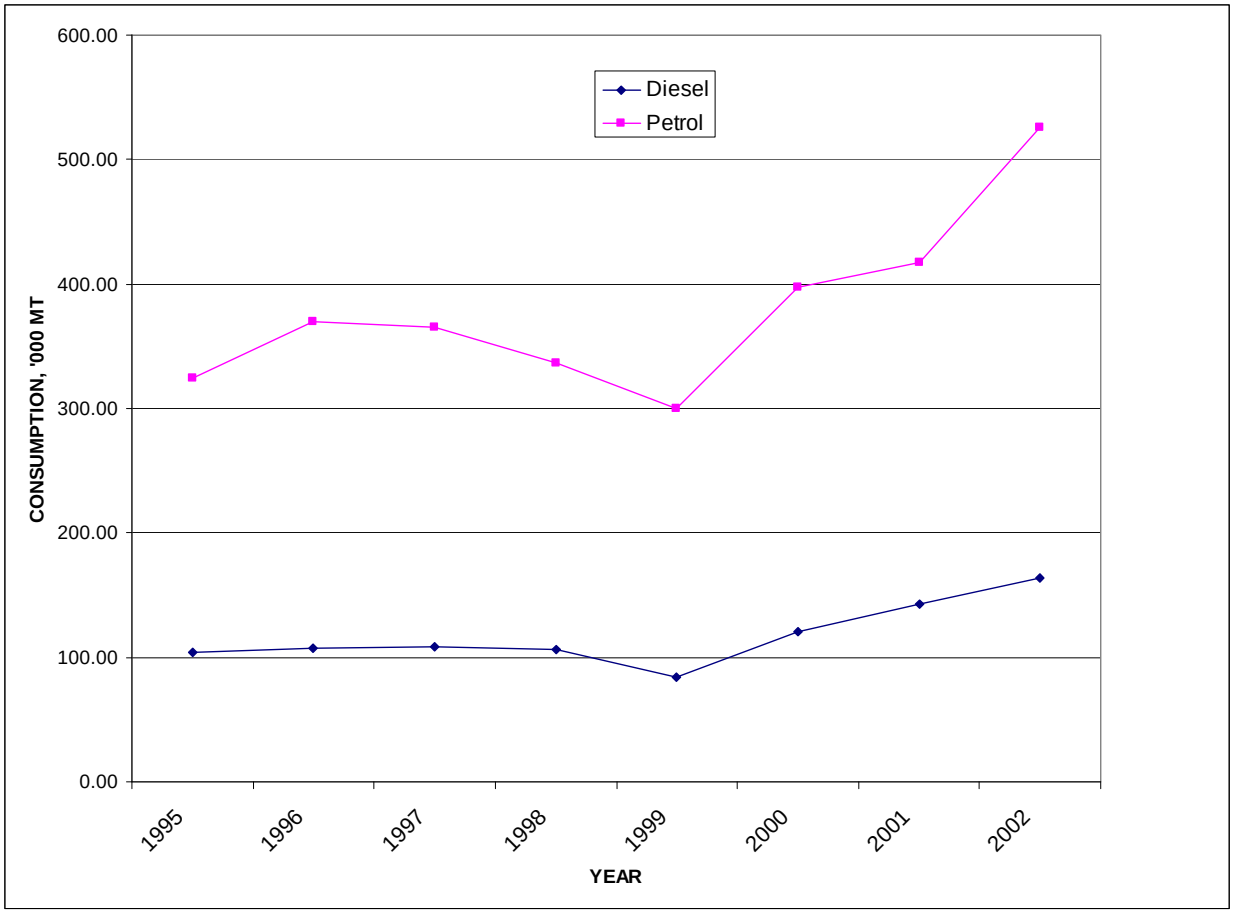


Fig. 1.3: Petrol and diesel consumption in Tanzania transport sector

The possibility that biofuels have a direct application in the transport sector is of high importance to Tanzania. Unlike electricity and other fuels that require high infrastructure investment, biofuels have an immediate application to the transport sector. This is supported by the fact that blended biofuels can run order model vehicles while new generation flex technology vehicles are capable of running on 100% biofuels.

Tanzania has a total land area of 88.6 million hectares, of which 55.2 million hectares have potential for rain-fed crop production; 20% of the 55.2 million hectares is under crop production, while 80% million hectares of land potentially available for further crop production. If a substantial amount of land is used for bio fuels production, Tanzania can produce enough bio fuels to meet its fuels need and excess for export (Ministry of Energy and Minerals Jul. 2006). Nevertheless bio-fuels production in Tanzania is just beginning to be established. As detailed in Table 1.2, several foreign companies have applied for bio-fuels production and have acquired land for planting bio-fuel crops. In order to ensure bio-fuels production is done in a sustainable manner, it is important for Tanzania to take into account the consequences of devoting a large

part of its fertile land for bio-fuel production rather than food, or at the expense of other land uses like wildlife conservation. Among the key public arguments on the subject matter have been food security, land sovereignty and as well as the overall bio fuel project viability in terms of replacing the current petroleum products. It has been argued that land is a limited resource; and thus crops for both human food and bio-fuel production stand to compete for this scarce resource. It is also claimed that the country's land lease periods to foreign investors (33, 66 or 99 years) are too long for the country to retain flexibility and sovereignty over land use; and the list is long.

Adoption of biofuels in Tanzania has twofold advantages through the accrued economical and environmental benefits. The nation has a possibility of reducing the burden of petroleum fuels importation and hence achieving energy security. Further economic advantaged are from the enhanced agricultural sector, which is dependable by the majority (80%) rural community. On the other hand, the environmental pollution saving via the use of cleaner renewable energy sources will be achieved.

It is therefore imperative for Tanzania to carefully plan and assess its chances and preparedness before embarking fully in this bio fuel business. First and foremost would be to study the policy environments as well as the institutional set ups that existed in early stages in countries with rich experience in the bio fuel business. Then, this knowledge could be used as a benchmark to enable a well informed basis for setting up guiding policies for the bio fuel sub sector in Tanzania.

Table 1.2: Current Bio fuel Production initiatives and their status in Tanzania

S/N	Feedstock/ crop	Investor	Location	Size of Land (ha) available	Remarks
1.	Sugarcane	SEKAB	Bagamoyo District (RAZABA & Bagamoyo Prison	22,000 + (500)	Seed cane farm has been planted and a reservoir for irrigation water has been constructed on the seed cane farm.
2.	Jatropha	Trinity Consultants (Bio-energy Tanzania Ltd)	Vigwaza Kidogozero (Bagamoyo district)	16,000	Out of the required 30,000 ha, investors got 16,000 ha and are busy surveying and also to be granted land after process is complete.
3.	Jatropha	Diligent (T) Ltd.	Bagamoyo	75,000 (requested)	Not given land yet.
4.	Jatropha	Shanta Estates Ltd.	Bagomoyo: Kibindu, Mihuga, Matipwili, Mkange and Miyono villages.	14,500	Agreement with villagers signed and other procedures to follow.
5.	Oil Palm	Tanzania Bio diesel Plant Ltd.	Bagamoyo: Mandera, Kilemera & Mihunga villagers	16,000	Out of 25,000 ha requested, the investor got 16,000 ha of which approval was

S/N	Feedstock/ crop	Investor	Location	Size of Land (ha) available	Remarks
					granted by district but at the level of TIC decision is yet to be received. Land survey is not yet done.
6.	Oil Palm	Clean Power Tanzania Ltd.	Visezi Village in Bagamoyo	3,500	Absconded after realizing the cost of surveying of Land Use Plans was too high for them.
7.	White sorghum	CMC Agric-Bioenergy Tanzania	Bagamoyo district	25,000	Request for land approved and asked to prepare land use plans for 3 villages.
8.	Jatropha	Sun Bio-fuel Company	Kisarawe district	9,000	Investors requested for 50,000 ha but only 9,000 ha was availed to them.
9.	Jatropha	ZAGA	Kisarawe district	?	Investor has applied for land (undisclosed)
10.	Oil Palm	African Green Oils	Rufiji district: Ruarake A, and Nyamatanga villages.	500 in Ruaruka A and 360 in Nyamatanga.	Investor financing land use plans in the villages of Nyamatanga Ruaruka A, Nyanjati, Ruaruka B, Nyamisati, Mangwi, Rungurungu. Investor has already planted 360 ha of oil palm.
11.	Sugar Cane	SEKAB	Rufiji District	400,000ha?	In process.
12.	Jatropha	InfoEnergy Ltd UK company	Mvomero district in Morogoro region (Existing derelict farm)	5,818	Land acquisition process in progress. EIA in progress
13	Jatropha and Pangamia	Bio Massive (Swedish company) in Tz since 2006	Land to be leased from community spread out in Lindi region	50,000	Envisage production of 100,000 tons per annum of bio fuels and will employ around 4,000 people. Process status unknown.
14	Jatropha	Diligent (T) Ltd.	Bagamoyo	75,000 (requested)	Not given land yet.
15	Jatropha	J&J Group (PTY) ltd. (South Africa company.	Tabora region	?	Status unknown
16	Sweet Sorghum	Abengoa Bioenergy company (origin unknown)	Bagamoyo district	?	Status unknown
17	Oil Palm	FELISTA (Tanzania/Belgium partnership).	Kigoma region	10,000 (targeted)	Out of the 10,000, half of it expected to be out growers. Has already acquired 4,258 ha disputed and currently in court)
18	Croton megalocarpus	African Bio fuel and Emission Reduction Company Tanzania Ltd. Registered in 2006. Joint	Biharamulo district in Kagera region.	20,000	Projected output 103million litres of bio diesel per year. Status: No progress due to lack of funds.

S/N	Feedstock/ crop	Investor	Location	Size of Land (ha) available	Remarks
		venture TTT-WILMA Bio fuel & Emission Reduction Company. Part of WILMA group- USA and National Investment Company Ltd (NICOL) of Tz			
19	Jatropha	Prokon BV (Dutch company)	Mpanda district since 2005	10,000	Contract farming with 2,000 farmers. Do not own plantation land. Existing production still low.
20	Jatropha	Mitsubishi Corporation (Japan company)	Looking for land in: Arusha, Dar & Coast region	?	Status unknown
21	Jatropha	Kapunga rice project	Mbarali district in Mbeya region	50,000	Plans to replant 50,000 ha rice field with Jatropha. Current status unknown. However, refuted the allegation of replanting of Jatropha in the rice farm.
22	Jatropha	Diligent Tanzania Ltd (Dutch company with branches in Tanzania and Columbia)	Located in Arusha. Has contracts with more than 1500 Jatropha farmers from Babati, Engaruka, Chalinze, Pangani and Singida)	NA	Has oil press with capacity to press 1500 litres of oil per month. However, due to limited supply of seeds, it currently produces 600-800 litres per month.
23	Jatropha, Moringa oleifera	D1 Oils Tanzania Ltd (British)	2003		Abandoned plans in Tz
24	Aloe vera Jatropha	Kikuletwa Farm (British)	Kilimanjaro (Moshi)	400	
25	Jatropha	Donesta Ltd and Savannah Bio-fuels Ltd	Dodoma	2,000 (200 already planted)	
26	Jatropha	Bio-Shape (Dutch)	Kilwa (Lindi)	81,000 (400 pilot farm planted)	Integrity of EIA questionable[1]

Source: This study field research July/August 2008, WWF (2008)
(Scoping Exercise (Situation analysis) on the Bio-fuels industry within and outside Tanzania. Report submitted by Energy for Sustainable Development (ESD) to WWF Tanzania Programme Office. Dar es Salaam)

1.2.3 Impact of bio-fuel production on environment and livelihood competition and conflicts

The world is seeing an increasing impetus towards research and development in bio-fuel production technology and use. This increased interest is brought about by various

[1] WWF 2008 Report

reasons including the push towards averting the environmental phenomenon of global warming and climate change in line with Kyoto Protocol. Others include the quest to reduce dependence of fossil fuels for motor vehicle use given that the demand for this resource is increasing by the day while the stock of fossil fuels is finite and declining. The recent price hikes of fossil-fuels have resulted in a spurt of activity towards the production and use of bio-fuels as substitutes to fossil fuels. In the United States of America, t*he amount of grain used to produce fuel is exploding*. Investment in crop based fuel production, once dependent on government subsidies[2], is now driven by the price of oil. With the current price of ethanol double its cost of production, *the conversion of agricultural commodities into fuel for cars has become hugely profitable*. In the United States, this means that investment in fuel ethanol distilleries is controlled by the market, not by government.

One of the major attractions of bio-fuels is that they are renewable while fossil fuels are not. Bio-fuels can be made out of a number of different types of biomass related feedstock. These include corn/maize, sugarcane, rapeseed and soybean, mustard, flax, sunflower, canola, palm, hemp, *Jatropha*, coffee beans, and algae either being used already or undergoing research for suitability[3]. One school of thought argues that bio-fuels are more efficient compared to fossil fuels while others object. The antagonists argue that bio-fuel consume more energy than they give out.[4] For all the debate surrounding its sustainability, effects on farming, land use and eco-balance, not to mention the operational issues associated with additives, handling and storage, the bio-fuels sector has no shortage of raw materials to choose from. With over 50 different crops, seeds, oils and fats sources that can be used, through an array of processes, to manufacture bio-diesel and bio-ethanol, the choice is wide and formidable says Helen Campbell[5].

The huge profits from converting corn into ethanol following the late 2005 oil price hikes have led to jumping groundbreakings for new ethanol distilleries in the last few months. The World Ethanol and Bio-fuels reports, published biweekly by F.O. Licht, show construction starting on an astounding 54 new ethanol distilleries in the United States between October 25, 2005, and October 24, 2006. With a typical construction period of 14 months, virtually all of them will be producing by the end of 2007. Together these plants, with 4 billion gallons of annual ethanol production capacity, will consume 39 million tons of grain per year, nearly all of it corn. This pace of events threatens the attainment of the MGDs as Lester points out below;

[2] Government encouragement is also helping to promote bio-fuel production and use. For instance, the federal government in the USA is helping by granting subsidies to companies engaged in the production and sale of ethanol.
[3] Ibid pp 43
[4] David Pimentel of Cornel University and Thaddeus 'Ted' Patsek Professor of Engineering at the University of California assert that it takes 10% and 70% more energy respectively to produce a unit of ethanol. Dan Kammen, a physicist and energy expert at the University of California at Berkeley on the other hand argues to the contrary.
[5] Bio fuel international (February 2007)

"The U.N. Millennium Development Goal of reducing by half the proportion of people suffering from hunger by 2015 is now failing, as the numbers who are hungry edges upward, and it could collapse completely in the face of the food-for-cars onslaught"
Lester R. Brown (bio-fuels international February 2007)



Figure 1.4: Bio-fuel Production initiatives in Tanzania

2.0 ANALYSIS OF LAND USES IN TANZANIA

Any initiative for large scale Bio-fuel production will have a direct bearing on land requirements at Village, District, Regional and national levels. It is therefore important to examine the extent to which current land use patterns and future land use proposals can accommodate this new requirement. At first, the chapter provides a brief account on the categories of land uses as elaborated in the Land Act (1999) and the Village Land Act (1999) so as to provide a situation analysis on what category of land uses can bio-fuel be accommodated. Secondly, it highlights the contents of the National Land Use Framework Plan (2007-2027) that stipulates land use proposals for the whole country and thirdly, in the later sections of this chapter, it provides a detailed discussion on current and proposed land uses at district level and how feasible are such land use categories are potentially viable in accommodating large-scale Bio-fuel production. These districts are; Bagamoyo, Bukoba, Kasulu, Kigoma, Kilwa, Kisarawe, Rufiji and Biharamulo.

2.1 Land Use Categories in Tanzania

Section 4(1) of the Land Act (1999) provides that all land in Tanzania shall continue to be public land and remain vested in the President as trustee for and on behalf of all the citizens of Tanzania. Section 4(4) of the same Act classifies public land to fall under the categories of general *land*, *Village land* and *reserved land.*

While general land refers to all public land which is not reserved land or village land and include unoccupied or unused village land, reserved land is that land designated or set aside under the provisions of; the Forest Act (Cap 389), National Parks Act (Cap 412), the Ngorongoro Conservation Area Act (Cap 413), the Wildlife Conservation Act No 12 of 1974), the Marine Parts and Reserves Act No 29 of 1994, the Urban Planning Act (2007), the Highway Act (Cap 167), the Public Recreation Ground Act (Cap 320) and the Land Acquisition Act No. 47 of 1967. Reserved land also include; land parcel within a natural drainage system from which the water resource of the concerned drainage basin originates, land reserved for public utilities and land declared by order of the Minister responsible for Lands, in accordance with the provisions to be hazardous land. On the other hand, Village Land refers to the land declared to the village land under and in accordance with section 4 of the Land Act including any land transferred to a village (Land Act, 1999). Village Land consists of land within the boundaries of a village registered in accordance with section 22 of the Loral Government (District Authorities) Act, 1982. It also includes land within the boundaries of which have been demarcated as village land under any land or administrative procedure before the 1999 Land Act came into operation. Included also in Village land are those lands whose boundaries have been agreed upon between the Village Council claiming jurisdiction over it and land other than reserved land which the villagers have been, during the

twelve years preceding the enactment of the Land Act regularly occupying and using a village land (Village Land Act, 1999). Until 2005, there were a total of 10,334 registered villages out of which, 6000 villages had their boundaries demarcated (URT, 2007).

It is imperative from the above classification that potential areas for large-scale Bio-fuel production will most likely take place in general and village land where mechanisms for land acquisition and planning intervention can be made through the Land Acquisition Act (1967) and the Land Use Planning Act of 2007. It is unlikely such an activity to take place in reserved lands where protection and conservation measurers restricting other uses have been clearly stipulated in respective legislations.

2.2 Existing and Proposed Land Uses at National level

The compilation of the existing land uses at national level was based on district maps (1960s, 1970s and 2002) supplemented with satellite imageries. This analysis resulted into production of land use and land cover maps at district level with 2002 being a base year. Compilation of district maps resulted into production of existing national land use map. The 2002 land cover maps provided a basis for land use framework plan to the year 2027. The main land use components as provided in the existing and proposed framework plan are summarised in Table 2.1. Statistics from the National Land Use Frame Work Plan (2007 – 2027) reveal that out of the total 945,167 square kilometres of Tanzania mainland land, 28.7% is under conservation and 6.7% under water resources (Figure 2.1). These two land uses apparently cannot be used for such purposes as Bio-fuel production. The proposed land use recommends that 29.78% of the land should be used for conservation; 6.7% for water resources and 5.7% for community conservation. This makes a total of 42.18% designated for conservation activities with a character of "*reserved land*". Further, the NLUFP recommends a 13.1% of the land for either community ranching where grazing activities were dominant or for conservation where wildlife dominated other uses (Figure 2.2). This converted the former Game Controlled Areas (GCAs) into these two uses. Included in the proposals of this plan is 0.4% for coastal settlements and ecological functions that ought to be separated from settlements, grazing, open land and ecological functions. This makes the proportion of the total land to be excluded from any form of cultivation activities to be 55.68%. This means that the proportion of land uses remaining for other activities such as cultivation, settlements, mining, open land and ecological functions to be 44.32%. This provides a challenge on balancing land use disposition for competing uses not included under conservation category and more, the introduction lf large-scale Bio-fuel production.

In other words, the introduction of large scale Bio-fuel production will create a competition with the remaining 44.32% presently used as settlements, agriculture and grazing; scattered settlements, agriculture and grazing; grazing, hunting and conservation and open land and ecological functions.

It is notable from Table 2.1 and Figure 2.2 that while there is redefinition for the proposed land uses, there is an apparent increase in land size recommended for conservation uses. This has been attributed to the introduction of such land uses as community conservation and conservation itself. Other new land uses introduced in the proposals include community ranching and coastal settlements and ecological functions. The implication of these new land uses is the reduction of overall land use which could be used for cultivation purposes.

Table 2.1: Summary of existing and proposed land uses

Existing Land uses	Area km^2	%	Proposed Land Uses	Area km^2	%	Remarks
1.Settlements, agriculture and grazing	161572	17.1	Crop cultivation, settlements, grazing and mining (intensification)	165605	17.5	No significant change: Intensification to offset the increased demand and optimize use of land resources
2.Scattered settlements, agriculture and grazing	198517	21.0	Crop cultivation, settlements, grazing and mining (expansion and intensification)	176747	18.7	No significant change: Intensification to offset the increased demand and optimize use of land resources
			Coastal settlement and ecological functions (expansion and intensification)[6]	44112	0.4	New land use separated from settlement and grazing and open land and ecological functions
3.Grazing, hunting and conservation	98289	10.4	Community ranching areas	123460	13.1	New land use for community ranching in specific areas (mainly from former GCAs)
			Community conservation[7]	53464	5.7	New land use mainly the WMAs created from former GCAs
4.Open land uses and ecological functions	155320	16.3	Open land uses and ecological functions[8]	77101	8.2	Part of land use category number 3
5.Water resource uses	63329	6.7	Water resource uses	63173	6.7	No significant change. Part of water resources included in land use category number 6.
6.Conservation	270840	28.7	Conservation	281757	29.78	No significant increase to include corridors, wetlands and water catchments
Total	945167	100		945167	100	

Source: URT (2007)

[6] Coastal settlement and ecological functions areas comprise of uses that include settlements, recreation, fishing, aquaculture, livestock keeping by sedentary and stall feeding small scale mining, open lands and biodiversity conservation

[7] Areas that fall under this category are those that are within village land and used for various forms of community based conservation i.e. Such uses include wildlife management areas, village forests, village/community sanctuaries, village hunting blocks etc

[8] The main activities allowed in this land use include harvesting of both woody products (timber for energy), non-woody (bee farming, taping wax/gum, wildlife harvesting). These areas are also supposed to provide ecological services that are directly connected to the use by the people such as water catchment areas and biodiversity.

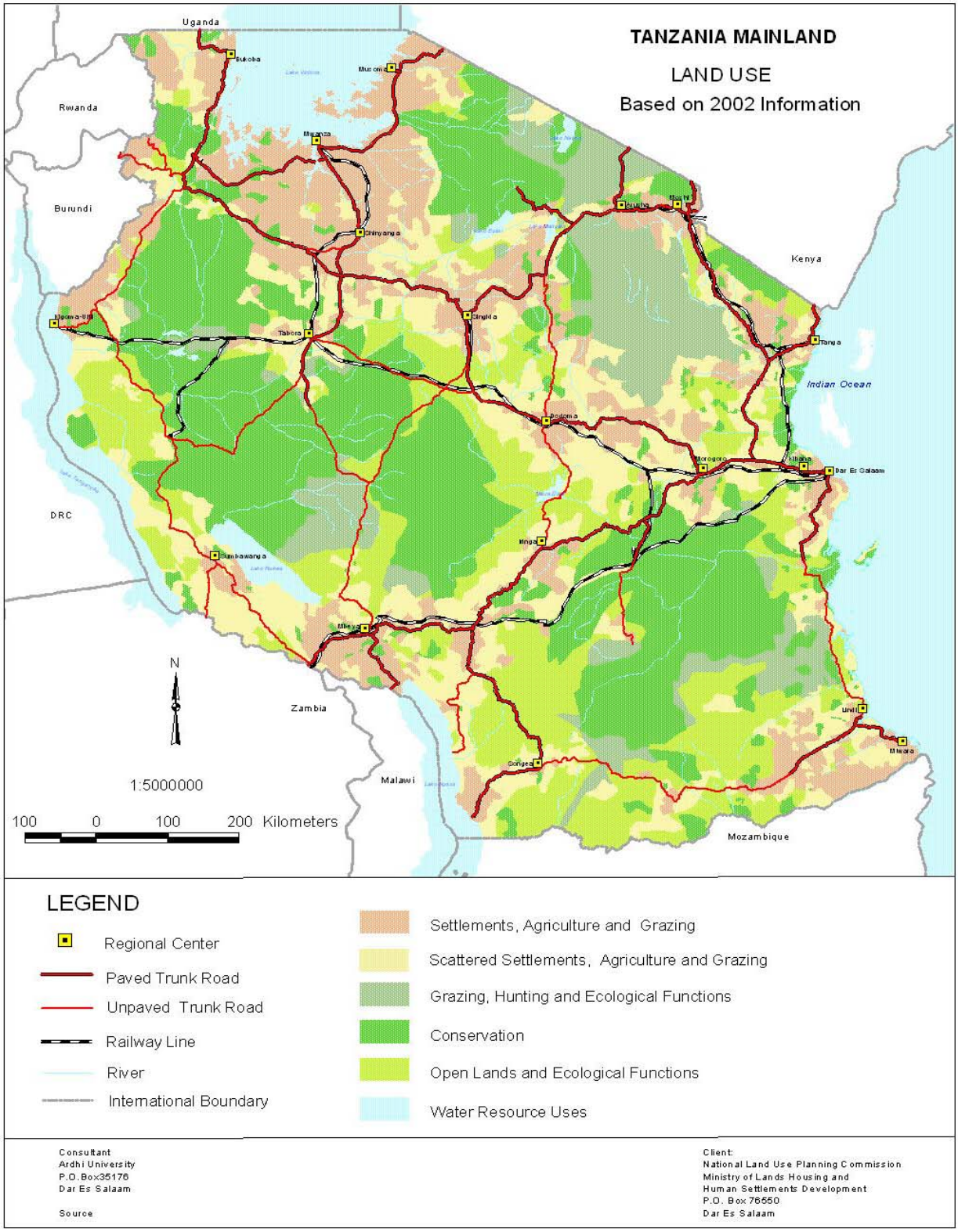


Figure 2.1: The existing land uses (Source: URT, 2007)

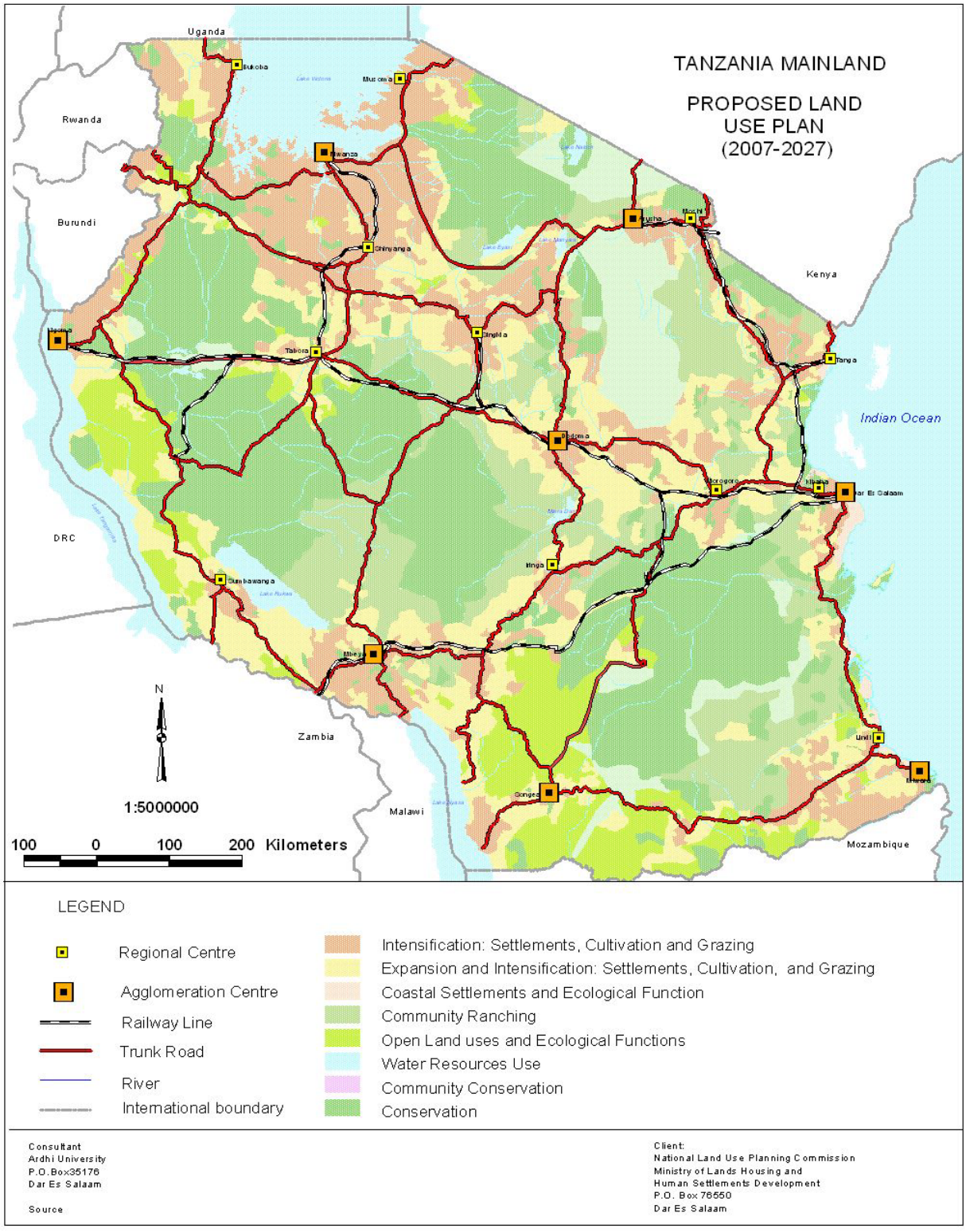


Figure 2.2: Proposed land use plan (2007-2027) (Source: URT, 2007)

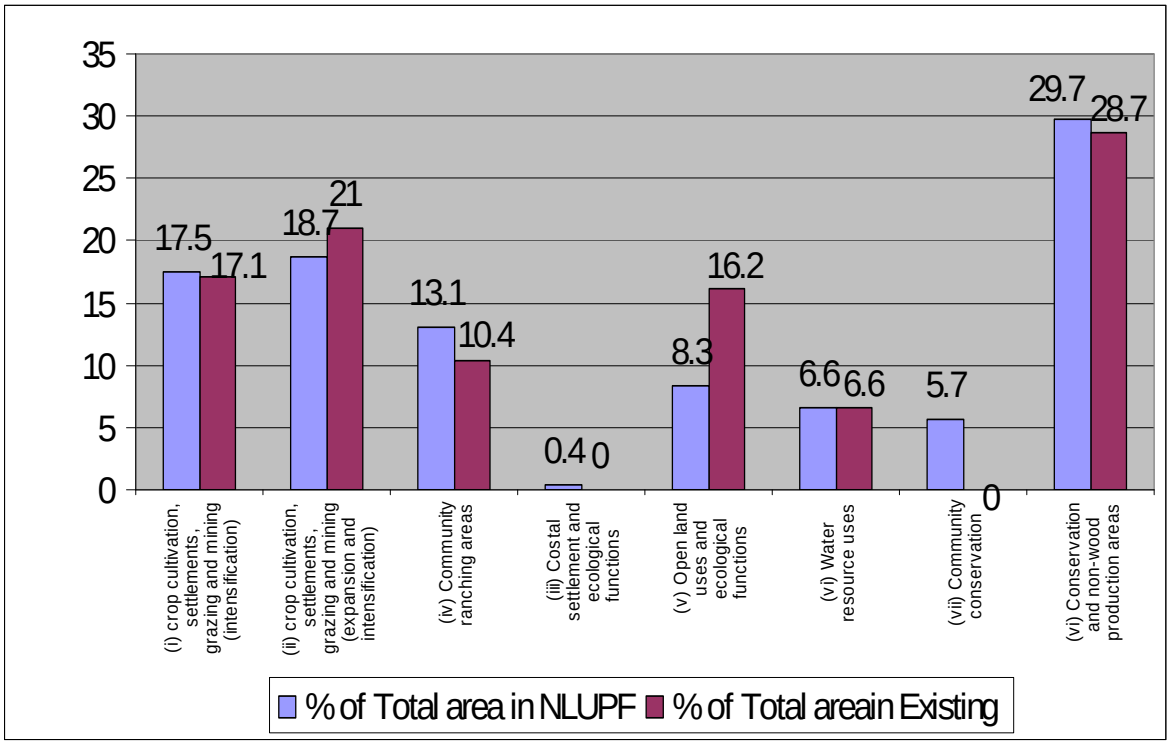


Figure 2.3: Comparison of existing and proposed land uses

2.3 Prevailing and proposed land uses at district level

This section provides an account on current and proposed land uses at districts level. These land uses have been extracted from the National Land Use Framework Plan (URT: 2007 – 2027).

2.3.1 Bagamoyo District

Bagamoyo district is located in Coast Region sharing borders with Handeni and Pangani Districts to the north, Mvomero District to the west, Kinondoni and Kibaha Districts to the south and the Indian Ocean to the east. It covers a total land of 859,336 hectares. More than half (50.3%) of this land is mainly used as scattered settlements, agriculture and mining. Other major land uses include; open land uses and ecological functions covering 23.5%, conservation (mainly forests reserves stretching northwards along the Indian Ocean) covering 21.8%; and settlements combined with agriculture and mining activities located on the southern parts of the District (Table 2.2)

The land use framework plan (2007-2027) recommended readjustment in the properties and redefinition of the land uses. For example, the scattered settlements, agriculture and mining was redefined as expansion and intensification areas (cultivation and

grazing); thus reducing the land use from the current 50.3% to 47.5%. The open land uses was redefined to be community ranching but maintains the land coverage of 23.5% (Table 2.3).

Table 2.2: Bagamoyo District; Land uses as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	187,179	21.8
Open Land Uses and Ecological Functions	202,312	23.5
Scattered Settlements, Agriculture and Mining	432,318	50.3
Settlements, Agriculture and Mining	37,527	4.4
TOTAL	**859,336**	100.0

Source: URT, (2007)

Although there are several Bio-fuel projects in Bagamoyo district, (Jatropa, Sweets Sorghum, sugarcane, Jatropa and Panga and oil palm), introduction of large scale farming is likely to conflict with other land uses. The proportion of land use earmarked for settlements, cultivation and grazing amounts to 52% or 438,261 hectares. Depending on the nature of land holding system, there are all symptoms of land use competition in event that large scale Bio-fuel production is introduced in Bagamoyo District.

Table 2.3: Bagamoyo District; proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Coastal Settlements and Ecological Functions	23,737	2.8	Not feasible
Community Ranching	202,312	23.5	Not feasible
Conservation	187,179	21.8	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	408,581	47.5	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	37,527	4.4	Potentially feasible
TOTAL	**859,336**	100.0	

Source: URT, (2007)

2.3.2 Bukoba District

The total land covered by Bukoba Rural District is 1,122,561 hectares. About half of this area is covered by water (this is part of the Lake Victoria). Other main land use

categories include scattered settlements, agriculture and mining which cover approximately 46% of the total District land (Table 2.4). There are no major changes in terms of land coverage in the proposed National Land Use Framework Plan (NLUFP) as compared to existing land uses apart from redefinition of the type of these land uses. The existing and proposed land uses and their potentialities for Bio-fuel production are summarised in Tables 2.4 and 2.5.

Table 2.4: Bukoba District; Land use as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	41,128	3.7
Open Land Uses and Ecological Functions	9,429	0.8
Scattered Settlements, Agriculture and Mining	234,006	20.8
Settlements, Agriculture and Mining	284,198	25.3
Water Resources Uses	553,800	49.3
TOTAL	**1,122,561**	100.0

Source: URT, (2007)

Table 2.5: Bukoba District; Proposed Land Uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Conservation	41,128	3.7	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	234,006	20.8	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	284,198	25.3	Potentially feasible
Open Land Uses and Ecological Functions	9,429	0.8	Not feasible
Water Resources Use	553,800	49.3	Not feasible
TOTAL	**1,122,561**	100.0	

Source: URT, (2007)

2.3.3 Kasulu District

Kasulu District covers a total land of 887,220 hectares of land. About a third (31%) of this land (274,250 hectares) is being used for conservation (mainly forest reserve) which cannot be committed for other land uses such as Bio-fuel production purposes (Table 2.6). The proposed land use Framework Plan (Table 2.7) recommends additional 5.8% of the land for *community conservation*. This makes the total land earmarked for conservation (reserved land activities) to be 36.7%. If the land uses designated as open land, hunting, and ecological functions are also excluded, the remaining land that is

potentially feasible for bio-fuel production is 58.2% or 516,362 hectares. However, it is important to note that this is the same land area that has been earmarked for uses such as settlements, agriculture and mining. It will require careful planning if large scale Bio-fuel production is to be introduced so as to avoid conflicts in future.

Table 2.6: Kasulu District; Existing land uses as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	274,250	30.9
Grazing, Hunting and Ecological Functions	51,758	5.8
Open Land Uses and Ecological Functions	44,905	5.1
Scattered Settlements, Agriculture and Mining	172,229	19.4
Settlements, Agriculture and Mining	344,078	38.8
Total	**887,220**	100.0

Source: URT, (2007)

Table 2.7: Kasulu District; Proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Community Conservation	51,758	5.8	Not feasible
Conservation	274,250	30.9	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	172,229	19.4	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	344,078	38.8	Potentially feasible
Open Land Uses and Ecological Functions	44,905	5.1	Not feasible
TOTAL	**887,220**	100.0	

Source: URT, (2007)

2.3.4 Kigoma District

Kigoma District shares its borders with the Lake Tanganyika to the West, Kasulu and Kibondo Districts to the south, Urambo and Mpanda Districts to the East. It occupies a total land of 2,193,930 hectares. About one third (28.1%) of Kigoma District land is covered by water (Lake Tanganyika). Other major land uses within Kigoma District include Forest reserves (*reserved land)*, open land uses and ecological functions altogether covering 15.1%, scattered settlements, agriculture and mining uses covering 12.2% of the total district land. Another land use is a composite of settlements, agriculture and mining which occupy 6.2%% (Table 2.8). Apart from redefinition of land use categories, the general pattern and distribution of land uses in the existing and proposed land use framework plan (Table 2.9) is more or less the same. If the water resources, conservation and open land and ecological functions are excluded from the

total land, the remaining area that can be used for cultivation is only 20.3% or 445,368 hectares. This provides an indication that large scale bio-fuel cultivation in Kigoma District can only be introduced if careful examination of land requirements prior to committing such as use is made. This is because even though 35.4% or 776,652 hectares of land seem to be on the higher side as compared to many other districts, this land has been designated for such other uses as settlements, cultivation and grazing.

Table 2.8: Kigoma District; Existing as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	616,915	28.1
Grazing, Hunting and Ecological Functions	41,530	1.9
Open Land Uses and Ecological Functions	331,034	15.1
Scattered Settlements, Agriculture and Mining	267,436	12.2
Settlements, Agriculture and Mining	135,892	6.2
Water Resources Uses	801,123	36.5
TOTAL	**2,193,930**	100.0

Source: URT, (2007)

Table 2.9: Kigoma District; Proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Community Conservation	41,530	1.9	Not feasible
Conservation	616,915	28.1	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	267,436	12.2	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	135,892	6.2	Potentially feasible
Open Land Uses and Ecological Functions	331,034	15.1	Not feasible
Water Resources Use	801,123	36.5	Not feasible
TOTAL	**2,193,930**	100.0	

Source: URT, (2007)

2.3.5 Kilwa District

Located in Lindi Region, Kilwa District has a total land coverage of 1,335,544 hectares. It has a relatively balanced land use distribution patterns proportionately distributed as conservation; grazing, hunting and ecological functions/services; open land uses, settlements and scattered settlements combined with agriculture and mining (Table 2.10). In the National Land Use Framework Plan, a new land use of community ranching was introduced in following the government decision to shift large scale

grazing activities from Ihefu water catchment areas and other fragile ecosystem lands of the country to this District. Thus 41.9% or 559,798 hectares of land was recommended under this use. Land for conservation purposes was recommended to increase from 19.5% to 22.4%. Included also in this category is community conservation that was introduced to the tune of 7.5%. This makes a total land use category under conservation to be 29.9% of the total district land (Table 2.11). Although Kilwa District seems to provide an opportunity for bio-fuel cultivation in terms of land availability, the introduction of large scale grazing activities in this area is likely cause conflicts between cultivators and grazers.

Table 2.10: Kilwa District; Existing land uses as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	260,320	19.5
Grazing, Hunting and Ecological Functions	594,199	44.5
Open Land Uses and Ecological Functions	172,069	12.9
Scattered Settlements, Agriculture and Mining	277,007	20.7
Settlements, Agriculture and Mining	31,949	2.4
TOTAL	**1,335,544**	100.0

Source: URT, (2007)

Table 2.11: Kilwa District; Proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Coastal Settlements and Ecological Functions	82,383	6.2	Not feasible
Community Conservation	99,888	7.5	Not feasible
Community Ranching	559,798	41.9	Not feasible
Conservation	298,557	22.4	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	194,624	14.6	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	23,587	1.8	Potentially feasible
Open Land Uses and Ecological Functions	76,707	5.7	Not feasible
TOTAL	**,335,544**	100.0	

Source: URT, (2007)

2.3.6 Kisarawe District

Kisarawe District has a total land coverage of 498,756 hectares. It is located in Coast Region sharing its borders with the Districts of Morogoro to the west, Kibaha to the

north, Ilala and Mkuranga to the east and Rufiji to the South. The main land uses include open land and ecological function areas covering 53.6% of the total land; settlements, scattered settlements, mining and agriculture altogether covering 28.7% and forest reserve (*reserved land)* covering 16.2%. There are no significant changes between current and proposed land uses in terms of proportions in land coverage apart from redefinition of these land use categories (Tables 2.12 and 2.13). If the land use components under community conservation, community ranching and community conservation are excluded as per the National Land Use Framework Plan, the remaining area that is potentially feasible for introduction of large scale Bio-fuel production remains to be only 28.8% or 143,642 hectares. This is a too limited land to introduce large scale production.

Table 2.12: Kisarawe District; Existing land uses as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	80,723	16.2
Grazing, Hunting and Ecological Functions	7,136	1.4
Open Land Uses and Ecological Functions	267,493	53.6
Scattered Settlements, Agriculture and Mining	101,399	20.3
Settlements, Agriculture and Mining	42,005	8.4
TOTAL	**498,756**	100.0

Source: URT, (2007).

Table 2.13: Kisarawe District; Proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Community Conservation	7,136	1.4	Not feasible
Community Ranching	267,493	53.6	Not feasible
Conservation	80,723	16.2	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	101,399	20.3	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	42,005	8.4	Potentially feasible
TOTAL	**498,756**	100.0	

Source: URT, (2007)

2.3.7 Rufiji District

Rufiji District is located in Coast Region and covers a total land of 1,300,996 hectares. It shares its borders with the Districts of Kilwa and Liwale to the South, Kisarawe and

Mkuranga to the north, Morogoro and Kilombero to the west and the Indian Ocean to the east. About half (48.3%) of this land is currently being used for conservation (forest reserves or *reserved land)*. Other land uses include; grazing, hunting, open land and ecological functions (35.8%); scattered settlements, settlements, agriculture and mining (15.9%) (Tables 2.14 and 2.15). The proposed land use plan redefine these uses introducing community ranching, community conservation and coastal settlements and ecological functions as new land uses. The three new land uses altogether cover a total land of 461,803 hectares or 35.5% of the total district land. When this area is combined with conservation land which cannot be committed for other uses, it gives a total of 1,114,931 hectares or 85.7%. Thus the remaining land that can potentially accommodate large scale Bio-fuel production (combined with other uses such as settlements, grazing and cultivation activities) remains to be 14.3% or 186,042 hectares. This is comparatively a limited land for any meaningful large scale cultivation.

Table 2.14: Rufiji District; Existing land uses as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	627,918	48.3
Grazing, Hunting and Ecological Functions	99,883	7.7
Open Land Uses and Ecological Functions	366,089	28.1
Scattered Settlements, Agriculture and Mining	141,565	10.9
Settlements, Agriculture and Mining	65,541	5.0
TOTAL	**1,300,996**	100.0

Source: URT, (2007)

Table 2.15: Rufiji District; Proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Coastal Settlements and Ecological Functions	21,041	1.6	Not feasible
Community Conservation	99,883	7.7	Not feasible
Community Ranching	340,879	26.2	Not feasible
Conservation	653,128	50.2	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	120,524	9.3	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	65,541	5.0	Potentially feasible
TOTAL	**1,300,996**	100.0	

Source: URT, (2007)

2.3.8 Biharamulo District

Biharamulo District shares its borders with the Districts of Muleba to the north, Chato to the east, Ngara to the west and Bukombe to the south. It covers a total of 1,044,142 hectares of land with the larger part of this land (45.4%) being used for conservation purposes (Table 2.16). Other land uses include open land and ecological functions covering 15.8%, scattered settlements, settlements, agriculture and mining altogether covering 35.6% and water resources 3.1%. The National Land Use Framework Plan maintains 45.4% of the land to be under conservation, 15.8% for open land uses and ecological functions and 3.1% for water resources. This makes a total of 64.3% as the proportion of the land that cannot be committed for other uses. One of the constraining factors for large scale bio-fuel production in terms of land use in this District may be the population pressure on land especially in the Lake Victoria zone where population densities are as high as up to 200 persons per square kilometre. See also table 2.17 for proposed land uses for the district.

Table 2.16: Biharamulo District; Existing land uses as per land cover map (2002)

LAND USES CATEGORY	**AREA (Ha)**	%
Conservation	474,345	45.4
Open Land Uses and Ecological Functions	164,874	15.8
Scattered Settlements, Agriculture and Mining	127,744	12.2
Settlements, Agriculture and Mining	244,515	23.4
Water Resources Uses	32,664	3.1
TOTAL	**1,044,142**	100.0

Source: URT, (2007)

Table 2.17: Biharamulo District; Proposed land uses (2007-2027)

LAND USES CATEGORY	**AREA (Ha)**	%	**Feasibility for Bio-fuel production**
Conservation	474,345	45.4	Not feasible
Expansion and Intensification: Settlements, Cultivation and Grazing	127,744	12.2	Potentially feasible
Intensification: Settlements, Cultivation and Grazing	244,515	23.4	Potentially feasible
Open Land Uses and Ecological Functions	164,874	15.8	Not feasible
Water Resources Use	32,664	3.1	Not feasible
TOTAL	**1,044,142**	100.0	

Source: URT, (2007)

Except for Kasulu District, the analysis of land use distribution tables shows that the proportion of land uses that can potentially be considered for large scale bio-fuel production is less than 50% of the total district land uses. Districts with acute shortage of land include Kigoma, Kilwa, and Rufiji where potentially feasible land availability is less than 20% (Table 2.18)

Table 2.18: Proportion of District land uses potentially feasible for bio-fuel (summary)

District	% of land potentially Feasible
Bagamoyo	49.9
Bukoba	46.1
Kasulu	58.2
Kigoma	18.4
Kilwa	16.4
Kisarawe	28.7
Rufiji	14.3
Biharamulo	35.6

Source: Summarised from District Tables

2.4 Land allocation for Bio- fuel investment versus available land in villages

A quick inspection of the land available in the districts as provided by the proposed land use plans compared with the amount of land requested and some already given to investors shows that some districts have already given out the bulk of their land. Considering the household land needs for farming purposes, districts need to consider setting aside a certain minimum amount of land for their inhabitants before even thinking of allocating land to investors be them local or foreign. From the tables above, some districts such as Rufiji does not even have the amount of land which investors request for. For example SEKAB's intention of acquiring some 400,000 hectares from Rufiji, whereas Rufiji has only 186,065 hectares of land that can potentially be used for Bio-fuel production purposes (including other uses) shows this shortfall (See also table 2.15). Table 2.19 demonstrates the amount of land which may have to be set aside for household agricultural purposes using a 2 hectare land per household using 2002 district population census data.

2.5 Summary of Key Issues

Emerging from the foregoing discussion, the following key issues are discernable:

2.5.1 Land holding systems in Tanzania versus bio-fuel production

Even though there are other legislations that provide and facilitate access to land for large scale investment in Tanzania, the key legislations governing land holding and administration are the Land Act (1999) and Village Land Act (1999). While Section 8 of

the Village Land Act provides for the powers of managing Village land to be vested on the Village Council, management of other land use categories are largely vested on the Commissioner for Lands (Section 10 of the Land Act). The more the Villages demarcate their land, the more the shift in land administration towards the Villages. The fact that in some instances other legislations have been employed to facilitate acquisition and use, especially in investment projects, there is a potential for conflicts to ensue as a result of application of various legislations.

Table 2.19: District Household Agricultural Land Requirement as a Proportion of the Total Land Available in the District

S/N	District	Proposed Land Use for Agriculture, Settlement and Grazing	Household Agricultural Land Needs at 2 ha per household[9]	% Household land needs to total land available for agriculture, settlements and Grazing
1	Bagamoyo	446,108	91,587	20%
2	Rufiji	186,065	80,800	43%
3	Kilwa	218,211	68,423	31%
4	Kisarawe	143,404	38,129	26%
5	Kigoma	466,926	195,708	42%
6	Biharamulo	372,259	163,755	44%

Source: URT (2007), URT (2003)

2.5.2 Increasing trends towards reserved land

Emerging from recommendations by the National Land Use Framework Plan (2007-20270) is the tendency towards increased land for conservation (reserved land) purposes. Increased land for conservation purposes implies that new land uses such as large scale Bio-fuel production will be constrained in terms of getting accommodated in the national land use plan. This has been vividly shown in the analysis of land uses at District level

2.5.3 Competition over land uses

It is notable from the analysis of District land uses that even in those lands where Bio-fuel production has been indicated to be potentially feasible, such lands are currently accommodating or designated to accommodate other uses such as settlements, grazing, mining and cultivation. The implication of introducing new uses in such areas will

[9] This figure excludes other household land requirements such as grazing, energy, socio-economic services. Similarly, a 2 hectare figure may vary from one district to another depending on socio-economic factors and environmental conditions.

create competition and if not well managed may culminate into conflicts. There is therefore a prompt need to prepare land use plans at Village, District, Regional and Zonal levels taking into account the present and future land uses and the potentials for large scale Bio-fuel production areas.

2.6 Conclusion

This chapter has analysed the main land use categories in Tanzania, both at national and district levels and the position of large scale Bio-fuel production in the context of these land use categories. It highlighted the existing and proposed land uses for Tanzania as stipulated in the National Land Use Framework Plan (2007-2027) and the tendency towards increased land provision for conservation purposes. Further, it maps the current and proposed land uses for some districts that were visited by the study team and describes the feasibility for bio-fuel production based on land the National Land Use Framework Plan. Generally it is summarized that from land use point of view, there are hardly districts that can fully support large scale bio-fuel production unless careful planning is made at District and Village levels to determine land availability for such uses. The legislative thresholds stipulated in the Land Act (1999), the Village Land Act (1999) and other legislations ought to be prudently deployed to avoid potential land use conflicts in the future.

3.0 BIOFUEL PRODUCTION AND LAND ISSUES IN TANZANIA

3.1 Introduction

Tanzania is often presented by foreign investors as possessing abundant idle land suitable for biofuel development. The so called unutilized or idle land has however a number of uses. The uses include: pastures, beekeeping, game reserves, reserves for food and other non-timber forest products, and a complex and highly biodiversity to protect. According to land use categorization by the Ministry of Agriculture and Food Security (2002; 2007) Tanzania's land is divided as follows: farming and livestock (47.5%), forest, bush land and woodland (37.1%), Water resources (7%), wetlands (8.6%), built areas are only (0.3%) and bare rock are only (0.2%). Agriculture and livestock keeping together form 46.9% of the land use.

Biofuel production entails the exploitation of 4 principal resources: land, natural vegetation, water resources and labour. Given the strategic significance for any nation of these resources, it is plain common sense to proceed cautiously, paying particular attention to the sustainability of the biofuel enterprise. Most biofuel related crops are known to grow well in areas endowed with regular rainfall, fertile soils, access to water, factors also essential to growing food crops and other important agricultural commodities, as well as for human settlement. Regions that are listed as 'highly likely'

candidates for biofuel production (Table 3.1) are those with an average rainfall of 1,000 mm per year and fertile soils. Those in the 'likely' class enjoy rainfall ranging from 500-1000 mm while in the third category (Less-likely), are found in those regions whose annual rainfall falls below 500 mm.

Table 3.1: Regions earmarked for biofuel feedstock cultivation based on availability of rain and soil fertility

Degree of Likeliness	Regions
Highly likely	North Morogoro, Iringa, Mbeya, Sumbawanga, Kigoma, Kagera, Kilimanjaro, Arusha, Tanga, Mara.
Likely	Tanga, Dar es Salaam, Coast, Lindi Mtwara, Tabora, Rukwa, Mbeya, Kigoma, Mara, Ruvuma, Morogoro.
Less likely	Arusha, Dodoma, Singida, Iringa, Shinyanga, Morogoro, Lindi, Mtwara

Source: Ministry of Agriculture, Food Security and Cooperatives, 2006

Areas so far identified for biofuel feedstock cultivation are not marginal lands, as wrongly indicated by many biofuel investors. These areas are characterised by a fairly high rainfall, water resources, rich soils, and naturally, are fairly or densely populated. For example, as far as sugarcane cultivation in the country is concerned, the primary sites are Kagera region (Kagera Sugar Limited), Moshi (Tanganyika Planting Company), Morogoro (Mtibwa Sugar Estate) and Kilombero (Kilombero Sugar Company), which are fertile areas and with enough rainfall/water (GTZ, 2005). See figure 3.2 for proposed land use.

There are now more than 40 companies that have shown interest in investing in biofuel, as registered with the Ministry of Energy and Minerals. Most investors are from Europe, USA, Japan and the Far East. The investors have identified several regions/land areas for biofuel development. The determining factors are rainfall, soil nutrients and infrastructure. These areas/regions also have port facilities, a factor which indicates that the biofuel investment in Tanzania is mainly for export. In this respect Tanzania's coastal regions of Tanzania tops the list.

Several Biofuel feedstocks are to be cultivated. However, the majority of the investors are planning to grow *Jatropha curcas* (figure 3.3) for biodiesel production, a plant in the same family as cassava.

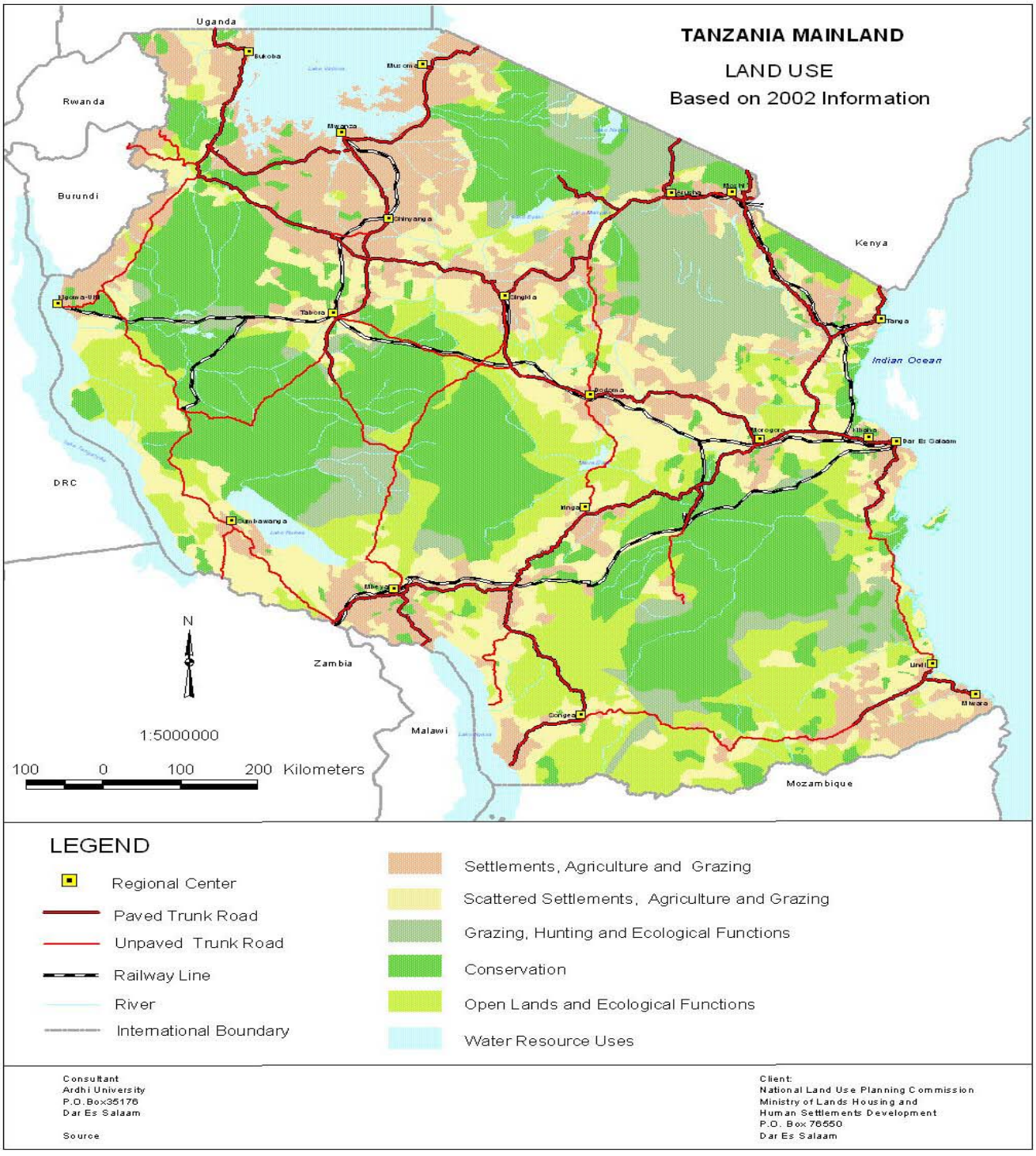


Fig. 3.1: Current land use map of Tanzania

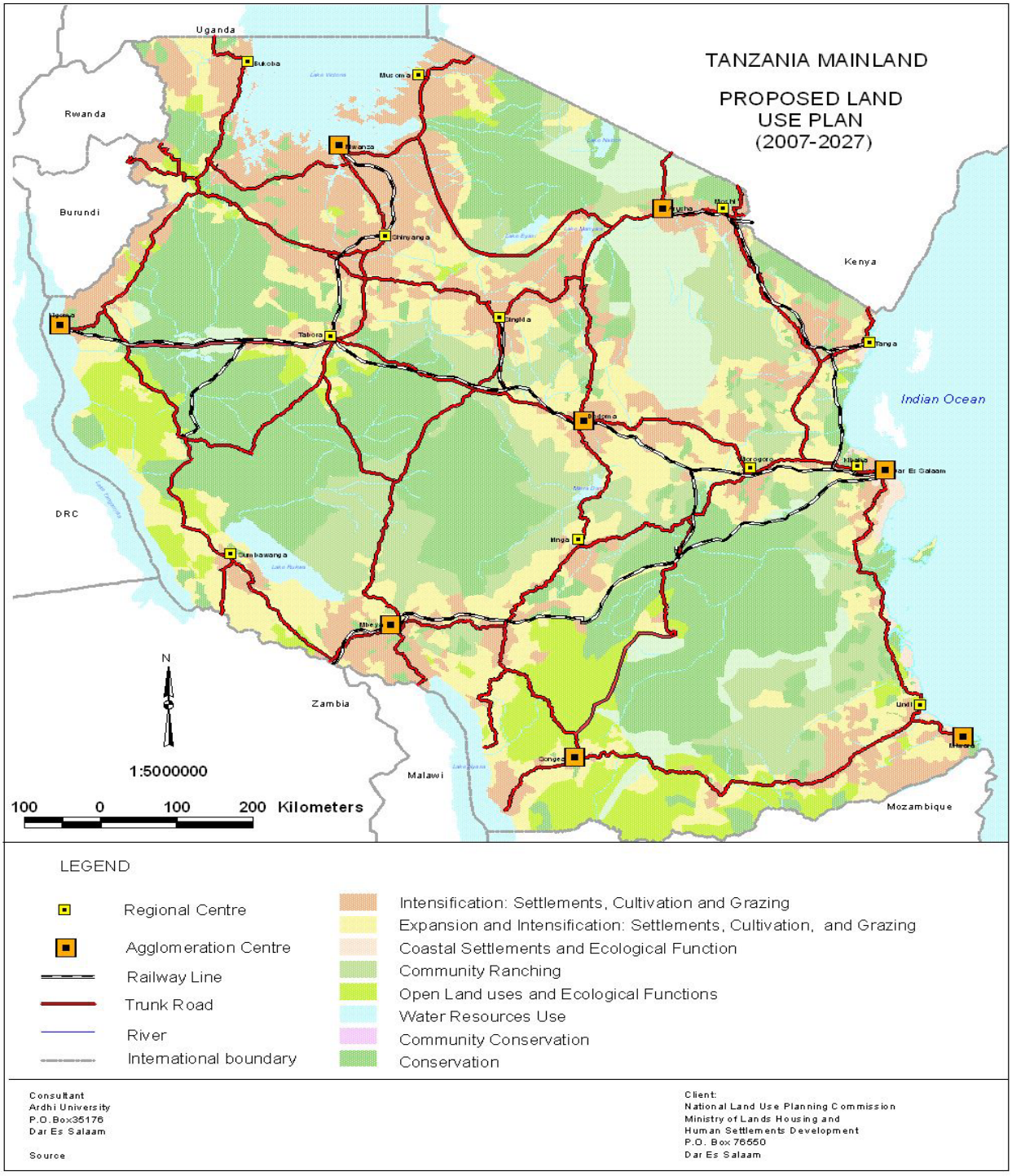


Fig. 3.2: Proposed land use map of Tanzania

3.2 Type of land allocated to Biofuel investors

Currently, several foreign and local companies have started initial trials on Biofuel production. However, large scale trials of cultivation of Biofuel feed stocks are by a Dutch company (BioShape Tanzania Limited) and a Swedish company (SEKAB BioEnergy (T) Limited). BioShape is planning to have plantations of *Jatropha curcas* (Fig. 3.3), while SEKAB is planning to cultivate sugar cane. BioShape has already acquired 82,000 hectares of land from 5 villages in Kilwa District (Fig. 3.4), while SEKAB has acquired 22,000 ha from Bagamoyo district in the Coast region (Fig. 3.6).



Fig. 3.3: *Jatropha curcas* plant and fruits

3.3 Land allocated to BioShape Tanzania Limited

The land allocated to BioShape is natural vegetation, mainly composed of miombo woodlands (Fig. 3.5) and patches of coastal forests.

3.4 Land allocated to SEKAB BioEnergy (T) Limited

Currently SEKAB BioEnergy (T) Limited Company has acquired 22,240 hectares of land from RAZABA (Figs 3.6 & 3.7) and Prisons in Bagamoyo for sugar cane cultivation as a bioethanol feedstock. However, SEKAB plans to develop several estates in Tanzania for BioEthanol production, including Rufiji, Kilwa and Bagamoyo.

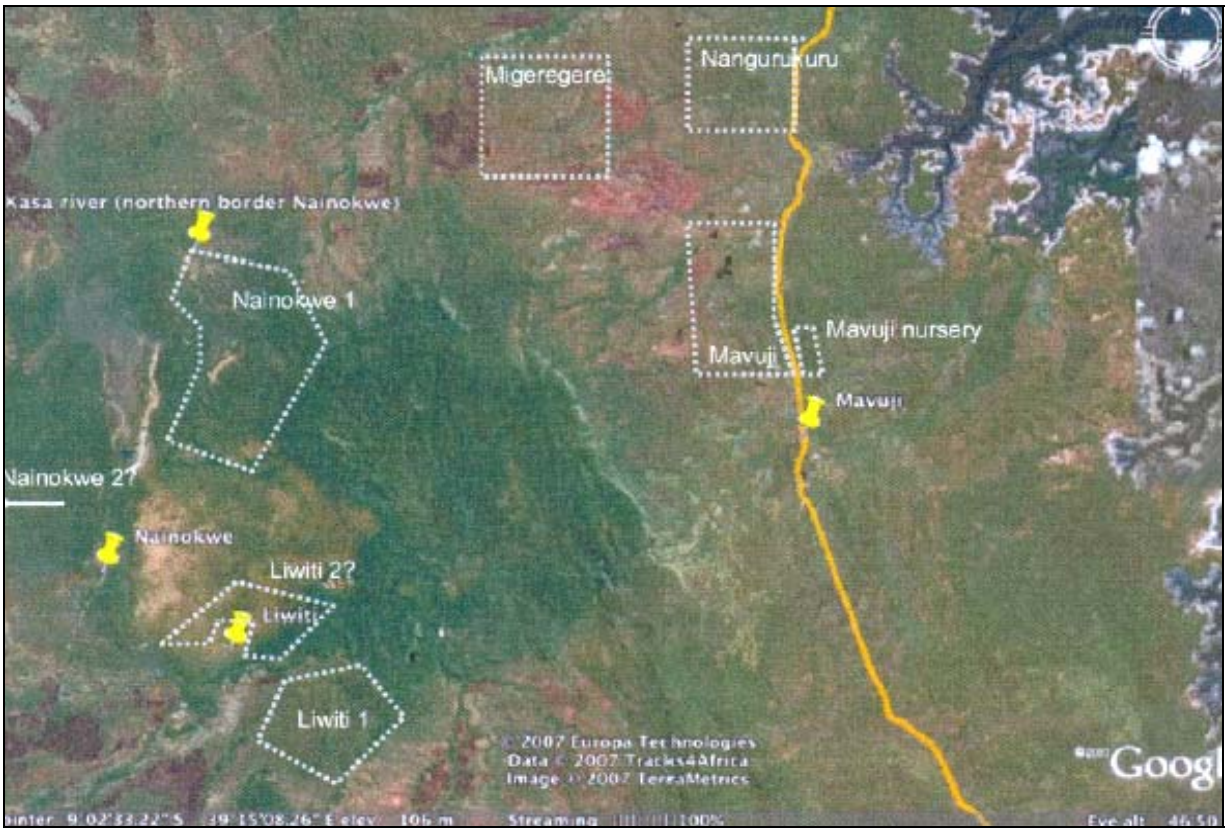


Fig. 3.4: BioShape plantation sites in 5 villages of Kilwa District
(Source: BioShape report, 2008)



Fig. 3.5: Miombo vegetation on Bioshape plantation sites
(Source: BioShape report, 2008)



(A) (**B)**

Fig. 3.6: SEKAB'S planned sugar cane plantation area at RAZABA;
A) Zanzibar Ranch (RAZABA) before division; B) Part of RAZABA land given to SEKAB. (*Note Saadani National Park to the north*)



(A) **(B)**

Fig. 3.7: SEKAB'S nursery at Bagamoyo. A) Adjacent vegetation to SEKAB's nursery suggests that the area is a wetland. Note the *Hyphaene* palms as indicator of a high water table (wetland); B) Situation after clearing

Biogeographically the RAZABA area belongs to the East African Coastal Forests zone that occurs in a narrow belt along the Indian Ocean from southern Somalia to Mozambique (Fig. 3.8).

Human activities have however transformed some of the coastal forest in the RAZABA area into a semi natural woodland habitat (Figs 9, 10 & 11) with bushland, dry

grassland, thickests, seasonally flooded plains, cultivation plots and a number of modified, but still surviving natural habitats such as mangroves and riverine forests. The closest relatively intact coastal forest fragment is the Zaraninge Forest in Sadani National Park about 20 km north of the study area.

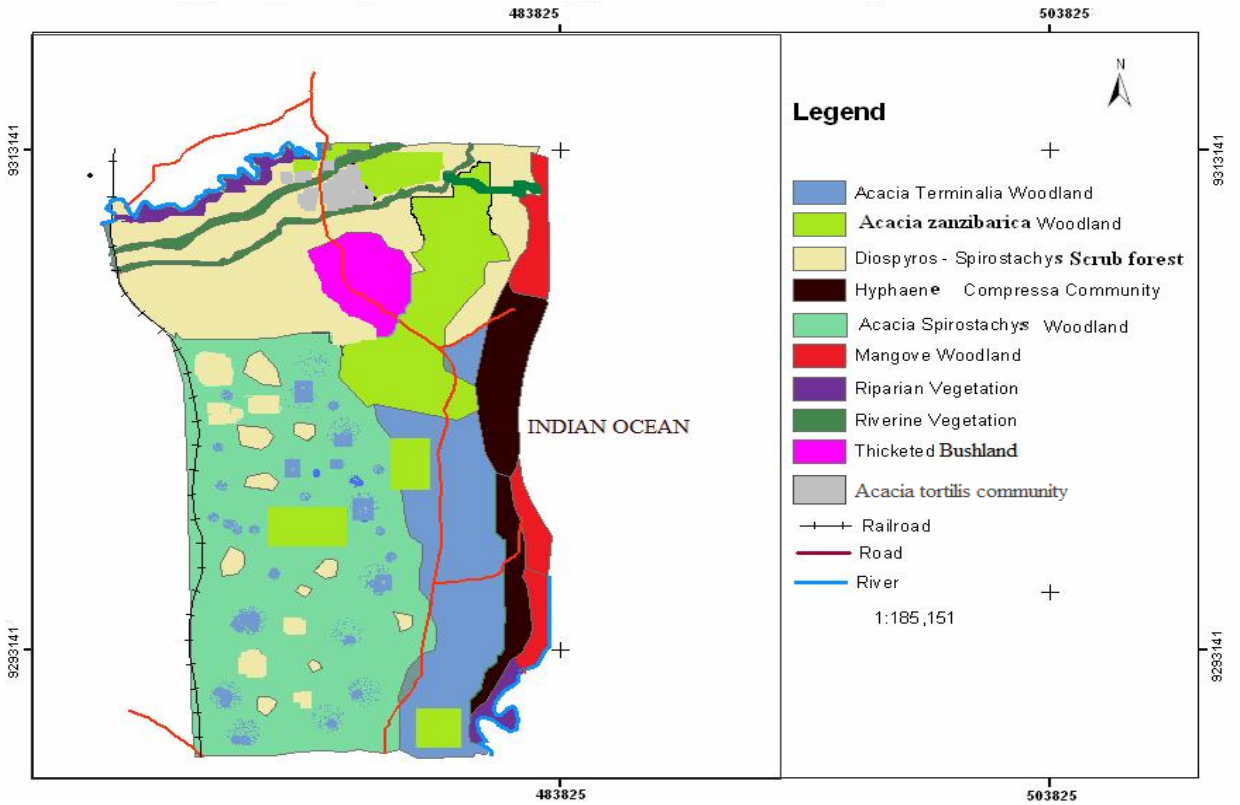


Fig. 3.8: Vegetation types in the SEKAB Project Area (*Source: SEKAB, 2008*)



(A) **(B)**

Fig. 3.9: *Acacia nilotica* (A) and Grassland (B) on SEKAB's plantation site at RAZABA Bagamoyo:



(A) **(B)**

Fig. 3.10: *Acacia seyal* var *fistula* (A) and *Acacia seyal*/grassland community (B) on SEKAB's plantation site at RAZABA Bagamoyo



(A) **(B)**

Fig. 3.11: *Acacia seyal*/*Suaeda*/grass (A) and Mangrove (B) communities on SEKAB's plantation site at RAZABA Bagamoyo

The majority of the RAZABA area is covered by *Acacia* woodlands (Figs 3.9 & 3.10) mixed with other species such as *Spirostachys africana* and *Terminalia*. Vegetation types dominated by pure stand of *Acacia zanzibarica* are found on the black cotton soils in a belt from the Ruvu River through the eastern part of the area to the other side of the Wami River continuing into Sadani National Park. The persistence of coarse grasses hinders the spread of the thickets to make continuous woodland. In the northern part of the area there are forest remnants dominated by various species such as *Diospyros bussei, Diospyros cornii* and *Manilkara mochisia, Afzelia quanzensis, Pterocarpus angolensis* and *Dalbergia melanoxylon* which are valuable timber species and products from these species have a very high market value.

Riverine vegetation occurs in narrow strips of land following the riverbanks or streams and is dominated by evergreen thickets of fig trees (*Ficus sur*) and other species indicating abundant ground water. The streams cause siltation and temporary swamps during the rainy seasons. These swamps are important for the biodiversity of the area and are used as sources of water for both wild and domestic animals. The vegetation on the coastal flood plain is dominated by palm species with *Hyphaene compressa* as the most dominant species. Most water logged areas covered by grasses especially elephant grass (*Pennisetum purpureum)*.

Mangroves (Fig. 3.11 B) occur at the estuaries of Ruvu and Wami Rivers dominated by five species: *Avicennia marina, Bruguiera gymnorrhiza, Sonneratia alba, Ceriops tagal* and *Rhizophora mucronata.* Ecologically, the mangroves trap terrestrial sediments, litter and nutrients and are thus very important breeding sites for marine organisms and for the protection of other near shore ecosystems such as sea-grass beds and coral reefs.

4.0 LARGE-SCALE BIOFUEL PRODUCTION AND THE ENVIRONMENT

Large-scale farming of biofuels if not well-managed could have serious negative environmental impacts. Altering existing natural ecosystems in quasi-equilibrium with the environment and replacing them with large expanses of low diversity monoculture crops and intensive management practices will have long-term negatively impacts on local hydrology, accelerate soil degradation and could in severe cases lead to desertification. The period between the time of large-scale clearing and often burning of residues, and the time the new crop is established is the most critical. Air and water pollution from periodic slash burning and heavy application of agrochemicals associated with large-scale biofuel plantations often lead serious negative environmental impacts. Both human, animal and plant life are likely to negatively affect unless preventive measures are initiated from the beginning.

4.1 Implication on water resources

High demand of water by large-scale biofuel plantations may reduce water availed to other users. Water pollution from agrochemicals used in cultivation and processing of biofuels if not prevented from entering surface and underground water bodies poses a long term danger to living organisms including humans. A careful balancing of water supply and demand by large-scale biofuel productions required if the needs of other users are to be met.

4.1.1 High water consumption

Biofuel crops especially sugarcane requires a lot water to grow (2000 – 3000mm ha^{-1} $year^{-1}$) and must be irrigated during the dry season. As this water must be abstracted from surface and underground sources, the long-term consequences of high water extraction to other users must be taken into account.

Furthermore, biofuel processing requires a lot of water for sugarcane extraction and ethanol production. Much water is also required to produce steam for producing power from bagasse. The high abstraction of water required for growing sugarcane and processing biofuels will thus affect water availability for other activities downstream. For example, the 850-ha sugarcane plantation in Bagamoyo, SEKAB has applied to use 0.59 m^3 s^{-1} at the beginning of June 2009, rising to 11.81 m^3 s^{-1} in October, and decreasing to 7.87 m^3 s^{-1} by March 2010. The anticipated high water abstractions during the low flow period (especially mid- September and early November) will transform the Wami River into a seasonal one. In severe dry years irrigation requirements will exceed available water in the river. For example on 9th November 2007, the measured flow at Matipwili was 6.8 m^3 s^{-1}, about 58% of estimated irrigation requirement of 11.8 m^3 s^{-1} on that day.

Water loss from irrigation can be minimised by increasing the water-use efficiency during irrigation. Less efficient irrigation practices include surface flooding, unplanned farrows, and irrigation during peak evaporation periods. Figure 4.1 shows the use of sprinkler irrigation to irrigate sugarcane in the afternoon enhancing evaporation losses and surface runoff.



Figure 4.1: Noon-time irrigation of sugarcane in Kilombero (Illovo) Sugar Company

The amount of water is required during extraction and processing of liquid biofuels from the raw material can be substantial. For example, a lot of water is required to wash sugarcane before crushing. According to the SEKAB -EIA report, three to 10 cubic metres of water are used for every tonne of cane, with an average of about 5 m^3/t of sugarcane washed. An average daily washing of 25,000 tons of cane will hence require 125,000 m^3 of water. If in addition the ethanol plant will consume from 20,000 to 30,000 tons/day (SEKAB BT, 2007), then 420,000 and 630,000 m^3/day of water will be required, assuming a typical total water use in bioethanol distilleries of 21 m^3/t cane. This is a very large amount of water demand will have to be met by extracting water from river water or underground sources during the dry season (June – February). Using the Wami River to meet the required water demands is likely to cause severe water shortage downstream with serious consequences on other users and natural ecosystems.

SEKAB Bagamoyo Bioenergy Project's water demand for irrigation is expected to be 97.2 x 10^6 m^3 yr^{-1} to be abstracted from the Wami River. The total water demand for irrigation, factory and domestic uses is estimated at 110.6 x 10^6 m^3 yr^{-1} for the 10,500 ha plantation. The peak demand will occur in February corresponding to 13.1 million m^3 (5.3 m^3 s^{-1}) for 10 500 ha and 19.2 x 10^6 m^3 (7.7 m^3 s^{-1}) for 15,500 ha. Figure 4.2 shows that water flow during dry years is very low and will not meet the requirements of the sugarcane farm and other down stream uses.

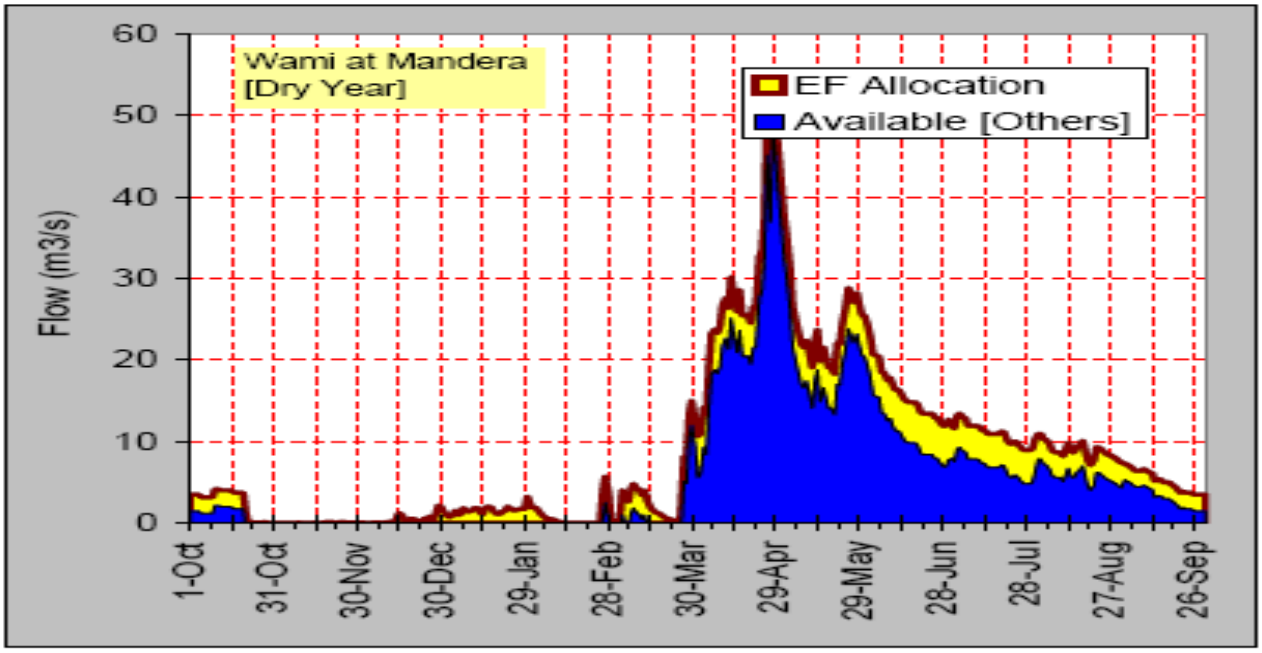


Figure 4.2: Water flow at Mandera during dry (drought) year (Source: Wami River Environmental Flow initiative – http://wami.fiu.edu*ESIA*).

4.1.2 Water pollution

Intensive production methods used in large-scale biofuel and processing are often associated with high water pollution. Large-scale biofuel farming entails heavy use of agrochemicals (fertilisers, herbicides, and pesticides) which pollutes the soil. Heavy use of N-fertilisers increases soil acidification and nitrate loadings that lower the quality of discharged water for human and animal and use. High doses of P fertilisers when washed into water bodies increase eutrophication and algal bloom that negative affects fish populations. High doses of herbicides are normally used in large-scale biofuel plantains to control weed growth. For example, Paraquat and Glyophate extensively used in large sugarcane farms are associated with serous human health problems. Discharging highly polluted water and sediments into water courses and underground water reserves pose serious hazards to living organisms including human beings, plants and animals relying on the water. The discharge of effluents from sugarcane processing and especially ethanol production directly into streams and oceans reduce water quality and can lead to serious water pollution and death of fish and other aquatic organisms. Accumulation of pesticides in water and soil will harm biodiversity and ultimately enters human systems via the food chain. Table 4.1 shows results of water intake from Diwale River and to the point of discharge to the Wami River in Turiani, Morogoro region. The WHO water quality standard for water discharge is also indicated. High deterioration in discharged water is evident for NTU, TDS, TSS, NO_3^-, PO_4^{3-} and Cl^-.

Table 4.1. Mtibwa Sugar Factory laboratory results for water quality

Source of water sample	Chemical substances in water									
	pH	NTU	TDS	OC	TSS	NO_3^-	PO_4^{3-}	Cl^-	Ca^{2+}	DO
		mg/l								
Diwale River	7.68	18.0	133.0	25.7	160	77.92	3.5	615	6.4	8.1
Terminal waste water ponds	7.92	1335	2532	25.8	285	115.84	21.0	457	205.6	2.5
Canal discharging water back to Wami River	7.11	1335	2540	25.6	285	115.84	210	457	205.6	2.5
WHO discharge Water quality standards		15	2000		35	50	2	250		6

Source: Mtibwa Sugar

Other effluents include those from mill cleaning, and are often rich in organic matter and heavy metals which lower O_2 levels and biochemical processes. There are reports that some of the existing factories discharge molasses into river water, but also to reduce road dust apply molasses on the roads. This molasses ultimately washes into

the rivers and streams increasing water pollution. Figure 4.2 shows water intake and discharge in Illovo Sugarcane plantations. The clean water normally received at the intake is discharged as sediment-rich and chemically polluted.



Figure 4.2: Clear water at the intake in one sugar plantation and factory, and turbid water discharged back to the river after use.

The water used to wash the cane to remove attached sediments, soot and chemicals before crushing is the first liquid effluent of the processes and contributes large amounts of wasres. Next is the material known as 'Vinasse', which is a by-product of ethanol production; it is a particularly strong pollutant if discharged into rivers. High concentrations 'vinasse' affect various living organisms downstream including causing massive death of fish and wildlife using the polluted water. For each litre of alcohol produced from sugarcane, 13 litres of vinasse are produced. Thus, with SEKAB initial

planned target of 2 million litres of ethanol per year, about 26,000,000 litres of vinasse will be produced. The volume of vinasse produced per tonne of cane processed ranges between 665 and 1,260 litres (SEKAB EIA, 2008). With the expected ethanol processing, about 12,500 tones of cane will be processed daily, producing 8,312.5 to 15,750 m^3 of vinasse. The next most important effluent is the cane washing water, and has a polluting potential roughly one tenth of the vinasse.

4.2 Projected large-scale biofuel impacts on green house gas emissions and air pollution

Contrary to claims that large-scale biofuel production will reduce greenhouse emissions, and hence global warming, it clear that large-scale clearing of land and especially use of fire to facilitate site preparation will increase greenhouse gases (GHG) emission and air pollution. Righaleto *et al.* (2008) estimates about 199 MgC/ha are lost during clearing of primary and secondary forests to establish biofuel plantations. Burning cause air pollution (elevated levels of CO_2, CO, NOx, and O_3) around sugarcane fields. Both pre-harvest and post-harvest burning contributes GHG emissions, with serious consequences on the health of local inhabitants (Cancado *et al.*, 2006). The study by Cancado *et al*. (2006) in Piracicaba, SE Brazil demonstrated the adverse impact of sugar cane burning emissions on the health of the population, emphasizing the need for public efforts to reduce and eventually eliminate this source of air pollution.



Figure 4.3: Pre-harvest burning of sugarcane contribute greenhouse gas emissions

Preharvest burning is common practice by the five large-scale sugarcane growers inn Tanzania (Fig. 4.3). It is not clear if biofuel investors with a much larger area will not practice burning with corresponding larger GHG emissions. This will also conflict with the country commitment ton reduce GHG emissions from deforestation. The potential for aggravating land degradation desertification need to be considered seriously as applications are being considered.

4.3 Projected Impacts on Soils

4.3.1 Loss of soil organic matter and lowered soil quality

Cultivation of feedstocks including sugarcane and Jatropha on large-scale plantations (>1,000ha) can significantly contribute to soil degradation through increased rates of erosion during land preparation and at harvesting. Clearing of natural forests or woodlands further exposes the soil to accelerated soil erosion and soil organic matter decomposition. Bellarby *et al.* (2008) reported that tropical forests account for 57% of global Carbon (vegetation 12% and soil 45%), tropical savannah contain 29% (vegetation 15% and soil 14%), and croplands (including biofuels) contain 11.2% (vegetation 10.6% and soil 0.6%). Converting tropical soils and savannah to biofuel monocultures, will lead large losses of C, reducing soil quality and land productivity. The implication is that it is better to leave the land to secondary savannah/forest regeneration or reforestation.

Burning of vegetation slash and preharvest sugarcane burning increases loss of sol organic matter. Research in India has shown that trash can improve soil organic C by 0.13 percent, available N by 37 kg/ha and available P by 10 kg/ha. Conversely, burning of trash reduced organic C by 0.02 percent, available N by 15 kg/ha and available P by 16 kg/ha (WWF, 2006). Traditionally, bagasse, the organic material left after juice extraction from sugarcane, is returned to the field to replenish soil organic matter and fertility. However, it is now common practice for existing sugarcane factories to burn this material to generate energy including electricity. Therefore over time, through continuous removal of successive crops, the plantations will be severely degraded. Burning of bagasse in effect increases GHG emissions, further challenging the benefits of biofuels to address the 'C debt' due to deforestation. For example the burning of bagasse from the 422,000 ha planned SEKAB sugarcane plantations in the Coast Region will generate so much GHG emissions that will compromise Tanzania's eligibility to participate in forthcoming REDD initiative.

4.3.2 Deterioration of soil properties

Practices that alter soil physical properties include clearing natural forest/woodlands which exposes the soil to erosion losses especially on sloping areas. Mechanised

cultivation and poor protection of the soil under sugarcane on sloping land increase soil erosion (Fig. 4.4). Soil erosion removes the top soil organic matter and nutrient-rich materials will lower the productivity of the soil. World estimates of soil losses to water erosion under sugar cane range from around 15 to over 500t/ha/y (WWF, 2006).



Figure 4.4: Soil erosion can be serious under poor soil conservation measures

All large-scale farming in Tanzania and elsewhere in the tropics promote mechanised farming. Use of heavy equipment (e.g. heavy tractors) to clear the land of existing vegetation, accompanied by residual vegetation burning, and use of farm tractors for ploughing is the standard practice. This approach promotes compaction in heavy soils, and promotes erosion by exposing soil aggregates to rainfall impacts. Soil compaction degrades soil structure and porosity, as it increases bulk density and soil strength, thereby restricting crop rooting ability, reduced activities of soil organisms. Reduced infiltration rates due to compaction will increase surface water runoff and alter peak flow. SEKAB plans to use 200 heavy equipment for the planned 22,000-ha sugarcane plantation in Bagamoyo (SEKAB, 2008), and is likely to cause serious compaction of susceptible soils.

Surface sealing and crust formation can occur on heavily compacted cane-growing soils, resulting in a relatively impermeable layer at the soil surface. Soils rich in sodium are quite vulnerable to sealing, and the loss of organic matter, usually associated with cultivation, are vulnerable to surface sealing (Pardo *et al.*, 2008). Sealing reduces water

infiltration and increases runoff erosion and pollution of waterways, but also reduce the water available to the crop, and can prevent seedling emergence.

Another consequence of large-scale biofuel is soil acidification resulting from heavy use of N fertilizers and loss of soil buffering capacity caused by loss of soil organic matter. For example, the large amounts of inorganic nitrogenous fertilisers such as urea and ammonium sulphate, and removal of base cations in the harvested biomass or lost during burning are major causes of soil acidification in sugarcane farming. Under high rainfall conditions or irrigation, increased nitrate leaching enhances acidification. The loss of nutrients by leaching further leads to a higher need for fertilisation, eliciting a cycle of acidification.

With respect to biodiversity, the natural forest and woodland vegetation have high soil biodiversity. Clearing large chunks of these for establishing large scale biofuel production will create conditions that lower soil biodiversity substantially, affecting long-term land productivity. Large-scale biofuel cultivation such as the planned 82,000 ha of Jatropha plantation in Kilwa and 422,000 ha of sugarcane plantation in Wami-Ruvu and Rufiji River Basins by replacing natural ecosystems over large areas with monoculture crops will produce significant environmental impacts through the loss of natural habitats. Replacing high bio-diverse natural ecosystems with large-scale intensively grown monoculture crops will alter soil organisms, reducing ecosystem resilience. The continuous deterioration of soil and water quality will greatly affect the long-term sustainability of these production systems.

The fishing, farming and increasing pastoral communities will be severely affected. In particular, the impairment of the mangrove ecosystem with its associated fish resources will affect wealth and nutrition of the coastal inhabitants and beyond. It is quite difficult but tragic, to contemplate the loss of the long-established coastal livelihoods. The plight of the pastoralists who consider the coastal environment as their last frontier will be cruelly shattered for to serve the interest of selfish liquid consumers overseas.

4.4 Implications of Biofuel Activities on Natural Vegetation and Biodiversity

4.4.1 Impacts of BioShape activities on Vegetation and Biodiversity

BioShape *Jatropha* plantations are going to destroy and replace the natural vegetation (miombo and coastal forests) of the area due to clearing (which has already started), to give a room for monoculture cultivation of *Jatropha* (Figs 4.5 & 4.6). In addition, BioShape plantation sites are adjacent to several catchment forests (Fig. 4.7). Tanzania's Miombo vegetation are important sites and belong to the Global 200 WWF list of important biodiversity eco-regions.

The Coastal Forests are recognized as a globally important conservation priority hotspot (Stattersfield *et al*. 1998; Olson and Dinerstein 1998; Myers *et al*. 2000). Trees dominate the coastal forest flora, with some of the more abundant species being *Afzelia quanzensis*, *Albizia* spp., *Bombax rhodognaphalon*, *Combretum schumannii*, *Croton* spp., *Cussonia zimmermannii*, *Cynometra* spp., *Dialium* spp., *Diospyros* spp., *Grewia* spp., *Hymenaea verrucosa*, *Manilkara* spp., *Millettia stuhlmanni*, *Nesogordonia holtzii*, *Ricinodendron heudelotii*, *Scorodophloeus fischeri*, *Sterculia appendiculata*, *Sorindeia madagascariensis*, *Xylia africana*, and *Zanthoxylum* spp. Lianas are also common as, too, are shrubs, herbs, grasses, sedges, ferns, and various epiphytes.

The entire Coastal Forests of Eastern Africa Hotspot is rich in endemic taxa. It contains an estimated 4 050 plant species within around 1 050 plant genera, of which 1 750 plant species and 28 genera are endemic; most of the endemic genera are monotypic. Around 70% of all endemics (1 225 species) and 90% of the endemic genera have been recorded from closed canopy vegetation types (forest, woodland, bushland, and thicket). Indeed, the lowland forest habitat is the most biologically valuable, with at least 554 endemic plant species and 18 of the 28 described endemic genera confined entirely to it (Clarke *et al*., 2000). The non-forested vegetation of the coastal strip of eastern Africa (i.e., swamp, wooded grassland, coastal margins) is also important, with at least 812 endemic plants and members of 10 endemic genera recorded from it.

Clearly, it is the forest patches that have the highest biodiversity importance per unit area. In addition, approximately 40% of the endemic plants are confined to a single forest (for example, the Rondo Forest area in southern Tanzania, has 60 endemic species and two endemic genera (Clarke *et al*., 2000; Clarke, 2001). The coastal forests also contain 11 species of wild coffee, of which eight are endemic (Clarke *et al*., 2000). None of these have been exploited as commercial crops. Similarly, these forest patches are important in terms of vertebrate diversity and endemism. Birds are represented by 636 species, of which 12 species are endemic. There are 198 mammal species recorded from this hotspot, of which 11 are endemic (Burgess *et al*., 2000). Among the remaining terrestrial vertebrates, some 250 reptile species are recorded, of which 54 are endemic. A single genus, *Scolecoseps*, is endemic, represented by three species. In addition, there are 116 amphibian species, of which seven are found nowhere else. The mosaic of habitats comprising this hotspot still supports considerable populations of large herbivores such as elephants (*Loxodonta africana*), especially in the larger protected areas and wilderness regions of southern Tanzania. Other African flagship species also occur, including the African wild dog (*Lycaon pictus*), lion (*Panthera leo*), leopard (*P. pardus*) in the Selous.

An amphibian species of great interest is the endemic Loveridge's snouted toad, the only member of its genus. This species is remarkable in that it is one of the very few amphibian species that breeds by internal fertilization, but lays eggs (instead of giving

birth to live young). It lays its eggs in very small water-filled holes and crevices (including snail shells).
Fishes also live in temporary swamps and floodplains of the coastal forests. One example is the air-breathing lungfishes *Protopterus amphibius* and *P. annecteus* that can aestivate as adults for over a year at a time in 'U'-shaped cocoons underneath the dried-up mud. The annual killifishes have a very short life cycle, and grow quickly in food-rich temporary water bodies. They lay their eggs in the mud and they die when the pool dries up, but the eggs survive and hatch when the rainy season begins (Hrbek and Larson, 1999). The littoral vegetation includes mangrove vegetation along some parts of the coast, especially in sheltered bays and along river mouths.



Fig. 4.5: Clearing of natural vegetation by BioShape at Mavuji village, Kilwa for *Jatropha*

4.4.2 Impacts of BioShape activities on Catchment forests and Water

There are a number of streams and rivulets in the area (Figs 4.7 & 4.8), therefore a catchment area in danger of destruction and pollution from agrochemicals by Bioshape activities. Interfering with the hydrological cycle of the area will have impacts on plant and animal life. Drying out of water bodies and pollution will cause some plants and animals to move or perish.



Fig. 4.6: BioShape's monoculture *Jatropha* trial plots at Mavuji village, Kilwa showing total clearing of vegetation except for the few Baobab trees

4.4.3 Impacts of BioShape activities on Habitat and Wildlife Migration Routes

Habitat fragmentation is the division of a once continuous ecosystem into strips or patches by erecting barriers between them. Habitat fragmentation prevents genetic exchange between various organisms, as populations which were once freely breeding will be divided into small isolated populations due to barriers imposed between them. Fragmentation may also affect free movement of pollinators. Pollinators are important in cross pollination, an important aspect of genetic material exchange and hence biodiversity. Habitat fragmentation is evident in the BioShape's so called strip cultivation. *Jatropha* plantations will create barriers between once continuous populations. In addition, by clearing the vegetation, some pollinators will eradicated as their source of nectar and pollen will also be cleared.

BioShape plantation sites are within the home range of many animals of the Selous Game Reserve. This is evident due to the proximity of the plantation sites to the game

reserve, and the number of animals spotted roaming in and around the areas. The plantations sites have migration routes for wildlife (Fig. 4.9), as reported by BioShape themselves (BioShape, 2008). The migration routes are important for animals going into the sea shore for salt licking, and are also used as breeding sites for a number of animals.

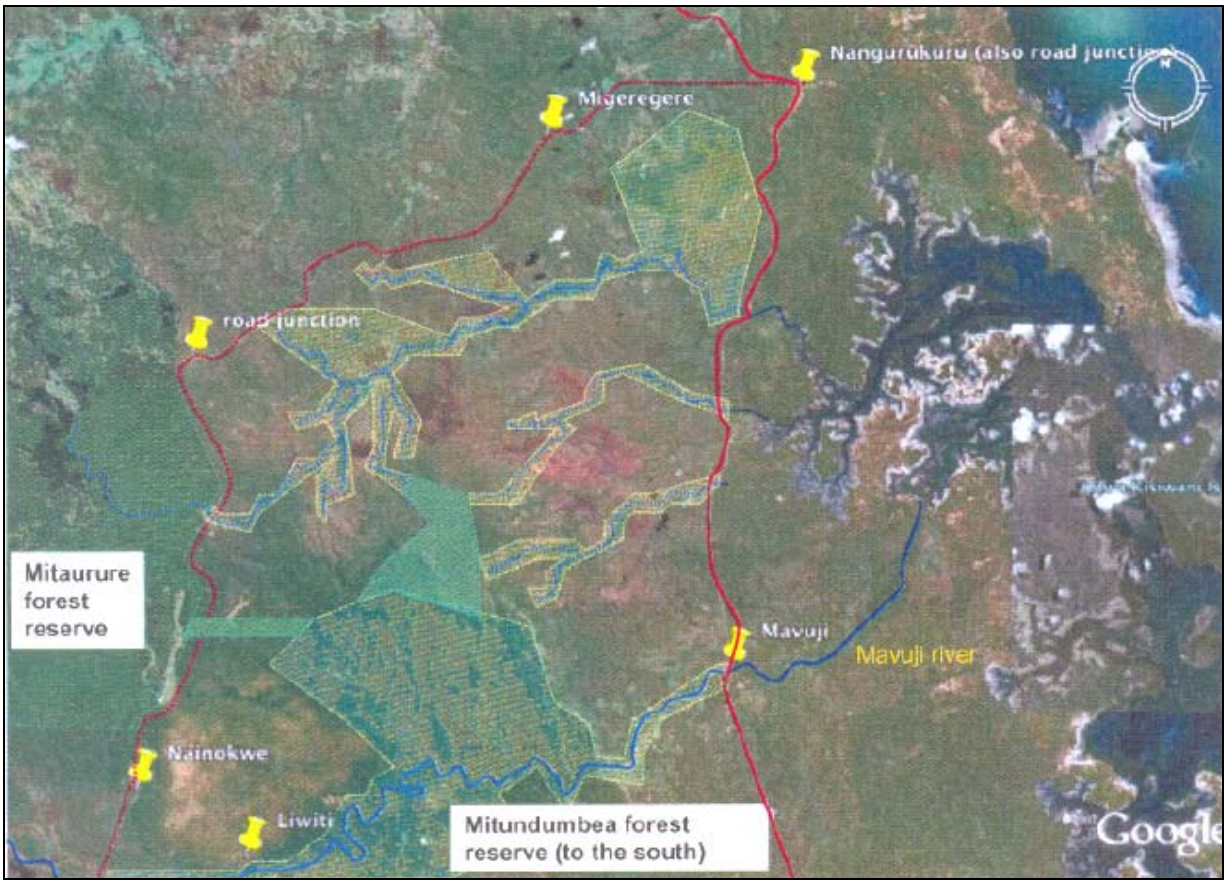


Fig. 4.7: Rivers and catchments in BioShape plantation sites
(Source: BioShape report, 2008)

4.4.4 Impacts of monoculture Jatropha on indigenous plant species and food crops

Jatropha curcas is a member of the plant Family Euphorbiaceae. It is known to have the potential of becoming weedy on areas introduced. This is due to its seeds that can spread rather easily and create dense stands on uncultivated lands. It has been reported as a weed in many places including, Australia, Brazil, Fiji, Honduras, India, Jamaica, Panama, Puerto Rico, and Salvador. *Jatropha curcas* is therefore an invasive alien plant species, likely to replace our diverse native species. In addition, *Jatropha curcas* is known to transmit diseases to cassava, also belonging to the Family Euphorbiaceae. Diseases spread by *Jatropha* pathogens include cassava superlongation caused by *Sphaceloma manihoticola/Elsinoe Brasilinesis*. In addition, *Jatropha multifida*, a relative of *J.*

curcas is an alternate host plant for African Cassava Mosaic Virus, which is transmitted by whiteflies (*Bemisia tabaci*), and it can be assumed that this also applies to *Jatropha curcas* (Heller, 1996). It is worth noting that cassava is a staple food crop for many Tanzanians endangered by large scale *Jatropha* plantations.

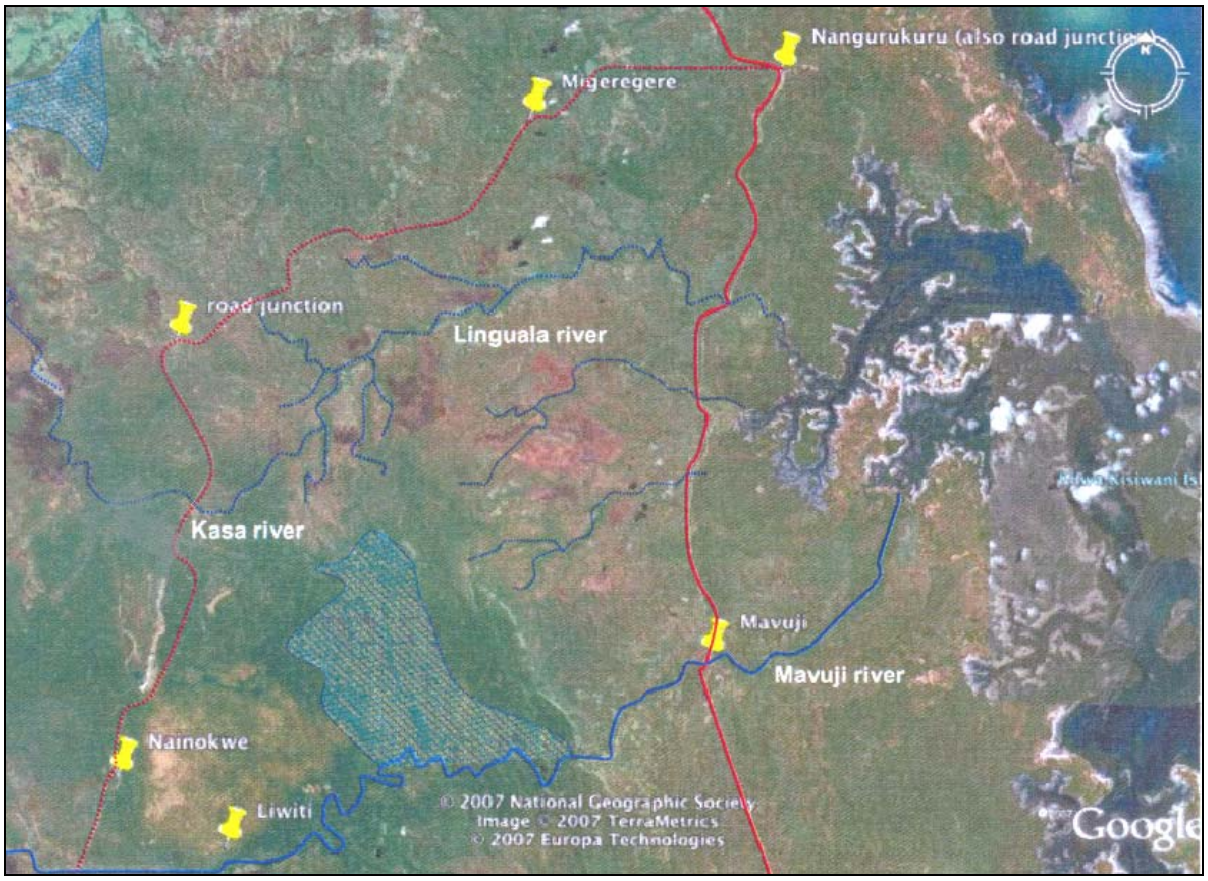


Fig. 4.8: Ecological network and hydrology in BioShape plantation sites (Source: BioShape report, 2008)

4.4.5 Impacts of SEKAB's activities on Vegetation and Biodiversity

As stated earlier, the plantation site at RAZABA has a number of plant communities with a diverse number of species. Rare and endemic plant species are found within the forest thickets and in the riverine vegetation in the northern part of the project area. Such species include the endemic *Encephalartos hildebrandtii*, the Cycad tree (Fig. 4.10) and important timber trees such as *Dalbergia melanoxylon* (African Ebony), *Milicia excelsa*, *Pteleopsis myrtifolia* and *Trichalysia* sp.



Fig. 4.9: Elephant migration routes and tracks at Nainokwe BioShape plantation sites. (Source: BioShape report, 2008)



Fig. 4.10: *Encephalartos hildebrandtii*, an endemic Cycad tree at RAZABA (Source: SEKAB, 2008)

The mangroves may also be destroyed by siltation or by chemicals transported from the project area by the water. In addition, large changes in water flow by the project may influence the mangroves as salinity will push inland. The SEKAB project site is potentially rich in wildlife and shares many species with the adjacent Saadani National Park. All taxonomic groups including mammals, birds, reptiles, amphibians, fish and many invertebrate groups are represented in the area (SEKAB, 2008).

The area has high diversity of both resident and migratory bird species with the composition and abundance of species changing with seasons due to intra-Africa and Palaearctic migrations. The importance of Makurunge area for bird conservation is indicated by the high abundance of birds observed during the Environment Impact Assessment survey (SEKAB, 2008). More than 30 different animals are known to occur in the RAZABA area (Table 4.2). The animals include the big mammals such as the elephant (Fig. 4.11) and the rare mammals such as the leopard (Fig. 4.12). RAZABA plantation site is within the home range of many animals of the Saadani National Park and it is an important breeding area for elephants. There is no doubt that this entire diverse ecosystem is going to be destroyed by SEKAB's planned activities of Biofuel production.

4.4.6 Impacts of SEKAB's activities on Habitat, Wildlife Breeding/Migration sites

Similar to BioShape activities and any other large scale agriculture on natural vegetation, habitat fragmentation is evident in the SEKAB's so called strip/retention cultivation. Sugar cane plantations will obvious create barriers between once continuous populations of RAZABA and Saadani National Park. Many animals reside (Table 2) and breed in the RAZABA area. In addition, by clearing the vegetation, some pollinators will eradicated as their source of nectar and pollen will also be cleared.

Table 4.2: Common animals of the RAZABA area

S/N	Species	Common name	Family/subfamily
1	*Alcelaphus bucelaphus*	Hartebeest	Alcelaphinae
2	*Connochaetus taurinus*	Wildebeest	Alcelaphinae
3	*Syncerus caffer*	Buffalo	Bovidae
4	*Madoqua kirki*	Dik dik	Bovidae
5	*Aepyceros melampus*	Impala	Bovidae
6	*Otocyon megalotis*	Bat-eared fox	Canidae
7	*Lycaon pictus*	African hunting dog	Canidae
8	*Cephalophus harveyi*	Red duiker	Cephalophinae
9	*Cercopithecus mitis*	Blue monkey	Cercopithecidae
10	*Cercopithecus aethiopus*	Vervet monkey	Cercopithecidae

S/N	Species	Common name	Family/subfamily
11	*Colobus guerreza*	Colobus monkey	Cercopithecidae
12	*Papio cynocephalus*	Yellow baboon	Cercopithecidae
13	*Crocodylus niloticus*	Nile crocodile	Crocodylidae
14	*Loxodonta africana*	Elephant	Elephantidae
15	*Equus burchelli*	Zebra	Equidae
16	*Panthera leo*	Lion	Felidae
17	*Panthera pardus*	Leopard	Felidae
18	*Acynox jubatus*	Cheetah	Felidae
19	*Galago senegalensis*	Lesser bush-baby	Galagidae
20	*Giraffa camelopardalis*	Giraffe	Giraffidae
21	*Hippopotamus amphibius*	Hippopotamus	Hippopotamidae
22	*Hippotragus niger*	Sabble antelope	Hippotraginae
23	*Crocuta crocuta*	Spotted hyena	Hyenidae
24	*Hystrix cristata*	Porcupine	Hystricidae
25	*Ictonyix striatus*	Zorilla	Mustelidae
26	*Mellivora capensis*	Honey badger	Mustelidae
27	*Pedestes capensis*	Spring hare	Pedetidae
28	*Redunca redunca*	Bohor reedbuck	Reduncinae
29	*Kobus ellipsiprymus*	Common waterbuck	Reduncinae
30	*Potamochoerus porcus*	Bush pig	Suidae
31	*Phacochoerus aethiopicus*	Warthog	Suidae
32	*Taurotragus oryx*	Eland	Tragelaphinae
33	*Tragelaphus scriptus*	Bushbuck	Tragelaphinae
34	*Tragelaphus strepiceros*	Greater kudu	Tragelaphinae
35	*Viverra civetta*	African civet cat	Viverridae
36	*Genetta genetta*	Genet	Viverridae
37	*Mungos mungo*	Banded mangoose	Viverridae

Source: Field interview

Most of the mammals are resident in the area while a few are migratory. Buffaloes, waterbucks, greater kudu, reedbucks, bushbucks and primates and other mammals are mostly resident and only do daily movements in search of food, water and avoidance of predators (SEKAB, 2008). At least 34 species of mammals occurring in the project area are threatened according to the IUCN redlist. Most are at Lower Risk (LR) but at least four species including the lion, Cheetah, African elephant and hippopotamus are Vulnerable (VU). Observations suggest that most species are threatened by loss of habitat and overexploitation.



Fig. 4.11: The elephant (*Loxodonta africana*) and its breeding site at RAZABA is likely to be disturbed by SEKAB's Biofuel activities. (*Source: SEKAB, 2008*)



Fig. 4.12: The Leopard (*Panthera pardus*) and its habitat at RAZABA is likely to be disturbed by SEKAB's Biofuel activities

4.4.7 Impacts of SEKAB's activities on Wami and Ruvu rivers' Water flow

SEKAB's RAZABA plantation sites are going to be irrigated by Wami and Ruvu waters (Figs 4.13 & 4.14). This will reduce water flow at the estuaries were mangroves are growing. The effect of this is increased salinity due to inland flow. This will have consequences on the mangrove ecosystem. In addition, agrochemicals from the farms will be carried by the rivers to the sea through the mangrove ecosystem similarly affecting the marine organisms.



Fig. 4.13: SEKAB workers laying water pipe to extract water from Ruvu River



Fig. 4.14: SEKAB's water reservoir for drip irrigation at their nursery

5.0 BIOFUEL PRODUCTION AND FOOD SECURITY ISSUES

5.1 Adequacy of land for food production in quality and quantity

Although Tanzania is an agricultural country, to date it has not achieved food security. In this case converting lands like those in Kilwa, Bagamoyo, Handeni and others suitable for growing food crops (rice, maize, cassava, bean etc) to produce biofuel crops may compromise food security as land and time for producing food crops will be reduced. For example, impacts of increased sugar cane cultivation on reducing rice production in Kilombero are so obvious. Sugar cane out growers have utilized larger portions of their suitable land for rice production to grow sugar cane as a result rice production in Kilombero has dropped tremendously leading to escalating rice prices and shortage food to the households. Some out growers would prefer to go back to rice production but unfortunately they are bound by contracts with sugar factory. If care is not taken on how the contracts are made this kind of situation could also occur to bio fuel feedstock out growers. It also envisages that other food crops such as cassava if their use is diverted to production of bio-ethanol, food insecurity will occur in areas where it is the staple foods (Figure 5.1).



Figure 5.1: Peeled cassava roots, one of the major staple foods in Kigoma region being transported to the market.

The Ministry of Agriculture, Food security and Cooperatives emphasizes whenever possible, non-food crops should be used for biofuel production. In some cases areas allocated for large-scale biofuel production are adjacent to rivers of which smallholder farmers also depend on to irrigate food crops during dry season. Irrigation in such

large-scale farms may lead into conflicts over access to water between large-scale biofuel crops producers and smallholder farmers in the areas and also reduce food production during dry seasons. This was the case in Mwakijembe village in Mkinga district where Jatropha nursery by investors (M/S Maurizio Cenci) has been established adjacent to the river preventing villagers from growing food crops in that area. This would also be the case in Bagamoyo where SEKAB is using water for irrigation from Ruvu River. In Kigoma as it is shown in Figure 5.2, it was observed that a smallholder farmer was forced to grow beans in an area that is not suitable leaving suitable land surrounding it for oil palm plantation.



Figure 5.2: A small portion of land planted with beans, surrounded by oil palm plantations in Kigoma. The bean plot will be vulnerable to floods if heavy rains occur leaving a farmer without bean harvest for food.

In areas like in Mkinga district, drought that had occurred for consecutively two seasons has led into food shortage in most of the villages. From the household survey in Mbuta village 96.8% of the respondents acknowledged experiencing food shortage. Hence, the establishment of jatropha plantations in those villages might force farming communities to seek labour in jatropha plantations and forget to cultivate food crops for their own consumption. This situation will lead into increased food shortage and dependency of villagers to work as labourers like what has been happening in sisal estates.

5.2 Implication on labour supply for food production

Another area that has raised eyebrows on the issue of large scale bio fuel production from the field visits is that of food security. With the introduction of bio fuels the impacts can have several facets. On the basis of cost-benefit analysis, if the value of cultivation of crops for bio fuel is higher than that of cultivation of food for human consumption, farmers will be attracted to trade-off their produce for bio fuel. Similarly, if value for labour in the plantation is higher than in their own farms, most farmers will opt to move to the plantations and sale their labour. This scenario is already unfolding in some of the areas we visited. For example, Bioshape is currently working on just 1000 acres and it employs 300 workers, of which only 100 are permanent and pension able. In the event that they manage to get the 34,000 hectares, the number of employees on the farms is likely to increase. Those who have taken up employment in these farms are young people who used to work in their small farms for food production. There are arguments that coastal people are naturally languid and that the region has always been food deficient. Much as we may not rebuff the strength of this argument, we consider that introduction of plantations for bio fuel may even worsen the situation.

5.3 Implications on agricultural extension services

Most of the farmers in Tanzania are small holders as shown in Figure 5.3. The majority are using hoes to till the soil which makes them unable to cover more than 2 acres. The small holder farmers depend on rain and subsidized fertilizer which is not always forthcoming. As such their production is subsistent. Furthermore, extension officers are difficult to get hold of as a result farming is based purely on experience. All these facts lead to small quantity and quality of produce which in most cases cannot meet market requirements. These facts could deter biofuel investors from adopting out grower scheme.

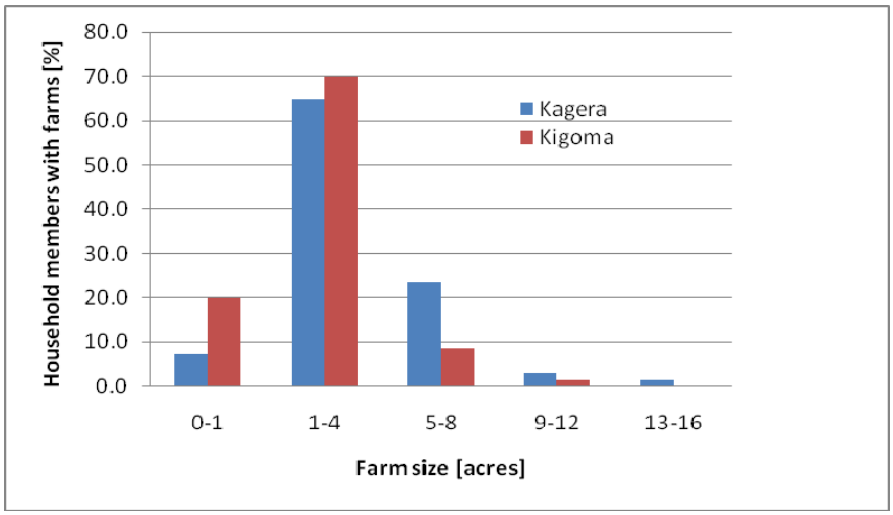


Figure 5.3: Farm sizes owned by households

Under these prevailing circumstances agricultural production cannot meet national demand for food. The situation is likely to worsen if some of what these smallholder farmers produce is diverted towards biofuel production. To avert this impending predicament agricultural extension services need to be enhanced so as to boost agricultural production for food crops including feedstocks for biofuel production.

To achieve this goal, there are challenges the country must address. One of the significant challenges is the inadequate agricultural extension staff. According to the 2006/2007 Budget Speech (URT 2007) and available statistics, Tanzania needs an estimated 15,000 extension officers if the country is to meet the requirements for extension officers. Tanzania has currently employed a total of 3,379 extension officers thus leading to a shortfall of 12,621 extension officers. According to the Ministry of Agriculture, Food Security, and Cooperatives statistics, the country (Tanzania mainland only) needs 15,082 extension officers but the total numbers of employed extension staff so far are 3914 countrywide. This leaves a deficit of 11,703 extension officers. Table 5.1 below gives a breakdown of the regional distribution of extension staff in Tanzania mainland.

From Table 5.1, it is clear that the availability of extension services is a major challenge for Tanzania if indeed the country is to produce enough food to feed its own people as well as have surplus for export and feedstocks for biofuel production. In the face of the likelihood of investing in biofuel, a potential threat to food security, this situation of insufficient number of extension officers becomes a real constraint under the present circumstances.

Table 5.1: The distribution of extension officers in Tanzania by region up to 23rd March 2007

Region	Extension Officers by Qualification			Total	Where posted		Required	Deficit
	Graduate	Diploma	Certificate		District HQ	Ward and Village		
Rukwa	9	73	46	123	14	114	496	382
Mbeya	31	189	79	290	33	257	1159	902
Iringa	26	142	46	214	25	189	1048	859
Ruvuma	11	86	49	146	20	126	693	567
Dodoma	13	139	44	196	24	172	717	545
Morogoro	24	202	66	292	24	268	772	504
Mwanza	15	130	40	185	29	156	1330	1174
Tabora	12	88	27	127	30	282	620	523
Kagera	5	80	65	149	26	123	769	646
Tanga	13	162	53	228	39	189	1008	799
Shinyanga	16	157	78	251	36	215	1165	950

Region	Extension Officers by Qualification			Total	Where posted		Required	Deficit
	Graduate	Diploma	Certificate		District HQ	Ward and Village		
Mara	14	119	49	182	28	154	633	479
Dar	14	92	4	110	15	95	365	270
Pwani	18	173	39	230	31	199	535	336
Singida	10	76	24	110	20	90	452	362
Kigoma	7	67	26	100	17	83	316	233
Mtwara	10	67	10	82	26	61	800	739
Kilimanjaro	13	213	88	314	24	290	586	296
Manyara	14	77	31	122	26	96	426	330
Arusha	12	105	47	164	20	144	523	379
Lindi	1	77	31	109	28	81	562	481
Grand Total	255	2,514	865	3,914	535	3,379	15,082	11,703

Source: Unpublished compilation by the Ministry of Agriculture, Food Security and Cooperatives

6.0 TECHNICAL ASPECTS OF PRODUCTION AND PROCESSING OF BIO-FUELS

6.1 Major types of commercial biofuels

Although biofuels encompasses liquid and solid biomass including firewood, biogas, etc., the biofuel of interest in this study are liquid biofuels mainly biodiesel and ethanol. Biodiesel and ethanol have higher commercial value than other biofuels because they are used as alternative fuels to petroleum fuels (diesel and petrol, respectively) to run automobile internal combustion engines which form the backbone of the transportation sector. Biodiesel and ethanol can be produced locally from the following agricultural feedstock.

6.2 Biofuel Feedstocks

6.2.1 Biodiesel feedstock

Biodiesel is produced from vegetable oil and fats including pure virgin vegetable oil, vegetable fats, animal fats, and used vegetable oils and fats. Typically, oils and fats contain up to 14 different types of fatty acids ranging from C8 to C22 carbon chain backbone. The fatty acid composition of the oils and fats is dominated by mainly C16 (palmitic acid) and C18 (Oleic and linoleic acids).

Biodiesel feedstock for majority of companies registered for biofuel production in Tanzania is *Jatropha curcas*. Few companies have registered for production of biodiesel from Palm, *Croton megalocarpus* and rapeseed as shown in Table 8.1. However, there are

some other oil producing plans such as avocado, castor, *Moringa oleifera Aleurite Moluccan,* etc. that are potential for production of vegetable oil for biodiesel production. Ten oil bearing plants with the highest oil yields are shown in Table 8.2. The first three, oil palm, coconut and avocado have competing higher value uses in food and cosmetic markets.

6.2.2 Ethanol Feedstock

Ethanol is produced from fermentation of sugars followed by recovery of ethanol from the fermentation broth. Sugarcane is the major source of ethanol production because its sugar is readily available for fermentation. A Swedish based company SEKAB has selected sugarcane as its feedstock for the production of ethanol in Tanzania.

6.2.3 Other Feedstocks

There are other feedstocks for production of biofuels around the world. Biodiesel is currently produced from Soya beans in United States of America, and Brazil. In Europe, Biodiesel is produced from Canola/rapeseed. Future biodiesel feedstocks include Algae which is capable of producing 30 times the amount oil per unit area of land, compared to terrestrial oilseed crops when grown in shallow ponds. Technology for production of biodiesel from algae is at advanced pilot scale trials and there are pilot plants in Portugal and United States of America.

Other feedstocks for ethanol are cassava, sorghum, millet and potatoes. Future ethanol feedstocks include seaweed and cellulosic materials. Cellulosic materials are hydrolysed to sugars (fructose and glucose) before fermentation. Examples of pilot scale for production of ethanol from cellulose are found in Sweden, United States and India. Due to abundance of cellulosic materials around the world, improvement and maturity of cellulosic ethanol technology is expected to revolutionarise ethanol industry. Another ethanol feedstock is seaweed. Pilot trial to produce ethanol from seaweed is conducted by a South Korean company which plans to grow 25,000 Ha of seaweed on Indonesian coast. Other non conventional feedstocks include waste materials such as whey which is used by New Zealand and Ireland; and Yucca which is considered as a potential feedstock in Mexico.

In Tanzania, sisal waste might be a good source for ethanol production. Sisal estates produce between 20,000 to 40,000 tons of sisal fibres, which constitute of 4% of the sisal leaf, the remaining 96% is a waste containing biomass and sisal juice. In addition, sisal stem remaining in the farm are cleared by unfriendly crash and burn techniques. This enormous waste can be transformed to ethanol. However, sisal sugar (inulin) is difficult to hydrolyse and research is needed to improve and reduce the cost for

hydrolysis before fermentation. Other potential feedstocks for ethanol in Tanzania are cassava and sweet potatoes, millet and sweet sorghum.

Table 6.1: Feedstock for major biofuel registered companies (2008)

Name of the company	**Feedstock**	**Estimated production**
Diligent Tanzania limited	Jatropha curcas	
PROKON	Jatropha curcas and rapeseed	
D1 Oils Tanzania Limited	Jatropha curcas and Moringa oleifera	-
Sun Biofuels Tanzania Limited	Jatropha curcas	-
SEKAB BioEnergy Tanzania Ltd.	sugarcane	16 Billion lt
Kikuletwa Farm.	Jatropha curcas	-
Africa Biofuel and Emission Reduction Company (Tanzania) Ltd	Croton megalocarpus	103 million litres of biodiesel per year
Donesta Ltd and Savannah Biofuels Ltd	*Jatropha curcas* and sunflower	-
Farming for Energy for better Livelihoods in Southern Africa (FELISA).	Palm	40 million of palm oil per year
Bioshape.	Jatropha curcas	-
InfEnergy.	Palm	-
BioMassive.	Jatropha curcas and pongamia	Initial production of over 100,000 tons per annum of biofuel
BioEnergy Resources, Tanzania limited.		
African Green oil.	Palm	

Source: Field interviews

Table 6.2: Potential crops and oil yield per hectare

S/N	**Crop**	**Litres oil/ha**
1	Oil palm	5950
2	Coconut	2689
3	Avocado	2638
4	Macadamia nuts	2246
5	Jatropha seeds	1892
6	Jojoba	1818
7	Croton megalocarpus	1717
8	Castor beans	1413
9	Rape seeds	1190
10	Moringa oleifera	800

Source: www.biodiesel.forever

6.3 Biodiesel Production

Biofuel production involves several steps as shown in Figure 6.1. The process starts with harvesting oilseeds in the farm, transporting seeds to the processing centre, dusking seeds, oil expression, chemical reaction to produce biodiesel, refining biodiesel, storing and distribution. The centre of the whole process is the chemical reaction known as transesterification whereby the oil is converted to biodiesel. Transesterification is the process of converting fatty acids by combining them with alcohol in the presence of a catalyst. The preferred alcohols are methanol or ethanol. The catalyst may be a strong acid such as sulphuric acid or a strong base such as sodium hydroxide or potassium hydroxide. The strong base is preferred to strong acid because it is easy to handle, the rate of reaction is high and the amount of oil converted to biodiesel is also high. The rate of reaction is affected by other factors such as temperature, stirring and oil acidity.

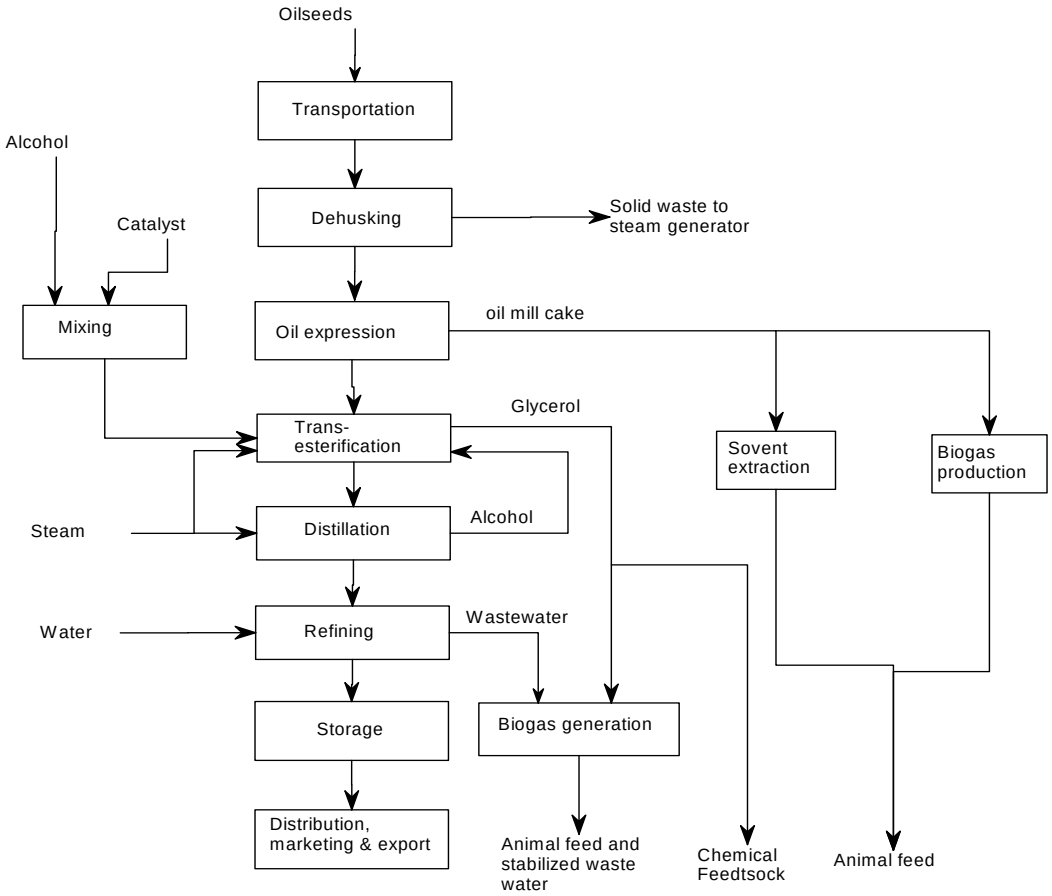


Figure 6.1: Block diagram for Biodiesel production

In general one litre of vegetable oil needs 150 to 200 mL of methanol (or ethanol) and 3.5 g of sodium hydroxide. Sodium hydroxide is dissolved in alcohol to form a solution of

sodium methoxide (or ethoxide). The solution is mixed with the oil and the mixture reacts to form approximately 1.15 litres of biodiesel. If methanol is used, a closed container (reactor) is necessary for protecting operators from methanol poisoning. Amount of water in the ingredients (alcohol or oil) reduces the yield of biodiesel by forming soap and should be avoided.

After the conversion process the mixture is allowed to settle into two layers: a layer of biodiesel at the top and a layer of glycerol at the bottom. The two can be separated by decantation or by siphoning biodiesel, faster separation can be achieved by using centrifuges. The biodiesel contains residual glycerol and alcohol which must be removed. Glycerol can plug fuel filter and form deposits in the engine combustion chamber, while alcohol reduces flash point of the fuel.

There are various methods for removing glycerol and alcohol. Alcohol is removed by distillation by heating crude biodiesel above alcohol boiling temperature and recovering the alcohol by condensation. Alcohol free biodiesel is washed with water to remove glycerol then heated above 100^{o}C to expel residual water. Alternatively, biodiesel may be refined by passed it through a column packed with molecular sieves resins which retains alcohol and glycerol while biodiesel passes through. The resins are regenerated or replaced when exhausted.

6.4 Production of Ethanol

Ethanol is produced by fermentation of sugar followed by ethanol recovery, usually by distillation and refining of the ethanol using molecular sieves as shown in Figure 6.2. The whole process goes through a number of stages. First the sugarcane is harvested manually or mechanically by cane harvesters and transported from the farm to the factory by either truck or rail network. Manual harvesting is generally cheaper than mechanical harvesting, but requires a large number of labour. Prior to harvesting, the cane field may or may not be burnt. Burning reduces leaf vegetation and increases efficiency of manual harvesting and improves efficiency of mechanical harvesting and loading operation. Secondly, the cane is crushed to yield juice with sugar concentration of 10-15^{o} Brix. The juice may be concentrated to high Brix (around 20^{o} Brix), by boiling or directly fermented to ethanol.
Conversion of sugars to ethanol is carried out by the aid of fermentative yeast such as *Saccharomyces cerevisiae.* For high ethanol yield, special strains such as distillers yeast are used. Depending on the yeast strain, concentration of starting sugar solution is approximately 20%. Fermentation is carried out anaerobically until most of the sugar is consumed. Maximum yield (ethanol from sugar) is 51% by weight but in practice the yield in 47%. Chemical equation for conversion of sugar to ethanol is shown below.

	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$		
Mol weight (g/mol)	180	92	88

After fermentation, ethanol is conventionally recovered from the fermentation broth by distillation. Ethanol for internal combustion engines is required in anhydrous form (without water) and distillation does not produce 100% ethanol due to azaetropic phenomena. To achieve a 99.99% ethanol, after distillation ethanol is passed through a molecular sieve which captures remaining water. The final ethanol with almost zero water content is pumped to storage ready for distribution and use as the fuel.

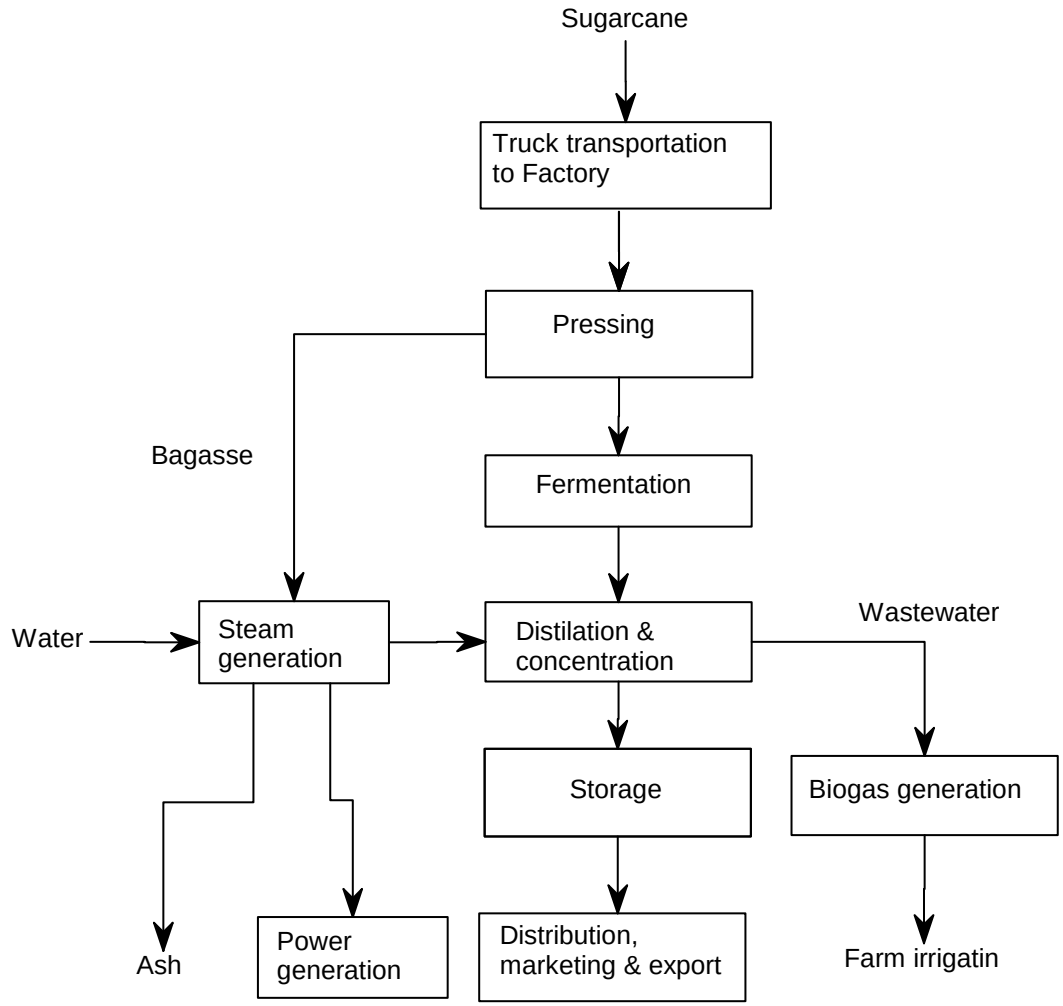


Figure 6.2: Block diagram for Ethanol production

Amount of ethanol produced per hectare can be estimated from Brazilian experience. In Brazil average production of burnt and cut (b&c) cane is 58 tons per hectare per year.

Each ton of b&c yields 740 kg of juice (135 kg of sucrose and 605 kg of water) and 260 kg of moist bagasse (130 kg of dry bagasse). The 135 kg of sucrose found in 1 ton of b&c are transformed into 70 liters of ethanol. Therefore, one hectare of sugar cane yields 4,000 liters of ethanol per year without any additional energy input because energy from bagasse exceeds the amount needed to distill the final product. Hence a 1000 Ha of cane produces approximately 4 million litres of ethanol.

6.5 Waste Management

Biofuel production, like most of chemical processes produces wastes. Waste materials associated with biodiesel are oil-mill cake obtained after oil expression, glycerol, and waste water. On the other hand, waste materials from ethanol production include bagasse, and vinasse. Some of the waste materials may be improved and converted to useful products by adding value while others might remain hazardous and must be disposed off to the environment. Description of each major hazard and possibility of its value addition is described below.

6.5.1 Wastes from Biodiesel manufacturing

Oil-mill cake: This is a solid material left behind when oil is recovered from oilseeds by expression process. Oil-mill cake contains approximately 10% residual vegetable oil, starch and protein. The residual oil can be recovered using a more expensive solvent extraction process, which is also a method used for recovering vegetable oil from oilseeds with lower oil content (percentage oil content in lower 20s and below) such as soybeans.

In Tanzania, oil-mill cake from vegetable oil industry is used for animal feed, in particular cows. Due to toxin found in seeds of *Jatropha,* castor and *croton* plants their cakes cannot be used for as animal feed. Several methods of treatment including have solvent extraction to recover residual vegetable oil, and production of biogas have shown to reduce toxins and make the cake useful as animal feed.

Glycerol: Glycerol is a chemical compound produced from transesterification of process. It is basically a tri-alcohol. Glycerol can be used as a feedstock for production of other chemicals such as of polyols for flexible foams, rigid polyurethane foams, and smokeless gunpowder (nitroglycerin). Pure glycerol is used in food as a sweetener and is an essential ingredient in pharmaceuticals. Quality of glycerol from biodiesel process limits it use in food and pharmaceuticals.

Biodiesel Wastewater: Biodiesel wastewater is generated from biodiesel refining process by washing to remove residual glycerol. Water equivalent to approximately 30% the volume of biodiesel is used for washing biodiesel to remove glycerol. The

wastewater can be treated before being discarded to the environment. Glycerol is a biodegradable compound and can be effectively reduced in the wastewater by standard wastewater treatment methods. Alternatively biodiesel can be refined without using water by employing molecular sieve (dry washing), thereby avoiding wastewater generation.

6.5.2 Wastes from Ethanol production

Bagasse: Bagasse is a dry pulp residue left after expression of juice from sugarcane. For bioethanol industry from sugarcane, bagasse can be used as a primary fuel source for producing heat needed for distillation and generate steam for production of electricity part of which can be used by the factory and excess sold to the national grid.

Other successful uses of bagasse have been to cultivate edible mushrooms, such as oyster or shiitake on blocks or bags of chopped up bagasse. Furthermore, bagasse might be a source of future ethanol. In Brazil, the cellulose rich bagasse is now being tested for production of commercial quantities of ethanol.

Ash: Ash is produced when bagasse is burn to produce steam and power. Ash contains minerals and can be spread in the field as soil conditioner and a source of minerals. Ash can also be used for soil stabilization in construction.

Wastewater: This wastewater from the factory is composed of water used for cleaning and washing cane, excess condensate, etc. that contains small amounts of sugar. The water can be treated aerobically or anaerobically to produce biogas. The treated water can be pumped to the sugar fields as irrigation water.

Distillery slops or distillery vinesse: Distilleries produce huge amounts of slops as they produce alcohol. The slops produced by the distilleries are high in Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) of approximately 60,000 and 30,000 mg/L, respectively, and usually very dark in colour making it necessary to undergo treatment to lower polluting potential before being disposed of the environment. On the other hand, distillery slops contains minerals in particular phosphorus, potassium and magnesium which are useful to crops. To prevent pollution while tapping to the mineral potential, the slops must be treated anaerobically to produce biogas or in lagoons and later applied in the fields as irrigation water.

6.6 Infrastructure

Large scale biofuel production needs infrastructure for transportation of raw materials, both local and imported and finished product within the country and for export. Infrastructure for water, power supply and wastewater treatment is also needed. The

need depend on location and scale of investment of the biofuel firm. While some investors target local market, others plan to export biofuel to European countries. Specific infrastructure requirement for biofuel production is described below.

6.6.1 Roads

There are farm roads that will be used to transport raw materials (sugarcane or oilseeds) from company farms and outgrowers. The roads are expected to be maintained by the biofuel company. Rural roads are maintained by Local Governments and many of them are in fairly good conditions. Long distance roads known as National trunk roads are maintained in good condition by Tanzania Road Agency (TANROADS); new trunk roads are being constructed. With exception of Rukwa and Kigoma, and part of Kagera, most of regions are interlinked through National Trunk Roads. Kigoma is linked to other regions by railway network. Hence, biofuel investors such as FELISA in Kigoma will for a moment relay on rail transport, while PROKON is a Germany based company in Mpanda district Rukwa will have to use unpaved roads until the region gets paved trunk roads.

6.6.2 Harbour facility

Most of the investors such as SEKAB, InfEnergy, Bioshape and African Green oil and BioMassive have invested along the coast in Bagamoyo, Rufiji, Lindi and Morogoro with a intention to export biofuels to European Union and other countries. For instance, a full fledged ethanol production by SEKAB is estimated at 1.6 billion litres a year. Such high quantities need a port facility for loading tank ships. Existing shipment ports are Dar es Salaam, Tanga, and/or Mtwara. Dar es Salaam and Tanga ports can handle bulk liquid cargos which include petroleum products, edible oils, detergents, industrial chemicals, etc.

Dar es Salaam port is currently fully utilised, hence biofuel export will have to use Tanga and Mtwara ports. Mtwara port needs additional investment to establish liquid handling facility, and investors have shown interested in using the port. Other new port that might be developed for boifuel export are: Mbegani port (in Bagamoyo District), Mtongani in Dar es Salaam where the ocean base is deep, and Lushungi port in Kilwa.

6.6.4 Power requirements

Biofuel factories will need power for their machinery and overheads. Power requirement for biodiesel production will depend on the process design. Energy will be needed for heating vegetable oil to reaction temperatures, preferably 50-60 ^{o}C, distillation (heating and cooling) to recover alcohol, heating refined biodiesel to remove

residual water and running auxiliary equipments such as pumps. On the other hand, power requirement can be minimised if process design includes dry refining of biodiesel.

Power requirement for biodiesel will be met from the national grid or standby generators. Information on cogeneration from seeds with high weight percentage of husks such as croton and biogas generation from biodiesel wastewater is scarce; hence the quantity of power (both heat and electricity) that can be produced from such waste was not immediately available. Generally, unless the biodiesel company produces it own electricity and heat, it may be necessary to establish company factory close to a national electric grid network.

Ethanol production process from sugarcane has a capacity to produce its own electric and heat power from bagasse as described below under power production section. It is anticipated that ethanol producing companies will produce enough power to run factory and company activities and excess for connection to the national grid.

6.7 Power production

Ethanol production from sugarcane has a high potential of producing more electric power from bagasse than what it needs for enough its industrial operations. In Tanzania, one ton of burnt and cut cane produces about 300 kg to 500 kg of moist bagasse. One hectare produces an average of 65 tons of sugarcane a year. Approximately 0.5 ton of bagasse is needed to produce 1 ton of steam. One MWh of electric power can be produced from 5.5 ton of steam. For a 20,000 ha cane farm (e.g. SEKAB Bagamoyo facility) harvested regularly throughout the year can produce the following power.

20,000 ha cane	year	1 day	65 ton cane	0.40 t bagasse	1 t steam	1 MWh
year	365 day	24 h	1 ha	1 ton cane	0.5 t bagasse	5.5 t steam

= Approximately 20 MW

A good percentage of the power is expected to be connected to the power grid.

6.8 Local Utilisation of Biofuels

Tanzania stands to benefit from production and utilisation of biodiesel. There are several advantages from local utilisation of biofuels. Biofuels are renewable, they have net zero carbon dioxide, a greenhouse gas emission. Biofuels are non toxic and on

combustion, they emit less harmful hydrocarbons particulate matter, hence environmentally friendly and better for our health than petroleum fuels.

Economically, biofuels will create jobs. Biofuels will improve energy security reducing vulnerability from high petroleum fuel prices and expenditure of high foreign currency and production of electricity from ethanol facilities. Furthermore, biofuels will attract carbon funds as an additional income to the country.

Technically, current technologies allow blending of both biodiesel and ethanol with petroleum diesel and petrol, respectively, in any proportion. However, recent diesel engines can use any ration of biodiesel-diesel blend, while older engines are limited to 20% biodiesel-80% diesel to avoid damage to pump seals and other rubber materials which are not compatible with higher percentage of biodiesel. Ethanol blend of up to 20% with petrol is possible for all engines. Higher ethanol percentage need engine tuning. Recently, a new Flex Technology automatically tunes the engine allowing the engine to run on any ethanol-gasoline ratio. The technology is now widely used in new cars in Brazil.

Biodiesel is less toxic, and less volatile than petroleum diesel and does not require specialised equipment. Due to 100% miscibility of petroleum diesel and biodiesel, tankers and diesel storage and dispensing facilities used for petroleum diesel can be used for biodiesel. Blending facility is the only investment needed in this area. Additional investment may be needed if biodiesel dispensing is to be separated from petroleum diesel. On the other hand, ethanol is more volatile with a boiling point of 78.4 ^{o}C compared to gasoline whose distillation temperature ranges between 60 to 178 ^{o}C and 50% evaporation ratio at 92 ^{o}C. Furthermore ethanol forms hydrogen bonding with water such that pure ethanol becomes hydroscopic and readily absorbs water from the air. For this reason, air contact with ethanol during transportation and storage should be minimised.

6.9 Implication on human resources

The whole production chain has implications of labour, raw materials, product, byproducts that are beneficial to the nation and waste materials that might have a negative impact to the environment. Employment to local community and experts within the country, stimulation of national economy, and reduction of use of foreign exchange of petroleum fuel are among the benefits that will accrue from biodiesel production. Table 6.3 summarises benefits of biofuel production through the production chain.

Table 6.3: Activities and Benefits from Biofuel Production Processes

Production Step	Input	Benefits
Biodiesel		
Crop cultivation	Seeds, land, fertilizer Labour	Semi and Unskilled labour
Harvesting	Labour	Unskilled labour - handpicking seeds e.g. Jatropha. Croton, castor, palm, etc Semiskilled labour – machine harvesting of canola
Transportation of raw materials	Transport trucks	Semi-skilled labour (Drivers)
Seed preparation	Labour Energy (electricity)	Semi-skilled labour (Machine operators) Production of solid waste – potential cogeneration
Oil expression	Labour Energy (electricity)	Skilled and Semi-skilled labour (technicians and machine operators) Oil cake – biogas production, animal feed, fertilizer
Chemical reaction	Alcohol and catalyst Labour Energy (electricity)	Skilled and labour (Engineers and technicians) Skilled labour (laboratory technician/scientist) Glycerol – chemical feed and thermal energy Biodiesel Technology transfer
Refining	Water (wet refining) Labour Energy (electricity)	Skilled and labour (Engineers and technicians)
Storage		Semi-skilled labour (Drivers)
Distribution	Transport	Semi skilled and labour (drivers technicians)
Ethanol		
Crop cultivation	Seeds, land, fertilizer Labour Water for irrigation Herbicides	Semi and Unskilled labour Water pollution
Harvesting	Labour	Unskilled labour – cane cutting Semiskilled labour – machine harvesting
Transportation of raw materials	Transport trucks	Semi-skilled labour (Drivers)
Cane crushing	Labour Energy (electricity)	Semi-skilled labour (Machine operators) Production of solid waste – potential cogeneration
Fermentation	Labour Energy (electricity)	Skilled and Semi-skilled labour (technicians and machine operators)
Ethanol recovery by distillation or extraction	Labour Energy (electricity)	Skilled and labour (Engineers and technicians) Skilled labour (laboratory technician/scientist) Ethanol production Technology transfer
Ethanol concentration	Labour	Skilled and labour (Engineers and technicians)
Storage		Semi-skilled labour (Drivers)
Distribution	Tankers and pipelines	Semi-skilled labour (Drivers)
Waste disposal	Bagasse	Cogeneration of electricity
	Waste water from factory	Contains venase, a pollutant
Ethanol utilisation		Reduction of foreign currency expenditure Stabilisation of

Source: www.biodiesel.forever

An example of job creation is a SEKAB Bagamoyo 22,000 Ha Bagamoyo sugarcane facility which will employ approximately 1,500 people of all sills (from unskilled to skilled and labour). Although the Bio-fuel industry is new and requires a threshold of competent personnel, labour requirement for biofuel production is available in the country. Tanzania has a history of in growing sugarcane, hence expertise from Kilombero, Mtibwa, Kagera and TPC sugar estates might be useful for SEKAB sugarcane-ethanol project. Similarly, biodiesel investor can learn from farm organisation in the sugar industries and adopt the situation for production of vegetable oils. Various skills are available from local institutions. Semi-skilled labour e.g. machine operators are trained by Vocational Education Training Authority (VETA). Skills personnel such as engineers and agriculturalist, accountants, managers, etc. are available from Tanzanian Universities, in particular University of Dar es salaam and Sokoine University. Short term training, might be required to familiarise the workforce with specifics of the biofuel industry.

Collaboration in training, research and development between biofuel industry should be encouraged to increase high level expertise in this area. Already SEKAB has shown interest to collaborate with local institutions in research and development through informal contact with the university of Dare s Salaam.

7.0 LEGAL ASPECTS OF BIOFUEL PRODUCTION IN TANZANIA

The legislation selected for review are those that seek to regulate agriculture, land, environment, natural resources management (water, marine parks, fisheries, forests and wildlife), local government authorities and investment. The policies also focused on the same sectors. This is mainly because of the affiliation between law and policy, the former being the main tool for implementing the latter.

7.1 Analysis of the Existing Policy Framework

7.1.1 The Agriculture and Livestock Policy, 1997

This policy's projections on the development of the agriculture and livestock sectors have implications and are relevant for the production of biofuels at a large scale. The policy takes note of the fact that environmental issues cut across different sectors and calls for a coordinated approach to the conservation of environmental resources as they ultimately have a bearing on the development of the agriculture and livestock sectors. This policy strategy and others ought to be seriously considered in the use of lands for purposes of cultivation of crops for biofuel production.

7.1.2 Energy Policy, 2003

The energy policy seeks to promote the use of alternative sources of fuel that are not harmful to the environment. The fact that it makes reference to alternative sources of fuels suggests that biofuels were also envisaged.

7.1.3 The Sustainable Industrial Development Policy, 1992

When broadly construed, this policy also contains sections that have a bearing on biofuel production. For example, it calls for the enforcement of EIAs for all projects and the continuous application of an integrated preventive environmental strategy to industrial processes, products and services. The processing, production and servicing of biofuels will certainly have to address the requirements of this Policy as well.

7.1.4 The National Environmental Policy, 1997

This policy sets the main foundation for directing overall sectoral and cross- sectoral environmental management and conservation activities. It notes that Tanzania is a signatory to a number of international environmental legal instruments.[10] Some of these instruments have a bearing on the production of biofuels. It also addresses a cross section of issues related to natural resources management generally and provides the overall guide in EIA processes.

7.1.5 The National Land Policy, 1995

This 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. The Policy's objectives on environmental concerns have a direct bearing on the production of crops for biofuel and to some extent the general management and tenurial issues related to the management of land upon which the crops would be cultivated.[11]

7.1.6 The Forestry Policy, 1993

This policy sets out the general guidelines for managing forestry resources. These inevitably include those found in forest lands or land neighbouring forests where bio-fuel projects are likely to be implemented. In this respect, this Policy has a bearing to the management of forest land where bio-fuels prospecting/investment is likely to be undertaken.

[10] See Chapter 1 section 7
[11] See sections 7.6.0, 7.6.1, 7.7.0, 7.9.0 and 7.9.1

7.2 Analysis of the Existing Legal Framework (Legislation)

7.2.1 Land Act, 1999

Under this law, 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. Non-citizens cannot obtain a right of occupancy, unless it is intended to be used for investment purposes registered at the TIC.[12] The Land Act needs to be read in tandem with other laws when it comes to regulating activities related to the production of biofuels.

7.2.2 Village Land Act, 1999

This law provides for the management and control of village land. The main purpose of this Act was to recognize and secure customary rights in land. The main target of this law was rural community members. These community members' rights had for sometime been placed at the periphery under the old land law regime. 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.

7.2.3 Wildlife Conservation Act, 1974

This Act becomes relevant where biofuel production would be conducted in the vicinity of lands neighboring areas occupied or used by wildlife. As will be seen from findings from the field, some biofuel production sites are being considered in the proximity of areas occupied or used by wildlife.

7.2.4 The Fisheries Act, 1970

This legislation makes provision for the protection, conservation, development and control of most types of fish and related resources that are found in areas where production of biofuels is to be conducted.

[12] Tanzania Investment Centre (TIC) is the primary agency of Government to coordinate, encourage, promote and facilitate investment in Tanzania and to advise the Government on investment related matters. TIC is the focal point for investors. It is the first point of call for potential investors; it is a "one stop facilitative centre for all investors".

7.2.5 Marine Parks and Reserves Act, 1994

This Act does not categorically refer to production of biofuels. However, its definition of "aquatic flora" implies that it takes into account their conservation and management in areas where the production of biofuels may be carried out. The term is defined to include plants, seaweeds, waterweeds and other aquatic vegetable kingdom and includes mangroves. Where the production of biofuels is likely to have a negative impact on these places, the Minister ought to invoke his powers under the law.

7.2.6 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. Section 17 of the Act provides for conditions for the use of water for forestry and industrial purposes or for generating power. The production of biofuels may entail these kinds of uses. The provision states that water used for these purposes: *"(i) Shall be returned to the body of water from which it was taken;* and that it *(ii) Shall be substantially undiminished in quantity; and (iii) Shall not be polluted …to such extent as to cause injury either directly or indirectly to public health, livestock or fish…"*

7.2.7 Local Government (District Authorities) Act, 1982

Some of the by-laws that may be promulgated under this legislation may have a general bearing to the management of environmental resources in areas where the large scale production of biofuels is conducted. The Act provides for some of the powers that may be exercised in managing production of biofuels by District Authorities. This can be inferred from the powers to: *Take all necessary measures for the prevention of soil erosion and the protection of crops; regulate the use of agricultural land; and establish, preserve, maintain and improve the use of forests and forest produce.*

7.2.8 Local Government (Urban Authorities) Act, 1982

This Act empowers Urban Authorities to make by laws to control and regulate, among other things, natural resources conservation and management activities. As pointed out earlier production of biofuels may be conducted in urban or peri-urban areas where natural resources need to be protected.

7.2.9 National Land Use Planning Commission Act, 2007

The Commission established under this law is charged with, among other things, the task of overseeing effective protection and enhancement of land quality and encouraging better land use plans. The Commission is also required to recommend

measures to ensure that government policies for development and conservation of land take into account its effect on land use.[13] In performing these functions the Commission would, in certain circumstances be putting in place policies that have some significance on the production of biofuels.

7.2.10 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 generally, including production of biofuels. However, it contains no provision that takes this factor into account. Manufacturing and industrial activities, for example, may therefore, technically be approved by the TIC without taking due regard to the need to conserve land and environmental resources in the production of biofuels.

Although the Mineral Policy of 1997 had called for the inclusion of, among other things, a focus on natural resources management factors when revising the investment law, this issue was sadly not directly dealt with.[14] The investment law therefore does not reflect a serious commitment to the management and conservation of land and natural resources, in the course of production of biofuels.

The Investment Act ought to read together with the Land Acts. As pointed out earlier, foreigners who want to invest on land in Tanzania must route their applications for allocation of land to the TIC. The surveying process in the course of determining to issue land under this Act must be consultative. Local communities must be involved where land is held under customary law.

7.2.11 Environmental Management Act 2004

This Act provides for a framework regulatory regime for environmental protection. The Act requires certain developments to be preceded by an Environmental Impact Assessment. An important requirement of the EIA process is that the developer (read biofuel investor) must consult, among other stakeholders, the local community where the development (read land identified for biofuel production) is to be undertaken.

[13] Ibid., section 4
[14] See sections 3.3.3 (vii) and 3.3.7 (ii) of the Policy

7.2.12 Forest Act, 2002

This Act also makes implied references to environmental concerns in the production of biofuels. Some biofuel production as will be noted from the case studies is already being conducted in the proximity of such areas.

7.3 Implementation of the Law: Lessons from the Field

7.3.1 Case Study I

RAZABA was established in 1976 primarily for rearing cattle to meet the demand for the Zanzibar beef market. Following political arrangements between the governments of Mainland Tanzania and Zanzibar, RAZABA was issued with a total of about 30,000 hectares of land in Bagamoyo. The ownership of the ranch by RAZABA is controversial. It is unlikely that it was ever issued with a title deed after the political arrangements.

When the ranch ceased to operate the government of Mainland Tanzania leased 22,000 hectares of the ranch for cultivation of sugarcane to SEKAB. Although its objective is to develop sugarcane plantations in Rufiji and Kilwa Districts, SEKAB has selected RAZABA as the first pilot site, eventually covering 15 – 30,000 hectares. It has leased land from prisons in Bagamoyo in order to start seed cane multiplication (200 hectares. At the time of field work, SEKAB was in the process of completing the EIA for the Bagamoyo plantation project, but no EIA report had been initiated with regard to the seedcane farm. Fourteen households and a number of pastoralists to be displaced were to be compensated.

When RAZABA was being established in 1976, there were people living in the area. Some of these were apparently compensated and relocated to other areas. However, there were others who did not accept the compensation, claiming that it was not adequate. In 1991 this disgruntled group filed a suit in court to challenge the adequacy of the compensation offered. Our efforts to verify the status of the case were fruitless at the time of the study. It is, however, very likely that the matter may still be pending in court. One of the legal issues that the court would have to address would be the ownership of the farm by RAZABA. It would be awkward for a person who has no title in law to claim to displace people from their land and offer them compensation.

RAZABA shares borders with the Sadani National Park. At some point the National Park had its borders extended to the ranch to secure water for the wild animals. If the matter is to be fully addressed by a court of law, the issue of whether the extension of borders of the National Park was lawful would not be avoided. However, since Sadani National Park has been established by law, its borders are now recognized as being lawful since the commencement of the law that established it. The bone of contention

would be whether the borders of the Park, could be made "lawful" by a subsequent piece of legislation.

The issue of environmental damage (overuse of water catchment areas, soil erosion, depletion of forests and loss of wildlife habitat) likely to be caused by large scale production of biofuel featured prominently in all the districts that the team visited. This concern was aired by the district councils' members of management teams, village government leaders and villagers. The concerns in our view are real having been based on a number of facts. First and foremost, the type of agriculture used/to be used in large scale biofuel production focuses on monoculture, which usually involves clearance of large tracts of land with a lot of biodiversity to plant a single crop. Bioshape, for example, has cleared 54,000 hectares of coastal forest to cultivate jatropha. This has led to loss of biodiversity and habitat for wildlife.

The loss of habitat for wildlife and biodiversity is also likely to occur in RAZABA, where SEKAB intends to clear a 22,000 hectare forest for cultivation of sugar cane. On the face of it, the lands may seemingly appear and be classified as barren land, with no use. However, the reality is that these areas have always been habitat for wildlife, and have been a source of timber and non timber resources for villagers. These habitats have played a significant role in maintaining the equilibrium necessary for the survival of a number of floral and faunal resources.

Secondly, the use of chemical fertilizers and pesticides in the plantations is likely to cause water pollution, especially in areas where the investors intend to use river water for irrigation. SEKAB is currently using water from Bagamoyo to irrigate the nursery, and is also intending to use water from Wami River to irrigate its main plantation. In the absence of proper management of upstream-downstream effects the two rivers are likely to be polluted. Thirdly, common to Kilwa and Bagamoyo, the Bioshape and SEKAB farms share borders with Selous and Sadani National Parks, respectively. In both these farms, there exist wildlife corridors which are used by wild animals annually in their migratory cycles. In the migratory period, the wild animals utilize the resources found in these areas. To mitigate these impacts Bioshape have purportedly undertaken to leave 45% of the farm intact. It could not be established whether the move by this firm was a result of corporate responsibility to the environment or it was a result of the dictates of the authorities as a conservation measure.

The concerns that respondents showed that biofuel processing on a large scale may cause emission of noxious gases which would have serious negative effects on the environment is also very real. The invasive character of jatropha coupled with its ability to suppress other indigenous vegetation in the vicinity was noted as a serious environmental threat by some of the respondents. In this respect, it is very unlikely that a thorough EIA for the production of biofuels on a large scale in most of the areas

visited was conducted. From the concerns and fears raised from all respondents in the Districts the team visited, (which are in our considered views justified) we may safely conclude that the EIA was not conducted. If it was, the process may have been flowed and therefore not conducted in a manner envisaged by the law.

Villagers are also concerned about the amount of land that was increasingly being given to investors under the guise of prospecting for large scale biofuel production. In some cases, the concerns focused on investors who have already acquired huge tracts of village land in order to engage in biofuel production. The concerns centered on the possibility of local communities being left without enough fertile land for their livelihood. It would appear that the process of acquisition of village land by these firms is contrary to the laws. Generally, most of the villages are in the process of developing land use plans and having their lands surveyed. Some of the village boundaries are still contentious. Country-wide, out of about 3000 villages less than 150 have land use plans. Most villagers are not certain how much land they hold, how much they may need in the near future and how much they may dispose off to investors. With the current demand for land by investors, and the way matters are being handled the situation may have far reaching effects.

There is also the question of constructive loss of land. When village land is earmarked for investment and transferred to the Tanzania Investment Centre, which then issues derivative rights to investors, the land in question ceases to be village land and therefore the village loses control of land previously held by it. There is no evidence of the Centre having allocated such lands to the investors. It would appear that some unscrupulous investment firms have wrangled village land from unsuspecting village councils dubiously. If the current trend continues, the concept of 'village land' envisaged by the country's land law reforms, which focused squarely on ensuring that village land remains in the control of villagers, will be rendered futile.

7.3.2 Case Study II

(a) Mavuji

This village is located in Kilwa District. It is among the 5 villages which contributed its land for the only biofuel investor in the district. The potential investor at this place goes by the name of Bioshape (T) Limited ('Bioshape').[15] Bioshape occupies an area of 54,000 hectares in five villages where it intends to cultivate jatropha. Other villages are Nangurukuru, Nainokwe, Migeregere and Liwiti.[16] In Mavuji, Bioshape occupies some

[15] Bioshape is a private company incorporated under the laws of Tanzania affiliated to Bioshape Holding B.V of the Netherlands.

[16] We could not verify the amount of land each village had contributed to facilitate the project. This is because the land use plans for the villages were not made available. They had not been prepared.

1000 acres of land which is used as a pilot-cum nursery farm. It intends to acquire an extra 81,000 hectares of land for jatropha plantation in the whole district.

Mavuji has an Environmental Committee which oversees environmental conservation activities. The committee meets once every month. The committee members have identified an area as a village forest reserve and they are in the process of charting out strategies on the management of the forest. Under the guidance of the District Council, the village has enacted bylaws to deal with, among other things, environmental conservation. The bylaws are in the final stages of approval, pending at the district council offices. These have, however, not taken into account the biofuel activities that are underway or even those that are planned by the investor.

Land in this village is generally held under customary tenure. There also exist village government allocations. Awareness of the Village Land Act is very low. The Village Executive Officer admitted that he was not aware of the Act. His office does not even have a copy of this important piece of legislation. This implies that the villagers' rights are not known to them despite the presence of the biofuel activities right in their midst.

(b) Makurunge

This village is located in Bagamoyo District. It is among the 3 villages which contributed land for the only biofuel investor in the district, SEKAB. As noted above, this investor deals with sugar cane as feedstock. The other villages that have contributed their lands to SEKAB are Matipwili and Kidomole.

Like Mavuji, Makurunge village has had an Environmental Committee since 2007 which is charged with environmental conservation activities. There were no significant concerns by this committee in the wake of the biofuel activities. There are no by-laws to deal specifically with environmental conservation or protection. There exist only general bylaws to deal with various activities. Environment conservation can be deduced from these general bylaws. The bylaws are yet to be approved by the District Council.

The ownership of land in the village is governed by customary rules that are known and well established. Transactions in land, (purchase and lease) are also common where there is a mixed blend of tradition and market systems of conveyancing. Awareness of the Village Land Act is very low. Interestingly, the Village Executive Officer had a copy of the Act but seemed unacquainted with it. He was also not aware of the regulations that have been made under this law.

The villagers have a lot of misgivings with the emergence of SEKAB in their vicinity. The farm that had been occupied by RAZABA had developed into a thick forest from

which the villagers were enjoying various benefits. With monoculture type of agriculture that SEKAB will embark upon for the production of biofuel crops, all these benefits will vanish. Villagers also complained that the clearing of the forest will lead to loss of biodiversity. They also lamented that they would also no longer be able to perform some of their cultural rituals which were performed in the forest. They were not involved as important stakeholders in the re-allocation process.

The villagers' access to the sea, where most of the households depend on for a livelihood is also no longer guaranteed with the emergence of SEKAB. When the land was under RAZABA there were covenants for easement (i.e. right of way) to the sea, among other places. Now the villagers are worried whether SEKAB would recognize the courtesy of its predecessor and carryover the covenants and thereby maintain the right of way for the villagers through its farm to the sea. The other concern of the villagers which has a bearing on their livelihood is the possibility of loosing access to the several fishing ponds that are located on the RAZABA farm, now under SEKAB. The two most important fishing ponds are Tembwezi and Chanyuki. These are crucial resources as fish from them are used for the maintaining livelihoods of the villagers and the neighbouring communities. Tembwezi alone accommodates about 300 fishermen who have a number of dependents.

The village government does not have an office. The filing system of the village government is also haphazard leading to poor record keeping. The VEO took 45 minutes to peruse through his files only to realize that the documents that the team had requested could not be traced. The level of understanding of basic but key issues relating to the village is also low. The village leadership often depends on the Council's legal officer to make decisions for them.

(c) Mtamba Village

The village is located in Kisarawe District in the Coast Region. It is one of the villages whose land has been allocated to Sun Biofuels (T) Limited. This investor has applied for 9,000 hectares in total from the villages of Mtamba, Muhaga and Kidugalo to cultivate jatropha. The actual size of land each village has given is not known as the villagers are waiting for maps after the process of surveying the land that was conducted under the auspices of the investor. The investor has not commenced any biofuel production activities as yet. This is because the process of compensation to the villages was suspended to give way to an assessment of the land allocation procedures and valuation of the land.

The existing village environmental committee charged with environmental conservation activities has made no significant achievement in addressing the possibility of biofuel production in the village. Apart from that deforestation is still

rampant with illegal charcoal dealers spread all over the nearby South Ruvu forest.[17] The village bylaws have failed to address this vice. The bylaws also address villagers only. According to the village government leadership, non villagers (including the potential biofuel investors) are not covered. They are to be dealt with by the general laws and Council by laws which have been criticized as being comparatively weak.

The most predominant land tenure regime is customary. Beside the customary tenure, land may also be allocated by the village government. Village land transactions also take place through the market. The village, however, does not have a land use plan. In fact there is no information on the size of the village. Although part of the village land has been allocated to Sun Biofuels the Village Government does not know the actual size of land it has parted with. It therefore does not know how much land will be left.

Although the process of giving land to Sun Biofuels has reached the final stages it appears that the villagers are not happy. They had been reluctant initially to offer any land until when their Member of Parliament came with the investors. The MP allegedly convinced the villagers to allow the investor on the promise that the investor would create employment and assist them in various development activities. The villagers are aware that suitable employment may require appropriate education/skills, which they do not have. They were of the view that the jobs promised could just be a brainwashing technique to grab their land.

The Council had entered into a verbal agreement with the investor which sought to guarantee that the production of biofuels process would not affect the biodiversity. Usually once a right of occupancy has been issued by the Commissioner for Lands, the conditions binding to the occupant are provided for in the certificate of title. Therefore, in the event the said agreement is not reflected in the certificate and the investor dishonors its part of the bargain, the investor may breach the agreement and go scot-free.

Valuation for the area allocated for Sun Biofuels was done, but it was not comprehensive. It did not take into account the value of the resources available in the area, for example timber and other non timber resources.

Also, one wonders why the Member of Parliament or the District for that matter has not required the investor to undertake an environmental impact assessment as provided for by the laws. The type of investment that would be established will certainly have an impact on the ecology of the area, the culture and economic well being of communities.

[17] The village borders the South Ruvu Forest

7.3.3 Case Study III

Due to land shortage in Kagera region there are many disputes. Also the shortage has led to villagers attempting to encroach upon nearby forest land reserves. Apart from the forests in Biharamulo and Karagwe, the land tenure regime in the region is predominantly customary. In the premises, should the pressure for land for biofuel persist there will be only two alternatives left. An attempt will be made to circumvent customary titles in favour of granted rights of occupancy, or to succumb to the pressure by letting part (or whole) of the forest go. In our opinion, none of these is a lesser evil.

(a) Kagera Sugar–Misenyi Ranch

Kagera Sugar has acquired 40,000 hectares of land forming part of Misenyi Ranch, and that the sugar company is about to acquire an additional 15,000 hectares. Our efforts to verify from the leadership why the company needs this extra land were not fruitful. Some of the villagers stated that the land to be acquired is intended for extension of the factory's cane farming activities. If the observations by the villagers are anything to go by, then there would be cause to worry. One would need to verify whether the company complied with the law in changing the use for which the land upon where the ranch is situate was originally issued. Even if the conditions may have been complied with, it could still be argued from a legal perspective, that the purported transaction defeats the purpose for which the ranch (including other National Ranches) was established. Looked from another perspective, the issue of whether the local communities were fully consulted would still raise questions on the legitimacy of the process. Some of the villagers suggested that there was no consultation.

(b) Sensitization of Local Communities (Out growers)

There are misgivings about the out growers program in Kagera Sugar. Lack of transparency in payment systems, valuation and weighing of their products are just some of the problems. Also the lack of basic knowledge on negotiation of contracts or entering into joint ventures for better terms with investors (or event the Company) is evident. The villagers' lack of basic knowledge on village land laws and investment laws, which is important under the circumstances the villagers find themselves, is also not addressed in the training.

(c) Land Disputes

There exists land disputes (and more are brewing) between Misenyi ranch and local community members of surrounding villages. Since 1968 when Misenyi Ranch was surveyed, villagers have encroached upon the ranch lands and set up various infrastructures. These include schools, health centres, water wells and settlements. The

villagers' occupation of the Missenyi ranch have been driven in part by population pressure, poor maintenance of borders between Missenyi ranch and surrounding villages and a search for arable/fertile lands. The dispute was raised recently by villagers during the meeting with President Jakaya Kikwete. The President ordered that the disputes be resolved and that encroached areas be recognized as belonging to the villages, leaving the unoccupied areas to Misenyi Ranch.

The Misenyi Ranch scenario described above indicates that the demarcation of borders during the privatization process was flawed. If the process was followed and all stakeholders involved, the survey conducted in 1968 would have provided a useful guide and averted the dispute. In our view, the mechanism applied to resolve the dispute following the Presidential directives is a clear case of premature acquisition of land. The acquisition of land for public purposes must be done in accordance with the provisions of the Land Acquisition Act.[18]

7.3.4 Case Study IV

This case study depicts our findings in Kigoma, where no large-scale farming for biofuel crops has started. There are two potential investors tied up in a legal battle for land in Ilagala area. One of the investors, FELISA, has acquired 400 hectares of land which is used for cultivation of oil palms and sunflower. At the same time, FELISA is arguing that some other 400 ha of land adjacent to Kalago village belongs to it. It transpired that there has been a double allocation of the same plot in Kalago village. This explains the case that is pending at the High Court of Tanzania at Tabora since 2003.

At Basanza village, FELISA has identified 4700 hectares of land and has applied for a title deed from the Ministry of Lands and Human Settlements. Although the TIC has developed a Land Bank, with several land plots for potential investment opportunities all over Tanzania, the process has not usually been transparent in some cases. It is therefore difficult to ascertain the extent to which consultation with local community members was done, in terms of the use to which the lands should be put and other issues of tenure.

Villagers of Kalago have allocated land which exceeds what is within their legal mandate to an investor instead of recommending to the District Council with the requisite mandate.

[18] Cap. 118, R.E. 2002, Section 3.

7.3.5 Case Study V

In Tanga there are several land applications for bio-fuel activities of varying scales. Most of the applications are still in the early stages with only two of them having been submitted to the Ministry of Land and Human Settlements for consideration, after the investors satisfied themselves that they had complied with the law.

The foreign investors in the biofuel sector in this region operate through local representatives who scout for possible areas where the foreigners can proceed to obtain land. The local counterparts (middlemen) also handle the initial processes of acquiring land including close follow up with different officials from the district, region, all the way to the Ministry level. This is against the law. Investors must be known.

(a) Mwakijembe and Mbuta Villages

The lands in these villages that have been earmarked for biofuel production are prime lands that are suitable for food and cash crop production. Villagers indicated that the potential investor had requested to have another area close to the river for establishment of a nursery for biofuel crops. Apparently investors consider this land to be idle while in fact it is part of the reserve land for the villagers under the law. Villagers were skeptical of the investor's intentions. They claimed that the subject land had rich minerals and that the prime motive of the investors' struggle to be allocated with large tracts of land was to have a bigger area for mining potential.

(b) Compensation

In Tanga Region generally compensation procedures for land to be taken by the investor are not clear to the villagers. While negotiating for the land some investors provided verbal offers. These included the provision of infrastructural services such as water, schools, dispensaries, electricity, roads and in one case a milling machine! In Mkinga district there are reported cases of "cheating" where the investor turned up with a one roomed dispensary and a domestic size milling machine as compensation for the whole village for the annexed large tracts of land and for leases that last up to 99 years.

There are cases where villagers have no idea of the size of their land. In this respect they are accepting requests that surpass the size of land owned. In Handeni, while majority of the villages have land of about 13,000 hectares, there are applications beyond what they own and need. In other cases, the villagers have no maps that show the boundaries of lands they claim are theirs. In Mwakijembe village the village leaders and villagers believe they own about 29,000 hectares. They did not have any documentation or maps to prove this.

There are no land use plans. The villagers are usually advised by the District Authorities to source from prospective investor(s) about T. Shs. 5 million. This money is to be used to survey the village land, make land use plans and then incorporate the investor(s) needs. In this kind of arrangement, the investor(s) is most likely to influence the results.

(c) Contracts with Investors

There is very limited knowledge on contracts in terms of preparing or interpreting them. This ignorance leaves the local stakeholders in the bio-fuel venture vulnerable in land and financial deals. Such vulnerability would have negative effects on investment generally. The ripples are not only be limited to biofuel production/investment, but to a wider spectrum that would affect rural livelihoods and economic prosperity.

(d) Land Conflicts

The existing process of land acquisition lacks transparency and is being taken advantage of by investors. The villagers are receiving verbal promises and information on projects and their benefits to the community. Villagers, District Councils, and the regional offices work in isolation. There is no specific by-law, policy or procedure to guide the villagers in the whole process. The whole process lacks guidance and expertise from the region and the village level. As the villagers are unaware of the exact value of their land and in the absence of land use plans, they are giving away their land almost freely.

Most of the residents interviewed in Tanga region have some bad experiences from the existing sisal plantations. Vast land is in the hands of the "investors" most of which has now been left idle for decades. As a result, these farms have provided hideouts for notorious animals that destroy their food crops. Unfortunately, the process of revoking these deeds is tedious and bureaucratic and there are cases whereby land conflicts emerged. For instance, at a village known as Kwa Msisi in Handeni District there is a land conflict that emerged due to an extended absence of the "investor". During the long absence the villagers occupied the land and even built a primary school. The District Authorities are in the process of resolving the conflict.

The existence of land conflicts was apparent from the responses to questionnaires in Tanga. An average of 72% of the interviewed villagers acknowledged that there were land conflicts relating to the production of biofuels in the area. (Fig. 7.1) Mbuta and Manga Mikocheni showed a higher response of 83.9% and 81.1% respectively.

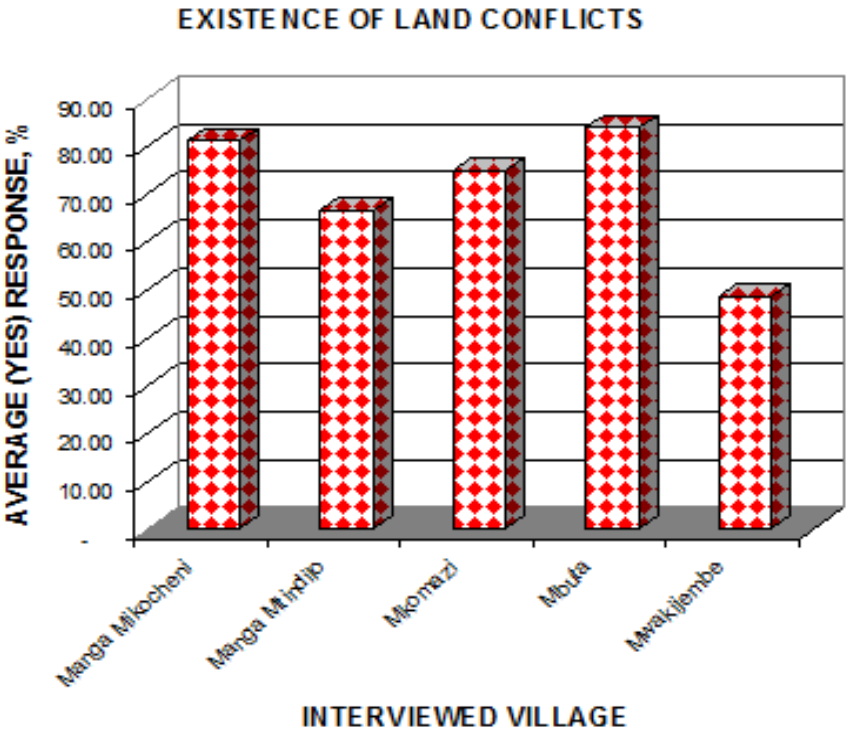


Fig. 7.1: Existence of land conflicts in the villages

The case studies reviewed above reveal a number of salient features in matters that cut across a diverse spectrum in the law relating to biofuel production in Tanzania. The implications cut across all legislation that we have reviewed above. Although we have used the few selected cases in our study, these merely reveal the tip of the ice-berg. In our view, emerging literature and studies on the subject will continue to prove this assertion.

7.4 Conclusions and Recommendations

The local communities must be sensitized and involved in all processes. Such processes should also focus on imparting basic legal knowledge to the villagers (including the leadership at the regional, district and village levels) on land and investment laws and their implications for biofuel production in their areas.

The displacement of local communities to pave way for large scale biofuel farms will fuel animosity among the investors and the communities.[19] There must be transparency in dealings with land at the village level. There must also be compliance with the relevant and applicable provisions of the law. The TIC should involve villagers in the allocation of potential lands to investors for biofuel production.

[19] The project for Sun Biofuels in Kisarawe District, for example, is likely to displace 11 villages. See http://www.biofuels-news.com/news/tanz_bio.html (23rd October 2008)

Investors in the biofuel sector are encroaching upon land that is contiguous to village land. It must be noted that the law directs the Village Council, to observe among others, the principle of sustainable development in the management of village land. More specifically the Council must take into account the relationship between land use, other natural resources and the environment in and contiguous to the village and village land.[20] River banks and other water sources that are likely to attract biofuel investors are also included in this category.

Investors are required to channel their requests for land through the TIC. Investors are not supposed to get direct access to village communities or use "agents." In some cases the law has not been complied with to the letter in the allocation of village land to investors. Since the investors have already invested heavily, they should be ready to be flexible to accommodate concerns and abide to the provisions of the laws of the land.

The current legislative framework governing biofuel production is scattered. It is therefore not correct to state that there is a lacuna in the legislative regime that can be used to regulate biofuel production in Tanzania. The same can be said of the policy framework. The misconception of the lack of a legislative and policy framework has, in part, led to investors grabbing land, especially village lands, on this pretext. The government should enforce the provisions of the legislation reviewed above while working on a comprehensive framework law on biofuel production.

A comprehensive framework policy would provide more guidance on large scale biofuel production. This would set a solid foundation for the envisaged framework law. At the time of writing, the government was still working on draft guidelines as the comprehensive framework law is being promulgated. A moratorium to stop further issuance of land for biofuel should be in effect until an effective policy and legal regime is in place. The current legislative regime could be employed to govern the developments that have already commenced.

The national guidelines on biofuel that are being developed could be improved. But it has taken unnecessarily too long. The guidelines should just be released to regulate the already approved developments and could be periodically amended to carter for circumstances as they emerge.

The issue of compensation is not clearly specified when land is acquired. Compensation should be holistic and benefit the villagers and not any other organ or authority. It may be important to put a check list to be utilized for this process. The checklist should, however, take into account the diversity of the cultural, economic and other peculiarities of specific communities to be affected.

[20] Section 8

The guidelines should ensure that the project write ups for biofuel production are made available in advance at all levels and are maintained in a register that is open for public scrutiny. Also a team involving villagers, district, and regional administrators should be involved in scrutinizing and monitoring the proposed projects and land applications. The guidelines should also prohibit biofuel production in village lands until relevant village lands are surveyed and respective land use plans and land use management zone plans are put in place. The guidelines should also provide that land allocated for a biofuel project should not be transferred for any other activity.

The guidelines could provide for model bylaws for villages to adopt and apply. The model bylaws would come in handy, taking into account that the village authorities (village councils) do not have the requisite capacity to draft good laws to protect their lands. The bylaws could address the diverse issues of monitoring of the land requested from the village governments assisted by district and regional authorities, revocation of land where developments are staggered and disposition of land allocated to biofuel investors in questionable circumstances. Villagers and district officials would greatly benefit by intensive training on laws relating to land, investment and contracts.

8.0 BIO-FUEL PRODUCTION, MARKETING AND TRADE

A number of bio fuel companies are currently processing land acquisitions in Tanzania or are at early stages of bio fuel production. The regions involved include Kigoma, Lindi, Mtwara and Pwani (Coast), with the latter being ahead of the other regions in most respects. The bio fuel companies in the Coast region, particularly in Bagamoyo, Rufiji and Kisarawe districts include SEKAB, a Swedish bio fuel firm, (sugar cane in Bagamoyo and Rufiji), Trinity and Bioenergy (jatropha in Bagamoyo), Shanta Estates (jatropha in Bagamoyo), Tanzania Biodiesel (oil palm in Bagamoyo), CMC AgriBioenergy (white sorghum in Bagamoyo), Sun Bio fuels (jatropha in Kisarawe) and African Green Oils (oil palm in Rufiji). Of the 565,360 hectares total land applied for, the companies obtained 313,360 hectares, with SEKAB alone expecting about 75% of the share. Currently, the biofuel sector in Tanzania is characterised with following features:

(1) Most of the bio fuel firms are still in early stages of obtaining land or establishing seed nurseries. Therefore, we could not obtain detailed information regarding their expected production systems out of which we could determine and then analyse their value adding processes; only that we got access to some information on SEKAB's plans for feedstock production. The company plans to pursue the following, among others, in its local bio fuel production processes: (i) production will be labour intensive on farms during the early stages; and it will gradually get mechanised over time (ii) irrigation will be employed in the plantations, drawing water from Ruvu river (iii) sugar-cane will be locally

processed into bioethanol in Bagamoyo, Tanzania. On the other hand, Bio-Shape Tanzania Limited states on page 3 of its feasibility study on jatropha plantation in Kilwa that feedstock will be produced in Tanzania and shipped to feed its biomass plants located in Europe. This contravenes the national policy that encourages building a robust economy based on local processing and exporting of value added products. On the financing aspect, Bio-Shape will be fully foreign owned and 100% equity financed. Therefore, the government should ensure that bio fuel investors–including Bioshape–behave consistently with the country's existing policies, especially those on local industrialisation and value added exports. Potential benefits accruing from this are clear: domestic bio fuel processing and value addition would result in technology transfer, capital accumulation and job creation.

(2) SEKAB plans to build a competitive and sustainable bio fuel sector that caters for both backward and forward linkages with other sectors of the economy. As for backward linkages, the Company plans to involve outgrowers who would produce sugar cane and supply/sell to the firm's factory. In so doing, the outgrowers would have to adhere to SEKAB's sustainability and competitive standards. In addition, the firm plans to employ Tanzanians on its sugar cane farms in Bagamoyo (20,000 hectares) and Rufiji (400,000 hectares being sought, but less than 250,000 hectares anticipated). Other services to be supplied include mechanical works and harvesters. Regarding forward linkages, SEKAB plans to saturate a big chunk of domestic bio fuel market, and then export surpluses. In this regard, a lot is expected in terms of local distribution channels and operations, marketing activities involving advertising and promotions.

(3) To-date, Kilombero Sugar Company (KSC) has been selling seed cane to SEKAB for its seed plantation at Bagamoyo. In addition, KSC and Mtibwa Sugar have been selling molasses in domestic and export markets; and these can be used as feedstock in the production of bioethanol. Therefore, KSC and Mtibwa potentially play a backward linkage role in the bioethanol production through supplying or selling key inputs that include seed cane and molasses.

8.1 The question of biofuel as a viable alternative to petroleum

Faced with acute energy security concerns, many countries have embarked on biofuels as an alternative to fossil fuels. As biofuels are a new form of energy relative to fossil fuels, among the critical questions developing countries have been struggling to address is on the economic viability and thus the competitiveness of biofuels in the face of the dominant petroleum imports. Table 8.1 below shows Tanzania's petroleum imports over the 2003 to 2007 period.

Table 8.1: Tanzania's Petroleum Imports – 2003 to 2007

Year	Particulars	Total importation	Domestic consumption
2003	Quantity (millions of litres)	1,707	1,370
	Cost (CIF in TZS millions)	406,531	341,528
	Cost per litre (TZS)*	238	249
2004	Quantity (millions of litres)	1,348	1,328
	Cost (CIF in TZS millions)	433,153	428,165
	Cost per litre (TZS)*	321	322
2005	Quantity (millions of litres)	1,726	1,697
	Cost (CIF in TZS millions)	785,490	770,431
	Cost per litre (TZS)*	455	454
2006	Quantity (millions of litres)	2,024	1,414
	Cost (CIF in TZS millions)	1,325,182	940,429
	Cost per litre (TZS)*	655	665
2007	Quantity (millions of litres)	3,212	1,620
	Cost (CIF in TZS millions)	2,149,314	1,098,606
	Cost per litre (TZS)*	669	678
	*** this is an average cost of various petroleum products under code 2710**		

Source: Author's table, with data extracted from various sources, including budget books at Ministry of Finance and Economic Affairs; budget speeches & estimates; TPA Annual Report (2006); and interviews with key petroleum stakeholders in Dar es Salaam.

The table shows a consistent growth in petroleum imports, both in volume and unit cost (i.e. average petroleum price per litre). This is also in line with global petroleum market dynamics. The fact that the unit cost of imported petroleum was on average TZS678 in 2007 while the actual market price paid by consumers was well above TZS1,000 indicates how heavily taxed the product is.

Field interviews with biofuel experts revealed that a hectare of sugar cane can on average produce about 4,200 litres of ethanol; and that a hectare of palm can generate 6,490 litres of biodiesel. Basing on available data, Tanzania has of recent been importing petroleum products in the following proportions: diesel (51%), petrol (34%) and other petroleum products (15%). The 2007 figures (Table 8.1) show that Tanzania consumed 1,620 million litres of petroleum products, whereby diesel and petrol were approximately 822 million litres and 548 million litres respectively. Assuming biodiesel and ethanol are perfect substitutes for petroleum diesel and petrol, respectively, Tanzania would have needed a total of 257,133 hectares of land (126,656 hectares for palm and 130,476 hectares for sugar cane) in order to replace its annual petroleum

consumption/importation, thus resulting in over TZS930 billion in financial savings,[21] making about 15% of the national budget (2007/2008 estimates). This would be a significant boost to the country's economy which spends about 55% of its annual foreign exchange earnings on petroleum imports. Assuming Tanzania has 44 million hectares of arable land (in totality), the land area (257,133 hectares) devoted for meeting local biofuel needs through displacement of petroleum (diesel and petrol) would represent less than a half percentage point (i.e.0.5%) of the country's arable land. Therefore, drawing from the preceding analysis we can confidently say that, given proper land use planning, application of productivity measures in food production, and appropriate choice of biofuel feedstock, food security risks, environmental and other concerns resulting from the biofuel activities in Tanzania are farfetched.

On the other hand, Brazil provides important lessons to Tanzania in relation to economic aspects of biofuel production. For instance, ethanol production costs were close to US$ 100 a barrel in the initial stages of the Alcohol Programme in 1980. Until 1985, as production increased, prices paid to producers reflected average costs of production, (Goldemberg et. al., 2003). During this initial phase, prices fell slowly, only reflecting the gains in agro-industrial yield and economies of scale captured by producers, and these gains were transferred to consumers through a pricing regulation scheme. More recently, economies of scale and market liberalization has meant that the price paid to producers has fallen much more rapidly, as shown in Table 8.2 below.

Table 8.2: Ethanol learning curve – Brazil experiences

Year	**1980**	**1983**	**1985**	**1986**	**1990**	**1996**	**1999**	**2000**	**2001**
Ethanol price paid to producers (US$/$m^3$)	625	558	567	500	400	367	200	400	417
Ethanol cumulative production (m^3 millions)	4000	14000	43000	57000	90000	150000	300000	330000	350000

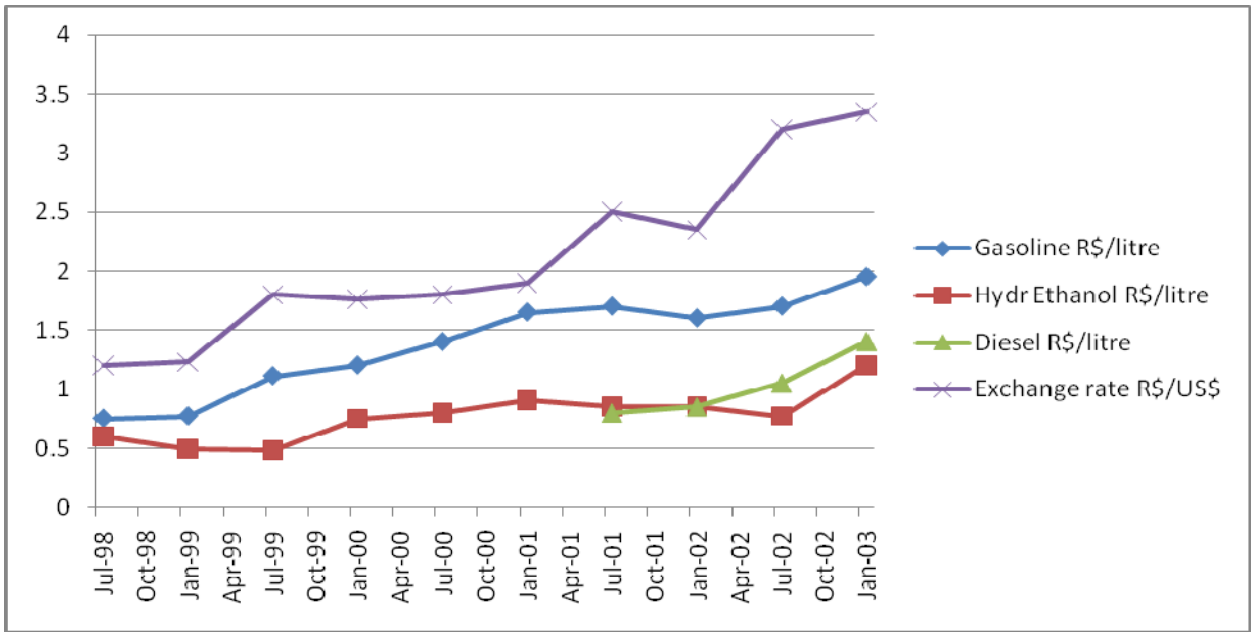
Source: Author's table, data extracted from Coelho (2005)

The total amount of investments in the agricultural and industrial sectors for the production of ethanol for vehicle use in the period 1975-1989 reached a total of US$ 4.92 billion (2001 US$) directly invested in the programme. Goldemberg et. al., (2003) says the use of locally produced ethanol has displaced oil imports and thus leading to savings in the Brazilian economy amounting to US$ 52.1 billion (January 2003 US$)

[21] The question would be whether transformational costs related to switching to biofuels (e.g. supportive technology, machinery and soft and hard infrastructure) would outrun these projected potential savings.

from 1975 to 2002. Hydrated ethanol is sold for 60 to 70 percent of the price of gasohol at the pump. These results show the economic competitiveness of ethanol when compared to gasoline. Figure 8.1 shows a comparison of the main transportation fuels used in Brazil in terms of the price paid in local currency (Real), and the exchange rates against the American dollar; it convincingly demonstrates the long-term competitiveness of ethanol fuel over comparable petroleum products.

Figure 8.1: Competitiveness of ethanol prices relative to petroleum products 1998 to 2003



Source: Authors' graph, data extracted from Coelho (2005)
Note: R$ = Brazilian Real, the local currency; and ethanol production is subsidy free.

Table 8.3 below summarises relative production costs for biofuel and petroleum products in the leading biofuel producing countries of USA, Brazil, the EU and Canada. This is based on strict energy-equivalent basis (without subsidies). The table shows that market costs for ethanol in Brazil is by far more competitive than in the US and Europe; and that it is economically cheaper than the average crude oil (petroleum) production. As for biodiesel production, Europe is more competitive than the USA.

8.2 Existing and Potential Biofuel Costs, Trade Distortions and Barriers

Tanzania and other new comers in the bio fuel business need to note that bio fuel projects are by no means cheap. Oxfam estimates that if the whole global supply of carbohydrates – starch and sugar crops – was converted to ethanol, this would only

replace a maximum of 40% of world petrol consumption; and that global oilseed production would generate less biodiesel than 10% of world conventional (fossil) diesel consumption. The EU estimates its 10% bio fuel target will until 2020 cost about US$90 billion, bringing along with it fuel security benefits valued at US$12 billion only. This suggests that measures or policies[22] should be taken to reduce demand for transport fuels, including regulations that encourage importation or manufacturing of fuel efficient vehicles, technologies and infrastructures. The infrastructure may include the installation of biofuel storage and pumping facilities at ports and distribution points. This is by no means cheap undertaking for a small economy like Tanzania; but investment arrangements such as public, private (local and foreign) partnerships (PPPs) may provide a better alternative.

Table 8.3: Actual Petroleum and Biofuel Market Costs Compared

Product	Biofuel market cost (without subsidies) by different producers US$/barrel			
	USA	Brazil	Europe	Canada
Ethanol	60	35	115	n/a
Biodiesel	70	n/a	65	n/a
Crude oil	68.25*			42**

Source: Author's table, data compiled from different sources; n/a = no data obtained.
* Basing on average 2006 NYMEX Crude Oil Futures prices
** Basing on Athabasca crude price (Strydom, 2006)

Although many countries seem to be rushing on the biofuel undertaking, about 90% of biofuel production is domestically consumed. This is because the major producers, namely the USA, the EU and Brazil are at the same time the main biofuel consumers. More marketing and trade has been in terms of feedstock rather than final biofuel products such as biodiesel and bioethanol. As for marketing and trade of final biofuel products, exporters have been faced unfavourable trade distortions and barriers in destination markets, including tariff escalation practices.[23] This has always resulted in market access and entry problems; and this has prompted potential disputes at the WTO, mainly between Brazil (currently perceived as most efficient bioethanol producer and exporter) on one hand and Europe and the USA on the other. Governments in these major biofuel producers (the US and EU; and to a small extent in Brazil) provide huge subsidies to bio fuels so as to make them competitive in relation to petroleum products such as petrol and diesel. These support measures include:

[22] Tanzania does not currently have a harmonised policy on biofuels; but efforts are underway to have temporary regulatory measures instituted. We hereby urge the government to fast track the formulation process of the measures as well as the policy.
[23] Tariff escalation occurs when higher tariff is charged in proportion to more value addition on a product. This is usually a policy measure meant to discourage value added imports in favour of raw inputs/materials for domestic industries/factories, mainly applied in the developed world.

(i) Production incentives such as tax incentives, loan guarantees and direct subsidy payments
(ii) Consumption incentives such as reductions on fuel tax
(iii) Mandatory consumption requirements such as a commercial mix of up to 20% of bioethanol in all petrol consumed in motor vehicles
(iv) High import tariffs and non tariff barriers (NTBs) on final biofuel products entering developed markets like the USA and the EU. This indirectly encourages importation into the USA or EU of raw unprocessed biofuel feedstock from the rest of the world – including Tanzania.

The preceding support measures have on average cost between US$5.5 billion and US$7.3 billion per year in the USA. The bio fuel sector in Brazil has also received sustained government support until it gained its competitiveness recently. American and European bio fuel producers enjoy additional government protection in the form of high import tariffs on similar imports. In the EU, for instance, bio fuel subsidies are estimated to represent about 70% of farmer's revenue. These measures have a tendency of artificially making producers competitive; and they are, by definition, trade distorting practices in the WTO perspective. The major policy challenge arising here is whether Tanzania will, in its early bid to launch a competitive bio fuel sector, afford to offer such expensive subsidies or other support measures with tremendous financial and socioeconomic implications, to its incapable indigenous producers. High import tariffs and barriers in the developed world form another challenge for Tanzanian producers and exporters. Tables 8.4 and 8.5 below summarise indicative trade barriers and distortions in biofuel production, marketing and trade in major global producers.

8.3 SEKAB's Preparedness for Biofuel Trade Barriers in Export Markets

The non existence of a well established local biofuel market is mainly attributable to lack of necessary infrastructures (biofuel storage and pumping/distribution facilities) and machines running on biofuels (such as motor vehicles). This has prompted SEKAB to plan for exporting while waiting for the local market to establish. In cases where bio fuel exports are to be made out of their production plants in Tanzania, SEKAB management do not worry about potential import barriers (tariffs and non tariff barriers) posed by countries in the EU on final products like bio fuel (bioethanol). They are ready to confront the market in any situation, and they believe sustainability and competitiveness standards maintained in their business practices are essential for a successful operation and growth in any market. Another possible motive pursued by SEKAB and other European bio fuel investors could be that of meeting the EU's 20% target of bio fuel market consumption by 2020. This is like a mandatory requirement set by the EU on fuel consumption such that by that date bio fuel should constitute a fifth of market fuel consumption (i.e. 80% petroleum; 20% ethanol). The measure is a drive to gradually limit EU's dependence on petroleum imports.

Table 8.4: Tariff and Non-Tariff Barriers (NTBs) Faced in Global Biofuel Trade

Exporter	Importer	Trade barriers
1.1 Tariffs		
RoW	Brazil	20% tariff on ethanol imports
Brazil (ethanol)	USA	54 cents per gallon. The tariffs mainly serve to protect inefficient corn-based ethanol production in the US. Note: Brazil considers the tariff to be too high, unfair and in breach of WTO rules; it plans to challenge USA at WTO
RoW	EU	import duties (ID): US$ 0.10 per litre
RoW	USA	ID: US$ 0.14 per litre
RoW	Canada	ID: US$ 0.06 per litre
RoW	Australia	ID: US$ 0.23 per litre
RoW	Japan	ID: 0 (zero)
RoW	New Zealand	ID: 0 (zero)
CBI countries under CBERA	USA	Tariff rate quota (TRQ) applies. In-quota tariff: 0%; out of quota tariff: 2.5%+US$0.54 per gallon. Overall, TRQ = 60 million gallons or 7% of US annual consumption – whichever is higher
1.2 Non-Tariff Barriers (NTBs)		
RoW	EU	(Proposed) requirement that exporters should meet (strict) environmental, social and labour conditions associated with imported biofuels. Note: It is still debated whether the requirement is WTO compatible
Brazil (Cosan, Guarani, NovAmerica & Alcoeste)	EU (SEKAB-Sweden)	Strict social and environmental ethanol/biofuel production standards : ➢ zero tolerance for child and slave labour ➢ ethanol/biofuel mills should have 100 percent mechanised labour by 2014

Source: Author's table, data compiled from different sources, including Coelho, (2005)

Note: RoW = rest of the world; CBI=Caribbean Basin Initiative; CBERA=Caribbean Basin Economic Recovery Act; this exempts duties on biofuels imported into USA from CBI countries. In the EU there is a preferential treatment (exemption of duties) for ethanol imports from ACP (Africa, Caribbean and Pacific) countries, under the EBA (Everything But Arms) arrangement.

Table 8.5: Selected Trade Distorting Measures in Major Biofuel Producing Countries

Nature of trade distorting measures	Trading country/region and quantification
(proposed) financial incentives (subsidies) to producers of biofuels	Those meeting 55 to 60% of greenhouse gas savings in EU. Strydom (2006) estimates that subsidies would represent 70% of total revenue received by biofuel crop farmers
Subsidization of internal biofuel production through tax reductions	€0.65 per litre (Germany); GBP 0.2 per litre (UK); €0.38 per litre (France); and €0.525 per litre (Sweden). ⇨ This helped Germany and France in 2005 to account for more than 66% of the total world biodiesel production, Frondel and Peters, (2005). In the US, E10G blends (gasoline with 10% ethanol) have partial tax exemption of US$0.052/litre if locally produced biofuel is used. The US offsets this subsidy through taxing ethanol imports at a rate of US$ 0.54 per gallon (or US$ 0.18 per litre) – equivalent to the Brazilian production cost). These measures cost annually around US$5.5 billion to US$7.3 billion in the US. ⇨ These measures helped the USA in 2005 to account for about 33% of total world ethanol production, Frondel and Peters, (2005).
Tax rebates	US$0.51 per gallon of blended ethanol with gasoline in USA
Tax exemption	In Germany, locally produced biodiesel enjoys tax exemptions leading to its price competitiveness (US$2.67/gallon) relative to US$2.77/gallon for regular diesel.

Source: Author's table, data compiled from different sources, including Coelho (2005)

8.4 Conclusion

To enable an economically efficient and socially beneficial allocation of bio fuel production, especially in developing countries like Tanzania, subsidies and other trade distorting arrangements should be stopped or significantly lowered. These can be addressed through the existing and potential bilateral, regional or even in multilateral trade talks at the WTO. Unless these support measures are stopped or reduced, developing countries will unlikely be competitive in bio fuel production, marketing and trade because they cannot afford to offer such incentives to their producers. One may however need to know: which socioeconomic benefits does Tanzania stand to gain if it chooses to protect and offer generous incentives to the bio fuel sector which is already highly dominated by foreign interests? Has the country planned sufficiently for the technology and infrastructure (hard-, i.e. physical installations; and soft-, i.e. enabling

policies, regulations and strategic human skills) necessary for tapping the maximum socioeconomic benefits that may come along with the biofuels?

9.0 COSTS AND BENEFITS OF BIO FUEL PRODUCTION

Apart from establishing the type of bio fuel feedstock in production currently, the potential of expansion of the same and introduction of new types of plants for the same is important. The technical capacity to carry out production in large scale farms and processing into usable fuel available within the country is similarly important. Likewise the management and monitoring of the activity with respect to legal and technical aspects for sustainable and benefit to the country have to be determined. The framework analysis provided in this chapter is concerned with the potential outcomes of undertaking the production of bio fuel in Tanzania socially, environmentally and economically. *We ask the question whether it is more beneficial economically, socially and environmentally to use land to produce bio fuels or continue with the business as usual scenario i.e. where villages continue current use of land or use it alternative investment arrangements.* The objective is to be able to provide a solid basis for policy and decision making for the government which is responsible for the overall welfare of Tanzanians.

In looking at the benefits and costs of bio fuel production we consider both those costs and benefits which occur at the national level such as tax revenues for the central government, foreign exchange earnings, investment flows into the economy etc as well as local aspects of employment, markets for local produce to workers etc. We also extend our analysis beyond the marketed monetary benefits and costs to non market benefits and cost in the environmental and social economic aspects. This is important in order to capture the type of benefits and costs which are not usually captured in market exchange and yet are important to everyday lives of communities such as time use, non timber forest products and own production contribution to livelihoods. It is acknowledged that rural communities' contributions of NTFPs to total livelihood income range from over 50% in some settings (e.g., Narendran et al., 2001) to less than 20% in others (Campbell et al., 2002 and Ambrose-Oji, 2003). This implies that if the natural resource base is degraded the livelihoods of these people will likewise be negatively affected.

The opportunity costs for using land for bio fuel production includes several aspects such as; resettlement of communities, marginalisation of communities in terms of access to land and competing uses for land and water resources, food insecurity through decline in production and hence supply of foodstuffs due to their utilisation for bio fuel production (maize, soya, sugarcane, etc) and increased general price level of foodstuffs. Alternative investment on village land under different arrangements does provide huge opportunities foregone in terms of benefits that could otherwise be enjoyed under

favourable conditions. For instance if the land remains in the hands of the villages while partnering with investors under better equity terms, better benefits could be reaped.

Our assessment of the costs and benefits of the feasibility of large scale production of bio fuels does not utilize the classical benefit – cost approach to economic feasibility due to the many setbacks in terms of addressing the complex issues involved and the uncertainties regarding the values to be placed on the numerous non-market costs and benefits. Since neither the revealed nor stated preferences were obtained in the field we therefore adopt the qualitative analysis of costs and benefits. Some quantitative analysis may be employed where the numbers seem to be credible. Thus the initial intention of doing the conventional cost-benefit analysis has been defeated by poor responses in data collection.

The main data points and variables included district income, village and house hold incomes. Other variables included expenditures in production (mainly agricultural production), Non Timber Forest Products use. Other non market environmental goods and services have not been considered in terms of measurement.

It is worth noting that this is still economic analysis in the sense that any feasibility study will be required to identify and enumerate all the benefits likely to arise from the project that may have a value to someone. Similarly all the costs that may be fall someone or a community in this case, have to be identified and enumerated. These include economic, social and environmental costs and benefits. The difference between this and the classical approach is that no monetary values are put on all costs and benefits. Rather, this approach identifies all the costs and benefits and quantification is done to the extent possible. Ultimately, stakeholders' losers and winners will be identified. This is done through a counterfactual analysis, considering the 'with' and 'without-Project' scenarios. It should be noted that, the 'without-project' scenario is not the "current" situation, but a continuously improving situation of communities improving their lot through government and non-state actors' interventions. This assessment includes a range of environment, social and economic impacts.

9.1 The 'Without Project' Scenario

9.1.1 The Tangible Benefits

(i) Local Tangible Benefits

The benefits referred to here are those accruing to communities who are involved in the drive for bio fuel production or agro fuels, in terms of contributing land to prospective investors both local and foreign. This analysis does not include the bio fuel production by villagers themselves since this was not the case the team observed during the field

survey, instead what was observed was the domination of foreign owned companies establishing themselves in this venture in all the five regions visited.

In the 'without project' scenario, the benefits which accrue to communities emanating from use of their village lands includes settlement and own production of food for home use and trade from their own lands whose size lies in the region of 2-3 acres for most households planted mainly with food crops like maize, paddy etc. The other major benefit is the sustained forest use for non-timber forest products (NTFP). The household survey revealed among others that the main NTFP enjoyed from the adjacent forests include firewood and charcoal, game meat, building poles, thatching grass, weaving grass, grazing grass, medicinal plants, wild vegetables including mushrooms and fruits (wild foods), pottery soil.

The other less obvious benefit arising from the village land ownership is the potential benefits that may be reaped from the direct use and indirect use of the land under the village ownership. Future benefit flows from the land that may arise from using the land include; production of food and cash crops by villagers through expansion of production due to technological and investment capital improvement. Also by the ability of the land to absorb the increasing population in the village in the years to come villagers could also use their land as investment share capital and go into joint ventures with investors with technology and financial capital. This way benefits would continue to flow for the foreseeable future without having to give away land which leads to the loss for good of the future benefit flows. Others include a sustainable supply of NTFP due to increased awareness and improved management of environmental goods and services.

Quantification of all these benefits would give us the value of direct and indirect use of the village lands that would otherwise be given to investors for bio fuel production. Furthermore, the use of these lands by villagers or in partnership with others would serve to effect and equitable distribution of the benefits to the wider population and hence facilitate the drive against poverty. Table 9.1 attempts to quantify the benefits outlined above as much as possible where data is available.

The values below are household averages for the surveyed villages. The total use values for the villages will require multiplication of the average household values by the number of villagers in a surveyed village adjacent to a bio fuel plantation. For instance if we want to know the value of NTFP for villages in Kilwa district adjacent to the Bio shape farm we multiply the Tshs 341,947 times 701 households in Mavuji, liwiti, Migeregere, Nainokwe villages. The outcome will be ***Tshs 239,705,064 worth of NTFP livelihood flows per year*** from the forested areas of the village lands given away to bio fuel investors culminating to ***Tshs 2.4 billion worth*** of sustainably utilized forest resources in 10 years and even more in the future use of forest resources.

The NTFP use in Missenyi district villages is even more illuminating in terms of the magnitude of values extracted by villagers. With a total of 3227 households in the five (5) villages surveyed and an average household NTFP use value of Tshs 681,051 per annum, the villagers' draw ***annual livelihood benefits worth Tshs 2,197,751,577*** *or* ***Tshs 2.2 billion*** *which translates into* ***Tshs 22 billion worth of constant flows of benefits in ten years in constant 2008 prices.*** This is quite a considerable amount of benefits which should be considered when decisions concerning the alternative use of land containing these resources.

Table 9.1: Estimated Non Timber Forest Products Use Values

S/N	NTFP Type	District Household Average NTPF use values per type of NTPF (Tshs/annum)							
		Missenyi	Chato	Rufiji	Kilwa	Kigoma	Bagamoyo	Korogwe	Mkinga
1	Poles	65,600	28,386	65,031	43,806	46,644	64,011	114,140	34,716
2	Grass thatch	52177	14,885	30,442	35,290	12,562	36,383	28,667	20,125
3	Weaving grass	-	4,000	-	-	3,000	2,600	3,735	6,000
4	Grazing grass	-	11,700	-	-	15,025	3,495	14,992	43,545
5	Building sticks	11,435	12,500	17,923	28,539	5,141	37,133	18,924	36,351
6	Medicinal plants	1,000	-	-	3,000	11,000	-	1,350	101,500
7	Pottery soil	50,000	-	-	2,500	-	-	5,050	-
8	Charcoal	9,911	7,364	7,067	4,633	8,353	6,857	16,917	16,000
9	Game meat	2666	-	-	-	2,680		5,045	4,585
10	Wild Vegetables	9000	-	-	-	3,005		8,783	13,676
11	Wild fruits	4812	-	-	-	1,608	12,000	3,000	1,333
12	Mushrooms	-			2,400	4,533		-	1,833
13	Edible insects	24,000	-	-	-	-	-	-	-
14	Fuel wood	450,450	882,912	138060	218,179	183,149	170,450	60,234	57,479
15	Edible roots	-	-	-	3,600	7,671	-	-	-
Total Average household use value appropriation per annum		681,051	961,746	258,523	341,947	304,372	332,927	280,837	337,144

Source: Study Field Survey, July August 2008.

Agricultural Production

As discussed earlier agricultural production plays a central role in natural resource use particularly the land resource. The findings from the villages surveyed show that each household has between 2 to 4 acres of agricultural land on average on which production of food and cash crops take place. In most of the villages production of maize is

common with some villages producing more than others. Also most villagers practice mixed farming which results into several crop varieties to be produced in the same land area. In the surveyed villages in the Coast region for instance maize is planted together with peas where the yield per acre of maize is five (5) 100 kilogram bags and peas 3 one hundred kilogram bags per acre. At Tshs 25,000 per bag of maize and Tshs 50,000 per bag of peas, the average household with 3 acres of farmland may get 15 bags of maize and 9 bags of peas which translate into Tshs 375,000.00 from maize and Tshs 450,000.00 from peas totaling to Tshs 825,000.00 of farm income/consumption per annum per household. The table below shows the household survey findings of average agricultural production values for the districts surveyed.

If we multiply the average household agricultural production value by the number of households in each locality, we may arrive at an estimate of the annual agricultural production value per village. For instance, the total number of households in the surveyed villages of Kilwa district is 701 and those of Missenyi 3,227 respectively. ***Therefore the total average agricultural production values accruing to these communities per year would be Tshs 924,286,025 (or Tshs 0.9 billion) and Tshs 2,232,725,803 (or Tshs 2.2 billion) respectively***. This is quite a significant benefit accruing to the village communities from the use of their land for agricultural purposes although not sufficient to lift them from poverty. This means any investment which comes their way has to generate greater benefits not only to the government through taxes but also to the communities as well. Currently the village land under crop cultivation is in the hands of villagers themselves. In the event that the villagers are resettled, this is the kind of benefit they will forgo. Alternatively, the opportunity to expand production given that the village land is still in the hands of the villagers will mean such benefits and even more will be obtained per household given the use of improved farming techniques. Cumulative benefits accruing to these communities for 10 years will be in the region of Tshs 9billion and Tshs 22billion respectively, something which they will lose if the land is taken away from them.

Table 9.2: Average Agricultural production value per household per annum

	Missenyi	Chato	Rufiji	Kilwa	Kigoma Rural	Bagamoyo	Korogwe	Mkinga
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Average household Agricultural income Tshs/annum	691,889	432,384	1,250,604	1,318,525	1,013,346	1,417,013	838,758	1,012,217

Source: Study survey July/August 2008

Table 9.3: Average Agricultural production value plus NTFP value per household and village per annum (Tshs)

	Missenyi	Chato	Rufiji	Kilwa	Kigoma Rural	Bagamoyo	Korogwe	Mkinga
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Average household Agricultural income Tshs/annum	691,889	432,384	1,250,604	1,318,525	1,013,346	1,417,013	838,758	1,012,217
Average household use value appropriation per year	681,051	961,746	258,523	341,947	304,372.02	332,929	280,837	337,144
Total household Benefits	1,372,940	1,394,130	1,509,127	1,660,472	1,317,718	1,749,942	1,119,595	1,349,361
Total Village Benefits surveyed districts (Tshs billions)	5.8	5.2	1.1	1.2	2.8	1.2	3	2.3

Source: Study survey July/August 2008

Note: Surveyed villages in the districts included in the table above with their household number in brackets are as follows; Missenyi (4227), Chato (3750), Rufiji (759), Kilwa (701), Kigoma vijijini (2150), Bagamoyo (712), Korogwe (2636) and Mkinga (1670).

(ii) National Level Tangible Benefits

Benefits accruing to the nation from the existing situation i.e. 'without-project' scenario include employment benefits, tax revenue and foreign exchange earnings and savings.

Foreign exchange earnings and savings

Production of own food and excess food for the domestic market is important in averting food shortage and minimizing food imports and hence saving foreign exchange. In most of the areas surveyed own food production is the norm. In the Lindi and Coastal regions, food production is at a subsistence level and not much is produced in excess for even the domestic market. Agricultural production of food and cash crops for export provides a good source of foreign exchange. Foreign exchange earnings will be collected from cash crops grown and exported from these lands in the case where their production is promoted. In the Lindi and Coast regions these include cashew nuts, paddy and livestock, while in Kagera region coffee, soya beans, sugar cane, are some of the cash crops being produced and can be expanded. In Kigoma region palm

oil, soya beans are included. In Tanga, oranges are grown in big quantities and most find their markets in neighbouring Kenya etc. The production of food crops in these lands in significant quantities may serve to avoid importation of food due to shortages and save foreign exchange but at the same time create employment.

Tax revenue benefits

Tax revenue collected at the local government level up to central government level from product cess sales taxes are some of the major benefits of village land use by villagers. Food and cash crop production for the market also provides tax revenue at the local government and central governments. Figures for these benefits have been difficult to obtain due to lack of proper records.

Timber benefits

The land which the NTFP are obtained is obviously forested and that is where the timber products are obtained. The current situation is such that timber resources found in these village lands are harvested through the set procedures and rules through the district local government and the Division of Forestry and Bee keeping on the Ministry of Natural Resources and Tourism. The revenue accrues to the local and central government coffers. We could not get the harvest figures and their concomitant revenue generation. However, the Bio shape investors who by the way started harvesting the timber resources from the land they have acquired from the proposed jatropha plantation, indicate that 25% of the overall biomass is wood that will be processed into timber which will be partly sold in Tanzania and partly exported. The 25% of the overall biomass represents 72,900m^3 of wood which could be turned into timber. One 2 meter long log of 50 cm diameter and a volume of 0.5 $m^{3,}$ about 10 logs can be sawn with a market value of US$ 120 per m^3 (Bioshape, 2008). In the 25% of the area which is 20,000 ha, will yield a total of 250,000 m^3 saw logs. At 12.5 logs per hectare, with each log producing 10 planks of timber, a total of 125 planks of timber will be obtained per hectare. In a 20,000 hectare area 2,500,000 planks of timber would be obtained at a price of US$ 6 per plank which means US$ 15 million will be generated in total on a conservative scale.

All this timber value will be lost to the nation because it is being appropriated without following procedure and set rules including getting a licence for harvesting and processing timber.

Charcoal Production benefits

The business plan by Bio-shape indicates that, "*75% of all wood harvested will be designated as fuel wood and thus can be used for charcoal production*". They estimate that

they could produce a yearly amount of 218,700m^3 wood from 8100 hectares, which translates into about 725,000 bags of charcoal worth *Tshs 10.875 billion or US* $ 8.7 million in 2006 prices. Like in the case of timber, this value which would otherwise be a benefit to the nation will also be lost due to the same reasons given in the previous paragraph.

Employment creation

In this scenario, overall employment is created through the household use of household labour to a large extent. It has been found from the study survey that an average of 75% of all labour supply for food and cash crop production is provided by households for farm preparation and weeding. Almost 100% of labour supply for harvesting activities is supplied by household labour in the study areas visited. It is well acknowledged that households in the rural sector provide the bulk of labour requirements for agricultural production. Furthermore, households do hire farm labour for weeding and farm preparation indicating that household labour alone does not suffice despite the average small size of farms – owned by households. The implication of this is that the coming of plantation farms which will employ many farm labourers whose time use will compete with household agricultural production for food and cash crops, hence affecting household food supply and excess for the market and therefore affecting the general food supply effect i.e. declining supply for domestic consumption from those areas which will be engaged in bio fuel production. It is normally asserted that in rural areas there exist disguised unemployment in the sense that labour force is not fully utilised hence inefficient outcomes occur including low productivity of labour. However, in the event of plantation farming establishment, the disguised unemployment will disappear and labour shortage will set in. It should furthermore be noted that labour demand in the rural areas is seasonal and hence even households find themselves hiring farm workers to help with household labour to prepare farms, weed and sometimes even harvesting of crops. Since all agricultural activities are done at the same time, then a situation of labour shortage occurs and therefore household food production is likely to suffer the most because it can not compete with instant cash from plantation labour hire.

The effect of decline of food production has been felt in Mavuji village. Villagers in Mavuji commented that labour power has been reduced in household agricultural production activity due to many youths being employed in Bio shape plantations. Discussions carried out with the Bio shape management informed the research team that during the preparation of the farm quite a large number of workers were employed i.e. more than 700 people. The surrounding villages provided labour but could not suffice until more people were brought from Kilwa Masoko and other places. This shows that the impact on labour supply is significant and has both positive and negative short term and long term effects. The positive effects include income

generation by villager working in the plantations, while the negative effects include decline in household agricultural production (both food and cash crops). An additional effect is the social impact where families are being stressed up due to change in production and social relations particularly family relations. Gender relations are being strained due changing conditions in employment and earning opportunities now open to women. In some cases in a household a man may not be working but his wife is working and earning relatively good income. Coupled with foregone benefits from the woman's absence from the home the whole day, husbands are disturbed and become envious and their positions as heads of household are threatened and therefore family harmony breaks down and disruptions happen. These social effects are not unique to bio fuel production alone but are common in many modern large scale production and commercial undertakings which necessitate changes to new ways of life at the household and society level.

9.1.2 The Local and National Level Costs or "Without Project" Scenario

(i) Local Costs

The costs of without project scenario at the local level include the costs of production of agricultural crops and harvesting of NTFP. Other costs include the opportunity costs of doing without Bio- fuel project. Here we consider the major cost of production for farmers in the Coast region being labour time. Labour time for cultivation is calculated by using the amount farmers pay for hired labour for 25% requirement of farm labour time and convert it into the total labour cost by imputing labour time values derived from hired labour payment. In this case then Table 4 below presents the labour time cost for agricultural work per annum.

The opportunity cost of the "without project" scenario is the forgone benefits of investment which would otherwise have been flowing into the community due to "with project" circumstances. These include amount of employment generation, where the amount indicated by Bio shape for their Kilwa venture include 10,000 manual labour positions by 2018 which creates a market for local food crop produce due to income obtained from being employed (i.e. Tshs 90,000 per month for the required work force of 10,000 people at full capacity i.e. 81,000ha (AIDEnvironment 2007)) which in turn creates an effective demand. Also, other costs include forgone social services that would have otherwise been provided by the investors. For instance In Nainokwe village, Bioshape has promised to help the village in construction of teacher's house and village government office. While in Mavuji a village government office which has already been constructed would have not been there.

Table 9.4: Average total labour costs of agricultural production by villagers on their own land

SN	Missenyi		Chato		Kigoma		Bagamoyo	
	Hired labour percentage	Average cost of labour incurred	Average hired labour percentage	Average cost of labour incurred	Average hired labour percentage	Average cost of labour incurred	Average hired labour percentage	Average cost of labour incurred
	16	25,362	18	11,000	10	15,740	38	66,250
Average total Household labour cost[1] (Tshs)	158,512		61,111		157,400		174,342	
Average total Village labour cost[24] (Tshs)	670,030,224		229,166,250		338,410,000		124,131,504	

Source: Data analysis based on field work

Note: The total amount of production cost can be determined by multiplying the average total costs of agricultural production by the number of households in the respective surveyed villages adjacent to bio fuel investment activities.

In Rufiji district, African green oils have promised the villagers to expect finance in development of social services and opportunities for out growers. In Nyamatanga, Rufiji district the company has promised to construct a dispensary and village government office. Other expected benefits are include the development of infrastructure.

(ii) National Level Costs

These include conservation costs and opportunity costs of benefits forgone by opting for "without project" scenario. These are conservation costs, crop destruction by wild animals in some villages[25] and Opportunity costs which include tax revenue missed, less the amount of employment that would be denied due to export of bio fuel processing jobs abroad. These are benefits denied to Tanzania by the design of the project to export seeds for processing in the Netherlands and Belgium. Furthermore apart from exporting jobs, this move denies Tanzania capital accumulation and

[24] Total labour is calculated by dividing the average cost of labour incurred by hiring labour by percentage of average hired labour by the household and then multiplying the result by 100 to get total value of labour used by the household (household plus hired labour).

[25] These are envisaged to decline due to expansion of bio fuel production and clearing of forested land. In addition, Jatropha is not edible to animals so the plantation can not make a good habitat for destructive animals or otherwise.

technological transfer for oil processing necessary to build the country's technological base.

9.1.3 The Intangible Benefits

These include the environmental services such as carbon sequestration, habitat destruction, biodiversity decline etc. Ecofys (2006) estimated 45 tons of CO_2 /ha is sequestered assuming a 50 m^3 /ha standing volume of woodland in Kilwa. This means by clearing 81,000ha of land, 3,645,000 tons of CO_2 sequestration will be forgone and hence contribute to global warming of the planet leading to climate change.

9.1.4 The Intangible Costs

These include the opportunity costs of bio fuel production which include degraded environment and biodiversity loss bringing with it changed local/ microclimatic variability and unpredictability. Conservation costs including Mpingo conservation and some costs from the Selous conservation programme due to community conservation strategies among others.

9.2 Costs, Benefits and Equity

The above analysis at local and national level costs and benefits has shown that the "without project scenario" provides an insight of how communities benefit from the use of their village land either through agricultural production of timber and non timber products utilisation. These are the direct benefits accrued to them and costs incurred due to exploitation effort. The attempted estimated values of the benefits and costs has shown that both marketed and non marketed goods culminate into quite a significant amount of benefits evenly distributed to households due the accessibility of those households to these resources.

Contrary to this picture, the "with project" scenario which obtains currently requires that villages give away land to investors who in turn will clear it of all vegetation cover to give way for plantation of bio fuel feedstock. The effect of this is to deny villagers of the current and future stream of benefits flowing from the cleared land and hence affecting their livelihoods. Although in most of the cases household farmland is not affected, future expansion of production due to family growth and the improvement in availability and affordability of better farming technology with higher factor productivity will be curtailed. Some of the villages have given away all of the 'extra'[26] land to bio fuel investors. This is partly the outcome of lack of land use plans for the villages who seldom know the actual size of their land.

[26] Land not under cultivation

The activities of this venture will tend to concentrate the benefits into fewer hands of investors and the government through tax revenues and some workers who will gain employment into these plantations, the income distribution will be lopsided. It could be that some of the villagers will end up worse off while a few ends up better off and hence their wellbeing impinging on others. Comparing the total benefits (both agricultural, forest resources both timber and non timber) enjoyed by village communities "without project" and "with project" one finds that benefits are fewer due to a de-facto redistribution of benefits from the communities to investors and government! For instance, even if all the 701 households in the 4 villages in Kilwa contributing land to the Jatropha plantation ,could have one member of their households employed in the plantation and being paid Tshs 90,000 per month, they will only bring home ***Tshs 0.76 billion*** only per year which is less than ***Tshs 1.2 billion*** per year households enjoy from agricultural production and timber and non timber forest products.

10.0 RISK ANALYSIS FOR BIO-FUEL PRODUCTION

10.1 General

The search for bio-fuels in Africa is clearly motivated by three main factors, namely; *depletion of oil reserves, climate change, and the huge bio-mass potential*. Tanzania is seen to be favourable for large-scale bio-fuel production because of availability of land, climate and the ease with which land can be acquired. But large-scale bio-fuel production entails the exploitation of four principal resources, namely; land, natural vegetation, water and labour. Further, the potential of bio-fuels as a source of renewable energy and as a direct source of support for some agricultural producers notwithstanding, there is evidence that they carry social and environmental risks. These include upward pressure on food prices, intensified competition for land and water, and land-use change that may outweigh the green-house gas benefits of fossil fuel substitution. Thus, prior to a long term engagement in large-scale bio-fuel production, it is necessary, among other things, that:

(i) A situation analysis of risks is undertaken; and
(ii) Implementation strategies are developed/formulated on management of the risks.

10.2 Situational Analysis of Risks

Risk is a concept that denotes a potential negative impact to some characteristic of value that may arise from a future event. Risks are events or conditions that may occur, and whose occurrence, if it does take place, has a harmful or negative effect. Risk analysis is, therefore, the detailed examination of potential risks with a view to determining

features and factors that need to be addressed in order to avert or minimize potential negative impacts. For the case under consideration, such potential risks relate to aspects briefly outlined in the sub-sections that follow.

(ii) Non-existence of relevant legislation, policy(ies) and standards to guide the bio-fuel development and production

There exists a number of legislations and policies that may be generically related to bio-fuels, but none of them adequately addresses the specific and thorny issues on large-scale bio-fuel development and production. For example, Land Acts Nos 4 and 5 place 70%-75% of the agricultural land in the hands of villagers. Whereas this may sound good, it is risky because the village governments are ill-prepared to deal with foreign investors neither is there a support mechanism to help them handle investors' advances properly. This risks getting big chunks of village land given away without taking into account future needs of the villagers. Further, once such land is given away it will not revert back to the village even after expiry of lease – leading to cumulative loss of village land. This is mainly because of the tendency of land grabbing by foreigners could not be foreseen when crafting and legislating the policies and laws respectively. The absence of such instruments presents a big risk in that:

- Too much land may be committed to bio-fuel development and production leaving too little land for other uses;
- Too much land may be leased to foreigners leaving too little for Tanzanian nationals;
- The natural bio-diversity may be completely disrupted to give way to large monocultural plantations of energy crops;
- Land grabbing may occur resulting in displacements of human settlements, disharmony and land conflicts and desputes;
- Mis-use and mis-management of water resource may occur resulting in depletion of sources;
- Misappropriation of natural resources wealth may occur with no or too little benefits accruing to Tanzanians;
- Exploitation of human labour may occur without adequate compensation;
- Perpetuation of scientific and technological dependence on developed countries.
- Food crops are turned into energy crops and farms for food crops changed to produce energy crops.

The instruments would spell out the responsibilities of the various parties and how they should be discharged. Observed instances where investors offer and are allowed to facilitate (in whatever way) preparation of land-use plans or organization of village meetings and preparation of minutes thereof would then be avoided and be clearly condemned as illegal.

The absence of these instruments, including detailed land-use plans, needs to be properly addressed urgently and expeditiously, before bio-fuel development reaches too far. Current engagement with investors should allow revisions upon appropriate instruments being put in place.

(iii) Land availability for energy-crops production

Tanzania has a land area of 886,000 km^2 (88.6 mill ha), 44 mill ha of which are said to be arable. The population of Tanzania is estimated to be 40 mills and it is growing at 2.3% [27]. Agricultural activities generally include food and cash crop farming, as well as livestock keeping. Farming of energy crops belongs to the cash crop farming category. With the introduction of energy crops it is very important that there is distinction between arable land for food crops production, livestock keeping and other agricultural uses, and that adequate land be reserved for food crop production and livestock keeping. This needs to be clearly spelt out in land-use plans, which are currently under preparation. The absence of such detailed land-use plans presents a risk in that too much land may be allowed for cultivation of energy crops thereby leading to food shortage and crisis. The absence of such land-use plans may also lead to speculations that Tanzania has a lot of idle land – this is a common belief among many foreigners as well as nationals. This belief stems from the fact that due to primitive farming methods the average farm size of villagers ranges between 0.2-2.0 ha only. This is bound to change significantly with improvement of farming implements and commercialization of agriculture. Further, land has many uses apart from agriculture, including pastures, beekeeping, game reserves, non-timber forest products for many people, a complex and rich biodiversity which needs to be protected, mining, etc. Thus, with all parameters considered it becomes clear that the notion of idle or un-utilized land is grossly misguided.

Thus, projections of demand of land for food crops should be worked out taking into account the country's high population growth, and land available for energy crops and other unknown future uses needs to be clearly demarcated. A rough comparison of countries based on land per capita points the need for Tanzania to be very careful in managing its land resources.

Although there have been claims that some energy crops, such as jatropha, grow well in marginal lands none of the investors has so far opted for anything close to that. Of course, it is understandable that investors look for lucrative business and that is only possible where yield is highest. So far we are not aware of any species of energy crops that flourish better in margin lands than in fertile lands. It may therefore not feasible to restrict farming of energy-crops to marginal land areas only. The definition of marginal

[27] 2002 Tanzania National Census

is contextual with respect to rainfall, vegetation and soil. Further, marginal land should not be confused for idle land, because it also has use.

(iv) Viability of large-scale bio-fuel business

Large-scale farming of energy crops is already, to some extent, being practiced in a number of developing and emerging economies, including Brazil, Malaysia, Indonesia, India, Thailand, Nigeria, South Africa, Mali, etc. It has, however, been observed that despite remarkable reductions in production costs, the bio-fuels industry has been struggling financially until recently – it has not been financially viable without government support and protection (WBI's Development Outreach, 2008). For example, US and EU producers receive protection through high import tariffs on ethanol. Such dependence on subsidies distorts market behavior and hides real costs. Thus, investors from US and EU factor into feasibility studies and business plans the various subsidies and mandates offered in their home countries. Such subsidies cannot be sustained forever, and considering the amount of investment in R&D on alternative and renewable energy there will come a time when they will be removed. The outcome of such a development will be catastrophic if developing countries, like Tanzania, where large scale feedstock production is introduced at the expense of huge environmental and social sacrifices.

If the assumptions underlying the feasibility studies and development of business plans are sound to the investor and the host country, the business should be viable and cater for the interests of both. However, in this report it has been observed that the interests of Tanzania cannot be adequately catered for especially because the instruments (policies, guidelines, laws and regulations, land-use plans, etc) that define them are not in place. It is thus difficult to establish that the business will be satisfactorily beneficial to Tanzania. Further, although Environmental (and Social) Impact Assessment (EIAs) are mandatory for any project of significant magnitude undertaken in Tanzania, the procedure adopted for carrying out the same does not guarantee objectivity and rationality, because:

- It is the investor who hires the consultant to carry out the EIA;
- The EIA may be carried out by the investor's in-house staff;
- The EIA consultant reports to and is paid by the investor;
- It is the investor who submits the EIA to NEMC.

Since the EIA is submitted to NEMC to support establishment of the business by the investor, it is most unlikely that a negative one will be entertained by the latter. This procedure creates room for subjectivity in favour of the investor, with respect to competence of the consultant, honesty, and contents and authenticity of the EIA document. In turn, it makes it difficult to determine the extent to which the business is environmentally friendly.

The above is clearly evidenced by the apparent contrast between the SEKAB and Bio-Shape EIA reports. Although the SEKAB EIA report has objectively and rationally identified and analyzed the adverse effects of implementing the bio-fuel project as proposed, the conclusions are nevertheless in favour of continuing with implementation of the same. On the other hand, Bio-Shape's EIA report is shoddy in many respects, including the competence of the consultant who carried out the assignment.

There is need to revise the EIA guidelines and procedures with a view to enhancing the objectivity and rationality of the same. Further, all EIAs should be reviewed by experts before being adopted by NEMC, and public hearing should be made mandatory.

(v) Inadequacy of relevant research and development base

Introduction of the new large scale bio-fuel farming requires existence of a strong Tanzanian R&D base for provision of solutions to the numerous problems that will emerge as implementation proceeds. Although there are many R&D institutions, in Tanzania, in the various fields relevant to large-scale bio-fuel development and production, their facilities are poor and they are poorly coordinated. There is therefore the risk that investors will tend to rely on their home country institutions for such services, and thereby minimize the science, technology and innovation benefits which would otherwise accrue to Tanzania if the R&D base was better. Such tendency by investors should be discouraged by requiring them to utilize locally available capabilities to the full before seeking external assistance. At the same time, local R&D institutions should be required and supported to improve their capability and linkage with other R&D institutions within and abroad. The Tanzania Commission for Science and Technology (COSTECH) on its part should oversee and ensure proper coordination of R& D activities in the country.

Enhanced R&D capability in Tanzania would assist in generating solutions which would attenuate the trade-offs between fuel on the one hand and food and the environment on the other. Participation by experts from countries like Tanzania, in the development of future bio-fuel technologies would guarantee that such technologies enable a shift of the reliance on food crops and hence pressure on food crop prices, to dedicated energy crops and the use of biomass wastes. The most desirable situation is achievement of energy security without compromising food security.

For sustainable national development, even in the context of large-scale bio-fuel production, *human capital development*, and *science and technology development (including research)* are key. Thus, the absence of relevant bio-fuel technologies will necessitate acquisition of the same from abroad and training of personnel to manage, maintain and

further develop the same. This process has to start during the development phase of the bio-fuel production.

(vi) Inadequate mobilization of bio-fuel stakeholders

Bio-fuel is very new to Tanzania, both from a business perspective as well as from a practice point of view. Investment in bio-fuels is a new venture with great risks if not properly and carefully handled. It should have been preceded by getting the society adequately informed and sensitized about possible risks and dangers. This would have helped to ensure informed decisions at all levels, and to equip those in relevant positions with best ways to handle such matters when they reach them, including being able to make better deals. In this regard Tanzania is ill-prepared to engage in large-scale bio-fuel production. But, information flow and sensitization of the society are only two of the many things that need to be addressed in the course of getting prepared for engaging in large-scale bio-fuel production.

Ill-prepared as it is, if no quick intervention is made, Tanzania may not benefit from the large-scale bio-fuel business. There is, however, still room for remedying the situiation, especially because the activities are still at an early stage.

(vii) Absence of benefit sharing schemes

Experiences from the development of the mining industry showed that there are no guidelines on benefit sharing schemes for large scale projects or programmes in Tanzania. Apparently, it is upon investors to come up with such schemes as part of their corporate social responsibility to the society and otherwise. While the investor makes huge profits, lack of benefit sharing schemes risks perpetuating poverty among communities surrounding the resource rich project area. This is not healthy – there is need to formalize and provide guidelines for benefit sharing for large-scale projects.

(viii) Lack of coordination and strategic handling of bio-fuels

Discussions with parties relevant to the bio-fuel initiatives have revealed that there is little or no coordination between them. Key officials of some very relevant public organizations (Ministry of Industry and Trade, Ministry of Agriculture, Food Security and Cooperatives, EWURA, Tanzania Ports Authority, etc.) are not only uninformed but are also apparently unaware of what is happening. There is also clearly no coordination between TIC, the district authorities and the village governments. This lack of coordination provides loopholes for unscrupulous investors to manoeuvre matters in their favour. For example district officials feel helpless when investors claim that TIC has already okayed their cases. This situation provides room for such investors to take advantage of the ignorance of some players like village government to do

unauthorized things – acquisition of 1,000 acres for the pilot jatropha farm in Kilwa, by Bio-Shape, is one such case.

Considering the complexity of issues and the multiplicity of actors related to large-scale bio-fuel and production, and the fact that such development cannot be avoided altogether anyway, there is need to establish a coordinating body whose terms of reference will include ensuring proper coordination of all aspects related to the same, monitoring of the development and the safe-guard of national interests. Alternatively, an appropriate existing institution could be charged with this very important responsibility, in additional to its current terms of reference.

(ix) Inadequate safe-guard of national interests

The most important objective of carrying out the risk analysis is to safe-guard short-, medium- and long-term interests of the nation and its peoples. The absence of instruments to guide, and provide checks and balances in the development and implementation of large-scale bio-fuel production implies deficiency in the safe-guard of national interests. Similarly, lack of coordination provides room for flouting of national interests. For example, it is in the national interest that all export products are value-added yet Bio-Shape has been granted approval to embark on large-scale farming of jatropha for the purpose of exporting raw seeds to the Netherlands for processing at their plant (already under construction) in Terneuzen.

In order to ensure that national interests are properly safe-guarded in the implementation of large scale bio-fuel production initiatives, the body established or designated to coordinate large-scale bio-fuel development and production, should have safe-guard of national interests as one of the items in its prime terms of reference, and should work closely with all other relevant organizations.

In order to ensure sustainable development of our nation, viz. balancing the fulfillment of human needs with the protection of the natural environment so that such needs can be met not only in the present but in the indefinite future as well, measures should be put in place to restrain extravagant exploitation of nature. With regard to large-scale bio-fuel production measures should be put in place to specifically restrain the following:

- Destruction of bio-diversity;
- Long lease of land to foreigners;
- Acquisition of too big pieces of land by foreigners;
- Depletion of water bodies;

Thus, a desirable long-term scenario for large scale bio-fuel production may entail the following step-wise development:

- Establishment of a coordinating body;
- Development of relevant instruments, viz. policies, laws, guidelines;
- Sensitization and awareness creation;
- Capacity building;
- Development and implementation.

(ix) Acquisition of large pieces of land on long lease tenure

One of the biggest and real threats of large-scale bio-fuel feedstock cultivation in Tanzania is land grabbing by foreigners. Land grabbing will displace village communities from their lands and thereby lead to encroachment by the displaced of land reserved for conservation (land leakage).

Land clearing for bio-fuel feed-stocks will result in loss, fragmentation and degradation of valuable habitats and negative impacts on associated bio-diversity and eco-system services. Increased use of agro-chemicals and water resources will lead to erosion of the biodiversity, water shortages, increased water pollution, and soil degradation and erosion. Release of carbon from natural carbon sinks, such as grasslands, woodlands and forests, as a result of land use changes will also adversely affect the environment. Un-properly known feed-stocks, may also be damaging to wildlife, spread diseases and pathogens to food crop relatives, competitively displace native species or lead to gene flow with native species.

Given the seriousness with which alternative sources of energy are being sought, there is no guarantee that fuel crops will remain attractive for long. Research in cellulose and raising algae for bio-fuel are yielding very promising results. There is, thus, the risk in that sacrifices made in form of de-vegetation and erosion of bio-diversity, in favour of growing energy crops may go down the drain with prices falling and farms/plantations being abandoned. Thus, there is need to limit both the size of land being leased to individuals and the tenure to shorter periods (of say, 15-20 years), allowing for the possibility to renew the same and adjust to changing circumstances. Similarly, erosion of the bio-diversity should be guarded against.

(x) Need to promote local market

The current situation is one where Tanzanians produce what they don't consume and consume what they don't produce. This is risky in that it deprives the nation of control and makes it vulnerable the manipulations from abroad – terms being set abroad for what is produced as well as what is consumed in the country. The situation pertaining bio-fuel is very much so. There is need to build capacity to influence developments in the country by its people.

(xi) Food for fuel

The growing demand for some food crops to produce bio-fuels has been the driver of surging food prices worldwide. Rising production of bio-fuels with accompanying incentives and mandates, will result in worse implications on food security in developing countries like Tanzania, as various vital food crops are diverted to the bio-fuel sector. Unfortunately, the risk of food crops being used for fuel cannot be ruled out even with the existence of sound instruments to regulate bio-fuel business. While it may be possible to prevent use of food crops for bio-fuel within national borders, it is difficult to effect the same for food crops sold abroad because the buyers may not reveal before-hand what the end product and use will be. Attractive prices may incentivize increased sales of food crops without regards to the end use/product.

Most feedstock production competes for the same natural resources used for food production thereby putting upward pressure on food prices even if the feed stock (such as jatropha curcas) itself is not edible.

(xii) Risks with Jatropha

Jatropha which appears to be a commonly referred to fuel crop is not known well enough, especially its characteristics and the technology involved. It is understood to have carcinogenic properties which would demand very careful handling. Further, although it is claimed to grow in marginal lands with little rainfall, economies of scale required in commercial production of bio-fuels are compelling investors to seek to make it financially viable by growing it in fertile land and applying irrigation to achieve high enough yields – Bio-shape's jatropha project in Kilwa is a case in point.

(xiii) Environmental aspects

The search for renewable energy sources is prompted by the fear of the eventual depletion of fossil fuel reserves and the desire to have sustainable sources of energy, while the introduction of bio-fuels is assumed to satisfy both the sustainability and the environmental requirements. The latter is based on the assessment of direct emissions from use of bio-fuels. If consideration of the entire bio-fuel production cycle is made then it is observed that it entails land-use changes which release enormous carbon emissions hitherto stored in the destroyed vegetation cover and peat. In other words, production of energy crops leads to destruction of forests, wetlands, grasslands and peat-land that store enormous carbon as depicted in Figure 10.1. It has been reported, for instance, that Indonesia and Brazil have bulldozed and burned so much wilderness to grow palm-oil and sugar-cane, respectively that they now rank among the top world's carbon emitters (Time Magazine, 2008). It is worth noting that deforestation already accounts for about 20% of all current carbon emissions, but more vegetation

and peat that store loads of carbon is yet to be torn down to grow crops which store much less carbon.

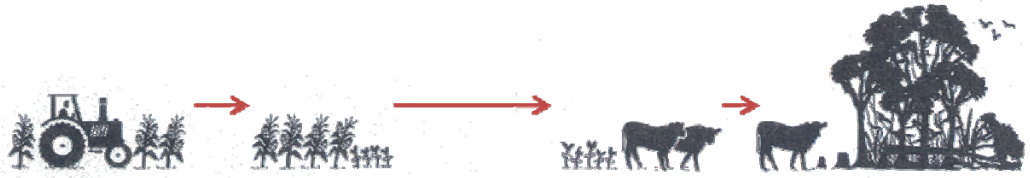


Figure 10.1: Possible effects of energy crop farming on deforestation and destruction of carbon sink. (Time Magazine, 2008)

(xiv) Political, economic and social pressures

The forces which bio-fuels have unleashed politically, economically and socially are too powerful to constrain. Very sober minds are required to manage the situation rationally.

10.3 Managing Risks during Implementation

Implementation of large-scale bio-fuel production has started with the acquisition of chunks of land, and establishment of pilot farms and nurseries. It is not enough to have sound instruments in place rather the same have to be put to proper use during implementation. This entails that all relevant parties play their part.

(i) The Role of the Government, Local and Central, and the Investors / Developers

The role of the government, local and central, is to facilitate and promote socio-economic growth for its people through provision of enabling environment by way of appropriate policies, laws, regulations and guidelines. The government also has the duty to protect weaker members of the society from being exploited. Relevant government bodies have to properly implement policies and enforce laws and thereby guard national interests. If the government and its various departments and agencies do not properly discharge their responsibilities implementation of large-scale bio-fuel production may not benefit the nation to the extent desired.

Investors and developers have a duty to abide by the rules of the game, observe human rights, and not to exploit the ignorance and poverty of Tanzania in their relentless pursuit of profits and business prosperity.

(ii) Institutional Framework for Bio-fuel Development

It is necessary to have an institutional framework to coordinate the roles of the various players, streamline and harmonize implementation strategies and processes. Fragmentation, disharmony, and lack of coordination provide excellent environment for flouting of procedures. In this regards either an existing body like EWURA should have its mandate extended to include regulation of large-scale bio-fuel production in the country, or a separate body should be created for the purpose. Since in the course of implementing large scale bio-fuel production a lot of data and information will be generated, such a body should establish and maintain a data/information bank on bio-fuels. It should also be responsible for institutionalizing benefit sharing schemes in respect of large-scale bio-fuel production.

(iii) Displacement, re-settlement and loss of land property/assets

As has been observed acquisition of large chunks of land for bio-fuel farming is resulting in the displacement of villagers. Displaced people should be handled humanely, promptly re-settled and adequately compensated for their lost property and assets. Where feedstock farms tend to block access to essential spots of value to communities, ways (e.g. corridor, road, etc.) should be provided to ensure free access to the same.

(iv) Contract farming for out-growers

Evidence from Kilombero in Morogoro has revealed the need to provide a mechanism for assisting out-growers from being exploited through unfair contracts. Poorly crafted contracts and poor negotiation skills can lead to conflicts and disharmony during the implementation phase. Training and empowerment of communities and nationals generally, with requisite knowledge and access to funds, is essential for averting such problems. There is also need to institutionalize procedures and processes related to contract farming for out-growers – they should not be left to the dictates of investors and/developers.

(v) Community engagement and facilitation

Large-scale bio-fuel production penetrates deep into communities, displacing some of them and disrupting others. The impacts on the communities are bound to be many and varied. It is, thus, important that the communities are engaged and properly facilitated to participate in the development. Such engagement will enable participatory handling of negative impacts where and when they occur, and impart a sense of ownership of the development among members of the community. Community engagement will also facilitate smooth handling of land issues and related dispute settlement. Communities

can very effectively be used to safe-guard of national interests, provided they are properly informed, sensitized and motivated.

11.0 EMERGING ISSUES, SUMMARY AND CONCLUSION

The presentations contained here are a witness of the situation analysis pertaining to Tanzania initiatives in entering into large bio-fuel production. It has been prompted, partly due to government targeting biofuel for substitution in energy budgets for transport, as a consequence of concern about high oil prices and promise of rural development, export expectations and contribute to mitigate climate change. Alongside these promised basics, the study underscores the status quo on the validity of debate on biofuels effectiveness to climate change mitigation, the contribution to fear on food price increases and the socio/environmental effect.
The emerging issues are a consequence of the outcome from the exploratory issues of concerns in the teams' presentations. It gives a summary and conclusion of the major observations encountered during our study.

11.1 Emerging Issues

(i) Impact of spread of biofuel for poorer groups

The team is of the opinion that the impacts of the spread of biofuels on land access for poorer groups are likely to be the same to those generated by the spread of other cash crops in the past. The biofuels shall be of more debatable nature as it is both on cash crops and energy sectors. It is for this reason that the product is attracting more Government attention and is being given specific consumption targets. Such a phenomena is likely to create an artificial demand not seen before among cash crops, and which is likely to persist beyond the commodity boom cycle of about 15 to 20 years.

(ii) Favouring switch to biofuels

The group sees the possible precursors warranting for biofuel investment as;

(a) Energy security
With oil increasing prices and future supplies uncertain, Tanzania like many other countries is seeking alternative energy sources to increase long-term energy security and reduce energy import bills.

(b) Rural development
A new and profitable land use will provide better opportunities and long-term security for farmers and employees, plus – if processing facilities are near to farms – for value-addition to profit rural areas.

(c) Export development

Tanzania may rest to benefit for new export markets and improve the trade balance when engaged in biofuels.

(iii) Food security and land access

Biofuels production may offer income-generation opportunities in rural areas. It may offer an opportunity for farmers traditionally squeezed by low agricultural prices to get better terms of trade. However, biofuels production may compete with food crops and bring significant negative impacts on food security. High food prices may have adverse effects on access to food for poorer and more vulnerable groups.

Policy and market inducements to turn land over to biofuels production will tend to raise land values. This could give new opportunities to poor farmers, as well as providing grounds for displacement of poorer people from land. As biofuels begin to push up prices of food and people are hence most in need of land for production, poor people's access to that land is liable to be at stake.

(iv) Misnomer for available and idle land

The majority of visited villagers admits that the Government promise was for biofuels feedstock crops to be grown on idle and marginal lands. It is also a fact that the Governments have claimed that significant land areas are under-utilized and available for biofuel production. This fact is not true as depicted in the text.

Growing evidence raises doubts about the concept of "idle" land. In many cases, lands perceived to be "idle", "under-utilised", "marginal" or "abandoned" by government and investors is vital for the livelihoods of indigenous people. In our study, an area identified for sugar cane plantations in Bagamoyo was in use for rice production by thousands of smallholders.

(v) Increased land demand

Increasing demand for land for biofuels is on the making as a result in changes to land access for poor people through linkages that involve land use change to biofuels crop production from other uses, and linkages that involve changes in land use triggered by biofuels expansion elsewhere.

(vi) Community displacement

At Bagamoyo, SEKAB a Swedish investor has obtained large tract of land (22,000 ha) in the Wami Basin, one of the country's major wetlands to plant sugar cane for ethanol. Various other proposed or ongoing land allocations for jatropha and oil palm cultivation, including various combinations of plantations and outgrowers, have been reported from different parts of the country, involving investors from Sweden, the United Kingdom, Germany, Malaysia and other countries. Some large-scale biofuel cultivation may be associated with significant negative impacts on land access for local groups. For example, jatropha project in the Kisarawe district is reported to involve acquiring land which is a home to poor indigenous people.

(vii) Disrespect for existing land rights

The team notes that the investment in large biofuel has repression displacement inclination of locals who do not have access to pertinent information. In the worse case scenarios, the loss of land rights culminate. These issues are associated to, among other things, to the weak protection of local land rights.

Issues of tenure security for local land rights are even more important where legal protection of these rights is subordinated to the fulfilment of productive use requirements and where legislation or administrative practice provide no clear definition of what productive use might be. This is even more so as biofuels may be seen as more productive than existing forms of local land use. Certain forms of resources are particularly vulnerable to this possession, such as pastoralism.

(viii) The role of investment center

The governments have established an investment center, TIC, for attracting investment, particularly foreign investment, including the biofuels sector. The center, among other facilitation enable land access for prospective investors and have exercised a direct role in identifying and providing land to investors, as well as with helping investors obtain all necessary permits in allocating land to investors. However, there is discontent in transaction due to allegations that the compensation offered to villages is inadequate.

(ix) Technology development against land tenure

Technology is developing fast, the state of the art today may be an obsolete technology in a near future. Ethanol technology from sugar cane may soon compete with cellulose from hydrolysis technology in probably twenty years to come. Another candidacy for the same is seaweed.

Based on above information and with more inventions developments to come, less land may be required for production of biofuels. Consequently production biofuels for export may be less attractive due to additional transport cost to European Union and other countries favouring biofuels produced in their own countries. There is no guarantee that land allocated for biofuel production today will be used for the same after twenty years. Therefore, land tenure of 99 years seems to be long. A periodic renewal should be considered as a sustainable option.

(x) Value addition of raw materials

There is an expertise threshold to cater for biofuel production and processing needs. Local processing adds value, provides jobs, provide taxes, and by-products can be used as animal feed and fertiliser. Unfortunately, there are investors whose business plans include transportation of raw materials (oil seeds) for processing abroad. Such exercise deprives the nation the benefits accruing from value addition. A policy is needed to maximize benefits from biofuel industry by encouraging value addition instead of exporting raw biofuel feedstock.

(xi) Change of land use and land use plans

The team is reporting to observe the harvesting of natural resources in the areas the investors had applied to engage in biofuel activities. It should be noted and put in perspective that this should have been part of the original agreement. In addition, there have been instances where the investors' request for land had exceeded the original planned available village land for agriculture or related use.

(xii) Conflicts and bio fuel production

The team noted the emerging conflicts of the nature listed below and described in detail in the preceding chapters.

(a) Land conflicts
(b) water use conflicts
(c) Pollution/environmental concern

11.2 Summary and Conclusions

Summary 1: Sustainability

The biofuel initiatives in Tanzania calls for a harmonious relationship between local community and investors coupled to awareness creation at all levels on land and investment laws related to biofuel production for an everlasting sustainability of the initiatives.

Conclusion

Based on the above, it is imperative to sensitize for awareness and involve in all processes those in the biofuel investments.

Summary 2: Transparency dealings

Lack of compliance with relevant applicable provisions of the law and non-involvement of community create unnecessary frictions. It is therefore concluded that the following should be observed.

(i) Avoid local community displacement
(ii) Ensure land allocation in accordance to land plan and land use
(iii) Adhere to standing laws and regulations pertaining to investments related to land use
(iv) Judicious in anticipation of resource utilization such as river banks, water resources, environment

Conclusion

The TIC should involve villagers in the allocation of potential lands to investors for biofuel production.

Summary 3: Weak legislative framework

The current government legislative framework governing biofuel production is weak. The misconception of the lack of a legislative and policy framework has led into investors grabbing land, especially village lands, on this pretext. At the same time, it is noted that the Governments effort to put in place guidelines related to the large scale biofuel farming in Tanzania has taken unnecessarily too long and without addressing land compensation and readily available model bylaws.

Conclusion

The government should oversee the enforcement of the provisions of the legislation framework law on biofuel production. This should be in addition to ensure that a National guidelines for sustainable production of biofuels is in place to carter for the already approved developments and be periodically amended. The guidelines should also address the following:

(i) Land compensation should be defined
(ii) Local communities should be informed of projects and should be involved in negotiations
(iii) Provision of model bylaws for villagers to adopt and apply

The team realizes that the desire to engage in biofuel by the Government, Social groups, Private groups and Investors is overwhelmingly. It is imperative that the solutions to obstacles that might lead to such a realization are sought in a sober manner. When this is attained the following are definitely un-restrictively obtainable:

(a) Smallholders can use and consolidate their land access through seizing the opportunities offered by biofuel feedstock cultivation for: income generation or energy self-sufficiency.

(b) Large-scale and small-scale biofuels production can co-exist and even work together in synergy to maximise positive outcomes for mutual development and secure land rights for smallholders can provide an asset in their negotiations with larger players.

Summary 4: Safeguards of local rights

Procedures for accessing land may perform a useful role in establishing safeguards for local land rights. These safeguards aim to ensure that, at a minimum, local groups are not arbitrarily dispossessed of their land as this is made available to investors without adequate compensation. In addition, there are no established mechanisms to monitor compliance with the agreement on the part of the investor especially in respect to other resources on the invested land. No effective sanctions exist in case of non-compliance – there are no effects on the concession.

Conclusion

Governments need to develop robust safeguards in procedures to allocate land to large-scale biofuel feedstock production where they are lacking and – even more importantly – to implement these effectively. Safeguards include clear procedures and standards for local consultation and attainment of prior informed consent, mechanisms for appeal and arbitration, and periodic review. Safeguards should be applicable across agricultural and land use sectors rather than specific to biofuels, to enable due process for both the direct impacts of biofuels crops and the indirect effects (displacement of non-biofuels crops from other farming areas by biofuels).

Summary 5: A strategic business models

A compelling strategy for securing land access for small-scale farmers is to facilitate their direct engagement in and benefit from the biofuels industry. Economies of scale in production, transport and processing will favour extensive cultivation, even for those feedstocks that have high labour demands. Even so, appropriate policy incentives can promote inclusion of small-scale operations on an economically viable basis. Possible business models are extremely varied.

Conclusion

Large-scale privately owned plantations are not the only economically viable model for biofuels feedstock production. Producers' associations, governments and investors may want to explore alternative business models such as joint equity in production and processing. Policy instruments based on financial incentives can help provide for inclusion of small-scale producers in the biofuels industry.

Summary 6: Sound policy

Land access for rural people requires policy attention in the broader circumstances that determine land use and agricultural economics. Relevant policy areas include taxation and subsidies, regional and international trade, and standards for environment and labour.

Conclusion

Local, national and international NGOs and civil society organisations have a continued role to play in holding governments and industry to account regarding their promises on protection of land access and food security to specific communities and more generally.

12.0 RECOMMENDATIONS

12.1 General Recommendations

(1) On land allocation for bio fuel production

It is strongly recommended that allocation of more land for bio fuel should be stopped until conducive conditions have been put in place for sustainable bio fuel production.

(2) On land allocation processes

Villagers should be empowered and facilitated to effectively participate.

(3) On land allocation to households for agricultural purposes

At least 50% of the village land should be set aside for household agricultural needs before considering allocating any land to investors

(4) On type of bio fuel feedstock to be produced

Government through it various institutions should play a pro-active role in deciding which feedstock should be produced and where

(5) On EIA process and credibility

A more inclusive and transparent process need to be put in place to ensure credible EIA due to capacity problems by NEMC. Furthermore, the government should make a concerted effort in strengthening the capacity of NEMC in order for it to perform its duties more effectively and efficiently.

(6) On nature of community involvement and benefit through land ownership and partnership arrangements

More capacity building and awareness raising needs to be done countrywide so that communities make informed and decisions.

(7) On value of land to include natural resources

Valuation and inclusion of non market environmental values to total values (costs and benefits) during feasibility assessment of any bio fuel project.

(8) Environmental conservation

Reserved and protected areas need to be left out from any other activities including biofuel production.

(9) On production and processing of biofuels

Value addition should be done locally. Regulations should be clear on this so as to benefit the country through job creation and capital accumulation through investment. Furthermore, this will facilitate technological transfer to the host country.

(10) Clarity and enforcement of regulations on natural resource utilisation

Government should move to prevent abuse of investment intended uses e.g change of land use from previously intended investment or activity.

(11) Land use plans should be adhered to

For example, land allocated for food crops production should not be used for other purposes.

(12) On suitable Bio fuel crop varieties

Agricultural research institutes should conduct research so as to identify suitable bio fuel crop varieties that will maximize yield and also develop appropriate agronomic packages that will minimize soil erosion and soil & water pollution.

(13) On food security

Village by-laws should be adjusted to require that biofuel out-growers allocate part of their land for food production so as to ensure food security. Where appropriate intercropping of bio fuel with other crops and crop rotation should be practiced to improve soil fertility and to reduce pests so as to increase crop yields

12.2 Recommendations for Bio-fuel Guidelines/Policy

12.2.1 On Land Issues

i) Land allocation for large-scale bio-fuel production should be suspended until the legal instruments, and other conducive conditions are in place.
ii) No land should be allocated from villages without land use plans.

i) Land allocation should take into account village land requirements for the lease period, factoring in technological advancement (in agriculture).

ii) Because technology is changing very fast, land tenures of 33, 66 and 99 years are not justifiable. Flexible short renewable periods of not more than 20 years (lease period) depending on type of feedstock should be adopted.

iii) Use of land by villages/villagers as equity for bio-fuel investment should be encouraged.

iv) There should be deliberate efforts to create awareness of villagers on land issues.

v) There should be a resettlement policy for affected communities, to take care of livelihood.

vi) In assessing the economic value of land all tangibles and intangibles which are lost when the land use is changed should be considered. Valuation should include non market environmental values (costs and benefits) during feasibility assessment of any bio fuel project.

vii) Existing legislations on land issues should be properly enforced to avoid deviation from intended land use. For example, land allocated for food crops production should not be used for other purposes.

12.2.2 Participation by Locals/Tanzanians

i) There should be a deliberate policy to accommodate participation of Tanzanians in the bio-fuel industry by setting a minimum percentage of investment by nationals.

ii) Communities within close proximity of a bio-fuel project should be entitled to benefit through contract farming.

iii) All investors should be encouraged to adopt an out grower system.

iv) Villagers should be empowered and facilitated to effectively participate in bio-fuel related activities.

12.2.3 Benefit Sharing

i) Tanzania should have a share of the carbon credit (of at least 50%) accruing from the bio-fuel business.
ii) A framework for benefit sharing schemes should be developed for adoption by all investors.

12.2.4 Environmental Issues

i) Bio-fuel activities should not be allowed to destroy important natural vegetation sites, biodiversity rich areas, wildlife corridors/migration routes, breeding areas, and other reserved and protected areas.
ii) A more inclusive and transparent process needs to be put in place to ensure credibility of the EIA process, and NEMC should be strengthened to enable it perform its duties more effectively and efficiently.
iii) Registration of EIA experts should be introduced by NEMC, and EIA should be done only by such registered and accredited experts in the relevant field.
iv) Public hearing should be mandatory for all EIA reports.
v) Regulations on utilization of natural resources should be made known and properly enforced.

12.2.5 Value-addition and Capacity Building

i) Legislation should require all raw materials to be value-added before export, so as to benefit the country through employment creation and capital accumulation, arising from investments, facilitate technological transfer.
ii) Investors should be required to participate in related capacity building efforts for the country.
iii) Investors should be required to utilize local R&D institutions fully for solving technological problems before seeking such services from similar institutions abroad.
iv) More capacity building and awareness creation needs to be done countrywide so that communities are properly equipped to make informed and decisions.
v) R&D institutions should carry out research to identify suitable bio-fuel crop varieties that will maximize yield, and develop appropriate agronomic packages that will minimize soil erosion and soil-water pollution.

12.2.6 Institutional Framework, Coordination and Strategic Handling of Bio-fuels

i) Instruments in form of land use plans, guidelines, policy, laws and regulations, and standards for bio-fuels should be developed and operationalized as a matter of urgency.
ii) There should be established a coordinating body with ToR to coordinate all bio-fuel related aspects, monitor and regulate the development and implementation bio-fuel projects, and safe-guard national interests. Alternatively, an appropriate existing institution may be assigned the coordination, monitoring and regulation functions related to bio-fuels.
iii) Certificates of commencement in respect of bio-fuel projects should only be issued to investors after it has been certified that all compensations, resettlements and EIAs have been properly and credibly executed. The bio-fuel coordinating body, referred to in ii) above (not TIC) should be assigned to so certify and issue the certificate of commencement.

12.2.7 Human Rights and Corporate Social Responsibility

i) Bio-fuel investment should be prohibited from dehumanizing or exploiting labour, and deploying child labour.
ii) Bio-fuel producers should be encouraged to produce food crops on their land as part of corporate social responsibility, to avoid food shortage.

12.2.8 Food Security vis-à-vis Energy Security

i) At least 50% of the village land should be set aside for household agricultural needs before considering allocating any land to investors.
ii) Government through its various institutions should play a pro-active role in deciding which feedstock should be produced and where.
iii) Village by-laws should be put in place that will require bio fuel out-growers to allocate part of their land for food production so as to ensure food security.
iv) Where appropriate inter-cropping of bio fuel with other crops and crop rotation should be practiced to improve soil fertility and to reduce pests so as to increase crop yields.

12.2.9 Others

i) Bio-fuel production should first saturate local markets before export is considered, *to minimize consumption of what is not produced locally*.
ii) International conventions/protocols of which Tanzania is a party should be respected by all parties.

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APPENDIX

Response Matrix on SEKAB's Comments on the Report

S/N	SEKAB Comments/Observations	Consultancy response
(1)	The objective of the report is however not well understood by us.	The general objective of the report has no ambiguity and is clearly stated in sub-section 1.1.3 on page 2 of the report thus; "*Generally, to examine the current bio-fuel production and trade dynamics in relation to economic, social, technical and environmental implications as well as* ***the potential that Tanzania holds in this arena***". The report is anchored on this general objective.
(2)	(i) While the title leads you to believe that the report will give a view of the feasibility of biofuel production in Tanzania, the report itself is more of an assessment of on-going projects and analysis of assumptions of the future. (ii) SEKAB BioEnergy Ltd therefore feels that the report has missed its objective as understood by us – to analyse the feasibility of large scale biofuel production in Tanzania.	This confusion should not be there considering response (1) above and taking into account the various issues addressed to achieve the general objective. Specifically, the report looked at: a) Ongoing bio-fuel production activities; important areas of enquiry being: *vii. Major bio-fuel crops grown in Tanzania;* *viii. Current production systems - their characteristics and implications (incl. agronomic, environmental, social, economic, technological, legal aspects);* *ix. Who, where and how much is produced;* *x. Costs and benefits of bio-fuel production;* *xi. Institution framework affecting bio-fuel production; and* *xii. Conflicts between bio-fuel production and other land-use systems.* b) Planned bio-fuel production activities *vi. Resource availability for large scale bio-fuel production (land, water, human capital, technology).* *vii. Research and development capacity status for bio-fuels.* *viii. Trade participation, marketing and market access situation.* *ix. Potential risks of production and processing bio-fuels.*

S/N	SEKAB Comments/Observations	Consultancy response
		x. Potential conflicts and possible resolutions. Essentially b) above is addressing the implications of large-scale production with respect to various key feasibility related aspects – thereby addressing SEKAB's comment (2)(ii).
(3)	Independently of focus, we were however expecting the three universities to carry out an independent and objective analysis.	The three universities carried out an independent and very objective analysis supported by empirical evidence and data derived from interview respondents and own observations, documents from district and regional offices, among others, which are very clearly shown in the report. In this respect, the validity of the analysis is undeniably legitimate. Furthermore, the EIA Reports from Bioshape and SEKAB provided very useful inputs.
(4)	The report has a number of valuable analyses, which will no doubt inform policy making by the Government of Tanzania as well as other actors active in the sector. These chapters are however mixed with many subjective statements and assumptions which analyse a worst case scenario and ignore the other side.	The report has objectively brought out what feasibility of large-scale biofuel production should entail by clearly indicating what should be acceptable/allowed and what should not be allowed. This includes the awkward procedure of obtaining land for planting irrigated sugarcane before ascertaining the availability of adequate water supply for the intended and other uses! In Chapter 9, the report has brought out both the tangible and intangible benefits large-scale biofuel production could provide to the country and the communities around the production sites. Since SEKAB has not identified any factual mis-representations, subjective statements or omissions in their comments, the study report remains guided by its objectives and maintains its conclusions and recommendations.
(5)	While this (report) gives a good overview of possible risks included in biofuel production, it also gives the reader an impression that a lot of this has already happened and/or that the	The report has identified possible risks of large scale biofuel production so as to properly inform the decision making process about what is at stake. Section 1.2.2 and Table 1.2 of the report provide details of current biofuel production initiatives in Tanzania and their status. The report is therefore very clear about what has already happened and what is in the

S/N	SEKAB Comments/Observations	Consultancy response
	worst case scenario is the only scenario.	offing. The report has analysed the cost-benefit of the 'with project' and 'without project' scenarios in Chapter 9, and within each scenario various options have been analysed.
(6)	Obviously, it would have been more beneficial if the report also would have viewed the possibilities of biofuel developments as an opportunity to enhance rural and social development.	Section 8.1 looks at biofuel as a viable alternative to petroleum or fossil fuel generally – and hence as an opportunity. In Chapter 9 the cost-benefit analysis looks at both the local (including rural communities) and national levels. But the report goes beyond to analyse what should be in place for the opportunity to make sense and be realizable, in the short-term, medium term and long-term. Hence the need to consider such other aspects as: land-use plans, the environment, food security, legal aspects, and various technical issues including processing, value-addition, waste management, human capital, R&D infrastructure and capacity, etc
(7)	By choosing to focus on risks at the expense of opportunities, the report is of limited use in the development of sustainable biofuel production.	It is the quest for sustainable development which makes it necessary to carry out a thorough risk analysis. It actually begins with the appreciation that there is an opportunity, which is then followed up by determination of what harnessing of such an opportunity entails.
(8)	SEKAB BioEnergy Tanzania feels there is an enormous opportunity for Tanzania to develop its agricultural and rural development potential by using biofuels as the catalyst for poverty reduction through large scale rural investments. Such a scenario requires that all stakeholders, government, universities, NGOs and	The study which has culminated in the report has involved all stakeholders, including villagers. Mere mention of the existence of potential for poverty reduction is not enough, rather it has to be proved beyond doubt that the potential can be harnessed – and that is what the report has endeavoured to do.

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S/N	SEKAB Comments/Observations	Consultancy response
	private sector to work together to develop this opportunity. These discussions are present in the report but only to a limited degree. Consequently, the poverty reduction potential of rural developments is limited in this report.	
(9)	We look forward to a constructive dialogue how this enormous industry potential can be harnessed for the benefit of all – local communities, government and investor.	This is welcome and the issues raised in the report should form the basis for such a dialogue, if indeed it is to be constructive. The recent global economic realities including the dramatic plunge in fossil fuel prices makes it necessary to re-evaluate the urgency for large-scale biofuel production in Tanzania.