

BIOENERGY FOR SUSTAINABLE DEVELOPMENT IN AFRICA – ENVIRONMENTAL AND SOCIAL ASPECTS

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ABSTRACT: The agricultural sector in most Sub-Saharan countries is dominated by subsistence farming with very low investment levels and yields. The development of modern bioenergy systems offers opportunities for investment and infrastructure improvements in agriculture with the promise to diversify agricultural production and thus to stimulate socio-economic development. In general, many African countries have suitable conditions for bioenergy development such as abundant labour and sufficient available arable land and water resources. However, in order to avoid potential negative environmental and socio-economic impacts, effective mechanisms to ensure sustainability need to be put in place. Several Sub-Saharan African countries are currently engaged in the formulation of policies and development plans to guide the development and ensure the sustainability of the bioenergy sector. In order to ensure food security of the population, African governments have implemented several initiatives such as agro-ecological zoning to identify land available for food and for bioenergy production and mandates for investors to use part of the allocated land to food production.

The project COMPETE (Competence Platform on Energy Crop and Agroforestry Systems - Africa) provides support for policy development in African countries through the organisation of policy workshops and the development of policy recommendation documents such as the *COMPETE Declaration on Sustainable Bioenergy for Africa*. This declaration highlights the African approach to sustainable bioenergy identifying *visions for bioenergy development in Africa, favourable market creation and land use strategies, as well as initiatives for capacity building*.

Keywords: developing countries, bio-energy policy, energy crops, liquid biofuels, sustainable use of biomass

1 INTRODUCTION

In Sub-Sahara Africa today the large majority of the population, especially in rural areas, depends on traditional biomass for cooking and heating [1]. This situation is not likely to change and it is estimated that in 2030 more than 700 million people will rely on traditional biomass such as firewood, charcoal, agricultural residues as well as human and animal waste [2]. In many regions traditional biomass resources are readily available for the local population. Their production and use, however, causes a variety of negative impacts including overuse of natural resources leading to deforestation and health effects due to Indoor Air Pollution (IAP) disproportionately affecting women and children in the poor areas of developing countries [3].

The agricultural sector in most Sub-Saharan African countries is dominated by subsistence farming with associated very low investment levels and yields as compared to developed countries. The development of modern bioenergy systems therefore offers opportunities for investment and infrastructure improvements in agriculture with the promise to diversify agricultural

production and thus to stimulate socio-economic development. Thereby, in Africa today the main focus of bioenergy development is placed on liquid biofuels (plant oil, biodiesel, bioethanol) as transport fuel and for rural electrification initiatives.

In addition, drivers for bioenergy development in Africa include security of energy supply, a reduction of the foreign exchange burden of oil importing countries, as well as environmental benefits such as alleviating desertification and reducing greenhouse gas (GHG) emissions.

The overall prospects for bioenergy development in Africa are good, as a number of studies have estimated a large resource base for the supply of biomass for energy highlighting large areas of 'unused potential agricultural land' in Africa (750 Mha) [4]. Smeets and Faaij predicted for Africa that between 41 and 410 EJ of energy could come from biomass by 2050, with the upper estimate equivalent to current total global primary energy consumption [5].

On the other hand, concerns exist that bioenergy (biofuels) expansion may have severe negative impacts on biodiversity and the use of natural resources through

increasing competition over land and water resources. Furthermore, rising prices of agricultural commodities will negatively affect food security of the poor in developing countries and the implementation of large-scale bioenergy projects may cause negative social impacts such as displacement of rural communities.

It is thus of crucial importance that policies and development plans are implemented in African countries to ensure environmentally, economically and socially sustainable bioenergy production. These policies shall aim at mobilising the benefits offered by bioenergy feedstock production to reverse the long-term decline in real agricultural commodity prices and to boost agricultural and rural development. Thereby, effective mechanisms to ensure sustainability need to be put in place and safety nets need to be established to protect the world's poorest and most vulnerable people to ensure their access to adequate food [6].

A variety of Sub-Saharan African countries are currently engaged in the formulation of appropriate policies and implementation strategies on how to ensure sustainable bioenergy applications for economic development (see section 5 of this paper). The project COMPETE (see section 2) is providing support for these policy developments through the organisation of policy workshops with representation of policymakers from African countries and the development of policy recommendation documents highlighting the African approach to sustainable bioenergy.

2 THE COMPETE PROJECT

2.1 COMPETE objectives

The objective of the Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa (COMPETE) is to stimulate sustainable bioenergy implementation in Africa [7,8,9]. COMPETE has established a platform for policy dialogue and capacity building in the major multi- and bi-lateral funding organisations and key stakeholders throughout the bioenergy provision and supply chains. The COMPETE project is co-funded by the European Commission in the 6th Framework Programme – Specific Measures in Support of International Cooperation for the period January 2007 until December 2009 [10,11].

COMPETE will carry out a comprehensive, multi-disciplinary, assessment of current land use, energy demand and technology innovation focused on Africa to identify pathways for the sustainable provision of bioenergy, which will:

- improve the quality of life and create alternative means of income for rural populations in Africa
- aid the preservation of the critical functions of arid and semi-arid regions in Africa as intact ecosystems
- enhance the equitable exchange of knowledge between EU and developing countries

2.2 COMPETE activities

COMPETE delivers a matrix of multi-disciplinary and cross-sectoral work-packages, to:

- provide an evaluation of current and future potential for the sustainable provision of

bioenergy in Africa in comparison with existing land use patterns and technologies

- facilitate South-South technology and information exchange capitalising the world-leading RD&D in bioenergy in the key countries Brazil, Mexico, India, China and Thailand
- develop innovative tools for the provision of financing for national bioenergy programmes and local bioenergy projects, including: carbon credits, bilateral and multi-lateral funding instruments, and the role of international trade
- develop practical, targeted and efficient policy mechanisms for the development of bioenergy systems that enhance local value-added, assist local communities and address gender inequalities
- establish the Competence Platform to ensure effective dissemination and knowledge exchange inside and outside the network

2.3 COMPETE partnership

The COMPETE partnership comprises 20 European and 23 non-European partners - 11 partners from 7 African countries, 3 regional African policy and financing bodies (African Development Bank; Food, Agriculture and Natural Resources Policy Analysis Network of Southern Africa; UEMOA - Biomass Energy Regional Program), 9 partners from Latin America and Asia - and the Food and Agriculture Organisation of the United Nations (FAO). Detailed information on COMPETE project partners is available at the website www.compete-bioafrica.net.



Figure 1: COMPETE logo

3 LAND AVAILABILITY IN AFRICA

In general it is emphasised by the majority of stakeholders from African countries that land availability is unlikely to be the limiting factor for bioenergy development in Africa. For example, in 2005 a study commissioned by the German Technical Cooperation estimated the available land for food and non-food production in Tanzania at more than 40 million ha [12].

This view is supported by a study estimating the global bioenergy production potential in 2050 for several agricultural investment levels [13]. Figure 2 shows that the modernisation of agricultural systems in Sub-Saharan Africa (from rain-fed, mixed animal production systems to irrigation systems with very high technology level and landless animal production) increases the bioenergy potential 10 fold to about 410 EJ per year. Furthermore, Hoogwijk et al. report that Africa has the potential to become an important producer and exporter of raw biomass produced on abandoned and rest land [14].

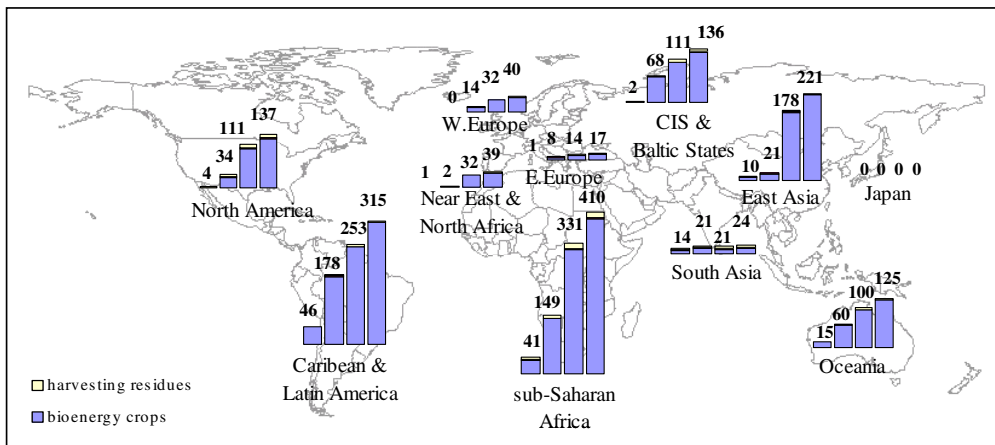


Figure 2: Bioenergy production potential in 2050 for different levels of change in agriculture and trade (EJ/yr) [13]

However, even though land is generally available for bioenergy production in Sub-Sahara Africa, the feasibility and sustainability of specific bioenergy projects need to be evaluated on a case by case basis, carefully taking into account local environmental constraints as well as potential competition over land and water resources. This will become increasingly important in the future in the light of natural resource limitation due to climate change and an expected population growth placing pressure on the supply of affordable and adequate food.

Furthermore, prevailing local land tenure systems need to be respected, displacements of local population avoided and actual benefits for rural communities ensured through employment and revenue creation.

As clearly indicated in Figure 2, an increase in investment in the agricultural sector can significantly enhance the production potential in many African countries. This may not only lead to increased bioenergy production, but also improve food supply if appropriate mechanisms are put in place by African governments to ensure sufficient production of food crops.

In this respect it is detrimental to limit bioenergy development in Africa to marginal and degraded land as currently proposed by some environmentalist groups. This will negatively influence the economic competitiveness of bioenergy production in Africa and block African countries from socio-economic development opportunities. On the other hand, bioenergy may play an important role in the rehabilitation of degraded lands. Due to the reduced economic viability of such projects, however, international financial support is required for the realisation of land rehabilitation efforts.

In the framework of the COMPETE project, land in semi arid and arid regions of Sub-Sahara Africa was identified where intensification of or conversion to bioenergy use will not have detrimental environmental and/or socio-economic impacts. For this, a wide range of Geographic Information System (GIS) data sets, FAO statistics and literature sources that categorise spatial and temporal variations in Africa's biophysiological parameters and anthropogenic activities were acquired, analyzed, and synthesized [15,16].

In Table 1 the identified available and suitable arid and semi arid land in the COMPETE study countries Senegal, Burkina Faso, Mali, Kenya, Tanzania, Zambia, Botswana, and South Africa is presented. The fraction of suitable and available arid and semi arid land varies between 15% for the Western African countries Senegal and Burkina Faso and more than 80% for Kenya.

Figure 3 shows suitable and available areas for bioenergy crops in arid and semi arid regions of Kenya. As a precaution against detrimental impacts on biodiversity, all categories of protected areas (International, Categories I-VI, Uncategorized), forests and wetlands were excluded. To safeguard food security, all areas under food and/or cash crop (herbaceous and woody) production were excluded. Finally, areas unsuitable because of severe water, terrain and soil constraints were also excluded.

For more details on land availability in arid and semi arid regions of African countries see the interactive maps presented at the COMPETE website at www.compete-bioafrica.net/current_land/current_land.html.

Table 1: Suitable and available areas for bioenergy crops in Sub-Sahara's arid/semi-arid regions

Country	Senegal	Burkina Faso	Mali	Kenya	Tanzania	Zambia	Botswana	South Africa
Total area km ²	196 013	272 339	1 252 281	581 871	941 375	751 920	587 337	1 221 361
Arid & semi-arid km ²	111 147	149 973	637 960	457 908	316 738	160 281	581 605	901 345
km ² arid & semi-arid available & suitable	15 783	22 756	192 438	379 698	147 252	67 383	291 860	722 874
% arid & semi-arid available & suitable	14	15	30	82	46	42	51	79

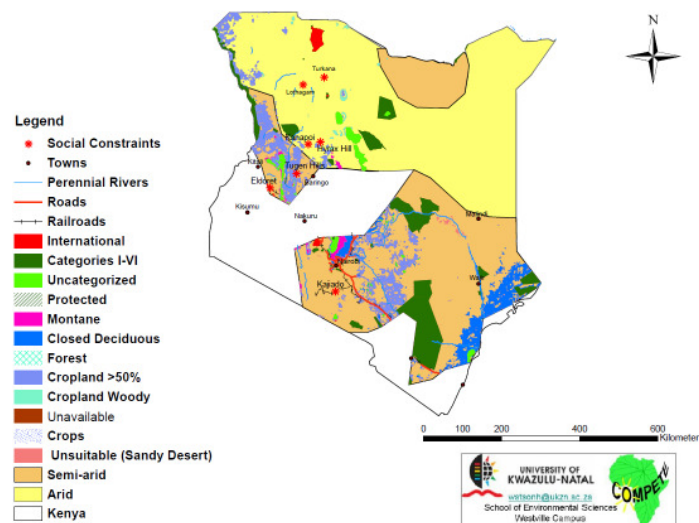


Figure 3: Suitable and available areas for bioenergy crops in arid and semi arid regions of Kenya

4 SUSTAINABILITY OF BIOENERGY IN AFRICA

In order to ensure sustainable bioenergy development in African countries it is essential for African societies and governments to identify a clear vision of the aims and objectives of bioenergy development and to enact effective policies and implementation strategies in order to realise this vision.

4.1 COMPETE Declaration on Sustainable Bioenergy for Africa

The COMPETE Conference and Policy Debate on 'Biofuels Sustainability Schemes - An African Perspective' on 16-18 June 2008 in Arusha, Tanzania, brought together more than 60 high-level participants including decision makers from several African countries. The main aim of this conference was to elaborate recommendations addressing the opportunities and challenges of global bioenergy development from an African Perspective. The *COMPETE Declaration on Sustainable Bioenergy for Africa* was elaborated in cooperation with high-level decision-makers from Kenya, Mozambique, Tanzania, Uganda, and Zambia [17].

The following five main topics were identified for the elaboration of suitable bioenergy policies and implementation strategies in Africa.

1) *Visions guiding policies for bioenergy development*

The following visions should provide the guiding principles for bioenergy policy development in African countries:

- Rural development and improved livelihoods for the rural population in African countries
- Increased energy access and income generation opportunities
- Sustainable large-scale production of biofuels involving communities, smallholders, co-operatives, local enterprises and foreign investors
- Modernisation of agricultural practices and sustainable soil and land management to exploit complementarities of food and bioenergy production

2) *Markets (local, national, international) for bioenergy development in Africa*

The following policy measures and principles for bioenergy market development should be implemented in African countries:

- Create policies and (technical) standards to facilitate and guide bioenergy market development in Africa (favour local over export markets in initial stages of market development)
- Give priority to small-scale projects and local markets (e.g. rural electrification, water pumping, transport fuels in agriculture)
- Then, explore export, global markets and large-scale projects
- In all cases, ensure value created for local farmers and rural development through local processing and value adding instead of exporting primary feedstock

3) *Development of Land Use Strategies*

The development of effective land use strategies (such as agro-ecological mapping and zoning initiatives) is an essential tool to avoid food-fuel conflicts and ensure food security AND bioenergy development in African countries through:

- Inclusion of bioenergy in national land use plans and regulations
- Zoning and identification of real potential of countries and regions to produce food, energy crops, materials and chemicals
- Mapping of indigenous land use practices (participatory mapping on grass-root level) in order to build bioenergy development on existing knowledge and practices
- Identification of appropriate use of land and water resources (with special focus on soil properties and environmental issues) with respect to the local needs of rural communities

4) Land tenure systems

Bioenergy development in Africa should take into account the prevailing land tenure systems in a way that creates benefits to local communities, especially the rural population. Land (ownership) is a sensitive issue in African countries and land ownership by foreign investors is restricted in many African countries.

- Concessions/ownership granted by national authorities for bioenergy projects focussing on rural and social development
- Avoid displacement of the rural population
- Avoid corruption regarding land use issues demonstrating transparency in all processes regarding land tenure

5) Capacity building and R&D

Capacity building of all stakeholders (decision-makers, farmers, extension services, technicians, scientists, researchers) as well as enhanced R&D activities are urgently needed to build-up the necessary human resources in African countries to ensure a sustainable bioenergy development. Fields of specific importance include:

- Knowledge on policies and implementation strategies and capacity to develop and implement clear strategies and regulations
- Agricultural and technical expertise, R&D on new crops and improved crop management systems (capacity building for farmers and extension workers)
- Scaling up of existing best practices in Africa

4.2 COMPETE Sustainability Guidelines

Based on the policy recommendations presented in section 4.1 the following 12 environmental, social, economic and policy related sustainability guidelines have been elaborated.

Environmental

- Good agro-ecological practices (biodiversity, soil)
- Not affecting water supply and quality
- No land use change that detrimentally affects food security

Social

- Community participation in planning
- Women's participation in planning
- Skills transfer

Economical

- Community inclusion in business models
- Added value in the community
- Improvement in services and infrastructure

Policy

- Compliance with national policies
- Compliance with local programmes or plans
- Respect land rights and avoid displacement

Bioenergy projects in Africa respecting these sustainability guidelines will be very likely to create opportunities for agricultural and rural development without causing unforeseen negative socio-economic impacts.

5 BIOENERGY POLICY INITIATIVES IN AFRICA

Currently, several African governments are in the process of developing bioenergy policies and implementation strategies with the aim to promote a truly sustainable development of the bioenergy sector.

5.1 Bioenergy policy in Mozambique

The Government of Mozambique is very actively encouraging the introduction of bioenergy (biofuels) in order to save foreign currency, to reduce environmental problems of the increasing transport sector, to reduce dependence on unpredictable and volatile world market oil prices and to contribute to rural development through generating employment and increasing income opportunities [18].

The main aim of bioenergy development in Mozambique is to foster large-scale production of biofuels for national consumption and exports. This shall be supported by the gradual introduction of biofuels blending with petrol and diesel starting with low blends of 5-10%. Furthermore, the Government of Mozambique supports biofuel based rural electrification projects and places high priority on increasing access to energy for the (rural) poor by promoting modern energy services such as Jatropha oil, gel-fuel and modern wood-stoves for lighting and cooking.

The conditions for the development of the bioenergy sector in Mozambique are favourable due to its suitable climate for the cultivation of sugar cane and other energy crops. Mozambique has 7 million ha of available arable land, abundant labour and water resources for the production of bioenergy without threatening food production and food security.

On 21 May 2009 the Government of Mozambique published a biofuels policy and strategy in its official journal [19]. This policy states the clear *vision to establish the country's biofuels sector to contribute to energy security and socio-economically sustainable development*. The institutional framework will include the creation of a National Programme for Biofuel Development to give financial support to activities and projects. Furthermore, a National Commission for Biofuels (CNB) will be set up to supervise the implementation of the biofuel strategy.

In order to establish a national market for biofuels in Mozambique a Biofuel Commercialisation Programme (PCB) will be established to purchase ethanol and biodiesel for blending with fossil fuels. With respect to biofuels export Mozambique will act as exporter of processed biofuels (i.e. biodiesel instead of vegetable oil) to enable local producers to add value to their production. It is expected that biofuel expansion (450.000 ha, compulsory blending of E10, B5) will generate substantial macroeconomic benefits including 150.000 new jobs.

Prior to the elaboration of the biofuels policy the Government of Mozambique has embarked in a detailed resource assessment and research on promising feedstock options. It was concluded that biofuel production in Mozambique shall be based on sugar cane and sweet sorghum for ethanol, and Jatropha curcas and coconuts for biodiesel.

Furthermore, the Government of Mozambique performed an agro-ecological zoning initiative to

specifically identify land available for food and for bioenergy production. The government will place strict limitations on land approval and it will identify selected agro-ecological areas for biofuel production which will be the only areas permitted for production. Thereby, guiding principles will be to avoid the use of basic food crops and monocultures, and to favour biofuel development that enhances biodiversity.

With the approach of agro-ecological zoning a potential conflict between food and fuel production can be avoided. It is now in the responsibility of the government to implement this land allocation method even though potential biofuel producers will be likely to object and challenge this limitation to their business development.

In order to ensure the environmental, economic and social sustainability of biofuels production, the policy states that all actors participating in the Biofuel Commercialisation Programme need to be certified to prove that their operations are in line with national norms and criteria. Priority is given to the development of a common approach to sustainability criteria in line with global initiatives such as the Round Table for Sustainable Biofuels (RSB) and the sustainability criteria included in the recently adopted European Renewable Energy Directive [20]. The Government of Mozambique has set up a Working Group within the national Biofuels Task Force to elaborate national sustainability principles. This initiative is supported by the bilateral SADC (Southern African Development Community) Programme for Biomass Energy Conservation (ProBEC) of the German Technical Cooperation (GTZ). First drafts of sustainability principles have already been elaborated [21].

Until today, 23 project applications for land approval have been submitted to the Government of which the following two have been approved and are currently under implementation:

- PROCANA, located in Massinger, Gaza province: 30.000 ha of land for sugar cane, production of 221 million litres of ethanol and 212 GWh electricity per year
- Principle Energy, Manica Province: 18.000 ha of land for sugar cane, production of 213 million litres of ethanol and 82.500 MWh electricity per year

In conclusion, Mozambique is among the leading countries regarding bioenergy development in Africa. The Government is taking active steps to implement policies and development plans with the aim to ensure environmentally, economically and socially sustainable bioenergy production.

5.2 Bioenergy policy in Tanzania

The *vision* set forth by the Government of Tanzania for the development of the bioenergy sector is to *contribute to the replacement of fossil transport fuels and to stimulate socio-economic development through rural electrification projects*. Benefits expected from the implementation of bioenergy projects are to improve energy security, reduce oil imports and foreign exchange burdens, as well as to provide alternative markets for farmers creating new jobs and income generation opportunities [22].

The conditions for the development of the bioenergy sector in Tanzania are favourable due to its suitable climate, as well as available arable land and water resources.

In 2005, the Government of Tanzania established a Biofuels Task Force under the lead of the Ministry of Energy and Minerals with the participation of a variety of government ministries and institutions. This Task Force has elaborated draft biofuel guidelines which aim at guiding the sector until policies, legislation and an institutional framework are in place.

These guidelines focus on ensuring socio-economic sustainability of bioenergy development, the avoidance of food-fuel conflicts, and sufficient value creation for the local rural population. Different land acquisition and tenure systems are introduced for bioenergy projects including shorter leasing periods of 5-25 years, the possibility to use land as equity, and mandatory villager shares in projects. Furthermore, investors will be required to use part of the land allocated for the production of food crops. Finally, contract farming, outgrower schemes and community engagement will be promoted, and Environmental and Social Impact Assessments (ESIA) will be required for the implementation of bioenergy projects.

As in the case of Mozambique, these measures are suitable to avoid conflict between food and fuel production. However, the Government of Tanzania will have to strictly implement these measures, if necessary against the pressure of biofuel investors.

Currently, the Government of Tanzania is engaged in the implementation of a Biofuels Action Plan including a thorough review of existing policies and legal and regulatory frameworks with the aim to develop new national bioenergy policies in the coming year. Furthermore, the action plan includes agro-ecological zoning of land available for bioenergy production, capacity building programmes for government departments and other stakeholders, as well as awareness creation initiatives for the population.

Today, several bioenergy projects are already under implementation or preparation in Tanzania. These projects include *Jatropha* plantations for biofuel production (managed by the German company Prokon in the Mpanda region and the Dutch company Diligent in the Arusha region) and for rural electrification within the framework of Multifunctional Platforms (MFP) (coordinated by the Tanzanian NGO TaTEDO). Furthermore, an oil palm project is implemented by the Tanzanian company FELISA in the Kigoma region and preparations were undertaken by the Swedish fuel supplier SEKAB to set up sugar cane plantations in the Bagamoyo region. The latter initiative, however, is currently under re-consideration (also due to sustainability concerns) and may not be realised.

Figure 4 shows regions of Tanzania where bioenergy projects are currently under implementation or preparation. Bioenergy feedstock includes *Jatropha*, sugar cane, oil palm, sunflower, and the indigenous tree *croton megalocarpus*.

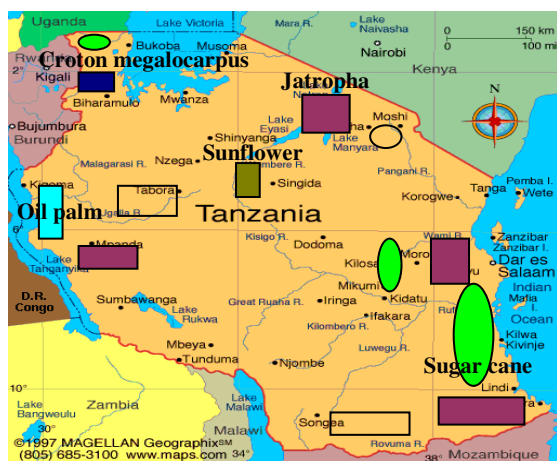


Figure 4: Areas currently under bioenergy development in Tanzania [22]

5.3 Bioenergy policy in Zambia

The *vision* of the Government of Zambia is to ensure environmentally sustainable exploitation of biomass resources in order to *realize supply security and stable prices of transport fuels, to increase investment in the agricultural sector and to contribute to socio-economic development*. Thereby, specific policy goals are to improve the management of woodlands for sustainable firewood production, to improve the efficiency of charcoal production, and to promote alternatives to firewood [23].

Activities under preparation by the Government of Zambia include the elaboration of appropriate financial and fiscal instruments for stimulating production and use of biomass, the implementation of public awareness campaigns, and the development of policies and a regulatory framework for biomass.

Also in Zambia the conditions for the development of the bioenergy sector are favourable. The current dependency of the country on food imports is mainly caused by the lack of infrastructure and investment in the agricultural sector. Therefore, bioenergy is seen as an excellent opportunity to significantly enhance the production potential of feedstock for both food and biomass production.

The Ministry of Energy and Water Development is elaborating a long-term Energy Strategy (2009 – 2030) that includes biofuels as priority sub-sector. Current policy measures include detailed assessments of available resources and market demand for bioenergy, the elaboration of an efficient legal and institutional framework, and the formulation of incentives to stimulate investments in the bioenergy sector.

So far, no specific initiatives have been implemented on how to guarantee socio-economic sustainability of bioenergy projects. In this field close cooperation with the Environmental Council is foreseen and Environmental and Social Impact Assessments (ESIA) will be required for bioenergy projects.

Further activities to ensure sustainability (such as measures under implementation in Mozambique and Tanzania) are thus urgently needed to provide guidance to the development of the bioenergy sector. This fact is underlined by the recent request to the Government of Zambia by a Chinese investor to allocate 2 million ha of land to Jatropha plantations for biofuels production.

On the other hand, also smaller scale bioenergy initiatives exist in Zambia which show better potential with regards to sustainability. The Zambian company Marli Investments initiated research on Jatropha in April 2003 and started planting in November 2004, using cuttings from a few existing Jatropha Curcas trees, seeds and seedlings. The company uses the outgrower model, starting with a few farmers in the Kasosolo settlement scheme in the central province of Zambia [24].

Currently, Marli Investments has distributed more than 12 million seedlings/seeds to outgrowers throughout Zambia. More than 25.000 outgrowers have joined the scheme with 12.000 ha under plantations and 6.500 ha in the seedling stage. The company provides capacity building and agronomic support through 100 Field Officers and 180 Coordinators working together with the outgrowers.

Seeds and training are provided free for farmers, and until today all Jatropha seed yields are used for the extension of plantations. Thereby, conflict between food and fuel production is avoided through the plantation of Jatropha on available additional land with no impact on existing food production.



Figure 5: Outgrower model for the production of Jatropha in Zambia [24]

The construction of a biodiesel pilot plant is foreseen in 2009. In order to ensure security of feedstock production and to provide a guaranteed market for outgrowers, production purchase agreements with farmers are signed with a duration of 30 years. Thereby, the price of Jatropha seeds will be calculated with a formula linked to the world oil price.

In order to establish the national market for the produced biodiesel, a blending mandate of biodiesel in diesel is currently under negotiation with the Government of Zambia. The larger scale biodiesel production under the outgrower scheme by Marli Investments is planned in 2011 with the construction of a 600.000 tons per year biodiesel production plant.

In conclusion, bioenergy projects based on the close involvement of local communities through outgrower schemes have the potential to contribute to socio-economic development in African countries by offering additional income opportunities for the rural population.

6 CONCLUSION

The development of modern bioenergy systems offers the opportunity for increased investments and improved infrastructure in the agricultural sector of African countries. In general, many African countries have suitable conditions for bioenergy development such as abundant labour and sufficient available arable land and water resources. The production of feedstock for bioenergy may thereby reverse the long-term decline in real agricultural commodity prices and boost agricultural and rural development leading to increased food and biomass production.

However, in order to avoid potential negative environmental and socio-economic impacts, effective mechanisms to ensure sustainability need to be put in place and safety nets need to be established to protect the world's poorest and most vulnerable people to ensure their access to adequate food.

Several Sub-Saharan African countries are currently engaged in the formulation of policies and development plans to guide the development and ensure the sustainability of the bioenergy sector. The main objective is thereby to stimulate socio-economic rural development and to contribute to energy security and a reduced economic burden of fossil fuel imports. In order to ensure food security of the population, African governments have implemented several initiatives such as agro-ecological zoning to identify land available for food and for bioenergy production and mandates for investors to use part of the allocated land to food production.

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7 ACKNOWLEDGMENT

The authors would like to cordially thank all COMPETE partners for their ambitious involvement in the project activities. A full list of COMPETE partners is available at: <http://www.compete-bioafrica.net/consortium/cons/partners.html>.

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