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Biofuel development initiatives in Tanzania: development activities, scales of production and conditions for implementation and utilization

Michael Martin [a,*], Agnes G. Mwakaje [b,1], Mats Eklund [a,2]

[a] Environmental Technology and Management, Linköping University, SE-581 83 Linköping, Sweden
[b] Institute of Resource Assessment, University of Dar es Salaam, P.O. Box 35097, Dar es Salaam, Tanzania

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ABSTRACT

In recent years biofuel activities have increased dramatically in Africa. Simultaneously biofuels have become popular for fuel alternatives and criticism in the media. Nonetheless biofuel initiatives are taking place on different scales. A depiction of several of these activities has been produced through descriptions and categorization based on scale, distribution and implementation. These initiatives exist due to a complex interaction of social and technical factors which have influenced their success for being introduced, and continues to influence the scale on which they exist and what will happen to them in the future. Conditions for implementation are furthermore explored regarding legislation, use of biofuels, environmental sustainability and the production of a new energy system in Tanzania.

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1. Introduction

Tanzania is a land of great expectations in view of investors and biofuel[3] producers, both on paper and in many presentations regarding its potential to supply the global market with biofuels. Enticements such as an abundance of arable land, workers and stable political climate are bringing investors in to supplement the foreign and local demand for a renewable energy source.

At present a large portion, over 90%, of rural families in Tanzania rely on biomass and wood as their domestic fuel. Fuels such as kerosene, electricity and gas are primarily too costly, unavailable or simply unreliable for employment. Additionally, deforestation and health problems associated with wood stoves are continuing environmental problems in Tanzania [1,2].

Regionally, biofuels could alleviate and supplement requirements for domestic and transportation fuel. The local demand for fuel and the expenditure for importing oil continue to hamper national economic development [3,4]. From 2003 to 2005 fuel imports nationwide increased from $400.3 million USD to $1.1 billion USD. Moreover, the country's demand and the price for petroleum products are growing rapidly at a rate of more than 30% per year [4].

Currently the potential for biofuel production in Tanzania has remained relatively unexploited although speculation in the various feedstocks and debates on the potential continue, as the world looks toward Africa as a source for renewable energy of the future. Crops such as jatropha, sugarcane, palm oil, coconut and others have gained the attention of biofuel investors. However, while scientists are pondering, initiatives for biofuel developments are being taken in Tanzania on a number of scales. These range from simple biogas technology to large scale jatropha and sugarcane plantations. Many of these are in their infancy, although plans for expansion exist [1–4].

2. Objectives

This paper aims to add to the available literature on the development of biofuels in Tanzania through a review of current biofuel initiatives[4] in Tanzania. This will be done by reviewing the development projects based on their characteristics, distribution, entrance into the market and future outlook. Moreover, the paper shall review the conditions required for the implementation of biofuels in Tanzania and review how biofuels are being used, and could be used in the future regionally.

* Corresponding author. Tel.: +46 13 28 11 32.
E-mail addresses: michael.martin@liu.se (M. Martin), amwakaje@usdm.ac.tz (A.G. Mwakaje), mats.eklund@liu.se (M. Eklund).
[1] Tel.: +255 222 410 144.
[2] Tel.: +46 13 28 17 26.

[3] Biofuel refers to biologically based fuels produced from wastes and biomass, i.e. biodiesel, bioethanol and biogas. In Tanzania, straight vegetable oil is also used as a diesel alternative and can be included therefore as a biofuel in this context. Wood and other biomass are not included as biofuels in this paper.

[4] *Initiatives* will be used in subsequent text to refer to recent biofuel projects and developments.

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Specifically the report aims at the following;

- Provide a description of the current biofuel initiatives in Tanzania
- Describe the range of scales on which the development of biofuels is being undertaken and where each scale is headed
- Review the conditions required for implementation of the projects and concerns related to biofuel developments
- Display different forms of employment for biofuels regionally.

3. Method

The research commenced with a literature review of available information on the development of biofuels and current initiatives for Tanzania and Africa. Sources for information ranged from scientific articles to company reports. Thereafter media coverage of biofuel activities, both in Africa and Tanzania, were reviewed due to the sparse amount of scientific information currently available. The literature review was aimed at assessing the different sizes of biofuel initiatives, as well as the distribution and descriptions of these activities. This stage was important for the research in order to establish the amount of relevant data in this field. Consequently in the Spring of 2008 a three week research trip was conducted in Arusha and Dar es Salaam to review current biofuel production and market details in Tanzania. During the trip, interviews were conducted in order to gain further data on and details of the biofuel initiatives and the conditions required for their implementation.

3.1. Individual interviews

Individual interviews were conducted with relevant managers and directors for biofuel production initiatives in Tanzania. Participants were chosen from biofuel initiatives discovered during the literature review, but also included many interviews from information received once we arrived in Tanzania. These interviews were conducted through visits to their production facilities and personal interviews held on site. In some cases interviews were conducted by telephone when necessary. Interviews with biofuel development actors allowed us to give a descriptive account of activities in the area. Questions were posed in regard to current activities, future plans, incentives, barriers toward development and the destination of biofuels produced.

A number of interviews were also conducted with potential biofuel users and local development agencies. Safari companies, development agencies and mining companies were interviewed in order to better understand the conditions under which biofuels could be used for operational purposes. This was done in order to learn of new activities and to discover the need for biofuels in the region. Follow-up questions and discussions were conducted by email communication and phone interviews.

3.2. Focus group interview

Following the individual interviews, a focus group interview was conducted in order to learn about the conditions for the implementation of biofuel initiatives in Tanzania in relation to sustainable development. Participants for the session were chosen from the ranks of academia and industry consultants in order to give a representative view of the initiatives in place and those being planned in a manner that would be independent of the biofuel development actors themselves. Botanists, energy specialists, resource specialists and consultants for sustainable development were invited to take part in the focus group interview. Additional information regarding the issues, current status and further activities in Tanzania was also gained. Open ended research questions for the session were discussed to discover how Tanzanians perceive feedstocks, biofuel investors, incentives, current research activities and factors influencing the success of regional biofuel activities.

3.3. Data organization and categorization

Once the interviews had been held, transcriptions and reviews of notes from meetings were analyzed to yield qualitative and quantitative data. Supplementary information was received through follow-up questions by telephone and email. Additionally, an opportunity to review the information noted was also given to each company interviewed in order to ensure the quality of data and that our information did not infringe upon interviewees' proprietary information.

Upon review of the main data and the information provided by the literature review and interviews, the data was structured and organized based upon the type and size of each activity. It became apparent that the biofuel activities could be categorized based upon the scale of production as well as their output or estimated output. The scales ranged from micro to large scale activities. Details and features pertaining to the range of scales of biofuel development will be specified further in each category in subsequent sections.

Information and data are categorized based upon biofuel development scales, distribution and commencement and future plans. After the categorization, the conditions for implementation required were then reviewed further to discern what barriers to and opportunities for biofuels and a new energy system in Tanzania existed. These were organized into themes concerning trust and cooperation, legislation and environmental sustainability.

4. Results

4.1. Information on biofuel initiatives in Tanzania

From the literature review it became apparent that there was a limited amount of information available concerning biofuel development in Tanzania. Moreover, most of the scientific information regarding biofuel development referred to potential, energy planning and future predictions or compares Tanzania with other African countries. Generally the information available is at present over a decade old [4–8].

Information available in Tanzania is commonly spread by word of mouth or through media publications; thus many activities are not publicized. It can be noted that a large number of biofuel projects are in place, especially biogas digesters for cooking and heating purposes which are accounted for in only a few reports [1,5]. Biofuel activities are discovered primarily through media publications and biofuel actor websites. Information about these activities is scarce nonetheless and deals primarily with debate articles on large scale biofuel plantations and country politics [9–12].

Subsequently the information received from interviews and the research trip revealed many details on biofuel development in Tanzania including different initiatives, scales of these activities, the distribution of biofuel initiatives, implementation and conditions for biofuel developments for successful introduction in Tanzania.

4.2. Scales of biofuel initiatives

Existing biofuel companies, and those interested in producing biofuels, exist on a whole range of scales for biofuel development. The following sections provide an overview of the scales of existing biofuel initiatives in Tanzania in order to provide details for each scale as well as an example of a typical initiative for the respective scale.

The descriptions and examples detailed in the subsequent text include some of the activities that are currently going on officially in Tanzania. Many of these developments have been registered with the Tanzanian Investment Centre and have offices and activities in Tanzania. Several of these exist in Dar es Salaam, while others are present in their respective production regions [13].

4.2.1. Micro scale

Micro scale production of biofuels exists throughout Tanzania as a means to help satisfy energy demand and to provide clean-burning cooking fuel. Throughout Tanzania, several actors are working to promote special crops and processes to better the lives of Tanzanian villagers, generally in the form of biogas and jatropha oil development. Micro scale developments exist primarily as a medium to deliver energy and electricity and become self sustaining.

In this context micro scale can be described as encompassing the following characteristics;

- Very small intercropped farms up to 200 ha
- Supplementing fuel supply on a micro scale (one facility, etc.)
- Localized employment of fuel
- Generators for electricity
- Farm based vehicle fuel
- No expectation to expand or market.

Micro scale biofuel activities are abundant in Tanzania, especially for biogas applications to provide fuel for clean-burning cooking stoves. Much of the biogas produced is done from livestock wastes and seedcakes. Already by 1992 over 560 biogas processors had been installed nationwide in Tanzania and the number continues to grow [14]. At present there are roughly 1000 biogas plants being installed throughout the country by companies such as KAKUTE Ltd., Karatu Development Association, the Danish Environment and Development Organization (Eco-Net) and many others [14–16].

4.2.2. Small scale development

Recently Tanzania has seen the introduction of small scale biofuel development projects. Many of these are in their initial stages and are run by foreign investors, primarily European. However, as sustainability issues are very important, outgrower schemes and sustainable farming are becoming drivers for business. Many farms throughout Tanzania are thus growing *jatropha curcas*[5] as a way to grow cash crops for biofuel development projects. Small scale development in biofuels exists in Tanzania on a limited basis. This scale of production can be viewed as a springboard toward medium scale development.

Small scale development, in this context, can be described as having the following qualities;

- Small farms (200–2000 ha)
- Intercropping with current farm products
- Straight Vegetable Oil (SVO) used for energy and vehicle fuel locally
- Plans for further expansion and market growth.

An interesting example of a small scale development comes not from a biofuel company, but a mining company. Barrick Gold Mining Corporation and Export Trading Company Limited in the Shinyanga and Mara Regions have partnered and implemented a jatropha plantation for biodiesel production. The plantation was set up to produce jatropha oil on exhausted land damaged by their mining activities. At present the existing plantation is around 11 ha and is used primarily as a clone bank to support plans for outgrowers and larger areas of jatropha [17]. As a large consumer of fossil diesel fuel for their open pit mining activities in Tanzania, Barrick views the opportunity of producing biodiesel from jatropha as a means to supplement their fossil fuel consumption and become more environmentally benign in the process. This will be done by sustaining a 10% blend of biodiesel.

Barrick also views an opportunity in improving community relations through the use of its ex-mine site by the locals as a knowledge center for jatropha. The site will house the nursery, small plantation and mini-refinery as a means of encouraging the community and to raise awareness of the potential of jatropha oil as an energy source [17]. Along with the small plantation, in the near future another 300 ha will be planted. The goal is to have around 1500 ha of outgrowers producing around 20,000 l of biodiesel daily. A production machine with a capacity of 800 l per day has been purchased and is prepared to begin producing high quality biodiesel for Barrick Gold Tanzania.

4.2.3. Medium scale development

The most prevalent form of biofuel initiatives existing in Tanzania are currently the medium scale developments. These medium scaled initiatives have commenced or established a biofuel feedstock market, with development and growth on the horizon. Currently these actors do not produce liquid biofuel (in the form of biodiesel) although they have converted their fleets to run on straight jatropha oil, otherwise known as SVO. Current practices are primarily focused on, for example, collecting jatropha seeds from small scale intercropped farms in order to produce oil for biodiesel processing.

The development of biofuels in Tanzania can thus be classified as medium scale whenever it meets the following criteria;

- Medium sized farms ranging in size from 2000 to 50,000 ha
- Batch production
- Outgrower schemes
- Purchase of biodiesel production equipment
- Plans to expand operations and market biofuels.

Diligent Tanzania Limited, a medium scaled renewable energy company of Dutch origin, has been a key player in Tanzania for the promotion and production of jatropha for many years. Diligent Tanzania Limited is located in Arusha, but their activities stretch to a much larger area of Tanzania and Africa. Diligent currently has over 1500 outgrowers which receive free seeds and knowledge for the production of jatropha seeds. Each of these outgrowers receives a 10 year contract for seed purchasing from Diligent to ensure jatropha does not end up as a failed cash crop, similar to coffee from years past [18–20].

An estimated 1.5 million liters of biodiesel per year are in the plans for Diligent Tanzania. This can be exported to the European market duty free. Currently the goal is simply to obtain over 100 ton of jatropha seeds a year to process them into fuel. By continued support and contracts with farmers, Diligent will be looking for expanding operations and larger holds of jatropha seeds from the outgrower schemes they have established and adding new farmers to the family in the future [19,20].

4.2.4. Large scale development

Many potential projects are being planned in Tanzania in order to meet fuel demands from the rest of the world. These come in the form of large scale plantations for ethanol and biodiesel, from

[5] *Jatropha curcas* will be referred to as simply jatropha in the remainder of the text.

a number of feedstocks, e.g. palm, jatropha and sugarcane. As with medium scale developments, these organizations are not producing biofuels commercially and are only in their infancy at the time being. Nonetheless, expectations and plans are grand, as large scale biofuel production in Tanzania looks to provide alternative energy sources for Tanzania and the rest of the world. Undoubtedly the biofuel projects most closely scrutinized in the media are those taking the form of large scale projects due to their impact on the surrounding environment.

Development of biofuels in Tanzania can be classified as large scale sector-wide, whenever it displays the following criteria;

- Large/several plantations exceeding 50,000 ha [20]
- Industrial activities
- Plans to meet future blending quotas for Tanzania and export abroad especially to European markets.

SEKAB BioEnergy Tanzania Ltd and Sun Biofuels are two large scale biofuel initiatives in Tanzania. SEKAB plans for large sugarcane plantations, analogous to Brazil, for the production of liquid ethanol. Sun Biofuels, in contrast, will produce biodiesel from large plantations of jatropha. These two projects will produce biofuels to be exported to the European market after meeting local demands.

In order to demonstrate the feasibility of bioethanol production, a pilot project is currently being developed at the Razaba Farm in the Bagamoyo district. This project aims to develop the model for future projects, demonstrating the commercial viability of bioethanol production if done in a way that is sustainable, both socially and technologically. Land preparation and planting are currently being conducted, and the factory is set to be in operation by the year 2010–2011 [20,21].

Once the pilot project is completed, additional land acquired and ethanol production proven to work, a cluster of the Bagamoyo model project will be developed in the Rufiji and Kilwa districts as well. Overall, the project will have a number of production units throughout the plantations for the estimated 200,000 ha of land under sugarcane. Each of the production units will handle around 20,000 ha of sugarcane and employ a number of local workers. Employment will consist of around 30,000 direct jobs. Furthermore, the cluster of plantations is estimated to produce around 2 billion liters of bioethanol and coproduce an estimated 2 TWh of electricity from the combustion of bagasse [20,22].

Sun Biofuels is currently active in Ethiopia where they have established a number of nurseries and are beginning their plantations. Sun Biofuels currently has not established a plantation or nursery in Tanzania, although they have recently acquired 8000 ha near Mtamba. Biodiesel will be produced from the jatropha oil from the large plantations. Further plantations will also expand as nurseries become established in Tanzania [9,20].

4.3. The distribution and commencement of biofuel initiatives

Biofuel initiatives in Tanzania are spread throughout the country. Fig. 1 provides an overview of many of these initiatives. Most of the biofuel initiatives are located in climatically favourable areas with rich biodiversity, natural forests and indigenous trees and are near to the coast with access to harbours or good infrastructural capacity. Those initiatives located deeper into the landscape tend to be primarily smaller scaled and aimed at self sufficient biofuel production measures [4,13–22].

Viewing the entrance of a selected few initiatives into the market in Tables 1 and 2, one can see that most biofuel activities in Tanzania (i.e. medium and large scale) have only recently been established. Only smaller scale developments (i.e. micro and small scales) have existed in Tanzania since the 1990s due to the initiative of development organizations and Tanzanian organizations in the form of intercropping to produce jatropha and biogas technologies for rural villagers. The table also shows that the primary feedstock is overwhelmingly concentrated on jatropha production [1,4,13–22].

5. Implementation of biofuel initiatives

Questions and concerns arose during the focus group interview from the structured questions, many of which centred around presented topics, although new comments were brought forward as well. Table 3 provides a review of the concerns, key statements and further comments provided during the focus group interview.

According to the focus group participants biofuel development projects in Tanzania display a number of key factors reflecting defined incentives. These range from giving farmers more power and incentives for investment companies to build up infrastructural capacity where resources are to be extracted and used. One major factor in the success of biofuel development projects in Tanzania concerned legislation and the control of projects, i.e. the need for a structured biofuel policy. Finally, Tanzanians are concerned about their resources and the sustainability of projects in the long term, including issues such as the monoculture of jatropha and the integration of different crops to improve success rates and output.

6. Discussion

6.1. Scales of biofuel initiatives and characteristics

The scale at which biofuel production initiatives exist can give information regarding the conditions and characteristics for immediate implementation as well as future ambitions. Initiatives also display characteristic distributions throughout the country and result from interaction with public and private actors.

6.1.1. Micro and small scale initiatives

Micro and small scale biofuel initiatives exist in Tanzania to promote renewable energy to alleviate the energy needs of villages and operations. They have arisen as responses to problems involving current infrastructure, deforestation, high energy prices and the limited availability of other fuels. Initiatives such as that of Barrick Gold have been started in order to supplement diesel fuel imports, and thus their scale will grow as more fuel is required.

Interestingly, these initiatives are located in the more remote areas of the country. Access to infrastructure has thus resulted in provisions being taken with renewable energy for energy security at these sites, where other forms of energy are difficult to obtain. Most interaction between micro/small initiatives and the public involves mainly the rural population, and thus enables these initiatives to quickly spread throughout the country. Furthermore, these initiatives have been around in Tanzania since the 1990s.

6.1.2. Medium and large scale initiatives

Conversely, large scale biofuel developments in Tanzania are owned by foreign investors, primarily European. Characteristically the intentions are to export the biofuels abroad. Nonetheless, many of these companies intend to fulfil local requirements prior to exportation, as there is an undeniable regional demand for fuels. Certainly markets exist both regionally in Tanzania and abroad.

The distribution of these initiatives reflects their export potential and market share. Large scale biofuel initiatives, as stated previously, are located in climatically favourable lands close to river basins and good infrastructural capabilities. Furthermore, many of these locations are near the larger cities in Tanzania, offering biofuels for use in transport, cooking, etc. However, the location on these favourable lands raises concerns about environmental and biodiversity degradation.

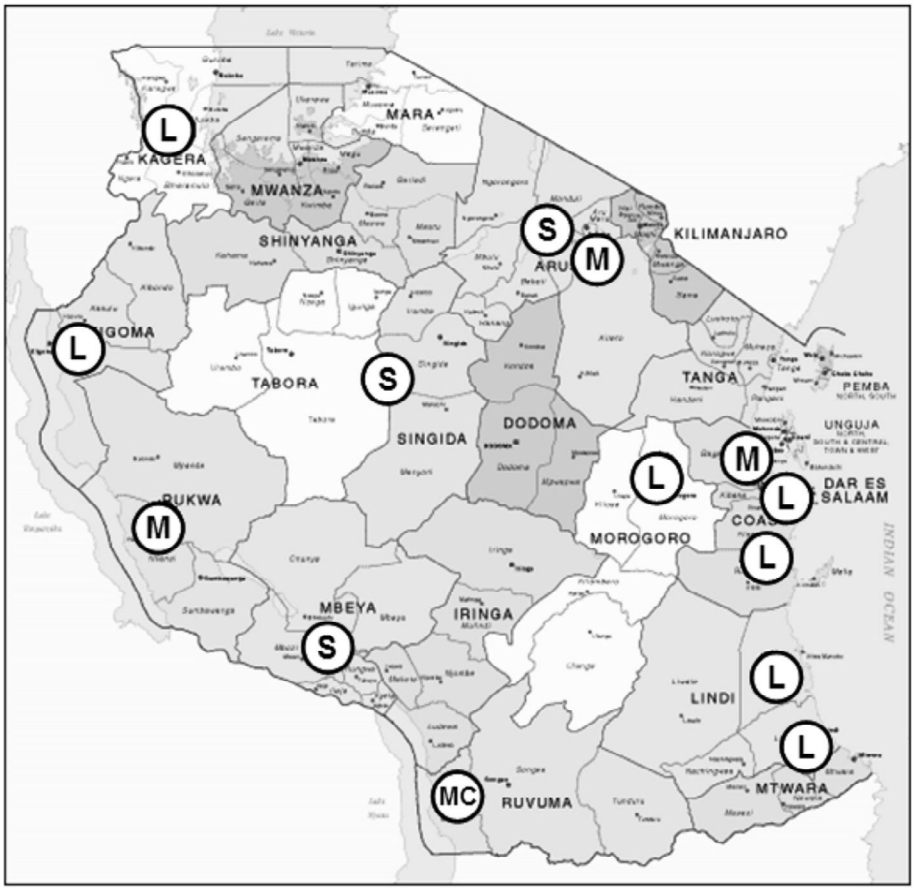


Fig. 1. Biofuel development initiatives in Tanzania*. MC-Micro Scale, S-Small Scale, M-Medium Scale, L-Large Scale. *Excluding Biogas Projects.

Interaction of large scale biofuel production initiatives ranges from public to private actors, although governmental bodies are also involved in regulating these initiatives. Land issues and contracts with rural populations are of primary concern for these initiatives. Once underway, these initiatives will deeply affect the lives of those in the area, and must ensure environmental sustainability and social responsibility for the sites chosen.

6.2. Regional use of biofuels

Due to the current interest in the production and use of biofuels, this renewable energy source offers a potential fuel for transport, cooking and electricity production in Tanzania regionally. Although it is not commonly used throughout the country, initiatives exist and are underway which could help the sustainable development of Tanzania and alleviation of poverty through the use of a regional renewable energy source.

Under the revised Petroleum Act and given a sufficient supply of biofuels, the government can set blending ratios and targets to use biofuels in the current transport fuel infrastructure [25]. At present there is neither production nor use of biofuels for transportation in Tanzania. However, initiatives for using biofuels have been started at the local level by companies such as Diligent and the Tanzania Traditional Energy Development and Environment Organization (TaTEDO). Biofuels such as biodiesel seem to be a solution for Tanzania. Nearly, 50 percent of all fuel sold in Tanzania in 2003 was diesel fuel. Moreover, blending programs would also benefit from the addition of ethanol [4,12,26,27].

Rural electrification has been a serious challenge for the Tanzanian government ever since the country attained its independence, and could comprise an additional use for biofuels. Because of the high poverty levels the private sector has been reluctant to invest in rural areas due to the uncertainties in recovering its investments. However, with biofuels developments, some of these challenges

Table 1
Biofuel production activity categorization.

Biofuel production activity scale	Size	Production of biofuels	Future plans	Biofuel market
Micro scale	0–200 ha	Biogas and oils	No future expansion	Self sustaining energy concepts for heating, cooking and electricity
Small scale	200–2000 ha	Production of oils and biogas	Used locally but also possible expansion and marketing	Self sustaining energy crops for cooking, heating and use in vehicles
Medium Scale	2000–50,000 ha	Production of raw materials and plan for biofuel production	Expansion and marketing planned	Self sustaining energy crops used in vehicles and expansion to local market
Large scale	Exceeding 50,000 ha	Developing biofuel plantations	Expansion and marketing of biofuels planned	Biofuels used for local market and export

Table 2
Market entrance and feedstock for typical biofuel development initiatives.

Scale	Year	Feedstock
Micro	1993	Organic wastes
	2006	Jatropha
Small	1995	Jatropha
	2007	Jatropha
Medium	2003	Jatropha
	2006	Jatropha
Large	2007	Sugarcane
	2007	Jatropha

could be addressed. TaTEDO is the pioneer in promoting the Multifunctional Platform (MFP). MFP, in this regard, is a diesel engine generator that can power different tools. TaTEDO has installed three MFPs thus far powered by jatropha oil in two villages in the Monduli and Meru Districts. In these villages the MFPs are powering milling machines, about 100 households and 22 enterprises, e.g. shops. The villagers pay 3000 TZS per month for four hours of lighting per day and small enterprises pay around 7000[6] TZS [20]. Normally villagers sell jatropha seeds to the MFP operators for oil extraction at a farm gate price of between TZS 120–150 per kilogram [23,24].

Biofuels may also play an important role in cooking applications. Moto Poa Company Ltd. produces ethanol jelly for cooking, and markets it throughout the Dar es Salaam Region. The currently company imports all its ethanol from South Africa. Daily, the production of ethanol jelly fuel is about 2000 ton. At present, the company is operating below capacity due to the low demand of the fuel. There are also initiatives for using jatropha for cooking. This is piloted by using Protos stoves; research and testing are being done on the KAKUTE JPTL stove prototypes in collaboration with the University of Dar es Salaam. Moreover, Diligent in 2007 constructed a 60 m^3 biogas plant that is used for cooking for about 500 workers at a flower farm located adjacent to the Diligent office [15,16,20].

6.3. Conditions for the implementation of biofuel initiatives

In the development of a new energy system, technology is not the only important factor; in Tanzania development is governed to a large extent by social and cultural contexts as well. However, demand and technology from foreign investors have driven the biofuel initiatives forward, although certain conditions must be met in order to provide a successful system. The recent influx of biofuel investments into Tanzania and the surge in the use of biofuels have thus raised concerns both in society and academia. Although some of the companies are looking to promote Tanzanian interests in becoming self sufficient in energy, others are looking to export resources abroad. Stakeholders from all arenas must work toward making sure biofuels will be produced sustainably through their involvement in the passage of legislation governing biofuel production and regional infrastructure capacity [28].

6.3.1. Trust and cooperation

Biofuel production exists in Tanzania due to foreign initiatives, particularly ones from European countries. However, large scale plantations and development projects may not run as well as investors are used to. Biofuel initiatives in Tanzania should serve Tanzanian interests and allow for direct involvement from a number of regional actors.

It has been reported that if biofuel projects are to succeed, one must have a very well informed individual involved, i.e. a local Tanzanian who knows his/her way around as regards the law [29,30]. Trust is major issue in development projects in developing countries such as Tanzania, and it impacts the success of projects on different levels. Understanding these concerns and the "economy of affection" is key to success and keeping business ties with Tanzanians intact [31].

Cash cropping and resource exploitation are also of concern to locals. Past examples of cash crops and market uncertainty, such as the earlier coffee programs, have resulted in reluctance to trust a novel crop. Future market prices and contracts for pricing on deliveries are of concern to farmers growing biofuel feedstocks such as jatropha [32].

Smaller scale biofuel developments have been started quite successfully by directly interacting with farmers and villagers, without encroaching upon their livelihoods or land. These projects have also delivered rapid results, which are trusted more locally. In order to appeal to those whose land will be intercropped, direct benefits and profits must be realized. Therefore, biofuel developments and aid organizations have given farmers the necessary knowledge and incentives, i.e. contracts, to allow for as little risk as possible.

Larger scale activities are currently being criticized by foreign and local journalists, and are rumoured to extend into village land with ensuing evictions from plots and farms [12,26]. Rumours and news like this can spread quickly throughout the villages and could make land leasing difficult for biofuel companies later on. Thus, trust must be established and incentives and risks clearly made understandable. Trust is a concern that Tanzanians can develop if allowed inspection and deeper knowledge of such projects.

6.3.2. Biofuel legislation and the task force

Tanzania is currently awaiting the introduction of a policy directly dealing with biofuels. To facilitate this process, with support from the Swedish Energy Agency, Tanzania began its National Biofuel Task Force (NBTF) in order to promote the development of biofuels and to develop legislation, policies and regulations for this recent market. It has been recognized that without a biofuels policy, incentives, tax concerns, etc. will not be documented, thus making the risks for biofuel developments very high. These risks include not only those incurred on investors, but also regional sustainable development concerns [33].

The development of such a policy is not a simple task. The process requires interaction with national and international leadership to balance the interests of citizens, manufacturers, consumers, environmental non-government organizations and many more interests groups [34]. Currently, however, no biofuel policy or laws related to biofuel developments are in place. Without such a document, officials are currently sorting through applications and granting permission for land and biofuel development projects on an *ad hoc* or even arbitrary basis. At present, due to the influx of biofuel investors into Tanzania with large scale ambitions, caution has been warranted, and the process of granting permission and rights has been "bottlenecked" and initiatives are being turned away. Moreover, the NBTF is being blamed for not having true representation even within the country. Most of the members are drawn from the government departments. It is suggested that to have a wide representation, the NBTF should also include academic and research institutions, private sector and non-governmental organizations [20].

The taxation of fossil fuels must also be part of the future legislation, as it is a very important source of revenue for developing countries such as Tanzania. It is estimated that in developing countries, this figure is around 20–25% of the national tax revenue

[6] $1 USD = 1331 TZS (10 April 2009).

Table 3
Review of common themes and concerns at the focus group interview.

General concern/question	Key factors/needs	Further comments
Barriers to biofuel development	• Infrastructure • Investments • Knowledge	• Developments occur where feasible • Not much investment • Public is not knowledgeable about biofuels • Inadequate awareness of costs and benefits of biofuels development among the communities
Incentives and Legislation needed for biofuel development	• More push from the Biofuels Task Force • Subsidies to farmers • Pressure to make a change	• Questionable what the Task Force is producing • Farmers should be given incentives • There should be a need to change
Raw materials for biofuel production	• Jatropha • Safflower • Anything non-edible • Sugarcane	• Should not just focus on one crop/monoculture • Jatropha not proven on large scale • Research underway on mapping oil seed plants • Avoid food crops to be used for bio-energy,
Factors for success of biofuel developments in Tanzania	• Farmers need incentives • Infrastructure must become be invested in • Win-Win Situation • The biofuel developments should be in the form of shareholding where farmers land contribution should be regarded as there contribution.	• Farmers are not only "pickers" • Tanzania must benefit from foreign knowledge • Prevent farmers from selling their land instead use land for shareholding in the investments
Influx of investors for biofuel development projects	• Too much land is promised for development of biofuel projects • Are these companies "sustainable?" • A hot issue at the moment and lots of investors from abroad	• A large portion of the available land is already being claimed by biofuel development projects • Currently a lot of investors which may "bottleneck" the process of applications and development
Resource use conflict	• Most of the investments are taking place in rich biodiversity and indigenous resources. • Land for food crops are converted to biofuel production	• Encourage investors to invest in marginal areas by improving infrastructures. • Minimize arable land for biofuel production • Promote more waste and non-edible crops for biofuel
Environment degradation	• Too much irrigation and chemical inputs	• Encourage organic farming • Price water and land to reflect scarcity • Internalize all environment costs

[3]. Promotion of biofuels therefore might offer some concerns, as increased use of biofuels could reduce tax revenues. This is assuming that common incentives such as blending quotas and tax exemptions are applied to promote the use of biofuels. As biofuels become more accepted and popular, this issue should be addressed and further research should be conducted in order to fully understand how to best deal with revenues and exemptions. Peters and Thielmann [3] argue that taxation on fuels is relatively easy and people do not react directly to changes in the rates. If this argument is true, biofuel taxation could become a reality, as production costs become lower and become more competitive with fossil fuels.

6.3.3. Environmental sustainability and monoculture

While the literature indicates that biofuels can grow well even in marginal areas, e.g. in the semi-arid areas of central Tanzania, many developers are not investing in these areas. There is a concern that if this trend is not checked, it could jeopardize the whole purpose of biofuel promotion as a strategy toward enhancing clean energy production as well as environmental conservation. Discussion with some investors shows that they favour such areas because of the water availability there and the relatively well developed infrastructure capacity [20]. A sustainable biofuel policy could reduce the competition between cultivating for fuel and cultivating for food purposes.

A concern was also raised during the focus group interview about large scale monoculture and a casting a blind eye toward other crops. As mentioned previously, with few exceptions, the majority of biofuel development projects in Tanzania rely on jatropha plantations for biofuel production. Moreover the environmental impact might rise as biofuel plantations increase in size and quantity. These could come in the form of increased use of pesticides and biodiversity loss along river sheds. In the Kilwa District in South East Tanzania, for example, natural forests have been cleared to pave way for bio-energy projects. Labour concerns and land development are also questioned [20,35,36]. Presently a large percentage of the available arable land in Tanzania is being appropriated in the many applications for biofuel projects. Tanzanian officials must ensure that biofuel developments and plantations will not interfere with villages, food crops and the arable land used for grazing. The task is time-consuming, but to insure the welfare of Tanzania to the fullest extent such a policy must be in place [33].

7. Conclusions

The aim of the preceding research paper was to describe the current biofuel developments in Tanzania, which are organized in scales, and to determine motivations, issues and future projections for these developments. From the text it can be concluded that biofuel developments indeed exist in Tanzania on a number of scales, although they are in their infancy.

Currently, there is a great deal of optimism that biofuels will reduce the burden of importing fossil fuels, enhance environmental conservation and improve livelihoods as well as alleviate poverty. However, knowledge transfer to the public is necessary in order to bring forward the potential and wide spread application. As seen in the text, this may be done best by using small scale initiatives due to the current legislation and conditions. Small scale initiatives could reduce some of the challenges of rural electrification, which the country has been facing since independence. It will also deliver fuel for other purposes, such as cooking, and could therefore reduce

deforestation and the health problems associated with indoor biomass burning.

Examples such as that of Barrick Gold Tanzania offer insight into becoming self sufficient and reducing imports of oil. Such best practice should be used as a model for other developers, especially those in the mining sector, which not only consume a great deal of energy but whose activities also impose a great deal of degradation on the environment.

Many conditions must be met before biofuels can become a future renewable energy source for Tanzania. In particular, a biofuel policy must be established with guidelines for future developments, as investments are expanding rapidly. By doing so, many of the issues related to environmental pressures, land conflicts and trust may be overcome. The pace at which investments have come in the last few years warrants the added attention and caution from Tanzanian officials nevertheless. Furthermore, the establishment and success of biofuel initiatives depends on a complex relationship of social and technological factors which must be met by both public and private actors. Through cooperation and mutual understanding, biofuels may become a relevant renewable energy source for Tanzania's future, both regionally and for export.

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